Public Comment Submittal on Generating Carbon Pollution-Free Electricity on the Idaho National Laboratory Site, Scoville, Idaho

Comment submittal by Tami Thatcher on November 2, 2023 (Due December 15, 2023)

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BACKGROUND

The U.S. Department of Energy is launching an initiative to increase clean energy production by making DOE land available for potential development of new clean electricity generation through leases, including land at the Idaho National Laboratory. [1] [2] Through Executive Order 14057, *Catalyzing Clean Energy Industries and Jobs Through Federal Sustainability*, clean electricity means the energy is produced from resources that generator no carbon emissions, including marine energy, solar, wind, hydrokinetic (including tidal, wave, current, and thermal), geothermal, hydroelectric, nuclear, renewably sourced hydrogen, and electrical energy generation from fossil resources to the extent that there is active capture and storage of carbon dioxide emissions that meets EPA requirements.

DOE is seeking the clean electricity generation by 2030 while ensuring robust protection for our lands, waters, and biodiversity; ensuring site security; elevating stakeholder and especially Tribal benefits where relevant; and creating good jobs. The energy projects are to be 200 megawatts-electric (MWe) or larger.

Approximately 19,000 acres of land at the DOE's Hanford Site have been identified for this use. Other DOE sites include the Idaho National Laboratory, Nevada National Security Site, Savannah River Site (South Carolina) and Waste Isolation Pilot Plant (New Mexico). [3]

First of all, the Department of Energy implies that its cleanup of radiological and chemical contamination of these sites has been effective and is complete. But DOE has not adequately addressed its cleanup of these sites. In fact, it places non-DOE contractor workers on these contaminated sites without access to the Energy Employee Occupational Illness Compensation Program. It would also place these projects where in reality, radiological monitoring of external

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[1] Department of Energy, Office of Nuclear Energy, U.S. Department of Energy Issues Request for Information on Potential Clean Energy Projects at Idaho National Laboratory, October 17, 2023. https://www.energy.gov/ne/articles/us-department-energy-issues-request-information-potential-clean-energy-projects-idaho and send comments to tanner.emrich@inl.gov (according to Request for Information RFI# INL-23-014)

[2] Federal Register Notice, Industry Day-Expanding Clean Energy Generation on DOE Lands, Department of Energy, 88 FR 42350, Publication Date June 30, 2023. https://www.federalregister.gov/documents/2023/06/30/2023-13932/industry-day-expanding-clean-energy-generation-on-doe-lands

[3] Department of Energy, Cleanup to Clean Energy – Expanding Clean Energy Generation on DOE Lands, undated webpage accessed October 11, 2023. https://www.energy.gov/management/osp/cleanup-clean-energy-expanding-clean-energy-generation-doe-lands?fbclid=IwAR3s-cKYqyaM6yHMiWC8iyiWV5rKUtqEzB0L0u_QMOISWv7_QC4mAi-rti8

radiation, of airborne radionuclides inhaled and of radionuclides in drinking water will be needed but isn't likely to be provided.

The basis for DOE deciding these workers would not need radiological monitoring of external radiation and of internal radiation (inhaled or ingested) is based on flawed radiation protection concepts that do not protect the fertility or health of even adults, let alone the unborn child.

Environmental monitoring of radiological contamination and ongoing radiological releases by the Idaho National Laboratory is increasingly tardy in its reporting. The program orchestrated by the Department of Energy and the State of Idaho monitoring are contrived to avoid admitting detections and to take measures to avoid or destroy elevated radiological detections. [4] And in fact, no clean technology need be located on the INL site — only dirty nuclear operations that no one wants near them are likely to push for leasing land on the INL. These dirty nuclear operations are destined to become future taxpayer liabilities and require federal dollars for management and cleanup.

DOE has included nuclear energy as a "clean" source of energy despite having no program to dispose of the spent nuclear fuel. The DOE is seeking to create more nuclear waste when it already would need two repositories the size originally slated for the never built Yucca Mountain repository. Hints that reprocessing would solve the waste problem are offered all while ignoring the reality of the cost and the pollution to air and water and ignoring the vast increase in the volume of waste requiring disposal.

The spent nuclear fuel already poised around the country is a federal liability of enormous cost to future generations who will face the unsolved challenge of repackaging this waste, and seeking the elusive solution of its permanent disposal. The failure to contain the radioactive waste means poisoning air, vast watersheds and vast regions of land. Not only accidents, but even routine operations of nuclear reactors release radionuclides that poison air, water and soil. No one in their right mind would ever refer to nuclear energy as "clean." And no one who cares about fiscal responsibility would ever promote nuclear energy with the unspoken yet obscene costs being passed on to future generations who will face the cost and the risk to humanity from attempting to manage the spent nuclear fuel.

Nuclear energy is the most expensive energy even when the cost of its management and disposal and the cost of accidents are ignored. Nuclear energy is slow to deploy, despite optimistic hype.

No progress is being made to obtain a repository. Various spent nuclear fuels must then be stored and for decades and longer. And even the DOE does not have a sound technical basis for

[4] Tami Thatcher, Environmental Defense Institute, "Airborne Radiological Releases from the Idaho National Laboratory and the Increasing Radioactive Contamination in Southeast Idaho," December 2021. http://www.environmental-defense-institute.org/publications/INLcontamination.pdf

understanding whether or not the spent fuel and its containers will safely contain the waste during long term storage and subsequent transportation.

The DOE's initiative to obtain consolidated interim storage on tribal lands or low population areas is not a solution. It may appear like a solution but it is not a solution to the spent fuel disposition or disposal problem.

The public should also be aware that there are loop holes in the Price Anderson Act that may leave citizens who are harmed by a nuclear accident inadequately compensated for the loss of the homes, property and lives. Locating a nuclear facility on a DOE site would not imply DOE liability coverage. And U.S. Nuclear Regulatory Commission coverage can be very low or even zero, depending of individual reactor size and on when the site becomes yet another stranded spent nuclear fuel site. See the 2021 report by the U.S. Nuclear Regulatory Commission discussing the Price-Anderson Act [5] and the 2023 report by the Department of Energy [6] and a report about one utility's difficulties trying to deal with stranded spent fuel. [7]

The DOE and the nuclear industry evade giving honest answers to crucial questions. This is unacceptable. Before any elected official or the DOE support any nuclear project, they need to answer the following twenty questions about expanding nuclear energy:

1. Will building new nuclear power plants, large or small, help address climate change?
2. How many new nuclear power plants would be needed to make a difference for climate change?
3. Is the cost of nuclear power plant construction affordable?
4. Who pays for the construction cost overruns for new nuclear reactors?
5. What are the additional inevitable costs of nuclear power plants such as decommissioning, long-term storage and management of spent fuel and disposal or reprocessing of spent fuel?
6. Are nuclear power plants needed for 24/7 baseload, or art there other, more affordable and rapidly deployable solutions?
7. Does nuclear energy have a small footprint, as nuclear promoters claim?
8. How long does the spent nuclear fuel need to be isolated from the biosphere?
9. Who pays for storage of spent nuclear fuel?
10. Does the US have a spent fuel repository?
11. Is spent fuel reprocessing the answer to the spent fuel disposal problem?

[5] H. Arceneaux et al., U.S. Nuclear Regulatory Commission, *The Price-Anderson Act: 2021 Report to Congress – Public Liability Insurance and Indemnity Requirements for an Evolving Commercial Nuclear Industry*, NUREG/CR-7293, December 2021. [ML21335A064]

[6] U.S. Department of Energy, *The Price-Anderson Act Report to Congress*, January 2023.

[7] NorthWind, Volume II, *Strategic Plan for the Relocation of SONGS Spent Nuclear Fuel to an Offsite Storage Facility or a Repository*, March 15, 2021. https://www.songscommunity.com/strategic-plan-for-relocating-spent-fuel/spent-nuclear-fuel-solutions-a-fresh-approach

12. Why do states with stranded spent fuel want it out of their state?
13. Are so-called "interim" consolidated storage sites the solution for spent fuel?
14. Are there health risks from routine nuclear reactor operations?
15. Is the push to reduce regulatory oversight a sound idea?
16. What is "high burnup fuel" and does it complicate spent fuel storage and disposal?
17. How bad is a nuclear accident? How often do major accidents occur?
18. Who pays if people must permanently evacuate their home due to a nuclear accident?
19. Are small modular reactors less expensive than large reactors?
20. Is a "small" sodium-cooled fast reactor like Bill Gates' proposed *Natrium* going to "burn the waste"?

I offer some information about the answers to these questions.

1. Will building new nuclear power plants, large or small, help address climate change?

Actually, no. Climate change has been used as a big selling point for nuclear because nuclear fission does not release carbon — all without a realistic plan for deployment in time to curb climate change. Uranium mining, nuclear fuel enrichment and building nuclear plants does burn fossil fuels, however, so the technology is far from carbon free.

The fact is that the cost of new nuclear power plants is so high, relative more affordable options, and it is so slow to deploy, that it actually guarantees continued reliance on fossil fuels. Net Zero Australia has decided that nuclear power is too expensive and too slow and they won't include nuclear energy in their plans. [8]

The cost of building nuclear power plants has continued to rise while the cost of renewables like wind and solar have fallen. Based on experience, the new reactor builds of prototype reactors can be expected to take a decade or more, after being licensed. [9] Once built, there is no guarantee that problems won't result in premature shutdown.

Nuclear boosters promised 20 years ago that they knew how to control costs on the four AP1000 Westinghouse reactors. Two AP1000 reactors were cancelled after spending billions of dollars in South Carolina. Two of the AP1000 reactors nearing completion at the Vogtle site in

[8] Net Zero Australia, "Groundbreaking report details how Australia can make net zero happen," Media Release July 12, 2023. https://nousgroup.com/how-australia-can-make-net-zero-happen/ "Nuclear power should not be in our plans, because it's too expensive and slow."

[9] David Schlissel, Opinion, UtilityDive, "NuScale Power, the canary in the small modular reactor market," March 21, 2023. https://www.utilitydive.com/news/nuscale-power-small-modular-reactor-smr-ieefa-uamps/645554/ "Given the history of the nuclear power industry, everyone – utilities, ratepayers, legislators, federal officials and the general public – should be very skeptical about the industry's current claim that the new SMRs [small modular reactors] will cost less and be built faster than previous designs." "SMRs also can be expected to take much longer to build than proponents claim…. Greenhouse gas emission reduction achieved in the near term have a bigger impact than ones that might be obtained a decade or more in the future."

Georgia have cost double the originally projected cost and it took 14 years for the first reactor to come online. [10] [11] [12] [13]

Problems with construction contractors and shoddy work took time and money to resolve at the Vogtle nuclear project. And rate payers have been paying higher electricity bills during the construction. Whether or not ratepayers will pay for all the cost overruns has not yet been decided.

The NuScale small modular reactor project still has much of the design incomplete as they have reapplied for license approval to the Nuclear Regulatory Commission with a modified proposed design concept. The currently stated schedule for NuScale to begin generating electricity with just one of its 77 MWe modules in 2029 is overly optimistic.

Bill Gates has wasted precious years on his "traveling-wave" reactor that was never built, and he has set his sites on building a fast reactor called *Natrium*. The *Natrium* reactor slated for Kemmerer, Wyoming, will be too small to make a difference and too late to make a difference. In fact, coal and gas-fired plants will be relied upon in Kemmerer Wyoming as the *Natrium* project sucks in federal dollars and will not be deployed in time to make a dent in climate change.

2. How many new nuclear power plants would be needed to make a difference for climate change?

In October 2020, there were 94 commercial nuclear reactors in the U.S. with a combined capacity of 96,557 megawatts-electric, at about 18 percent of the nation's electricity. And most of the existing fleet is approaching end of life. It would take far more nuclear reactors than will be or could be built in the next decade to even double the current generation capacity from nuclear energy. Despite the wide variety of proposed new nuclear power plants, of various sizes vaguely called micro or small, these various novel reactors will cost billions of dollars and yet,

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[10] Nick Ferris, *Energy Monitor*, "Why a new era for US nuclear looks unlikely – Evidence suggest the Inflation Reduction Act and the advent of small modular reactors is unlikely to lead to a US nuclear resurgence in the medium term," May 26, 2023. https://www.energymonitor.ai/sectors/power/why-a-new-era-for-us-nuclear-looks-unlikely/ Vogtle AP1000 reactors cost more than $30 billion, more than $16 billion over budget and more than 6 years behind schedule. In South Carolina, 2 AP1000 reactors were cancelled due to rising costs.

[11] Dave Williams, *Capitol Beat News Service, The Augusta Chronicle*, "PSC expert: Plant Vogtle expansion bad deal for Georgia Power customers," July 27, 2023. https://www.augustachronicle.com/story/news/environment/2023/07/27/psc-expert-calls-plant-vogtle-expansion-a-bad-deal-for-georgia-power-ratepayers/70480878007/

[12] Stanley Dunlap, *Georgia Recorder*, "Cost controversies still inflame critics of Plant Vogtle expansion as kilowatts go online," June 5, 2023. https://georgiarecorder.com/2023/06/05/cost-controversies-still-inflame-critics-of-plant-vogtle-expansion-as-kilowatts-go-online/ "…over the last seven years that have led to projected costs doubling to north of $35 billion."

[13] Jeff Amy and AP, *Fortune*, "America's nuclear power revival arrives – 7 years late and $17 billion over budget, May 25, 2023." https://fortune.com/2023/05/25/georgia-power-nuclear-power-revival-arrives-7-years-late-17-billion-over-budget/ "Georgia electric customers have already paid billions, and state regulators will ultimately decide if they're on the hook for billions more." "Some of the key promises of Vogtle – like building modules offsite and shipping them for cheaper on-site assembly – did not pan out." "Construction delays drove Westinghouse Electric Co., … into bankruptcy when the company couldn't absorb overruns."

even if successfully deployed, this small number of novel reactors will not make a difference for climate change.

Deployment of a significant number of reactors over the next several decades is unaffordable and unsustainable. Pretending nuclear energy is going to solve the climate change problem actually prevents affordable and timely solutions from being implemented.

The additional spent nuclear fuel, however, will actually be disproportionately high and add to the spent nuclear fuel the U.S. already has no program for and no money to provide for disposal or any other option such as reprocessing.

Also, if nuclear reactor operation were to make a dent in climate change, the U.S. would need a new spent fuel repository, the original size estimated for the Yucca Mountain Repository, every year.

3. Is the cost of nuclear power plant construction affordable?

The high cost of nuclear power made it fail in the market place. This has spawned nuclear lobbyists who are successful at getting taxpayer money from government agencies and Congress. They also lobby state governments including Idaho for more tax breaks for new reactors and lobby for bailouts for financially failing existing nuclear plants, like in Ohio. [14]

Since 2000, billions of dollars of taxpayer funds have been given to promote nuclear projects. Beneficiaries of the funds are limited to a few folks like Bill Gates and a handful of nuclear companies, and public relations people.

Nuclear energy is the most expensive way to make electricity, even when many of its inevitable costs are ignored. Future generations will be faced with the costs and burdens of storing the spent nuclear fuel.

4. **Who pays for the construction cost overruns for new nuclear reactors?**

Electricity ratepayers can be on the hook but it depends on how the project is funded. Westinghouse declared bankruptcy due to cost overruns building AP1000 reactors in the U.S., and ratepayers may still pay for cost overruns, even on two reactors that were never completed in South Carolina. While the companies building nuclear power plants seek government handouts and seek to have ratepayers pay for cost increases or project failures, there has been a tendency for struggling projects to be less than truthful about the difficulties. [15]

5. What are the additional inevitable costs of nuclear power plants such as plant decommissioning, long-term storage and management of spent fuel and disposal or reprocessing of spent fuel?

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[14] Stephanie Cooke, *Fortune*, "There's no such thing as a new nuclear golden age-just old industry hands trying to make a buck," July 28, 2023. https://fortune.com/2023/07/28/no-new-nuclear-golden-age-just-old-industry-hands-trying-to-make-a-buck-energy-politics-stephanie-cooke/

[15] Stephanie Cooke, *Fortune*, "There's no such thing as a new nuclear golden age-just old industry hands trying to make a buck," July 28, 2023. https://fortune.com/2023/07/28/no-new-nuclear-golden-age-just-old-industry-hands-trying-to-make-a-buck-energy-politics-stephanie-cooke/

Some of the cost of decommissioning and spent fuel storage is paid by electricity rate payers. But premature shutdown from reasons such as an accident or premature aging issues, can mean taxpayers and ratepayers get stuck with more of these costs. In addition, no money is collected from ratepayers for disposal of spent fuel because the agency required by law to be accountable for spent fuel disposal, the Department of Energy, has no spent fuel disposal program.

The cost of continued spent fuel storage, the cost of repackaging spent fuel, and the cost of spent fuel disposal is not included in the nuclear build and operating costs. Nor is the cost of transportation to a disposal site, the cost of road and railway infrastructure improvements or the cost of reprocessing and disposal of reprocessing wastes. Nor is the cost of the next trillion-dollar nuclear accident.

6. Are nuclear power plants needed for 24/7 baseload? Are there other, more affordable and rapidly deployable solutions?

Many experts — who aren't selling nuclear power plants or seeking large government handouts for trying to sell nuclear power plants — think there are options without nuclear. [16] [17] Solar, wind, batteries and energy conservation could go a long way. But yes, fossil fuels would still be needed. With nuclear energy build, fossil fuels are still needed because nuclear plants often have lengthy shutdowns. In fact, nuclear plants take so long to build that fossil fuel consumption is aided by planning to slowly deploy more nuclear plants.

Nuclear promotors like to argue that nuclear plants are the only solution for replacing fossil-fueled plants. Nuclear plants operate steadily — but only when they operate. Nuclear power plants are so expensive that there is great incentive to operate the nuclear plants as much as they are able to operate. But nuclear power plants have to shut down for refueling. They also have to shut down for unexpected repairs. Many nuclear reactors are shut down for many months at a time. But when they do operate, they want to squeeze renewables out of the market in order to recoup money for nuclear construction and operating costs.

In Kemmerer, Wyoming, where Bill Gates has proposed building the *Natrium* reactors, they are converting coal plants to gas plants because they know they can't rely on *Natrium* reactors any time soon. [18]

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[16] Mark Jacobson, *No Miracles Needed: How Today's Technology Can Save Our Climate and Clean Our Air*, 2023. https://web.stanford.edu/group/efmh/jacobson/WWSNoMN/NoMiracles.html

[17] Amory B. Lovins, *UtilityDive*, "Opinion – Nuclear energy should not be part of the global solution to climate change," April 12, 2022. https://www.utilitydive.com/news/nuclear-energy-should-not-be-part-of-the-global-solution-to-climate-change/620392/

[18] Renee Jean, *Cowboy State Daily*, "Optimists Bet Big On Kemmerer's Next Generation Nuclear Plant," July 31, 2023. https://cowboystatedaily.com/2023/07/31/optimists-bet-big-on-kemmerers-next-generation-nuclear-plant/ "There are three coal-fired power plants in the community…[one of them] has already been converted to natural gas." The other two are going to be converting to natural gas. "There's also two companies, Glenrock Energy and Kanata, exploring a partnership to convert coal into ammonia." "A lot of companies in Japan, they're now using ammonia at their coal mine operations plants. So they're changing the fuel to ammonia, with is carbon neutral." "…there are many challenges ahead of Kemmerer as it seeks to prepare for the construction of the 345 Megawatt nuclear power plant that Bill Gates' Terra Power has announced it will be siting in Kemmerer." "There have been

7. Does nuclear energy have a small footprint, as nuclear promotors claim?

No. While a nuclear power plant has a similar footprint to a coal plant, the mining of uranium, milling, fuel enrichment, fuel fabrication, spent fuel storage, spent fuel disposal, disposal of the radioactive waste other than spent fuel — all require enormous amounts of land and threaten watersheds and air and water quality. Decommissioning of nuclear plants is relying on much of the radioactively contaminated material staying at the site, basically forever contaminating the reactor site, even if the spent fuel is taken to another location. The transportation of spent nuclear fuel as well as the transportation of micro reactors puts the elevated radiation exposures and the potential catastrophic accident in everyone's neighborhood.

The Department of Energy has continued to characterize the nation's spent nuclear fuel inventory as able to fit on a single football field. Yet, whether characterized as 15 ft deep for 69,000 metric tons or 30 ft for 83,000 metric tons, the characterization is very misleading.

Although the proposed Yucca Mountain repository license submittal was for 70,000 metric tons of storage, as limited by the Nuclear Waste Policy Act, it has been projected that for past and expected nuclear reactor operation in the U.S., by 2055 there will be roughly 10,000 canisters (or 140,000 metric tons heavy metal) of spent nuclear fuel needing disposal, and a significant portion of them would be capable of going critical if water ingress occurs. [19]

The fact is that the Department of Energy was needing 41 miles of waste emplacement tunnels (or drifts) at the proposed Yucca Mountain repository as limited by law to 70,000 metric tons of spent nuclear fuel. And this assumed repackaging and positioning the waste to limit the thermal heat load. [20] Even so, the repository could heat up and invalidate the geological stability of the repository.

8. How long does the spent nuclear fuel need to be isolated from the biosphere?

The longevity of the radioactive waste is hard to fathom, and even nuclear professionals often do not realize how long the radioactive waste in spent nuclear fuel (and high-level waste) remains radioactive. While certain fission products like cesium-137 and strontium-90 each have a roughly 30-year radioactive half-life, and their presence is greatly diminished in 500 years, other radionuclides in spent nuclear fuel remain radioactive for thousands and over hundreds of thousands of years. The radioactive decay of some decay series actually makes the waste more radioactive over time. The waste is more mobile in the environment than it was when bound up

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questions lately about how to supply the grade of uranium the plant needs… [High-Assay Low-Enriched Uranium or HALEU]."

[19] Alsaed Abdelhalim, Enviro Nuclear Services, LLC, Spent Fuel and Waste Disposition, *Review of Criticality Evaluations for Direct Disposal of DPCs and Recommendations*, SFWD-SFWST-2018-000***, SAND2018-4415R, April 20, 2018. https://prod-ng.sandia.gov/techlib-noauth/access-control.cgi/2018/184415r.pdf

[20] U.S. Department of Energy, *Draft Supplemental 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*, DOE/EIS-0250F-S1D, October 2007. https://www.energy.gov/sites/prod/files/EIS-0250-S1-DEIS-Summary-2007_0.pdf

in uranium ore. The waste remains highly radiotoxic for a million years even though the decay heat generated at that time is far less than when the fuel was removed from a nuclear reactor.

The radioactive material in spent nuclear fuel remains toxic and hazardous to humans and other living things for millennia. But obtaining permanent disposal for spent nuclear fuel remains more elusive today than it was 20 years ago.

9. Who pays for storage of spent nuclear fuel?

Electricity rate payers may expect to pay for spent fuel storage even after the reactor has long closed. Ultimately, taxpayers will pay for "indefinite" storage and for as-of-yet undesigned disposal. The cost of spent fuel management and disposal is so high, the U.S. government refuses to estimate just how high, but it will certainly be trillions of dollars. And no one is certain that any disposal option will actually contain the spent fuel for the millennia that the fuel remains radio-toxic.

10. Does the US have a spent fuel repository?

No. We already need two deep geologic repositories the size of the legally mandated Yucca Mountain repository just to accommodate existing spent fuel, high-level waste and the spent fuel expected from currently operating reactors.

If no nuclear power reactors were built, but existing reactors continued to run as projected, the spent nuclear fuel inventory was projected to be approximately 139,000 metric tons heavy metal (MTHM) by 2055, or 10,000 canisters in 2055. [21]

The Department of Energy is responsible for taking ownership of the nation's spent nuclear fuel. The Department of Energy promised to begin disposal of spent nuclear fuel by 1998. In 2010, Yucca Mountain was defunded. In 2014, "Zero Day," the Department of Energy had to stop collecting fees from rate payers for spent nuclear fuel disposal because it has no program to obtain a deep geologic repository. [22] [23]

The proposed Yucca Mountain disposal site has a tunnel but was never granted a license to construct. The technical flaws in the various proposed concepts for Yucca Mountain are even more problematic than the political problems. The State of Nevada was astutely aware that the analysis claims for container robustness against corrosion and the claimed limited water infiltration and trickle-out were not just unreliable, the claims were known to be scientifically

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[21] E. Hardin et al., Spent Fuel and Waste Disposition, Prepared for U.S. Department of Energy, Office of Used Nuclear Fuel Disposition, *Investigations of Dual-Purpose Canister Direct Disposal Feasibility (FY14)*, FCRD-UFD-2014-000069 Rev. 1, October 2014. https://www.energy.gov/sites/prod/files/2014/10/f19/7FCRDUFD2014000069R1%20DPC%20DirectDispFeasibility.pdf

[22] 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

[23] 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

unjustified. The final stated low radiation doses from the trickle-out of radionuclides relied on the installation of thousands of undesigned and impossible to install titanium drip shields.

A review of Sandia's modeling for Yucca Mountain that yielded estimates of low radiation doses from water contamination from the trickle out of radionuclides found that the Sandia models were technically indefensible. [24]

That independent review of DOE's calculations had been contracted by the DOE but withheld from the State of Nevada. The review's conclusion was that the Department of Energy's modeling, by Sandia, of water infiltration to the disposed of waste did not provide a credible representation of water infiltration at Yucca Mountain.

In other words, because the periodic spikes in water infiltration had raised the estimated radiation dose, the water infiltration spikes were simply removed from the modeling in order to drive the estimated radiation exposures down. The contamination trickle-out problem that had previously estimated 95th percentile radiation doses above 1000 mrem/yr (yes, one thousand mrem/yr) and would struggle to meet the 100 mrem/yr median requirement by EPA regulations now had contrived the modeling to slash the estimated radiation dose to a person living 15 km (or 11 miles) downgradient to less than 1 mrem/yr. [25]

The Department of Energy's rapidly evolving waste emplacement concepts continued to evolve as every assumption about how the Yucca Mountain repository would contain the waste didn't hold up. Also, no utility has packaged its spent nuclear fuel into DOE's recommended "transport, aging and disposal" TAD canister.

The Department of Energy initially hand-waved away criticality concerns in the Yucca Mountain repository. After analyses were finally conducted especially for the use of higher enriched or "high burn-up" fuels, the agency began claiming that multiple criticalities in the waste repository wouldn't add that much harm to a disposal repository's already estimated harm. Criticality risks peak in 25,000 years, despite government standards for criticality risk ending in 10,000 years.

When the question of spent nuclear fuel disposal is raised, nuclear promotors decline to give meaningful answers about the enormous cost and technical difficulty. They avoid discussing the consequences of leaving spent fuel above ground in aging containers. They would never describe permanent evacuations and health catastrophe, and extensive permanent radiological contamination that will occur if spent fuel is not isolated from groundwater, freshwater and atmosphere.

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[24] Senate Hearing 109-523, Yucca Mountain Repository Project, May 16, 2006. https://www.govinfo.gov/content/pkg/CHRG-109shrg29473/html/CHRG-109shrg29473.htm

[25] Letter from Council for the State of Nevada to Secretary of the U.S. Nuclear Regulatory Commission, State of Nevada's Supplement to its June 4, 2008 Petition Asking the NRC to Reject DOE's Yucca Mountain License Application as Unauthorized and Substantially Incomplete, July 21, 2008. The letter cites the review of DOE's infiltration model performed at DOE's request by ORISE (Oak Ridge Institute for Science and Education). ORISE provided the results of this independent review to DOE on April 30, 2008. http://www.state.nv.us/nucwaste/news2008/pdf/nv080721nrc.pdf

Pictures of the Waste Isolation Pilot Plant in New Mexico are sometimes shown to give the impression that the Department of Energy is capable of using WIPP for disposal of spent fuel. The WIPP disposal facility is for defense-related nuclear weapons waste and is not licensed for disposal of spent nuclear fuel. The WIPP facility is already overcommitted. It is deceptive to imply that WIPP could ever take the massively heavy spent nuclear casks or canisters.

The fees that have already been collected from ratepayers will not even cover the cost of repackaging the fuel into disposable casks. And there is little assurance that a repository will adequately limit the migration of radionuclides to future generations.

The cost of repackaging above ground dry storage spent nuclear fuel will also be the burden for the not-too-distant future and for future generations despite the cost not being addressed by the U.S. Nuclear Regulatory Commission licensing of dry storage facilities. [26]

If the one or several deep geologic repositories are constructed and licensed, the cost will be the burden we have placed on future generations.

11. Is spent fuel reprocessing the answer to the spent fuel disposal problem?

The cost of spent fuel reprocessing would double the cost of nuclear energy for electricity. Never mentioned by nuclear promotors is that reprocessing is extensively polluting to the environment (air, water, land) and thus to people and other living things. [27]

Reprocessing increases the volume of radioactive wastes many-fold. World-wide, spent fuel reprocessing has been costly, highly polluting, and has resulted in vast stocks of plutonium that are a liability to store or dispose of. All nuclear reactors create plutonium-239; spent fuel storage and reprocessing increases weapons material proliferation concerns.

In the UK, France, and other countries that reprocess their spent fuel, they still need but do not have needed permanent repositories for their spent fuel or high-level waste from reprocessing. In addition, the hundreds of metric tons of separated plutonium are a liability to store or dispose of. [28]

In France, despite its reprocessing, their spent fuel pools are filling up with mixed-oxide (MOX) fuel that they don’t reprocess and now requires about 30 years of pool cooling, rather than the typical five years, prior to dry storage. [29] They are now facing an emergency in the need to build another refrigerated pool for storage of spent MOX fuel as they continue to struggle to

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

[27] Pete Roche et al., Greenpeace France, *The Global Crisis of Nuclear Waste – A Report Commissioned by GP France*, November 2018. “In addition to direct discharges of nuclear waste via pipelines, and atmospheric releases of radioactivity, reprocessing produces multiple other waste streams, the most hazardous of which are liquid high level wastes.” Difficulties with designing permanent disposal facilities are also described.

[28] Frank N. von Hippel and Masafumi Takubo, International Panel on Fissile Materials (IPFM), *Banning Plutonium Separation*, 2022.

[29] Institut de Reioprotection et de Surete Nucleaire, IRSN, Assessment of dry storage possibilities for MOX or ERU spent fuels, IRSN Report No. 2019-00903, French Issue April 2019, English translation of 2019-00265 also issued April 2019.

obtain a disposal repository. [30] [31] The short-sightedness of the nuclear industry is not limited to the U.S. [32] [33]

12. Why do states with stranded spent fuel want it out of their state?

Stranded spent fuel, and any spent fuel for that matter, is stored in casks or canisters that have a limited lifetime. The casks and canisters will age and the spent fuel will need to be repackaged. The spent fuel also poses accident risks, such as by flooding, or terrorism. The U.S. Nuclear Regulatory Commission, however, licensed thin-walled canisters without admitting that no method has been developed to repackage the welded closed canisters. Facilities to repackage the spent fuel will be needed but do not exist and are not funded. Taxpayers presumably will be paying for this repackaging.

A damaged cask or canister will mean the release of airborne radioactive material. Dry storage of spent fuel has been licensed by the NRC in very vulnerable places such as the San Onofre stranded fuel site on the coast of the Pacific Ocean.

A study updated in 2019 by the Department of Energy confirms that the NRC had no documented evaluation of the consequences of spent nuclear fuel canister failure. The NRC has prepared the draft Environmental Impact Statement for the proposed Holtec consolidated interim storage facility in New Mexico without having any documented basis for the consequences of an expected event, leakage of a spent nuclear fuel canister. [34]

Instead of using thin-walled welded canisters that cannot be adequately inspected or repaired, the Swiss required the use of bolted thick-walled casks. They store them in a building, away from ocean salt spray air, for example. The Swiss require a hot cell for repackaging a cask if needed. Read more at SanOnofreSafety.org [35]

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

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[30] Benjamin Mallet, LA HAGUE, France (Reuters), Syndicated Content, wtaq.com, "France seeks strategy as nuclear waste site risks saturation points," February 2, 2023. https://wtaq.com/2023/02/02/france-seeks-strategy-as-nuclear-waste-site-risks-saturation-point/

[31] Reuters.com, "French nuclear waste agency applies for new storage site," January 17, 2023. https://www.reuters.com/business/energy/french-nuclear-waste-agency-applies-new-storage-site-2023-01-17/

[32] Department of Energy, Disposition of Surplus Plutonium, Appendix J, Evaluation of Select Reactor Accidents With Mixed Oxide Fuel Use at the Browns Ferry [Alabama, BWR] and Sequoyah [Tennessee, PWR] Nuclear Plants, 2015. This appendix gives a history of MOX fuel testing in the US up to 2015.

[33] *Friends of the Earth*, "Duke Energy Abandons Plutonium Fuel (MOX) Testing Program in South Carolina Reactor," circa 2008, https://foe.org/news/2009-11-duke-energy-abandons-plutonium-fuel-mox-testing-prog/ [accessed February 27, 2023]

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

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

Donna Gilmore of SanOnofreSafety.org confirmed that the nuclear industry has admitted that they currently have no ability to inspect canisters for cracks. They have no ability to "detect the flaws" or "understand and characterize the flaws." [36]

In 2010, the U.S. Nuclear Waste Technical Review Board (NWTRB) recommended the "design and demonstration of dry-transfer fuel systems for removing fuel from casks and canisters following extended dry storage." [37] But this still hasn't happened.

In addition to the costs associated with spent nuclear fuel disposal because the industry's welded canisters were not considered suitable for disposal, the U.S. Nuclear Regulatory Commission has not grappled with the safety ramifications of not being able to retrieve spent fuel from these canisters, should a canister be damaged. [38]

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

The dose from Table 1 is for a person standing in the radiological plume 500 meters from the canister for 30 days. Also, the respirable fraction is assumed to be 1.0, consistent with Department of Energy assumptions for high burnup fuel. [39]

An acute radiation dose exceeding 400 rem is considered lethal. **The acutely high doses in Table 1 far exceed 400 rem**, and this perhaps explains why the NRC refuses to admit that a canister leak of significant size is credible. The U.S. NRC has also been eliminating requirements for canister monitoring and capability for emergency response.

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

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

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

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

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

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

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

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

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

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

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

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

13. **Are so-called "interim" consolidated storage sites, such as have been proposed for New Mexico and Texas, the solution to spent fuel storage and disposal problems?**

The DOE would like to give the impression that parking lot dumps, like the spent fuel storage facilities proposed for New Mexico and Andrews, Texas are a solution. [40] [41] [42] But those facilities are not designed for the long-term. In fact, these facilities are about the same as the stranded fuel facilities but are located in low population zones. And when their U.S. Nuclear Regulatory Commission license expires and there is still no disposal facility, these states will be stuck with radioactive waste that cannot be repackaged and has no place to go.

Promoting consolidated interim storage of spent fuel may provide the appearance of a solution to the spent fuel problem. But when there is no ultimate disposal facility and no repackaging facility, the problem is only shifted and not solved. With all the spent fuel in one or two states, it will be even more difficult to get any responsible action for spent fuel management.

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[40] Environmental Defense Institute comment submittal by Tami Thatcher on the NRC's draft Environmental Impact Statement for the Holtec Consolidated Interim Storage Facility Project, Docket NRC-2018-0052, September 2020 at http://www.environmental-defense-institute.org/publications/CommentNRCdEISHoltecT.pdf

[41] David B. McCoy, Citizen Action New Mexico, comment submittal for the NRC's draft Environmental Impact Statement for the Holtec Consolidated Interim Storage Facility Project, Docket NRC-2018-0052, September 2020 at http://www.environmental-defense-institute.org/publications/CommentNRCdEISHoltecM.pdf

[42] Environmental Defense Institute comment submittal by Tami Thatcher on the Interim Storage Partners proposed Consolidated Interim Storage at the Waste Control Specialists site in Andrews County, Texas at http://environmental-defense-institute.org/publications/CommentNRC2018Texas.pdf

While there are a variety of spent fuel dry storage designs, including casks, the most prevalently used are thin-walled stainless steel welded closed canisters.

The dry storage of spent nuclear fuel is a single barrier system, with a thin layer of stainless steel of the canister that is long-known to be susceptible to through-wall cracking, such as chloride-induced stress corrosion cracking and other mechanisms.

There is currently no technology to detect cracking in a loaded canister. There is currently no technology to repair a damaged canister containing spent fuel and no way to unload the fuel. There is no overpack to contain radiological releases from a canister that will provide sufficient long-term cooling of the spent fuel.

While other countries chose bolted-closed thick-walled casks that allow replacement of the cask, the U.S. NRC allowed commercial utilities to use the cheaper thin-walled welded closed canisters.

Moving the spent fuel from stranded fuel sites will entail great expense, accident risk and radiation exposure to people along the transportation routes. Transportation of spent fuel involves costly and dangerous transportation on crumbling U.S. highways and on railways that have a growing number of derailments.

Repackaging the spent fuel will ultimately be needed and the proposed consolidated spent fuel storage sites do not provide any method of spent fuel repackaging. It is not the custom of the U.S. Nuclear Regulatory Commission to worry about such things, let alone worry about the cost.

The costs and the risks of continued spent fuel storage will fall to generations who never benefited from the electricity produced. The only rational first step is stop making more spent fuel.

14. Are there health risks from routine nuclear reactor operations?

Yes, if you examine the evidence.

A study of breast cancer in women in the U.S. has consistently shown increases in breast cancer near commercial nuclear power plants or Department of Energy nuclear reactors. The study by Jay M. Gould compared the rate of breast cancer mortality for counties within 50 miles of 51 nuclear reactors from 1950 to 1954 to the rates from 1980 to 1984 and also to 1985 to 1989. [43]

When the industry depicts what it considers a "safe dose" it usually is not pointed out that public radiation standards do not protect women, children or the unborn developing child. It is long known that women are more vulnerable to radiation health harm than men. And female

[43] Jay M. Gould with members of the Radiation and Public Health Project, Ernest J. Sternglass, Joseph U. Mangano, and William McDonnell, *The Enemy Within – The High Cost of Living Near Nuclear Reactors – Breast Cancer, Aids, Low Birthweights, and Other Radiation-Induced Immune Deficiency Effects*, Four Walls Eight Windows, 1996. ISBN 1-56858-066-5. See pages 131 and 281.

children are more vulnerable than male children. In the 1950s, Dr. Alice Stewart found increases in childhood leukemia and cancer rates in children who were exposed *in utero* to medical radiation in doses less than 500 millirem. [44] [45]

Before the late 1990s, radiation risks to females were generally treated as roughly equal to the radiation risks to males. But by the late 1990s, studies of the survivors of the atomic bombing of Japan in 1945 by the International Commission on Radiation Protection (ICRP) had higher radiation risk harm to women than men, for the same dose. And the studies showed higher cancer risk to children, especially female children, than to adults for the same dose. The National Research Council BEIR VII report issued in 2006 found even higher risks to women and children. [46] [47] [48]

The higher risk to females than males is treated as acceptable by using a radiation cancer death (mortality) coefficient not protective of adult females. And the high risk to children, especially to female children and to the unborn, is not addressed in National Environmental Policy Act (NEPA) environmental impact statements.

Jay M. Gould and Benjamin A. Goldman would write in their book *Deadly Deceit – Low Level Radiation High Level Cover-Up* of excess infant deaths near the Department of Energy's Savannah River Site and near the 1979 Three Mile Island nuclear accident. [49]

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[44] Gayle Greene, *The Woman Who Knew Too Much – Alice Stewart and the Secrets of Radiation*, The University of Michigan Press, 1999. ISBM 0-472-11107-8

[45] John W. Gofman, M.D., Ph.D., Committee for Nuclear Responsibility, Inc., "Radiation-Induced Cancer from Low-Dose Exposure: An Independent Analysis," 1990. (See page 741, "Diagnostic irradiation on the order of 1 to 2 rads, delivered to the fetus in utero provoked about a 50% increase in the frequency of a variety of childhood cancers and of childhood leukemia." And page 746, "the risk in cancer-leukemia risk with each additional film is consistent with a linear relationship between number of films (@ 200-400 millirads per film) and cancer-leukemia risk.)

[46] "Health Risks from Exposure to Low Levels of Ionizing Radiation BEIR VII – Phase 2, The National Academies Press, 2006, http://www.nap.edu/catalog.php?record_id=11340 The BEIR VII report reaffirmed the conclusion of the prior report that every exposure to radiation produces a corresponding increase in cancer risk. The BEIR VII report found increased sensitivity to radiation in children and women. Cancer risk incidence figures for solid tumors for women are about double those for men. And the same radiation in the first year of life for boys produces three to four times the cancer risk as exposure between the ages of 20 and 50. Female infants have almost double the risk as male infants.

[47] Arjun Makhijani, Ph.D., Brice Smith, Ph.D., Michael C. Thorne, Ph.D., Institute for Energy and Environmental Research, *Science for the Vulnerable Setting Radiation and Multiple Exposure Environmental Health Standards to Protect Those Most at Risk*, October 19, 2006.

[48] Read the Environmental Defense Institute August 2020 newsletter article, "Rising radiation-induced cancer incidence rates and higher risks to women and children," at http://www.environmental-defense-institute.org/publications/News.20.Aug.pdf

[49] Jay M. Gould and Benjamin A. Goldman, *Deadly Deceit – Low Level Radiation High Level Cover-Up*, Four Walls Eight Windows New York, 1990. ISBN 0-941423-35-2. The finding of excess infant deaths near the Department of Energy Savannah River site around the 1970s and near the 1979 Three Mile Island nuclear accident are described in Jay Gould's book *Deadly Deceit*.

Elevated rates of infant mortality and birth defects were found in communities near the Department of Energy's Hanford site, but workers were not told of these epidemiology results and newspapers did not report the findings. [50]

Following the 1986 Chernobyl nuclear disaster, a comprehensive study also found a spike in perinatal mortality (still-births plus early neonatal deaths) in several countries that received airborne radioactivity from Chernobyl. The amount of airborne radioactivity to cause this was far smaller than generally assumed. [51]

The US NRC cancelled what would have been the first meaningful epidemiology study of health effects near US nuclear reactors, [52] despite the German epidemiology study of children living near nuclear plants having roughly double the incidence of cancer and leukemia and similar findings resulted from the study of clusters of childhood leukemia near nuclear sites including Sellafield, Dounreay and La Hague where an excess of 300-fold infant leukemia were found. [53] [54] [55]

The U.S. NRC refused to pay $8 million for the new study, and preferred the results from a National Cancer Institute study [56] that was designed to not find evidence of elevated health risks. Basically, the NCI study relied on comparing people living near nuclear power plants to people living near nuclear power plants. Unsurprisingly, they didn't detect excess risk from living near nuclear power plants.

While the radiological releases from nuclear plants are stated to be low, the reality is that radiological releases can be significant and are poorly monitored.

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[50] Kate Brown, *Plutopia – Nuclear Families, Atomic cities, and the Great Soviet and American Plutonium Disasters,* Oxford University Press, 2013. ISBN 978-0-19-985576-6. Note that many publications use spelling variation Mayak instead of Maiak. *Plutopia* documents the elevated percentage of deaths among infants in the Richland population in the 1950s. Elevated fetal deaths and birth defects in Richland were documented by the state health reports, yet Hanford's General Electric doctors and the Atomic Energy Commission that later became the Department of Energy failed to point these statistics out. The local newspapers failed to write of it. The Department of Energy has continued to fail to tell radiation workers and the public of the known risk of increased infant mortality and increased risk of birth defects that result from radiation exposure.

[51] Alfred Korblein, "Studies of Pregnancy Outcome Following the Chernobyl Accident," from *ECRR Chernobyl: 20 Years On – Health Effects of the Chernobyl Accident*, Editors C.C. Busby and A. V. Yablokov, 2006.

[52] NRC (Nuclear Regulatory Commission) 2010. NRC Asks National Academy of Sciences to Study Cancer Risk in Populations Living near Nuclear Power Facilities. NRC News No. 10-060, 7 April 2010. Washington, DC: NRC. The framework for the study was reported in "Analysis of Cancer Risks in Populations Near Nuclear Facilities; Phase I (2012). See cancer risk study at nap.edu.

[53] P Kaatsch et al., Int J Cancer, "Leukaemia in young children living in the vicinity of German nuclear power plants," 2008 Feb 15;122(4):721-6. http://www.ncbi.nlm.nih.gov/pubmed/18067131

[54] Spix C, Schmiedel S., Kaatsch P, Schulze-Rath R, Blettner M., Eur J Cancer, "Case-control study on childhood cancer in the vicinity of nuclear power plants in Germany 1980-2003." 2008 Jan;44(2):275-84.Epub 2007 Dec 21. http://www.ncbi.nlm.nih.gov/pubmed/18082395

[55] Chris Busby, "Infant Leukaemia in Europe after Chernobyl and its Significance for Radioprotection; a Meta-Analysis of Three Countries Including New Data from the UK," Chapter 8 of *ECRR Chernobyl: 20 Years On – Health Effects of the Chernobyl Accident*, Editors C.C. Busby and A. V. Yablokov, 2006.

[56] S. Jablon et al., *Cancer in Populations Living Near Nuclear Facilities*, Washington: National Cancer Institute, National Institute of Health, publication #90-874, July 1990.

The reality is that relatively small amounts of radioactive particles such as radioactive tritium, iodine, cesium, strontium, uranium, plutonium and americium and others are chronically poisoning air, water and food, within about 50 miles of the plant. **In addition to increased rates of cancer and shortened life spans, elevated nuclear releases also coincide with increased infant mortality, increased rates of birth defects, low-birth weights, lowered intelligence in children, comprised immune systems and increases in other illnesses.**

Radiation protection standards fail to protect men, women, and especially children and the unborn.

15. Is the push to reduce regulatory oversight a sound idea?

Let us review three prominent nuclear reactor accidents. For the 1979 Three Mile Island nuclear accident, the U.S. Nuclear Regulatory Commission was deliberately downplaying identified problems regarding nuclear-licensed operators shutting off emergency coolant injection before knowing the cause of the injection actuation. The NRC had also been made aware of the problem regarding relying on pressurizer level to assume the water level in the reactor was known. TMI management were falsifying the primary coolant system leak rate, helping nuclear operators to cheat on exams for operator re-qualification, and did not require operators to assess the status of safety system alignment at the beginning of or at any time during the operator's shift. The stack of design, training, and poor conduct of operations at TMI Unit 2 resulted, unbeknownst to the operating crew, in melting about half of the core within 2 hours of the plant trip on the complete loss of condensate caused by a known design vulnerability, accepted by the regulator.

For the 1986 Chernobyl accident in the Ukraine, the safety test that was conducted that caused the accident was needed because the plant had been licensed by its regulatory authority despite a serious vulnerability to the loss of commercial power. The test plan had been given to the regulatory authority, but not reviewed. The managers at the plant then modified the plan with pen and ink, without any safety reviews. The Chernobyl plant managers were accustomed to breaking safety rules and demanded that the young plant operators violate safety rules. This resulted in the withdrawal of too many control rods, when they tried to raise power to the needed test condition. The regulatory authorities had covered up past accidents and this contributed to the culture of covering up rather than solving safety problems.

For the 2011 Fukushima nuclear disaster, the nuclear regulator in Japan was well aware that the tsunami wall height was inadequate. It was known that the nuclear reactors faced an unacceptable tsunami risk. But the regulator thought it more important to save the electric utility money by avoiding the cost of modifications than to protect its citizens.

Nuclear accidents have occurred because known operational problems were ignored by regulators (TMI), because operator training was inadequate, because plant management took excessive risks without nuclear regulator intervention (TMI and Chernobyl), and because regulators approved unsafe designs in order to save money (TMI, Chernobyl, and Fukushima).

Government officials who press for less oversight of nuclear reactors are foolish and they are not just putting the public at risk. Nuclear plant meltdowns can also put governments at risk because of trillions of dollars of damage to surrounding areas, not to mention unleashing crops of cancers and other adverse health effects.

16. What is "high burnup fuel" and does it complicate spent fuel storage and disposal?

High burnup fuel is nuclear fuel that contains more than about 3 percent uranium-235. Early commercial nuclear reactors used about 2 or 3 percent enriched in U-235 fuel. High burnup fuel of nearly 5 percent allows the fuel to be used longer in a reactor. However, as the fuel is fissioned in a reactor, radioactive fission products and neutron capture products build up. High burnup fuel builds up more fission products and has more decay heat to contend with. It also builds up more plutonium isotopes. This complicates spent fuel storage and disposal. Criticality risks during storage and disposal are also greater.

A new form of fuel called high-assay low-enriched uranium (HALEU) fuel is up to 20 percent enriched in uranium-235. This is the type of fuel TerraPower's *Natrium* and X-energy TRISO fueled reactors plan to use. While blending of existing highly enriched uranium might be used to make HALEU fuel, when used in a nuclear reactor, the spent HALEU fuel creates additional difficulties in managing of spent fuel.

17. How bad is a nuclear accident? How often do major accidents occur?

There has been a major accident about every decade: Three Mile Island in 1979, Chernobyl in 1986 and Fukushima in 2011. The Chernobyl accident not only caused at least thousands of premature deaths; it broke apart a government due to the extremely high cost of trying to address the accident. With more nuclear power plants, you can expect serious nuclear accidents to be even more likely. The many diverse reactor designs increase the difficulty of attempting to assure adequate safety.

Thousands of people had to evacuate their homes following the Chernobyl and the Fukushima nuclear disasters. The reality of these tragedies is glossed over by nuclear promotors.

And it has become clear that nuclear power plants are terrorist targets and may be targets during war. Sabotage or terrorism can defeat safety systems and cause the widespread airborne release of radioactive material.

18. Who pays if people must permanently evacuate their home due to a nuclear accident?

Because the cost of a nuclear accident is so large, the U.S. government extends liability insurance for the damage, maybe. It will all depend and can vary depending on reactor size. The actual cap on the insurance may be far below the actual costs that may occur. The Fukushima accident was around a trillion US dollars and US Price Anderson Act liability is capped at $13.4

billion for large NRC-licensed nuclear reactors. [57] For small NRC-licensed reactors, under 100 MWe and non-reactor operations, Price Anderson liability remains capped at $500 million per accident. Your home, vehicle, your community, may be compensated in pennies on the dollar, not to mention loss of your health and your family's health and will depend on the circumstances and whether Congress calls upon additional payment.

19. Are small modular reactors less expensive than large reactors?

On an energy equivalent basis, no. And the cost of building nuclear plants, large or small, continues to rapidly escalate, even when many inevitable costs are ignored. Experience like the recent cost overruns at the full-sized and conventional Vogtle plant's new AP1000 reactors [58] indicates that further cost increases and schedule delays can be expected for both large and small nuclear reactor construction.

The cost for building the NuScale US460 small modular reactor project near Idaho Falls has increased significantly and it hasn't even broken ground. Last January, the NuScale cost estimate increased to $89/megawatt-hour (MWh) from $58/MWh. [59] Without extremely generous government subsidies granted to NuScale, the cost would already approach $120/MWh. NuScale has admitted that they must triple its subscription level for the UAMPS project in Idaho by early 2024.[60]

Scaling down from 12 modules, the modified NuScale project slated at the Idaho National Laboratory is to deploy 6 reactor modules. The proposed power generation has been scaled up from 60 megawatt-electric (MWe) to 77 MWe each, and with all 6 modules operating could generator 462 MWe. The power level scale up for the NuScale US460 design has not been approved by the U.S. Nuclear Regulatory Commission.

With the two 1000 megawatt-electric reactors being built in Georgia at Vogtle now costing $35 billion, [61] the cost is $17.5 million per MWe. With the 462 MWe NuScale project that has

[57] U.S. Nuclear Regulatory Commission, *The Price-Anderson Act: 2021 Report to Congress, Public Liability Insurance and Indemnity Requirements for an Evolving Commercial Nuclear Industry*, NUREG/CR-7293, Published December 2021. (This report does not discuss Department of Energy reactors or operations.)

[58] Nick Ferris, *Energy Monitor*, "Why a new era for US nuclear looks unlikely – Evidence suggest the Inflation Reduction Act and the advent of small modular reactors is unlikely to lead to a US nuclear resurgence in the medium term," May 26, 2023. https://www.energymonitor.ai/sectors/power/why-a-new-era-for-us-nuclear-looks-unlikely/ Vogtle AP1000 reactors cost more than $30 billion, more than $16 billion over budget and more than 6 years behind schedule. In South Carolina, 2 AP1000 reactors were cancelled due to rising costs.

[59] David Schlissel, Institute for Energy Economics and Financial Analysis, "Eye-popping new cost estimates released for NuScale small modular reactor," January 11, 2023. https://ieefa.org/resources/eye-popping-new-cost-estimates-released-nuscale-small-modular-reactor

[60] Stephen Singer, *UtilityDive*, "NuScale must triple subscription level for small modular reactor in Idaho by early 2024, company says," March 17, 2023. https://www.utilitydive.com/news/nuscale-smr-uamps-funding-nrc-doe-idaho-lab/645262/

[61] Stanley Dunlap, *Georgia Recorder*, "Cost controversies still inflame critics of Plant Vogtle expansion as kilowatts go online," June 5, 2023. https://georgiarecorder.com/2023/06/05/cost-controversies-still-inflame-critics-of-plant-vogtle-expansion-as-kilowatts-go-online/ "…over the last seven years that have led to projected costs doubling to north of $35 billion."

yet to break ground, estimated to cost $9.3 billion, [62] the cost is $20.1 million per MWe. **The NuScale project's cost per megawatt-electricity is already higher than the two AP1000 nuclear reactors at Vogtle.**

Small reactors are susceptible to more material degradation issues as materials are closer to the fissioning core. Premature shutdown due to material problems will make the small reactors even less economical. Small reactors also create disproportionately more spent fuel, compounding already untenable spent fuel disposal issues.

The design of the NuScale fuel will require more space in a deep geologic repository, on an energy equivalent basis, than large light-water reactor spent fuel. And whereas existing light-water spent fuel would fit 4 assemblies in a canister, the number of assemblies from a NuScale reactor could be restricted to 1 or perhaps less per disposable canister.

The nuclear waste from the variety of small modular reactors (water-, molten-salt-, and sodium-cooled SMR designs) has been evaluated and can be expected to "increase the volume of nuclear waste in need of management and disposal by factors of 2 to 30" for each megawatt produced. [63]

Claimed cost savings from modular building won't be saving any money any time soon due to the small number of reactors being deployed.

The deployment of small or micro reactors to everyone's neighborhood does increase security concerns and creates ever more stranded fuel sites. No one is even thinking about what it will be like to have these SMRs next to their homes, schools, hospitals, colleges, etc. and to have that stranded spent fuel there until the casks or canisters fail.

Unlike what promotors want people to believe, there is no basis to expect NuScale small modular reactors to be affordable, reliable, or safe. [64] [65] [66] [67]

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[62] Sonal Patel, *Powermag.com*, "Novel UAMPS-NuScale SMR Nuclear Project Gains Participant Approval to Proceed to Next Phase," March 2, 2023. https://www.powermag.com/novel-uamps-nuscale-smr-nuclear-project-gains-participant-approval-to-proceed-to-next-phase/ "…the first VOYGR-6 [NuScale] module scheduled to be in service by December 2029. All modules are slated to be in service by November 2030." Total project costs "now hover at $9.24 billion."

[63] Lindsay M. Krall, Allison M. Macfarlane, and Rodney C. Ewing, *PNAS*, "Nuclear waste from small modular reactors," Received June 26, 2021, Published May 31, 2022, https://doi.org/10.1073/pnas.2111833119.

[64] David Schlissel, Institute for Energy Economics and Financial Analysis, "IEEFA U.S.: Small modular reactor 'too late, too expensive, too risky and too uncertain,'" February 2022. https://ieefa.org/articles/ieefa-us-small-modular-reactor-too-late-too-expensive-too-risky-and-too-uncertain

[65] Environmental Working Group, "Questions for NuScale VOYGR Reactor Certification: When Will It Be Done? And then, Will It Be Safe"," May 2023. Posted on the Institute for Energy and Environmental Research (IEER.org) website. https://ieer.org/resource/reports/questions-for-nuscale-voygr-reactor-certification-when-will-it-be-done-and-then-will-it-be-safe/ See also Grant Smith and Anthony Lacey, EWG.org, "Small size, big problems: NuScale's troublesome small modular nuclear reactor plan," July 11, 2023. https://www.ewg.org/news-insights/news/2023/07/small-size-big-problems-nuscales-troublesome-small-modular-nuclear

[66] *Neutronbytes*, "NuScale Small Modular Reactor Costs Hit Hard by Inflation," January 24, 2023. https://neutronbytes.com/2023/01/24/nuscales-smr-costs-hit-hard-by-inflation/ "...the Carbon Free Power Project offers new details about these costs." "UAMPS [Utah Associated Municipal Power Systems] will have the option

The Department of Energy is also generously giving away taxpayer money to high temperature gas-cooled reactor designer X-energy. [68] The Xe-100 was initially to be 80 MW electric (MWe), and scalable to a 320 MWe four-pack. The Xe-100 would use TRISO fuel somewhat like the troubled and uneconomical Fort St. Vrain nuclear reactor. The spent fuel from the failed Fort St. Vrain reactors costs millions of dollars each year for continued storage.

20. Is a "small" sodium-cooled fast reactor like Bill Gates' proposed *Natrium* going to "burn the waste"?

The so-called "small modular reactors" being promoted by Bill Gates for Kemmerer, Wyoming, are not mature technology but are large enough to cause a serious accident. While Gates won't put much of his own money into the project and prefers instead to get government handouts, coal plants in Kemmerer are being converted to gas plants.

The Department of Energy is giving money to Bill Gates' backed TerraPower that is planning to build a 345-MWe sodium-cooled fast reactor called *Natrium*, in Kemmerer, Wyoming. The *Natrium* reactor scales up the Idaho National Laboratory's (INL's) former 20 MWe EBR II sodium-cooled reactor and is to be accompanied by a molten salt-based energy system. [69] About half of the money to build the $4 billion *Natrium* reactor is coming from the Department of Energy.

Despite billions of dollars spent world-wide on this type of reactor, sodium-cooled fast reactors have a long legacy of poor reliability and premature shutdown. Experience with the U.S. Fermi nuclear plant, France's Super Phoenix, and Japan's Monju and others have proven sodium-cooled reactors to be costly and prone to frequent outages. Sodium-cooled reactors are considered the most difficult to operate due to sodium fires and prone to sudden catastrophic failure.

World-wide, fast breeder reactors like the one Gates wants to build have a terrible track record. These have not been affordable or reliable reactors. There are many reactor safety problems with the fast breeder reactors as well.

All uranium fueled nuclear reactors make plutonium. They all fission (or burn) plutonium to some degree, as well. **While plutonium is indeed an important component of nuclear waste, burning plutonium in the *Natrium* reactor creates more nuclear waste.**

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to terminate the project and be reimbursed if the total of all member utility subscriptions do not reach 370 MW (of 462 MW available) by the end of 2023." Also see https://www.sec.gov/Archives/edgar/data/1822966/000110465922056493/tm2213736d7_ex10-22.htm

[67] Allison Macfarlane, iai.tv, "The end of Oppenheimer's energy dream, Modular reactors are supported by ideology alone," July 21, 2023. https://iai.tv/articles/the-end-of-oppenheimers-energy-dream-auid-2549

[68] X-energy, X-energy awarded $80 Million for the Department of Energy's Advanced Demonstration Program (ARDP), October 14, 2020. https://x-energy.com/media/news-releases/x-energy-awarded-80-million-department-of-energy-advanced-reactor-demonstration-program-ardp

[69] David Pace, *The Idaho Falls Post Register*, "INL director joins Bill Gates at future Natrium reactor site," May 5, 2023.

As nuclear reactors are operated, they all generate radionuclides and some of these gaseous radionuclides are very difficult to confine, such as tritium, iodine-129, technetium-99, krypton and xenon and carbon-14. Fissioning either uranium or plutonium, in a nuclear reactor or in a nuclear weapon, also creates many radioactive fission products including cesium-137 and strontium-90, that contaminate air, water and food.

The *Natrium* sodium-cooled fast reactor is seeking approval from the U.S. Nuclear Regulatory Commission. [70] If the proposed reactor design wasn't already bad enough, TerraPower is seeking to allow the significant **release of radionuclides** during operating transients rather than meet fuel design limits (see ML23024A281 at nrc.gov) during plant upsets.

A vast amount of misinformation is coming directly from the Department of Energy, like misleading claims that a sodium-cooled fast reactor can burn spent nuclear fuel, see https://www.energy.gov/ne/articles/3-advanced-reactor-systems-watch-2030 where DOE states that sodium-cooled fast reactors "can burn spent nuclear fuel from current reactors."

The *Natrium* will produce more nuclear waste than it can burn and cannot use but a tiny fraction of the existing nuclear waste for its fuel.

When used in the reactor, the HALEU (up to 20 percent enriched in uranium-235) will create more plutonium and that plutonium will be a weapons proliferation risk as well as a spent fuel disposal problem.

TerraPower claims Natrium can be running by 2030 – which appears unrealistic. INL is collaborating with the nuclear fuel design, despite the news that the fuel material will be imported from Russia, rather than INL's HALEU from EBR-II from its Materials and Fuels Complex. [71] [72] The *Natrium* reactor is facing at least two years of delays because of difficulty getting its HALEU nuclear fuel from Russia. [73] And now *Natrium* backers are seeking lawmakers to provide another $2.1 billion to support HALEU fuel production.

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[70] U.S. Nuclear Regulatory Commission website at nrc.gov and NRC's ADAMS database. https://www.nrc.gov/reactors/new-reactors/advanced/licensing-activities/pre-application-activities/natrium.html See also flow blockage issues at https://www.nrc.gov/pmns/mtg?do=details&Code=20220791 NRC Adams ML22227A058.pdf gives link to NATD-LIC-PRSNT-0026 which leads to NRC Adams ML222078814.pdf, a 2022 Gap analysis, including various safety exceptions for emergency planning and others. In ML23024A281.pdf TerraPower, January 24, 2023, Submittal of TerraPower Topical Report, "Principal Design Criteria for the Natrium Advanced Reactor" allowing radiological releases is being sought, rather than meeting fuel design limits in order to prevent radiological releases.

[71] Dustin Bleizeffer, *WyoFile, The Idaho Falls Post Register*, "TerraPower boost nuclear fuel effort amid calls for import ban," March 23, 2022.

[72] Environmental Defense Institute, April 2022 newsletter article, "HALEU Fuel for the TerraPower's Proposed Sodium-Cooled Natrium Nuclear Plant Could be Impacted by Ban on Russian Imports of Low-Enriched Uranium" at http://www.environmental-defense-institute.org/publications/News.22.April.pdf

[72] Department of Energy, Yucca Mountain Repository SAR, Docket No. 63-001, DOE/RW-0573, Rev. 1,

[73] Catherine Clifford, CNBC, "Bill Gates-backed nuclear demonstration project in Wyoming delayed because Russia was the only fuel source," December 16, 2022. https://www.cnbc.com/2022/12/16/bill-gates-backed-nuclear-demonstration-delayed-by-at-least-2-years.html

The *Natrium* reactor will not be deployed in time to help combat climate change, and its high cost will take resources away from more timely, affordable and effective solutions.

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