Public Comment Submittal on Oregon State Legislature House Bill 2410 Small Modular Reactor Demonstration proposal for Umatilla County

Testimony submittal by Tami Thatcher, February 28, 2025.
https://olis.oregonlegislature.gov/liz/2025R1/Measures/Overview/HB2410

SUMMARY

Background

Oregon has a sensible moratorium on building nuclear reactors in Oregon – one that nuclear promotors are again aggressively seeking to unravel.

Oregon is one of several states that enacted moratoriums on nuclear energy. Oregon's moratorium was enacted by voters in 1980 and is known as Ballot Measure 7. A key provision of the measure is that a federally-licensed repository for the spent fuel exists before a nuclear project can proceed.

In the 45 years since 1980, the U.S. Department of Energy, the agency tasked with obtaining a repository for spent nuclear fuel (and/or high-level waste), is no closer to siting and licensing a repository. There is no disposal repository for spent nuclear fuel in the U.S. and no program to site, license or build a repository.

House Bill 2410 would have citizens in Umatilla County be asked to vote to allow an unlimited number of Small Modular Reactors (SMRs), of unspecified type, all without discussing the lack of progress toward obtaining a permanent solution for the reactor waste, the spent nuclear fuel, which is called high-level radioactive material in the bill.

There is no limit to the amount of spent nuclear fuel that can be generated by the "demonstration project." The bill seeks a demonstration project apparently because it does not want to use an SMR type that is being pursued somewhere else. Why is Umatilla actively seeking to provide a home for a demonstration project SMR design no one else wants?

The U.S. Department of Energy is responsible for obtaining a permanent solution for the spent nuclear fuel, yet today, 45 years after Oregon passed a Moratorium on new nuclear reactors, the DOE has no repository and it already may need several repositories for the SNF the nation already has. The DOE has made no plans for the waste that would be generated by its goal to triple nuclear energy by 2050.

The DOE has continued to study waste disposal and those studies actually point to serious deficiencies in the proposed Yucca Mountain repository that was not granted a license to construct and was terminated in 2010.

Since 2014, no fees have been collected from rate payers for a future repository because the DOE has no repository program. The DOE has no program to site a repository. The DOE is attempting to site one or several Consolidated so-called "Interim" Storage sites, untethered from a disposal site (or even a reprocessing and disposal site). Consolidated Interim Storage (CISs) are being sought with the paid help of various businesses, universities and others that are called the "consortia." The consortia are to seek communities and to help entice them to accept a CIS and

while doing so, to help create the favorable messaging, even if that means omitting or glossing over the short-term and long-term problems with a CIS that stores spent nuclear fuel.

The U.S. Department of Energy knows that there are serious gaps in its understanding of the risks of long-term storage of spent nuclear fuel, and the risks of transporting spent nuclear fuel, particularly after long term storage. The DOE knows that the containers for spent nuclear fuel have a limited lifetime and are susceptible to aging mechanisms and corrosion that result in breaching of the container of the spent nuclear fuel.

The Department of Energy acknowledged the gaps in the technical basis for continued storage of spent nuclear fuel, first in 2012. [1] Then in 2019, an additional gap was identified that was the lack of technical basis for understanding what the radiological consequences of a spent nuclear fuel canister breach would be. [2] **Each new fuel type for Small Modular Reactors (from the use of HALEU) will require additional research regarding the storage and disposal of the fuel. The Department of Energy acknowledges that it is already behind in researching the technical basis for fuel already in storage.** [3]

In regard to what has been learned about spent nuclear fuel dry storage for existing light-water reactor spent nuclear fuel, vulnerability to material corrosion issues was learned late and existing SNF canisters will begin to fail. The timing of the canister failures will depend on specific spent fuel design, burnup, handling, dry storage system design, atmospheric chloride exposure, etc. The full impact of the currently inadequately designed spent nuclear fuel canisters we already have, is poised to be seen in the next few years and it may require evacuation of the public.

The reasons why spent nuclear fuel poses serious harm to humans and the environment if the radioactive particles in the fuel are released to the air, water and soil are rarely, if ever, discussed by nuclear promotors. The truth about radiological exposures and emissions routine operation, and from faulty designs that allow serious accidents, and from nuclear facilities being targets for terrorism or war, was not discussed at the February 27, 2025 HB 2410 meeting and are a topic any nuclear booster will actively avoid.

There seems to be no disclosure of the unreliability of Price Anderson Act compensation in the event of a significant radiological release. Compensation may depend on whether or not each reactor is below 100 megawatts-electric. Small modular reactors being proposed have a variety of safety characteristics and yet no detailed information is available and no reactor type was designated.

House Bill 2410 is oddly tailored to limit the choices for achieving “resilient energy.” Apparently, only Small Modular Reactors can be considered and only SMRs that are 300 megawatts of less (and could be below 100 MWe each). And only those reactors not already

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[1] B. Hanson et al., *Gap Analysis to Support Extended Storage of Used Nuclear Fuel*, FCRD-USED-2011-000136, For the Department of Energy, January 2012.

[2] M. Teague et al., *Gap Analysis to Guide DOE R&D in Supporting Extended Storage and Transportation of Spent Nuclear Fuel: An FY2019 Assessment*, For the Department of Energy, SAND2019-15479R, 2019.

[3] Ned Larson, U.S. Department of Energy, Office of Nuclear Energy, “Back-end Management of Advanced Reactors (BEMAR),” U.S. Nuclear Waste Technical Review Board Public Meeting, Idaho Falls, Idaho, August 30, 2023.

being pursued somewhere else. House Bill 2410 does not provide its rationale for excluding various kinds of "advanced reactors" or for excluding non-nuclear approaches to achieve energy resilience.

Nuclear promotors tend to talk as though they are confident that all of the various advanced reactors are safe. This is despite new designs not be completed, documented or licenses. This is despite NRC's tendency to avoid releasing sufficient information to the public. So, unsubstantiated claims of high levels of safety do not necessarily examine all aspects of safety, include militarized drone attacks. No small modular reactors are operating in the U.S. and relevant operating performance is insufficient to conclude that they are safer than previous nuclear reactors which have been prone to meltdowns, world-wide, about every decade. Fukushima's multiple meltdowns cost billions of dollars and had relied on a General Electric containment design which, it turns out, didn't work.

For some reason, the problems including the high costs of new nuclear energy and who will pay them, are rarely included in a meaningful way by the nuclear boosters. The meeting on House Bill 2410 held February 28, 2025 was no exception. Far more testimony time was given to nuclear boosters, and very limited time given to those who oppose the bill.

House Bill 2410 is asking citizens to vote on an issue that they are not being adequately informed about the dismal status of no progress toward achieving a disposal repository for the spent nuclear fuel. Recycling is mentioned but no mention of its costs or polluting. Nuclear energy is being promoted despite its high costs, accident risks, and health risks. The reason citizens are being misinformed is simple – if they understood the costs and the risks, to themselves and to future generations, they would vote to prevent new nuclear energy projects.

House Bill 2410 Should be Opposed

The promotors of House Bill 2410 want the highest economical risk, the highest technical project risk, and the unavoidable problem of spent nuclear fuel stranded for many decades or longer. I oppose House Bill 2410 and its effort to undermine Oregon's Moratorium on new reactor construction. If, as nuclear promotors say, the spent nuclear fuel problem really isn't a problem, that it's really only a volume of fuel like an Olympic swimming pool, every year, then they should site and license a repository before Oregon considers repealing its Moratorium.

The proposed bill is narrowly tailored to Small Modular Reactors, excluding fusion, and excluding non-nuclear solutions. Yet, the proposed bill leaves many questions vital to ratepayers and taxpayers unanswered. I would call the bill oddly tailored to reactors less than 300 MWe but no limit to the number of reactors or the total fission product inventory to be allowed. The choice of the reactor is to be studied for the demonstration project, but the process so far is to declare all the advantages of nuclear and apparently, to gloss over the disadvantages. There is no assurance that the selection process for the Umatilla Demonstration Project won't be biased, attained by inappropriate pressure, and arrived at with the unwillingness the question any aspect of nuclear

booster claims that was so prevalent in the presentation materials and the February 27, 2025 hearing. [4]

This legislation (House Bill 2410) would allow an unlimited number of small modular reactors to be operated in Umatilla County, in Oregon, and an unlimited amount of spent nuclear fuel to be generated to be stored in Umatilla for an unlimited time referred to in the bill as "temporary."

The type of small modular reactors (SMRs) for the project are not of a specified design or type, but are to each be 300 megawatts-electric (MWe) or less. The number of reactors and the amount of spent nuclear fuel that would be generated was not specified.

A conventional large nuclear reactor may be about 1000 MWe. So, "small" does not mean the construction and operating costs are small, that the amount of spent fuel generated is small or that the accident risk is small.

The type of reactor being completely unspecified means that the water usage, routine radiological emissions, safety characteristics are completely unknowable even in a comparative way. Currently, in the United States, despite many years of aggressive promotion by the U.S. Department of Energy, there are currently no operating SMRs and no fully licensed SMR designs.

The nuclear promotors did not discuss the reduced Price-Anderson Act coverage for reactor modules less than 100 MWe each, nor the difficulties associated with obtaining compensation following a significant radiological release from the nuclear project.

The routine radiological releases from operating nuclear reactors depends on the particular reactor, its operating mode, and other factors such as the operating history of the nuclear fuel. And for example, operation of light-water reactors similar to NuScale, with leaking steam generator tubes, allows far higher routine radiological emissions than intact steam generator tubes. But monitoring and reporting of routine radiological emissions has typically been scanty to non-existent. Without knowing the particular SMR the bill writers have in mind, no one can predict just how high the routine emissions will be, of tritium, iodine-131, and other radionuclides.

The projected costs of the project, its subsidy sources, and owners of the reactor project remain unspoken. How the inevitable cost overruns for this nuclear demonstration project in Umatilla be paid for? Will it be another case like the Advanced Reactors in Georgia (and South Carolina) that ratepayers are on the hook for, whether or not the reactors actually operate?

While energy resilience is needed, it is already being provided by fossil fuels and with this project, fossil fuels would still be relied upon for 10 or 15 years or more. Nuclear reactors operate, some with high capacity, until they are shut down and then replacement power for the reactors is needed.

Multiple Small Modular Reactors deployed can all be forced to shut down due to a common safety or operating problem, including extreme weather. Nuclear reactors do sometimes operate

[4] https://www.oregonlegislature.gov/citizen_engagement/Pages/How-to-Testify.aspx

for an entire year, but are sometimes shutdown for months or longer. The operating capacity numbers for nuclear reactors can appear rosier than the reality.

New Nuclear Construction Costs Continue to Rise, Voters Need to Know Who Pays

Not only do the schedules for delivering new nuclear construction slide years beyond original estimates, the cost of building nuclear plants, large or small, continues to rapidly escalate, even when many inevitable costs are ignored. Voters need to know if ratepayers will be on the hook for unlimited reactor cost overruns.

Experience like the recent cost overruns at the full-sized and conventional Vogtle plant's new AP1000 reactors [5] 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 had increased significantly by 2023 and it hadn't even broken ground. In January 2023, the NuScale cost estimate increased to $89/megawatt-hour (MWh) from $58/MWh. [6] 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.[7]

Scaling down from 12 modules, the modified NuScale project slated at the Idaho National Laboratory was 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. The electrical utilities, wanted to avoid locking their ratepayers into unlimited cost overruns and pulled out of the NuScale project, now cancelled for UAMPS that was to be located in Idaho.

With the two 1000 megawatt-electric reactors being built in Georgia at Vogtle now costing $35 billion, [8] the cost is $17.5 million per MWe. With the 462 MWe NuScale project that has yet to break ground, estimated to cost $9.3 billion, [9] the cost is $20.1 million per MWe. The

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[5] 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.

[6] 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

[7] 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/

[8] 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."

[9] 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

NuScale project's cost per megawatt-electricity was already higher than the two AP1000 nuclear reactors at Vogtle when NuScale's UAMPS project was terminated.

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. [10]

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 extraordinary high cost of new nuclear construction means that owners will seek to keep the reactors operating as much as possible, and this forces out lower cost energy. New nuclear construction is likely to suffer from early end of life problems because of the new designs and problems yet to be discovered.

IMPORTANT DETAILS ABOUT THE PROBLEMS OF NUCLEAR ENERGY

What is an Advanced Reactor?

The definition and characteristics of a so-called "advanced reactor" are extremely broad. There are light-water reactor variants like NuScale, sodium-cooled reactors like TerraPower's Natrium, high-temperature gas-cooled reactors like X-energy, and others. The design concepts are very diverse and there is no operating history for any of the new "advanced reactors."

Nuclear promotors are taking a "no advanced reactor left behind" approach, despite that approach being the most expensive approach and the least safe approach. Reactor experience to discover problems will be slow and licensing efforts diluted.

A presentation on Advanced Nuclear Energy in 2024 presented the names of companies pursuing the design and building of advanced reactors. [11] The names included NuScale, TerraPower (Natrium reactor), X-energy, GE Hitachi, Ultra-Safe-Nuclear, Terrestrial Energy,

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service by December 2029. All modules are slated to be in service by November 2030." Total project costs "now hover at $9.24 billion."

[10] 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.

[11] Kati Austgen, Nuclear Energy Institute, Presentation - Advanced Nuclear Energy – Oregon House Interim Committee on Clmiate, Energy and Environment, December 10, 2024.

Westinghouse, Zeno, Newcleo, NuCube Energy, Kairos Power, Oklo, Holtec International, Last Energy, NuGen, BWXT, General Atomics, and a number of others. None of these reactors have completed designs or NRC licenses. Some have begun engaging with the NRC to begin the licensing process. In one case, TerraPower, the heavily redacted documents are preventing the public from independently looking at the safety aspects of the design.

Nuclear promotors worked to pass a bill called Accelerating Deployment of Versatile, Advanced Nuclear for Clean Energy (ADVANCE) Act. The 2024 bill aimed to streamline, i.e., weaken, the licensing process for advanced reactors and promoting the development of fusion technology.

According to the ADVANCE bill, the definition of an advanced reactor is as defined by 951(b) of 42 USC 16271(b) https://www.govinfo.gov/content/pkg/BILLS-116hr6097ih/html/BILLS-116hr6097ih.htm and it means any nuclear reactor or fusion reactor. The definition of advanced reactor does not mean it meets any particular safety standard. The definition given, of an advanced nuclear reactor, means

(A) A nuclear fission reactor, include a prototype plant (as defined in sections 50.2 and 52.1 of title 10, Code of Federal Regulations (or successor regulations)), with significant improvements compared to reactors operating on the date of enactment of the Nuclear Energy Research and Development Act, including improvements such as –

(i) Additional inherent safety features;

(ii) Low waste yields;

(iii) Increased fuel performance;

(iv) Increased tolerance to loss of fuel cooling

(v) Enhanced reliability;

(vi) Increased proliferation resistance;

(vii) Increased thermal efficiency;

(viii) Reduced consumption of cooling water and other environmental impacts;

(ix) The ability to integrate into electric applications and nonelectric applications;

(x) Modular sizes to allow for deployment that corresponds with the demand for electricity;

(xi) Operational flexibility to respond to changes in demand for electricity and to complement integration with intermittent renewable energy; or

(xii) Improved resilience; and

(B) A fusion reactor

In others words, an “advanced nuclear reactor” is in no way clean, safe, affordable, or likely to be deployable in time to combat climate change. It is just a way to shuffle taxpayer money to influential recipients.

How Long is "Temporary" Storage of Spent Nuclear Fuel?

Statements in the bill would **imply** that the spent fuel storage is Oregon will only be temporary. The bill states only that Oregon will pursue agreements with the Department of Energy and the Nuclear Regulatory Commission regarding the removal of spent nuclear fuel. The NRC issues licenses for operating reactors, for spent nuclear fuel storage, and for transportation of radioactive material, but does not take physical actions such as operating, transporting or radioactive contamination cleanup.

"Temporary" could be beyond the time that the spent nuclear fuel needs to be repackaged, but that ability, if available, may be costly, and release radioactive gases. What are cash-strapped communities going to do when DOE has not taken ownership of the fuel and transported it away? Temporary may become permanent. And long-term storage will eventually mean radiological releases from spent fuel dry storage. Residents could be forced to evacuate.

With no limit on the number of reactors and no limit on how many years they would operate in the proposed bill, there is effectively no limit on the amount of spent nuclear fuel that would be stored in Umatilla.

The Department of Energy has historically contracted with commercial nuclear power plants to take the spent nuclear fuel and dispose of it. But the Department of Energy, despite its contractual obligations, has not taken spent nuclear fuel for disposal. The Department of Energy has proven to be an unreliable partner with regard to its contracts and promises. The NRC should not grant any nuclear reactor facility a license unless the DOE has agreed to take ownership of the spent nuclear fuel. But it is difficult to predict how future contracts with DOE will play out. The commercial nuclear power industry has been collecting money for part of the costs of spent nuclear fuel storage due to the failure of the DOE to take the spent fuel by 1998, money achieved only by suing the DOE.

Yet during testimony for this bill to open Oregon or at least Umatilla to new nuclear reactors, neither the bill nor the promotors testimony acknowledges the well-known problems with relying on the expectation that the Department of Energy will take the fuel to either a consolidated interim storage facility that currently does not exist or to a repository that does not exist and has yet to be cited, designed, licensed, built or operated.

The U.S. Department of Energy has no repository program and is actually no closer to obtaining a permanent and protective solution to the nation's spent nuclear fuel than it was 40 years ago.

The Yucca Mountain repository project was terminated in 2010. The Department of Energy has no repository, no repository program and no repository siting program. Yet, the nation already has enough spent fuel to fill two Yucca Mountain repositories – and the DOE isn't even looking at what it would do with the spent nuclear fuel generated by its recent push to triple nuclear energy by 2050. The U.S. DOE has not addressed how many repositories will be needed for the expansion of nuclear energy.

Assertions get tossed around that recycling or reprocessing will be the answer to spent nuclear fuel are leaving out the discussion of the high costs and of who pays for reprocessing,

and they are leaving out the radiological polluting caused by the release of gaseous fission products that can't be caught by filters and other polluting aspects of reprocessing.

Reprocessing by the UK and by France both entailed ocean dumping of liquid waste and high airborne levels of radioactivity releases. The UK finally admitted that the high cost of reprocessing made it unsustainable. And despite reprocessing spent nuclear fuel, these countries still need geologic repositories for the high-level waste and the plutonium they obtained by reprocessing is a liability to store and to dispose of.

Many misleading statements were made by nuclear promotors at the meeting held February 27, 2025, including that the spent nuclear fuel disposal technology was lessoned by small modular reactors. A study of a variety of small modular reactors concluded that the spent fuel would exacerbate disposal problems and require far more space in a repository by factors of 2 to 30 compared to existing large reactors. [12]

Consolidated Interim Storage being pursued by DOE

The Department of Energy is seeking to site Consolidated Interim Storage and seeking communities to accept the spent nuclear fuel from other communities to be consolidated into basically parking lot dumps. Even if the vaults are partially below grade, the storage vaults require air circulation and are open to the environment.

The Department of Energy has been aggressively seeking Consolidated Interim Storage sites, untethered from where a repository would be located. In describing how the DOE would seek communities to accept a Consolidated Interim Storage facility, the DOE publicly admitted that it would seek the best narratives to convince the community, and would withhold information, withhold the truth about the problems that would arise, if fully disclosing information would discourage acceptance. The DOE has been handing out money to a broad "consortia" or businesses, universities and various groups, largely to seek to community to connive and bribe into accepting a Consolidated Interim Storage facility.

Two consolidated interim storage sites projects were proposed, not by the Department of Energy, but by private companies. Those projects were proposed for New Mexico and Texas, but both states have enacted laws to prohibit away-from-reactor consolidated interim storage. The State of Idaho also has a Settlement Agreement restricting DOE from bringing more commercial spent nuclear fuel into the state.

The current Nuclear Waste Policy Act regulations set expectations and limitations on away-from-reactor consolidated spent nuclear fuel storage. The difficulties associated with obtaining a spent nuclear fuel repository or even a temporary consolidated interim storage facility were not provided by the project's promotors.

It was emphasized that about 40 years of spent nuclear fuel storage experience has been safe, yet the safety analysis gaps were not discussed. Welded-closed thin-walled canisters are subject to aging and corrosion mechanisms that the U.S. NRC ignored when the systems were designed

[12] 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.

and licensed. But they have not discussed what happens when spent nuclear fuel in a pool when the pool drains, like the pool of a NuScale small modular reactor project that contains the cores from several reactors. They have not discussed what happens if the reactors or the spent fuel in dry storage is attacked by weaponized drones.

Specific language in the bill states that "…**no high-level radioactive waste should be stored at the site of the demonstration project after termination of the operating license**…" By "high-level radioactive waste" it means the spent nuclear fuel. And where would the spent nuclear fuel go after the license expired or was terminated?

Then Consolidated Interim Storage is mentioned in the bill which states: "…a person operating the demonstration project under a license issued by the United Stated Nuclear Regulatory Commission shall remain responsible for proper temporary storage of high-level radioactive materials at the site of the demonstration project after termination of the license and until such materials are removed from the site for consolidated interim storage or permanent storage."

Citizens in Oregon and Umatilla need to ask where would the spent nuclear fuel go if consolidated interim storage or permanent storage do not exist? Next, they need to ask how will the fuel be repackaged if this is needed for transportation or if containers for the spent nuclear fuel face aging and corrosion problems? This will depend on the design of the SMR and its SNF storage. Citizens and legislators ought to ask who will pay for repackaging of spent nuclear fuel and who will pay for transportation of the spent nuclear fuel. Who will pay for improving roads, railways and bridges that will be used to transport spent nuclear fuel?

When San Onofre studied possible ways to remove the spent nuclear fuel stored right at the edge of the Pacific Ocean, all licensed by the NRC as safe, the utility discovered that the liability associated with transportation of the spent nuclear fuel was untenable. [13] This is despite the DOE's and NRC's continued assurance that transportation is safe.

And a key point to keep in mind is that consolidated interim storage is not a permanent solution. The CISs proposed so far have safety features essentially the same as the at-reactor storage. The only thing a CIS does is gets the garbage out of your state into someone else's backyard. And when the spent nuclear fuel or the containers are not safe for transportation because so many decades have elapsed that the materials are unsafe to transport, you could be stuck with spent nuclear fuel you need to repackage somehow. But for weld-closed thin-walled canisters, no method has been developed. Opening a welded closed thin-walled canister of spent nuclear fuel will entail explosion risks and releases of radioactive gases in addition to the shielding requirements.

The Moratorium in Nuclear is Needed Now More Than Ever

The clever sounding statements to make it seem like spent nuclear fuel won't be allowed to languish in Oregon in Umatilla County are misleading – and missing the point.

[13] 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

The nuclear industry continues to not clean up its messes. At Hanford and Savannaha River and Idaho where spent nuclear fuel reprocessing was conducted, they still haven't cleaned up their messes. There are over 70 sites in the U.S. with spent nuclear fuel in containers that are aging. And the nuclear industry is denying to true extent of the risk that spent fuel storage entails and continues to deny the costs of continued storage and of the promised but as elusive as ever, permanent solution of the containing the spent nuclear fuel. If a repository is ever operated, it may be an experiment that fails to contain the dissolving spent nuclear fuel as it allows the dispersal of radioactive particles throughout water sheds, air and soil.

Our nation has moved no closer to obtaining a permanent way to contain the nation's spent nuclear fuel than when the Oregon's moratorium was put in place. These nuclear promotors never seem to take solving the waste problem seriously. They act as though poisoning people and the environment just isn't a problem.

The Blue-Ribbon Commission report concluded that stable funding is part of the problem in obtaining a repository. They recommended that funding priority be placed on a spent nuclear fuel repository program, putting funding the care of spent nuclear fuel at the head of the line, ahead of all other government priorities. [14] Somehow, that sounds more complicated than the misleading characterization of the spent fuel volume as fitting in an Olympic swimming pool, see Department of Energy Five Fast Facts webpage [15]

About the small modular reactor cost estimates

Small modular reactors and other advanced reactors are claimed to be safe, affordable, and reliable. Yet, nuclear energy is the most expensive way to product electricity. That is true even when ignoring the cost of attempting to find a permanent solution for the spent nuclear fuel and ignoring the cost of accidents that involve large releases of radioactive particles to the environment.

The colorful and carefully crafted presentations by nuclear boosters gloss over or simply don't talk about the negative aspects of their proposals – and that's no accident.

Frankly, there is nothing people fear more, than to be ridiculed for not being in favor of new technology. The nuclear boosters claim to be backed by science. The glossy brochures and colorful presentations are impressive – unless you understand what they very deliberately aren't telling you.

The nuclear promotors don't admit that they take money away from more timely and affordable solutions to reduce carbon emissions and therefore undermine more effective ways to reduce carbon emissions sooner.

They don't admit that the costs of new nuclear are continuing to rapidly rise. They point to the latest cost estimate for a small nuclear reactor (NuScale) as though that reactor had actually

[14] *Blue Ribbon Commission on America's Nuclear Future, Report to the Secretary of Energy*, 2012.
[15] U.S. Department of Energy, 5 Fast Facts about Spent Nuclear Fuel at https://url.us.m.mimecastprotect.com/s/B1j1CG6YMDcLPLDxuKfxTB49To?domain=energy.gov

been built and as though the construction costs would not have continued to rise after the project in Idaho was halted.

They address the estimated costs of nuclear energy without admitting that the estimates for construction and operation do not include the costs of a repackaging the spent fuel in perhaps 80 years or the costs of siting one or several repositories for the radioactive waste.

The cost estimates for a permanent solution for the spent fuel, when included, are underestimated. They do not include the cost of siting one or several repositories because they are scaling the costs based on the never-built Yucca Mountain site. They do not include the realistic costs for disposal of spent nuclear fuel we have now, let alone the vast increase in the amount of spent nuclear fuel the Department of Energy is seeking. They are not accounting for the added difficulty of the new higher enriched fuels, and other characteristics that add the need for more analysis and higher costs.

These small reactors cost more than large conventional reactors (on an energy equivalent basis), and despite being "small" or even "micro," when deployed in groups pose significant costs and risks for accidents involving the reactors and the storage of spent fuel.

The X-energy high-temperature gas cooled reactors can release airborne radionuclides, particularly if overheated and also as the fuel ages. The radionuclide releases from routine operation are not fully characterized. Operating experience with high-temperature gas-cooled reactors has shown this type of reactor to be unreliable and uneconomical to operate. This demonstration project is destined to fail, yet the spent fuel will remain and will poison and/or burden future generations. There is no developed technology to "recycle" this type of reactor fuel, TRISO fuel. Attempts to do so would be very costly and produce a significant amount of liquid waste.

No matter how hard the nuclear boosters try to decouple the Department of Energy from its continuing failures to clean up existing messes from nuclear weapons and reactor search programs, Oregon must keep in mind the years of failures and broken promises at the nearby Department of Energy's Hanford site in Washington. The radioactive liquid waste from spent fuel reprocessing and plutonium recovery continue to leak into the ground near the Columbia River and despite years of promises and projects, the waste has not been vitrified. Spent nuclear fuel also languishes at the Hanford site, despite promises to send the spent fuel somewhere else.

The Data Centers create a particularly speculative and unstable income source as there is extensive competition and the lowest cost energy will win the AI market. That lowest cost energy source will not be X-energy's high-temperature gas-cooled reactors. Oregon will be left with spent nuclear fuel that is radioactive for over hundreds of thousands of years. Future generations will be left to grapple with the problem of attempting to confine the radioactive material in the spent fuel.

The Department of Energy, for all its reports and brochures, has no program to site the one or several spent nuclear fuel repositories. The experiment to discover whether or not a repository can safely be operated and confine the radioactive material for over millennia will be an expensive one. Since 2014, no money has been collected to fund spent nuclear fuel disposal or

repackaging efforts. No money has been allocated for the research needed for long-term storage and disposal, research that is unique for each fuel type and also varies by fuel operating and storage history.

Weaking of Regulatory Oversight Affects the Safety of Nuclear Energy

The nuclear promotors at the February 27, 2025 meeting made many assertions about the safety of all proposed "advanced reactors" and about their faith in the effective regulatory oversight in the U.S. Extensive discussion of excessive and stifling regulation were given, mostly having nothing to do with nuclear safety.

The U.S. Nuclear Regulatory Commission has a poor performance record already and it is about to get far worse. The NRC has historically been all too willing to bet on contrived arguments to save reactor owners money, to grease reactor approvals and to avoid shutting down nuclear reactors. Public safety is not the priority.

The NRC licensed the Three Mile Island Unit 2 reactor and others like it and actively ignored the identified problem that operators did not have adequate monitoring of water level in the reactor. The NRC had also ignored unsafe practices and poor training at that reactor. At another reactor, the Trojan reactor, the NRC would pull out the stops to permit it to operate with excessive leaking from steam generator tubes. The cost of dealing with the leaky steam generator tubes finally led to owners to permanently shut down the Trojan plant. [16] Years later, the NRC would again try to pull out the stops to allow the San Onofre plant continue to operate with its leaky steam generator tubes from a botched steam generator replacement project. The NRC didn't seem to mind that the nuclear owner had lied when they had claimed that it was a "like-for-like" replacement of the steam generators, circumventing more in-depth reviews.

The U.S. NRC partially approved the NuScale design and the Department of Energy heralded the partial approval as it implied it was a comprehensive review and approval. But in fact, the NRC's ACRS had stopped the review based on a schedule and not based on review completion. The review lacked adequate information about the novel helical coil steam generators for NuScale, despite having analysis of serious problems of oscillating density waves associated with those never-built-before steam generators. The premature failure of the steam generators would mean economic disaster for the project. Steam generators can provide a path for radionuclides to the environment during routine operation and during an accident.

The transcript of the publicly available portion of the February 4, 2020 Advisory Committee on Reactor Safeguards (ACRS) meeting discusses problems with NuScale's unique helical steam generator design — and that part of the problem is that the NuScale Final Safety Analysis is full of unproven statements. [17] For a multitude of systems and components, the ACRS admitted that there were not enough design details and no design standards and no operating experience, yet the US NRC and the ACRS rubberstamped their approval of the NuScale design. The technical

[16] Gregory Nipper, Portland State University, Dissertations and Theses, *Progress and economy: the clash of values over Oregon's Trojan Nuclear Plant*, January 2005. https://doi.org.10.15760/etd.249

[17] Official Transcript of Proceedings, Nuclear Regulatory Commission, Advisory Committee on Reactor Safeguards, NuScale Subcommittee. Open Session, February 4, 2020. NRC.gov Adams accession number ML20043D049.

requirements for analyzing the various components are not even delineated and may not even exist because of the unique design.

Licensing of the earliest partially completed design was reviewed and then prematurely rubber-stamped with U.S. NRC approval, with caveats or unresolved issues that will be left to a few NRC staffers who will face mounting pressure to approve anything NuScale wishes. [18] It should also be noted that obtaining NRC licensing approval does not mean the design is workable, reliable or affordable, let alone safe. NuScale later submitted a modified design that has not been approved.

Furthermore, it bears repeating that the NuScale spent nuclear fuel will require at least double the space in a repository due to characteristics of small reactors. The U.S. Nuclear Regulatory Commission does not bother itself with continuing storage or disposal problems or costs. A study of a variety of small modular reactors concluded that the spent fuel would exacerbate disposal problems and require far more space in a repository by factors of 2 to 30 compared to existing large reactors. [19]

Nuclear boosters may imply that "advanced reactors" or "small modular reactors" are safer than existing reactors, but that remains unproven.

Now the NRC is faced with the task of reviewing a large number of diverse reactor designs, from high-temperature gas-cooled reactors, to sodium-cooled fast neutron reactors, to molten-salt reactors and others. Advanced nuclear designer members include Bill Gates' Natrium by TerraPower, X-energy, NuScale, Ultra Safe Nuclear USNC, Oklo, GE Hitachi, BWXT, General Atomics, Kairos Power, Holtec International and others, according to the Nuclear Energy Institute.

Despite the claims that Advanced Reactors are safe or safer, the definition of advanced reactor is very broad and many are undocumented and unlicensed. There is no reason to expect higher levels of safety from so-called advanced reactors. This is particularly true because of the increasing prevalence of weaponized drones that can target nuclear facilities.

So, with an understanding of just a few highlights of how the NRC puts the nuclear owners pocket book ahead of public safety, it is truly alarming to see further weakening of the NRC.

Allison Macfarlane, formerly a Nuclear Regulatory Commission chairman, wrote of the damage to the NRC's independence with current actions by Trump and of damage to the NRC before Trump took office in 2025.

Macfarlane wrote "Proponents of small modular reactors, for instance, have pressured Congress and the executive branch to reduce regulation and hurry the NRC's approval of their novel – and unproven – reactor designs. They wish their reactors could be exempted from the

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[18] See more NuScale documents at Federal Register, NuScale Small Modular Reactor Design Certification at https://www.federalregister.gov/documents/2023/01/19/2023-00729/nuscale-small-modular-reactor-design-certification and NuScale slides for 3/21/2023 PreApplication meeting for a new reactor design https://adamswebsearch2.nrc.gov/webSearch2/main.jsp?AccessionNumber=ML23076A124

[19] 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.

requirements that all other designs before them have had to meet: detailed evidence that the reactors will operate safely under accident conditions. Instead, these proponents – some with no experience in operating reactors – want the NRC to trust their simplistic computer models of reactor performance and essentially give them a free pass to deploy their untested technology across the country." [20]

Now in February 2025, President Donald Trump has been working to further undermine government agency independence and he has stated his intention to waive requirements for those people he favors even those from outside the U.S.

While a single small modular reactor is smaller than many currently operating commercial nuclear reactors, many small modular reactors can be deployed at a single site, and thus create the potential for a significant radiological release. Small modular reactors may also lack the containment structures, have reduced evacuation distances to nearby populations, and may lack personnel to respond to problems.

An Example of Hyped Licensing Approval Progress and Rising Construction Costs

Iceberg Research has written an article [21] that NuScale's marketing leans heavily on the one claim that it is the first and only SMR design certified by the NRC. However, the design certification was for the original 50-megawatt-electric reactor design and the company was forced to upsize its SMR to 77-MWe after it found that the economics of the 50-MWe version didn't work. Iceberg writes that the increasing the power output to 77-MWe is not a simple update of the previous design. And while NuScale has applied for a Standard Design Approval for the 77-MWe design, it is not complete and it is not a full certification.

The previous 50-MWe design had issues that still have to be addressed including design of the shield wall, containment leakage from the combustible gas monitoring system, and steam generator stability. The propaganda ignored the U.S. NRC's communications to the Idaho Leadership in Nuclear Energy Commission at its October meeting[22] and to NuScale in writing state that "… this SDA [standard design approval of the 50-MWe] does not constitute a commitment to issue a permit, design certification (DC), or license…." [23] [24] The 77-MWe design

[20] Allison Macfarlane, *Bulletin of the Atomic Scientists*, "Trump just assaulted the independence of the nuclear regulator. What could go wrong?" February 21, 2025. https://thebulletin.org/2025/02/trump-just-assaulted-the-independence-of-the-nuclear-regulator-what-could-go-wrong/

[21] Iceberg Research, NuScale ($SMR) Has Deceived Investors about the Certification of its Reactor, May 16, 2024. https://iceberg-research.com/2024/05/16/nuscale-smr-has-deceived-investors-about-the-certification-of-its-reactor/

[22] Doug Hunter, CEO and General Manager of Utah Association of Municipal Power Systems (UAMPS), presentation to the Idaho Line Commission CFPP [Carbon Free Power Project] October 14, 2020. https://line.idaho.gov/wp-content/uploads/sites/84/2020/10/2020-1014-cfpp.pdf

[23] U.S. Nuclear Regulatory Commission, Letter from Anna H. Bradford, NRC to Zackary W. Rad, NuScale Power LLC, Subject: Final Safety Evaluation Report for the NuScale Standard Plant Design, August 28, 2020 at https://www.nrc.gov/docs/ML2023/ML20231A804.pdf

[24] U.S. Nuclear Regulatory Commission, Letter from Anna H. Bradford, NRC to Zackary W. Rad, NuScale Power LLC, Subject: Final Safety Evaluation Report for the NuScale Standard Plant Design, September 11, 2020 at https://www.nrc.gov/docs/ML2024/ML20247J564.pdf

has the added difficulty of higher reactor power levels which adds heat load and increases safety challenges.

Fluor has invested more than $600 million in NuScale and has sought to divest from NuScale according to Iceberg Research.

According to Edwin Lyman of Union of Concern Scientists, the now-cancelled NuScale project to build a 460-megawatt, 6-unit small modular reactor in Idaho "was estimated to cost over $20,000 per kilowatt, which is greater than the actual cost of the Vogtle large reactor project of over $15,000 per kilowatt." Also, "The levelized cost of electricity for the now-cancelled NuScale project was estimated at around $119 per megawatt-hour (without federal subsidies), whereas land-based wind and utility-scale solar now cost below $40/MWh." [25]

The levelized cost of electricity is the cost of building and operating a power plant over an assumed lifetime. If the nuclear plant closes prematurely or experiences long unplanned shutdowns, the levelized cost can be far higher.

Other small modular reactors are not likely to be more affordable, even as safety features are jettisoned. **And microreactors will be even more expensive, [26] perhaps two or three times as costly as unaffordable SMRs according to Lyman.** This is without the cost of long-term management and disposal of the spent nuclear fuel.

The nuclear boosters are scrambling to give the impression that they are solving the problem of high construction for advanced reactors.

Militarized Drone Threats to Nuclear Facilities

It has been reported by the Associated Press that "A drone armed with a warhead hit the protective outer shell of Ukraine's Chernobyl nuclear plant early Friday, punching a hole in the structure and briefly starting a fire, in an attack Kyiv blamed on Russia. The Kremlin denied it was responsible." [27]

The drone attack was not on an operating reactor nor was it directly near spent nuclear fuel, so the lack of radionuclide release from that drone attack is not indicative of the harm that drone attacks may cause. It is important to recognize from the 2025 drone attack that it may be difficult or impossible to readily identify who perpetrated the drone attack.

While the U.S. Nuclear Regulatory Commission downplays sabotage of reactor facilities, the prevalence of drones that can be weaponized is a reality. And the attacks can involve multiple drones thus attacking multiple small modular reactors or the spent fuel at a reactor site.

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[25] Edwin Lyman, *Union of Concerned Scientists*, "Five Things the 'Nuclear Bros' Don't Want You to Know About Small Modular Reactors," April 30, 2024. https://blog.ucsusa.org/edwin-lyman/five-things-the-nuclear-bros-dont-want-you-to-know-about-small-modular-reactors/

[26] Abdalla Abou-Jaoude et al. Nuclear Science & Technology Directorate, Idaho National Laboratory, *Literature Review of Advanced Reactor Cost Estimates*, INL/RPT-23-72972, Revision 3, October 2023. https://inldigitallibrary.inl.gov/sites/sti/sti/Sort_66425.pdf

[27] Illia Novikov and Efrem Lukatsky, *AP, World News*, "A drone pierced the outer shell of Ukraine's Chernobyl nuclear plant. Radiation levels are normal," February 14, 2025. https://apnews.com/article/russia-ukraine-war-chernobyl-zelenskyy-71d781dbd66754d0a548edd388f3447a

Despite the NRC assuming that less industry-required insurance would be needed for small modular reactors on the basis of the reactor size being below 100 megawatts-electric, a targeted event that affects multiple SMRs may cause a significant radiological release that contaminates people, homes, agriculture and property. The reduced nuclear owner insurance requirements lower owner costs and putting citizens reliance on federal Price Anderson Act coverage which would be paid by the Federal Government but only if granted.

The Price-Anderson Act liability coverage will not necessarily cover damages at all for consolidated spent nuclear fuel storage or transportation, and won't cover reactors smaller than 100 megawatts even though the radiological consequences can still be wide-spread and severe and will not be covered by home or auto insurance. [28] See the 2021 report by the U.S. Nuclear Regulatory Commission discussing the Price-Anderson Act [29] and the 2023 report by the Department of Energy. [30]

Price Anderson Act Liability Coverage in the event of a radiological release may not cover citizens harmed

The Price Anderson Act of 1957 (PAA) requires that commercial nuclear power reactor licensees have insurance to compensate the public for damages arising from a nuclear incident. But there's plenty of devil in the details.

The requirements of PAA depend on whether the nuclear operation is under the Department of Energy — or not. While some Department of Energy operations actually have a license from the Nuclear Regulatory Commission, these are still considered as conducted under the Department of Energy. Commercial nuclear reactor operations are conducted under an NRC license and are non-DOE operations. I'll refer to these as licensees.

For NRC licensees, the amount of liability coverage required depends on whether or not the licensee still has an operating reactor; the electricity generation capability of the reactor being above 100 MWe; evolving NRC regulations; and exemptions granted by the NRC.

At stranded fuel sites where the commercial nuclear reactor is no longer operating, the NRC can reduce or waive the liability coverage requirement for Independent Spent Fuel Storage Installations using dry storage of spent nuclear fuel. In the event of an accident or sabotage, there may be zero dollars for compensation available to the public.

Currently, the Price Anderson Act does not require insurance coverage for non-DOE Independent Spent Fuel Storage Installations and these can include consolidated interim storage

[28] See the October 2023 Environmental Defense Institute article, "Will the public be compensated for a radiological release from a spent nuclear fuel storage or transportation accident" Liability coverage ranges from about $13 billion to zero dollars."

[29] 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. https://www.nrc.gov/docs/ML2335/ML21335A064.pdf

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

facilities. See also the 2021 report by the U.S. Nuclear Regulatory Commission discussing the Price-Anderson Act [31] and the 2023 report by the Department of Energy. [32]

Citizens cannot count on any compensation or adequate compensation following a nuclear accident for a variety of reasons including evidence of harm will likely be limited to the radiation monitoring conducted by those at fault for the accident.

Whether or not a facility is covered by the Department of Energy may be vague depending on the contractual arrangement with DOE. Should a serious accident occur at an away-from-reactor consolidated interim storage facility or an at-reactor dry storage facility called an Independent Spent Fuel Storage Installation, the existence of any, let alone adequate, financial compensation to citizens who lose homes, vehicles, and/or health may be doubtful.

The Department of Energy could take ownership of the spent nuclear fuel at the boundary of the commercial utilities facility and should an accident occur as the spent fuel is transported to the boundary of the facility, the utility could be liable for the accident, rather than DOE.

The NRC concluded based on inadequate accident evaluations that dry spent fuel storage poses no risk of offsite radiological contamination, or less than 1 rem. The NRC's evaluation of dry canister accident risk is based on the faulty logic that since the spent fuel in dry storage can be air-cooled, no radiological release from spent fuel in dry storage is possible. [33] But the NRC failed to adequately address sabotage, transportation, load drops during loading or unloading canisters into storage vaults, canister leakage with water ingress such as known rising groundwater levels at San Onofre, canister leakage with hydride explosion or fire and perhaps other accident types. Apparently, it will up to community leaders to review currently unresolved issues for dry storage spent fuel systems licensed in the U.S. [34]

There are currently three separate efforts to create consolidated interim storage facilities for spent nuclear fuel. Two private consolidated interim storage facilities have been licensed by the U.S. Nuclear Regulatory Commission for "interim" storage of spent fuel, one in New Mexico by Holtec and another in Texas by Interim Storage Partners. The Department of Energy has a separate effort to build one or more consolidated interim storage facilities.

From Table 1, for a non-DOE stand-alone Independent Spent Fuel Storage Installation such as the proposed consolidated interim storage (CIS) facilities proposed by private companies for New Mexico and Texas, the Price Anderson Act would not require or provide liability coverage. The NRC may request some amount of liability coverage and can modify or exempt the licensee from carrying this coverage at a later time even if coverage was initially required. An accident at the proposed Holtec CIS in New Mexico or Interim Storage Partners CIS in Texas could occur

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[31] 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]

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

[33] Federal Register, Volume 83, Number 8, January 11, 2018 at Page 1385.

[34] Seirra Club letter to the U.S. Nuclear Regulatory Commission, RE:Advanced Notice of Proposed Rulemaking (ANPR): Regulatory Improvements for Decommissioning Power Reactors, Docket ID NRC-2015-0070, March 21, 2016. https://www.nrc.gov/docs/ML1608/ML16082A004.pdf

Table 1. Requirements for financial protection and the availability of indemnification for NRC Part 50 licensees and DOE contractors.

Entity	Primary Tier Financial Protection	Secondary Tier Financial Protection	Indemnification
Large (>100 MWe) Operating Reactor: NRC Part 50 [Reactor] Operating Licensee (including SNF stored onsite at an ISFSI under an NRC Part 72 license)	$450 million provided through private insurance.	$13.21 billion provided through deferred premium payments from all operating licensees.	If the secondary tier financial protection is depleted, Congress is committed to review the incident, and take any actions determined to be necessary for fuel and prompt compensation of all public liability claims.
Permanently Shut down Reactor: NRC Part 50 Shutdown [Reactor] Plant Licensee Applicable to SONGS (including SNF stored onsite at an ISFSI under an NRC Part 72 license)	$100 million provided through private insurance.	No secondary tier required per PAA.	NRC indemnified licensee for an additional $460 million, for a total financial protection of $560 million. Beyond this amount, Congress is committed to review the incident, and take any actions determined to be necessary for full and prompt compensation of all public liability claims.
DOE Contractor (General)	As may be determined by the Secretary of Energy.	Not applicable.	DOE indemnifies contractor up to $13.70 billion total. Beyond this amount, Congress is committed to review the incident, and take any actions determined to be necessary for full and prompt compensation of all public liability claims.
DOE Contractor (Performing Activities Funded by the NWF)	As may be determined by the Secretary of Energy.	Not applicable.	Public liability claims are paid from the Nuclear Waste Fund, in an amount not to exceed $12.58 billion. Beyond this amount, Congress is committed to review the incident, and take any actions determined to be necessary for full and prompt compensation for all public liability claims.
NRC Part 72 Stand-Alone Independent Spent Fuel Storage Installation	As may be determined by the NRC and implemented through a site license condition.	Not applicable.	**$ 0, Zero dollars** NRC regulations do not provide NRC indemnification for 10 CFR Part 72 stand-alone ISFSIs. Such facilities do not have PAA protection available to them.

Table notes: 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 See Appendix C, Table on page C-7. And see 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]. Note that in the event there is no coverage, Congress could decide to provide coverage after an accident.

with no compensation for the public because the Price Anderson Act does not require it of the NRC-licensed private facility.

Both private facilities proposed for New Mexico and Texas have now faced state legislation prohibiting the facilities. Texas has also successfully challenged the legal authority of the NRC to authorize an away-from-reactor facility. While the NRC has licensed dry spent fuel storage at commercial nuclear reactor licensed by the NRC, at issue is that the regulations governing the storage and disposal of spent nuclear fuel laid out specific regulations for spent fuel in the NWPA. The NRC has asserted that the agency can ignore the NWPA provisions passed by Congress and authorize spent fuel storage anywhere and without regard to NWPA provisions.

The Department of Energy is also seeking one or more federal consolidated interim storage facilities. The specific types of spent fuel or high-level waste, whether for commercial spent fuel or non-commercial spent fuel, is not being disclosed but is indicated to include commercial spent nuclear fuel. The DOE's effort has been funded under the Consolidated Appropriations Act of 2021 and 2023.

There is interest is sending spent fuel currently stored at electric utilities to interim storage facilities such as the proposed private consolidated interim storage facilities in New Mexico and Texas. **But despite electrical utilities wanting the spent fuel sent away from their communities, these utilities do not want the cost of transporting the fuel. They did not want the cost of providing insurance or the liability for accidents during transportation or storage at these away-from-reactor sites. And no one even knows what the annual storage fees at these sites would be.**

The utilities wanting the spent fuel sent to consolidated interim storage sites want the Department of Energy to take ownership of the spent fuel, to pay for the transportation away from the reactor site, to accept the liability for transportation and for storage, and to pay for storage fees at the away-from-reactor storage site.

Read about one electric utility's survey of the high cost and many difficulties associated with trying to relocate the San Onofre spent nuclear fuel away from the vulnerable Pacific Ocean coastline. [35] These private facilities have a mysterious business model that seems to be an attempt to go around existing Nuclear Waste Policy Act (NWPA), 1982 and as amended in 1987. The NWPA regulations constrain the interim spent fuel storage facility(s) with regard to capacity and also require that a construction license has been obtained for a disposal facility.

[35] 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

The Department of Energy, which has no permanent disposal program is seeking a community to engage with, and is enlisting many universities and others in the consortia to find a community and identify who to convince and how to bribe them. The DOE admitted at the August 2023 NWTRB meeting that the communities will only be provided with carefully filtered information but the consortia members would have access to the "unfiltered" information. See more about that meeting, as well as my comment submittal at https://www.nwtrb.gov/meetings/past-meetings/summer-2023-board-meeting---august-30-2023

No community can provide informed consent when the length of time the fuel will be stored at the consolidated interim storage facility is unknown. Statements that the NRC's license for the storage is limited to a certain duration, whether 20 or 40 years, are not meaningful. The refusal to renew the license would not remedy the situation if there is no way to remove the spent fuel. Furthermore, no community can provide informed consent when the potential accident consequences being asserted are based on optimistic fiction and are not technically defensible.

Despite the lack of actual research or sound technical basis for understanding the radiological releases possible from dry storage of spent fuel or its transportation, the NRC is asserting that the risk posed from dry storage of spent fuel is low so that it can save the licensees from having to buy insurance coverage.

Pursuing dreams of data centers, grabbing federal subsidies, and propping up nuclear energy demand, at least on paper

American billionaires are signing long-term power purchase agreements (PPAs) to supply electricity for large data centers. The February article pointed to Amazon (Jeff Bezos) and Energy Northwest to develop four small modular reactors with a combined capacity of 320 MW in Washington State. Ultimately, Amazon aims for 5000 MW of SMR capacity in the U.S. by 2039. [36]

The power purchase agreements have flexible terms and include non-binding capacity targets, largely because there is uncertainty over the electricity needs for data centers and the hope of newer technologies that make the artificial intelligence data centers more energy efficient. How nice to make non-binding agreements, yet be able to harvest U.S. federal government subsidies for the SMR projects.

And how nice for the Department of Energy, who can point to increases in nuclear energy usage while the department does not have the money for repackaging, transporting, reprocessing or disposal of the spent nuclear fuel we have, let alone the SNF from new reactors.

Electric utilities don't want to sign up for reactor projects because of the high and escalating costs and schedule overruns. It appears that part of the solution has been to get the military complex aligned billionaires to get into the act.

[36] *Reuters Events*, "Big Tech contracts inject life into new nuclear," February 19, 2025. https://www.reutersevents.com/nuclear/big-tech-contracts-inject-life-new-nuclear?utm_campaign=NEI-19FEB24-WK-%28Newsletter%29%28A%29-&utm_medium=email&utm_source=Eloqua

Low-balling the Cost of New Nuclear Energy

Despite the glossy presentations on projected nuclear costs, the cited GAIN report admits that "There is a high degree of uncertainty associated with their cost." …Because future US nuclear-reactor costs are still unknown due to little recent observed data, the report opted to compile a comprehensive list of bottom-up estimates…" [37] The report uses NuScale estimated costs even though no reactor has been built and the actual costs may not be accurately reflected at all.

The nuclear cost analysis points to including disposal and transportation costs, however, these would be based on an analysis based on an already cited Yucca Mountain. The DOE has created low-balled estimates of spent nuclear fuel disposal which does address transportation costs but not road and bridge infrastructure costs. Thus, the GAIN report does not include the cost of siting and licensing one or more spent nuclear fuel repositories. The report does not include the cost of repackaging spent nuclear fuel that languishes and cannot be transported or is will need to be repackaged due to container aging. The report does not address the costs of dealing with a criticality event at the repository which becomes increasingly likely with the higher-enrichment of the nuclear fuels used. The report does not address the costs of discovering that the repository simply won't confine the radioactive spent fuel over time.

The Department of Energy is being less than forthcoming about the uncertainties in its nuclear cost estimates. And when nuclear operators post construction and operating costs, these cost estimates generally do not include spent nuclear fuel disposal, disposal siting or possible reprocessing costs. Reactor owners don't plan to pay for disposal. And the federal government ceased collecting fees for disposal back in 2014 when it had to admit that it had no repository program (and still doesn't). Seeking Consolidated Interim Storage untethered to a permanent solution is an irresponsible action to give the illusion of a solution.

Bill Gates Natrium reactor will require reprocessing but the GAIN report nor do other cost estimates address the cost or airborne releases of radioactivity from reprocessing via pyroprocessing of the sodium fuel.

The GAIN report does point out that the cost of small modular reactors is higher than the cost (2022$/kWe) of large reactors. But they emphasize their hope that the cost will come down to the level of large reactor capital costs. The GAIN report is methodical but also very biased toward overly optimistically low nuclear costs.

The nuclear promotors in one presentation (by Tonkin Torp) actually refer to a Department of Energy Five Fast Facts webpage [38] that contains several misleading statements. [39] In Fact #1 it emphasizes that spent nuclear fuel is a solid, but ends with Fact #5 that spent nuclear fuel can be recycled to make new fuel and byproducts. Hanford knows about liquid high-level waste and so

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[37] Gateway for Accelerated Innovation in Nuclear (GAIN), (Idaho National Laboratory and others), *Meta-Analysis of Advanced Nuclear Reactor Cost Estimations*, INL/RPT-24-77048, April 2024. https://url.us.m.mimecastprotect.com/s/ySh5CKrYL0crYrXgc3ivT574gP?domain=gain.inl.gov

[38] U.S. Department of Energy, 5 Fast Facts about Spent Nuclear Fuel at https://url.us.m.mimecastprotect.com/s/B1j1CG6YMDcLPLDxuKfxTB49To?domain=energy.gov

[39] Maureen McGee, Government Affairs Advocate, Umatilla County, Tonkon Torp, LLP, Power Point Presentation - House Bill 2410 Overview Small Modular Reactor Demonstration proposal for Umatilla County, 2025.

does Savannah River and the Idaho National Laboratory – all DOE facilities still struggling to deal with their liquid HLW waste from SNF reprocessing. The "recycled" fuel from pyroprocessing would not use an aqueous process, but the DOE does not mention of the costs or pollution from recycling. By dangling it, they don't have to mention the cost or perform a NEPA evaluation.

Fact #4 states that spent fuel is safety transported across the United States. What it doesn't say is how contaminated shipments have occurred. And it doesn't say how far heavier and larger some of the spent fuel shipping will now be. In the past, fewer fuel rods were shipped at a time and the casks were lighter. It does not say what happens to a sabotage or drone attack with spent fuel being shipped becomes a target for terrorism or warfare.

Fact #3 states that the nation's spent fuel is stored at more than 70 reactor sites across the country. It does not say that repackaging of the spent fuel at some or all of these sites will require designing and building fuel transfer capability, nor does it say who will pay for it. The reactor owners are avoiding this like the plague. These costs are not covered by reactor D&D costs, nor is it included in DOE's waste disposal estimates.

Fact #2 switches from the old football field analogy to the Olympic-sized swimming pool analogy but it does not admit how much space it actually requires in a repository due to the high decay heat and due to the need to limit the impact of criticality events. The Yucca Mountain repository was to require 41 miles of emplacement drift, yet was limited to far less spent nuclear fuel than the U.S. already has. And to limit the migration of radionuclides out of the Yucca Mountain repository, the U.S. NRC assumed the installation of thousands of titanium drip shields that likely could never actually be installed despite their being essential to slow the migration of radioactive material from the repository.

And regarding any presentation by the Nuclear Energy Institute, it should be recalled that the Nuclear Energy Institute has a history of promoting unvetted claims and it ran radio ads for a now defunction nuclear company, Transatomic Power, whose inflated claims were shown to be wrong by an MIT study. [40] [41]

Low-balling of Spent Nuclear Disposal Costs

Regarding the GAIN report meta-analysis of nuclear costs, the devil is in the assumptions. [42] While this report was used to support the argument in support of repealing Oregon's ban on nuclear energy, this report used highly flawed assumptions not only to low-ball reactor construction costs but also to low-ball spent nuclear fuel disposal costs. The report acknowledges

[40] James Temple, *MIT Technology Review*, "Nuclear Energy Startup Transatomic Backtracks on Key Promises," February 24, 2017. https://www.technologyreview.com/2017/02/24/68882/nuclear-energy-startup-transatomic-backtracks-on-key-promises

[41] Edwin Lyman, Union of Concerned Scientists, *"Advanced" isn't always better – Assessing the Safety, Security, and Environmental Impacts of Non-Light-Water Nuclear Reactors*, March 2021.

[42] Gateway for Accelerated Innovation in Nuclear (GAIN), (Idaho National Laboratory and others), *Meta-Analysis of Advanced Nuclear Reactor Cost Estimations*, INL/RPT-24-77048, April 2024. https://url.us.m.mimecastprotect.com/s/ySh5CKrYL0crYrXgc3ivT574gP?domain=gain.inl.gov

some uncertainty but does not fess up to the bias to provide the lowest cost estimates for nuclear energy.

The GAIN report admitted that "There is some uncertainty in the back-end costs (i.e., spent-fuel disposal)." Well, that is an understatement. The GAIN analysis is based on an out-of-date cost escalation of the Yucca Mountain repository, a 2017 report by Dixon. [43] The analysis assumed unlawful direct disposal of existing canisters never designed for disposal at Yucca Mountain. The GAIN analysis assumed that no repackaging was needed in order to transport spent fuel currently stored in containers (or the spent fuel in the containers) do not meet transportation requirements.

The GAIN report assumed that the cost of spent fuel disposal did not depend on the nuclear reactor type, while admitting that certain fuel types could require higher volumes and would increase the disposal costs. The GAIN analysis assumed that no recycling would be required for fuel used in sodium-cooled reactors.

There are more recent spent fuel disposal estimates that are based on a 2012 Yucca Mountain repository analysis, which also low-ball spent fuel disposal costs. No additional repository siting costs are included because the Yucca Mountain repository site had been selected. The Yucca Mountain repository design assumed that spent fuel would be placed in special Transport, Aging and Disposal (TAD) casks. But commercial nuclear spent fuel was never placed in TAD casks. Commercial spent nuclear fuel was placed in welded-closed thinned walled canisters, never designed for long-term storage, never designed for disposal and no method of removing the SNF from a thin-walled canister has even been developed. The disposal of spent fuel in the thin-walled canisters is called "direct disposal" but this was never addressed in disposal licensing efforts and the efforts to relicense the repository for different containers and different fuels isn't addressed, if you are expecting Yucca Mountain to be the repository.

In 2010, the Yucca Mountain repository was defunded. And the Department of Energy announced that commercial spent nuclear fuel would go to a separate repository than the DOE-managed nuclear waste repository. Neither repository exists.

A more recent cost estimate was given in 2021 GAO-21-603 for the disposal of commercial spent nuclear fuel as $168 billion. **But this only includes the spent nuclear fuel generated by commercial nuclear reactors and excludes the separate disposal of DOE-managed spent nuclear fuel and high-level waste.** [44]

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[43] B. Dixon, et al., Idaho National Laboratory, "Advanced Fuel Cycle Cost Basis-2017 Edition," INL/EXT-17-43826, https://www.osti.gov/biblio/1423891

[44] U.S. Government Accountability Office (GAO), Report to Congressional Addresses, "Commercial Spent Nuclear Fuel – Congressional Action Needed to Break Impasse and Develop a Permanent Disposal Solution," GAO-21-603, September 2021. https://www.gao.gov/nuclear-waste-disposal The estimate for spent fuel disposal at YM is $75 billion to $117 billion is for repository operations beginning in 2031 and from $141 billion to $158 billion for repository operations beginning in 2117.

GAO-21-603 cites a 2019 Sandia National Laboratory [45] estimate of the Yucca Mountain spent fuel disposal cost for 109,000 metric tons of spent fuel if the never-built Yucca Mountain repository licensing was restarted. The actual costs will be higher for a number of reasons.

The 2021 GAO report GAO-21-603 [46] states that there was then existing 86,000 metric tons of commercial spent nuclear fuel stored on-site at 75 operating or shutdown nuclear plants in 33 states, an amount that grows by about 2,000 metric tons each year. This depends upon the number of operating nuclear reactors and the number of hours they operate that year. The GAO report also states the estimated total accumulation of commercial spent nuclear fuel, by roughly 2035 (with no new nuclear plants), is 140,179 metric tons but depends on when existing plants permanently shut down and how many new nuclear reactors enter operation. The GAO report buries in a footnote on page 34 is the fact that the cost estimate is limited to only 109,300 metric tons of commercial SNF, not the already expected 140,179 metric tons.

GAO-21-603 cost estimate ignores the fact that the disposal cap of 70,000 metric tons heavy metal (MTHM) on the Yucca Mountain repository — as well as the small detail that there is no repository program at Yucca Mountain or for any other site.

The statutory limit on the amount of spent nuclear fuel Yucca Mountain was limited to is 70,000 metric tons — and so the amount of commercial spent nuclear fuel slated for disposal is already expected to be double the currently legal amount, even without the defense- and research-related government-owned SNF and HLW. The cost of another repository for the defense- and research-related government-owned SNF and HLW is not available and tracking of the increases in this waste, such as Advanced Test Reactor spent nuclear fuel and naval submarine and carrier spent nuclear fuel isn't being addressed by the GAO.

The uncertainty of the costs of addressing the technical challenges of licensing, building and operating a repository cannot be overstated.

The technical challenges of repackaging welded-closed canisters, of transporting spent nuclear fuel some of which is far larger in length and weight than previously transported, of preventing accidental criticalities in waste with high uranium-235 and/or plutonium content, and of the overall repository create tremendous cost and schedule uncertainty. These technical challenges are going to be costly, not by 20 or 40 percent, but by factors of 2 to 20 or more.

The ability to achieve a successfully operating repository — ever — is questionable. The GAO continues to put an undeserved air of credibility to these highly speculative repository cost estimates presented in Department of Energy funded reports.

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[45] Geoffrey A. Freeze et al., Sandia National Laboratory, *Comparative Cost Analysis of Spent Nuclear Fuel Management Alternatives*, June 2019. https://www.osti.gov/biblio/1762633

[46] U.S. Government Accountability Office (GAO), Report to Congressional Addresses, "Commercial Spent Nuclear Fuel – Congressional Action Needed to Break Impasse and Develop a Permanent Disposal Solution," GAO-21-603, September 2021. https://www.gao.gov/nuclear-waste-disposal

Department of Energy Admits it Will Actively Withhold the Truth about the Problems of Spent Nuclear Fuel.

Currently, the Department of Energy is not attempting to site a geologic repository but is seeking the figure out the messaging and the incentives to get a community to sign up to allow a consolidated interim spent fuel storage facility. The DOE emphasized that it will use a flexible, adaptive, but not yet defined approach to entice a community to sign up for consolidated interim storage. **The DOE stated that it would use carefully filtered messaging in order to persuade the community's leaders.**

During the Nuclear Waste Technical Review Board meeting on both August 29 and August 30, 2023 the DOE emphasized its outreach to states and tribes and its intention to have special consortia seeking to identify people and possible incentives that would be effective in gaining approval by a community to have consolidated interim storage of spent nuclear fuel. [47] The DOE stated that consortia members will have ready access to DOE experts, special computerized tools and access to "unfiltered" information. **The non-tribal communities and tribes, it was stated, would not have access to DOE experts, special tools, or to "unfiltered" information.** The messaging and story-telling to attain siting that was most effective would be studied and applied by DOE.

With regard to transparency, the DOE also stated that the public would not be given or allowed access to information about its information gathering and discussions with consortia. The operation to convince and provide "incentives" to persuade a community into accepting a consolidated interim storage facility will be conducted in secrecy.

The U.S. Nuclear Regulatory Commission helps the lack of transparency. When the NRC did not include the carbon-14 releases from spent nuclear fuel thin-walled canister systems and belatedly addressed the issue, it made all documents concerning the methodology and the amount of carbon-14 released from a canister unavailable to the public. The air flowing past the spent fuel in thin-walled stainless steel canisters is open to the environment and is bombarded by neutrons from the spent fuel. Carbon-14 emissions, particularly from a Consolidated Interim Storage facility may be significant, especially if people live nearby or if crops are grown near the CIS.

The deceptive tactics of the Department of Energy, and other nuclear boosters, who seek to promote nuclear energy so matter the cost in the long run or the harm, cannot be overstated.

Some Details on Radiation Doses from Dry Storage of Spent Nuclear Fuel

Unshielded, the thin-walled canisters used prevalently for dry storage of spent fuel in the U.S. are enormous and can exceed 100,000 rad/hr. [48] For external dose, you can assume 1 rad is

[47] Environmental Defense Institute, Public Comment Submittal on the U.S. Nuclear Waste Technical Review Board (NWTRB) meeting held in Idaho Falls, Idaho on August 29 and 30, 2023, by Tami Thatcher at http://www.environmental-defense-institute.org/publications/CommentAugust2023NWTRBrev1.pdf

[48] S. Chu, EPRI Project Manager, The Electric Power Research Institute (EPRI), *Dry Cask Storage Welded Stainless Steel Canister Breach Consequence Analysis Scoping Study*, Technical Update, 3002008192, November 2017. (Note that gamma dose rates from unshielded spent fuel canisters assumed for 60 GWd/MTU of 5 percent initial enrichment, gamma dose rates of 1.18E4 rad/h and 1.69E5 rad/hr.)

equivalent to 1 rem, even though the details of depth of the dose into the body, versus the dose at the surface of the body, which depend on the gamma ray energy, complicate this. A lethal dose often being defined as 400 rem, an unshielded spent fuel canister presents a large hazard, a lethal dose in about 14 seconds. With shielding, the doses are far lower, but still pose a chronic dose health hazard.

For a single pressurized water reactor (PWR) storage cask, initial enrichment of 5 percent of uranium-235, average burnup of 70 GWd/MTU, and a 1-year cooling time, at 1 meter, the total dose rate is 509 millirem/hr. At 100 meters, the total dose rate is 0.343 mrem/hr. And at 1,600 meters, the total dose rate is 8.0E-7 mrem/hr. Over 80 percent of the dose is due to primary gamma for each of these distances.

After a 40-year cooling time, at 1 meter, the total dose rate is 4.73 mrem/hr. At 100 meters, the total dose rate is 3.13E-3 mrem/hr. And at 1,600 meters, the total dose rate is 1.6E-8 mrem/hr. However, for the 40-year cooling time, at 1,600-meter, secondary gamma contributes over 90 percent to the total dose. Also, at 1000 meters, primary dose is equivalent to neutron dose and neutron dose won't be measured without a neutron detector. [49] The low energy beta radionuclides of carbon-14 and tritium, also will not be detected by typical radiation monitoring metering or TLD badges.

For a hypothetical concrete cask loaded with pressurized water reactor fuel, the external radiation dose rate increases with increasing fuel burnup. The dose rate decreases with increasing distance from the cask and with increasing air density. The dose rate also decreases with years of cooling time. No one who values their health, especially their reproductive health would stand or work in the vicinity of spent nuclear fuel casks.

The primary gamma radiation that passes through the cask or canister system creates a range of gamma energies. The radionuclides confined inside the cask or canister that contribute to primary gamma outside the container are cerium-144, ruthenium-106, cesium-134, europium-154, strontium-90 and cesium-137. [50]

But in addition to the gamma radiation, neutrons are escaping the casks or canister systems. Neutrons go right through metal. The neutrons hitting a human body do great harm. But not only that, these neutrons collide with air or soil and create what is called "secondary gamma." High burnup fuels emit more neutrons and cause higher neutron dose and higher secondary gamma dose. They would also create more carbon-14 and also activation products in air and soil.

The amount of radiation dose from neutrons is less than for primary gamma, but it contributes proportionately more to the dose rate with increasing distance from the cask. The contribution to radiation dose from secondary gamma is significantly increased with higher fuel

[49] Georgeta Radulesuc and Peter Stefanovic (Oak Ridge National Laboratory), *A Study on the Characteristics of the Radiation Source Terms of Spent Fuel and Various Non-Fuel Hardware for Shielding Applications*, ORNL/SPR-2021/2373, May 2022. (ML22144A062)

[50] Georgeta Radulescu (Oak Ridge National Laboratory), U.S. Nuclear Regulatory Commission, Office of Nuclear Regulatory Research, *Updated Recommendations Related to Spent Fuel Transport and Dry Storage Shielding Analyses*, NUREG/CR-7302, ORNL/TM-2023/2629, May 2023. (ML23135A870)

burnup. The secondary gamma radiation also stays higher over time and does not decay away as rapidly as the primary gamma radiation.

Neutrons are emitted from the curium-244, curium-242, curium-246, and plutonium-238. Curium-244 is the dominating neutron source throughout a 40-year period.

For a 70 GWd/MTU average assembly burnup value and a 40-year cooling time, secondary gamma radiation dominated total dose rate at distances beyond 700 meters. A 10 percent decrease in air density produced a total dose rate increase at 1,600 meters from the cask of about 110 percent for fuel with a 5-year cooling time. [51]

Air density and soil composition affect radiation dose rates from the spent fuel in dry storage, particularly the far-field dose rates. Small air density variations can have a large effect on radiation dose rates at long distances from a cask. The dose rate increases with decreasing air density.

Depending on soil type, the groundshine dose is affected by the various scattering, neutron moderation, and absorption characteristics of the elements in the soil. The concentration of hydrogen in the soil as the hydrogen reduces the neutron energy and increases the probability of radiative capture reactions. This decreases the neutron groundshine but generates new secondary gamma sources. [52]

To recap, gamma radiation from the dry cask or canister systems occurs as gamma rays escape the cask. This occurs without external contamination of the cask or canister and without the loss of containment of the cask or canister. In addition to the gamma rays streaming from the cask or canister, neutrons are escaping from the cask or canister. While steel helps to shield gamma rays, neutrons are not stopped by steel. Neutron shielding typically includes material with hydrogen. Some neutron shielding materials may be vulnerable in a fire or other degradation. The escaping neutrons are not detected by gamma radiation detectors. The neutrons, however, to do create secondary gamma rays by interactions with the elements in soil. The neutrons also activate and make radioactive metal and concrete in the cask system. [53]

Metals can become activated by neutron absorption. For example, cobalt-59 present in metal can absorb a neutron and become cobalt-60 that is radioactive. The cobalt gamma dose from fuel upper and lower fittings gas plenum of the fuel assemblies is significant, especially at about 5 years of cooling, but tapers off after that.

When I was given training as a radiation worker, it was emphasized that beta radiation is easily shielded. Stontium-90 contained in the spent fuel is a beta emitter. Beta particles are

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[51] Georgeta Radulesuc and Peter Stefanovic (Oak Ridge National Laboratory), *A Study on the Characteristics of the Radiation Source Terms of Spent Fuel and Various Non-Fuel Hardware for Shielding Applications*, ORNL/SPR-2021/2373, May 2022. (ML22144A062)

[52] Georgeta Radulescu (Oak Ridge National Laboratory), U.S. Nuclear Regulatory Commission, Office of Nuclear Regulatory Research, *Updated Recommendations Related to Spent Fuel Transport and Dry Storage Shielding Analyses*, NUREG/CR-7302, ORNL/TM-2023/2629, May 2023. (ML23135A870)

[53] Waste Control Specialists, *WCS Consolidated Interim Storage Facility Safety Analysis Report*, Revision 2, ML18206A527, undated. [See neutron monitoring, secondary gamma, neutrons in air, soil or concrete, "skyshine."]

shielded by the metal cask or canister. **However, the beta emission inside the cask can create x-ray photons outside the cask through the production of Bremsstrrahlung radiation. And this adds to the primary gamma from the cask.**

Not usually mentioned regarding dry spent fuel storage is that the neutrons activate air and dust that can be inhaled. [54] Nor is the potential surface contamination from contamination in the spent fuel pool mentioned. Based on the allowable surface contamination from radionuclides in spent fuel pool water that could contaminate the metal canister lowered into the pool to load the spent fuel, those radionuclides can pose an inhalation dose as well.

Inhaled radionuclides become incorporated into the body. While the radioactive decay rate and biological clearance time is taken into account, the actual harm to specific organs and overall health harm are thought by independent experts to be perhaps 100 times higher than indicated by stated radiation whole-body doses in rem. This means that what would be considered negligible, such as a 10 mrem per year dose may in reality be more like a 1 rem dose annually.

When visiting nearby a dry storage facility for spent nuclear fuel, the radiation monitoring may be inadequate. Neutron monitoring is needed. Alpha particles may be present from canister surface contamination. Low energy beta particles may not be monitored, such as carbon-14 and tritium. Gamma activation of soil and air may be inhaled. And gamma radiation monitoring may be calibrated at these facilities to understate the true gamma dose. The gamma dose can vary depending on top or bottom of the system.

The extensive shielding report by Oak Ridge National Laboratory did not address the carbon-14 created by the spent nuclear fuel in dry storage in thin-walled canisters.

An Energy Secretary photographed standing near and placing their hands on the outer container structure for spent nuclear fuel dry storage sends the wrong message. I don't think this is being explained to the communities asked to host Consolidated Interim Storage facilities, or to Umatilla residents.

Nuclear Promotors Gloss Over the Problems of Low-Level Radioactive Waste

Nuclear promotors like to use the term "low level" waste. They don't explain that there are several classes of low level waste and it is a catch-all category that includes extremely concentrated, radiotoxic, and long-lived radioactive waste. It just isn't intact spent nuclear fuel, nor is it the waste for spent nuclear fuel reprocessing. Class A low level waste is the least hazardous class, while "greater-then-class C" is virtually unlimited radioactivity and longevity. So, the public may assume the "low level" means relatively benign and the nuclear promotors exploit this.

[54] Department of Energy, *Final 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*, Volume II Appendices A through J, DOE/EIS-0250F-S1, ML081750216, June 2008. [See activated air and dust in the repository and canister surface contamination dose description.]

Typical to the nuclear booster playbook to minimize the radioactive waste problem, they mention the Class A waste disposal areas and also mention the Waste Isolation Pilot Plant (WIPP) in New Mexico. It makes it seem like there are plenty of radioactive waste disposal opportunities.

During the testimony, a promotor of HB 2410 stated that the waste disposed of at WIPP was contaminated gloves and boots. This is a misrepresentation of the predominant waste disposed of at WIPP.

Concentrated chemical sludges contaminated with transuranic radionuclides are disposed on at WIPP, in addition to surplus plutonium. Only after spending billions of dollars, the Department of Energy decided to cancel the MOX fuel project. It was determined to be less costly by about half, to dispose of much of the surplus plutonium at the Waste Isolation Pilot Plant (WIPP) in New Mexico. [55]

There are still high costs and high risks associated with the blending and the transportation of the plutonium. And there is also the problem that WIPP is overcommitted and the Department of Energy has more waste than WIPP can hold. [56] Two accidents in 2014 at WIPP occurred, one resulted from explosion of a waste drum at WIPP which shutdown WIPP for about three years and costs to resume shipments may exceed $2 billion dollars. [57] [58]

WIPP is operated by the DOE and had two serious accidents that were caused by weak regulatory oversight and could have been far worse. WIPP is already overcommitted for the nation's nuclear weapons-related waste. WIPP was not designed to accommodate spent nuclear fuel. WIPP's license and commitments to citizens of New Mexico prohibit taking spent nuclear fuel or the high-level waste from reprocessing.

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[55] U.S. Department of Energy and NNSA, *Final Surplus Plutonium Disposition Supplemental Environmental Impact Statement Summary*, DOE/EIS-0283-S2, April 2015.

[56] National Academies of Sciences, Engineering, and Medicine, *Review of the Department of Energy's Plans for Disposal of Surplus Plutonium in the Waste Isolation Pilot Plant*, Washington, DC: The National Academies Press, 2020. https://doi.org/10.17226/25593 Surplus plutonium, 48.2 MT, but not ZPPR fuel has been slated for disposal in WIPP. Only 4.8 MT of plutonium-239 to be emplaced in WIPP, the addition of 48.2 MT of surplus plutonium in WIPP greatly increases the plutonium inventory disposed of at WIPP.

[57] U.S. 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 example shows how DOE safety analyses are unreliable and biased to lower the radiological consequences.

[58] Dr. Jim Green, *The Ecologist*, "WIPP nuclear waste accident will cost US taxpayers $2 billion," September 20, 2016. https://theecologist.org/2016/sep/20/wipp-nuclear-waste-accident-will-cost-us-taxpayers-2-billion

Hanford babies and naval nuclear personnel and many others harmed by radiation show us that radiation protection standards in the U.S. are not protective.

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. [59]

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. [60]

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. [61]

Robin Whyte wrote in the *British Medical Journal* in 1992 about the effect in neonatal (1 month) mortality and stillbirths in the United States and also in the United Kingdom. The rise in strontium-90 from nuclear weapons testing from 1950 to 1964 has been closely correlated, geographically, with excess fetal and infant deaths. The doses from strontium-90 due to atmospheric nuclear weapons testing were less than 50 millirem (or 0.5 millisievert), according the Chris Busby. Radioactive fallout from atmospheric nuclear weapons testing would not only include strontium-90, it would include iodine-131, tritium, cesium-137, and other radionuclides, including plutonium. [62]

Radiation-induced birth defects have typically been ignored or not reported by U.S. agencies and must be evaluated

Time magazine mentioned Julian Aguon's book *What We Bury At Night*, a chronicle of how irradiated Marshallese mothers had borne "jellyfish babies" with translucent skin and no bones.

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[59] 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*.

[60] 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.

[61] 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.

[62] R. K. Whyte, *British Medical Journal*, "First day neonatal mortality since 1935: re-examination of the Cross hypothesis," Volume 304, February 8, 1992. https://www.bmj.com/content/bmj/304/6823/343.full.pdf

From 1946 to 1958, the U.S. tested 67 nuclear weapons in the Marshall Islands near Guam. Official reports omitted the truth of the birth defects.

For more information about the health effects and after math from the U.S. bomb tests over the Pacific islands and the repeated deceptions about the consequences, read Giff Johnson, *Don't Ever Whisper —Darlene Keju, Pacific Health Pioneer, Champion for Nuclear Survivors*. [63]

Birth defects were omitted from studies of the Marshallese people that the U.S. exposed in nuclear weapons tests in the Marshall Islands. [64]

While the Department of Energy ignores its releases of uranium and thorium radionuclides in its environmental monitoring programs, despite the ever-increasing amounts of these radionuclides in our environment, honest epidemiology that finds elevated birth defects in regions that have higher levels of natural uranium is also ignored. [65]

Gulf War veterans who inhaled depleted uranium have children with birth defects at much higher-than-normal rate. The same kinds of birth defects also became prevalent in the countries where citizens were exposed to depleted uranium. There are accounts to suggest that the actual number of birth defects resulting from the World War II atomic bombs dropped on Japan and by weapons testing over the Marshall Islands have been underreported. The Department of Energy early on made the decision not to track birth defects resulting from its workers or exposed populations. But people living near Hanford and near Oak Ridge know of increased birth defects in those communities.

Naval Nuclear Personnel have 9.2 times the national cancer incidence rate and this points to radiation protection deficiencies

The Navy's own data for over 65,000 individuals reveal that Naval personnel have cancer rates exceeding nine times the national average, yet the Navy continues to tell its personnel that their radiation doses are too low to cause health harm.

Chris Busby compared the control group of 65,269 naval personnel, the control group not exposed to Fukushima, to the US national population, using the data on cancer rates in the US by age group from the SEER database, https://seer.cancer.gov/data/ **The result showed a 9.2-fold excess of cancer in the naval personnel compared to the national rates. "There were 121 cancers predicted on the basis of national rates, and 1119 reported by the DTRA study."** This is almost 1000 extra cancers and during less than a 3-year follow-up, only 2.55 years.!

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[63] Giff Johnson, *Don't Ever Whisper – Pacific Health Pioneer, Darlene Keju, Champion for Nuclear Survivors*, 2013. ISBN-10: 1489509062.

[64] Giff Johnson, *Don't Ever Whisper – Pacific Health Pioneer, Darlene Keju, Champion for Nuclear Survivors*, 2013. ISBN-10: 1489509062. *Time* magazine (around 2017) has also mentioned Julian Aguon's book *What We Bury At Night*, a chronicle of how irradiated Marshallese mothers had borne "jellyfish babies" with translucent skin and no bones. From 1946 to 1958, the U.S. tested 67 nuclear weapons in the Marshall Islands near Guam. Official reports deliberately omitted the truth of the birth defects.

[65] Kendall et al (2013). A record-based case–control study of natural background radiation and the incidence of childhood leukaemia and other cancers in Great Britain during 1980–2006. Leukemia. 27(1):3-9. http://pubmed.gov/22766784

The real stunning result proves the fallacy of the Navy's claim that they don't expose navy personnel to higher cancer risks. Unstated by the DTRA study was that the control group of 65,269 other naval personnel revealed a far higher rate of cancer, over nine times higher, than expected in the US population.

The motivation for the Navy's study was to evaluate the claim that personnel exposed to Fukushima were harmed.

In 2011, the Navy's nuclear powered aircraft carrier USS RONALD REAGAN was about 100 km from the Fukushima reactor meltdowns. The aircraft carrier then took part in "Operation Tomodachi" to assist victims of the Tsunami.

Personnel who served on the aircraft carrier started reporting a wide range of health problems, including cancers and sought legal action. However, a California judge later ruled that the case had to be heard in Japan, [66] undercutting any chance of success in the legal action. But in 2014, the publicity about the problem led to the US Navy deciding to prepare a report to address the accusations that the Fukushima fallout had harmed those who participated in Operation Tomodachi. A report was prepared by the US Defense Threat Reduction Agency (DTRA) that estimated the radiation exposure of personnel exposed during Operation Tomodachi and also the report compared the cancer rates of those exposed to Fukushima fallout to other naval personnel who are exposed to radiation but did not participate near Fukushima. [67]

As of the end of 2021, the U.S. Navy operated 70 nuclear-powered submarines, 11 nuclear-powered aircraft carriers, and three moored training ships. There are also six shipyards to maintain, overhaul, or refuel these nuclear propulsion plants, and two tenders and six naval bases. The U.S. Navy expounds on its meticulous radiation monitoring and attention to avoiding radiation doses that exceed federal standards.

Regarding annual radiation doses, the Navy has long claimed that it keeps average radiation doses far below the permissible 5 rem annual dose. In a 1994 report, the Navy claimed average doses were 200 millirem per year and that total lifetime doses from radiation associated with Naval nuclear propulsion plants averages only about one rem person. [68] More recently in 2022, the Navy states that no personnel have exceeded 2 rem in any year in the last 41 years. The Navy also states that most of the dose is from external radiation and the since 1962 no civilian or military personnel received more than 500 millirem annually from internal radiation exposure from naval nuclear propulsion plants. The average occupational exposure since 1954 from

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[66] Chris Busby, *Counterpunch*, "Cancer in US Navy Nuclear Powered Ships," March 6, 2020. https://www.counterpunch.org/2020/03/06/cancer-in-us-navy-nuclear-powered-ships/

[67] Dose Assessment and Recording Working Group (DARWG) with support from the Defense Threat Reduction Agency (DTRA), Submitted by the Office of the Assistant Secretary of Defense for Health Affairs, Final Report to the Congressional Defense Committees in Response to the Joint Explanatory Statement Accompanying the Department of Defense Appropriations Act, 2014, page 90, "Radiation Exposure," June 2014. https://www.health.mil/Reference-Center/Reports/2014/06/19/Radiation-Exposure-Report

[68] Naval Nuclear Propulsion Program, *Occupational Radiation Exposure from U.S. Naval Nuclear Plants and Their Support Facilities*, NT-94-2, March 1994. "The average occupational exposure of each person monitored is less than one-fifth of a rem per year, The total lifetime exposure from radiation associated with Naval nuclear propulsion plants to date for all personnel monitored since 1954 has averaged about one rem per person."

external and internal radiation combined is less than 110 millirem per year, according to the Navy.

Regarding lifetime average radiation doses, according to the 2022 report by the Navy, the total lifetime average exposure during this 68-year period is less than 1 rem per person. [69]

The DTRA study discounted the claim that doses from Fukushima had harmed naval personnel. The DTRA study compared the cancer rate of the 4,843 naval personnel who participated near Fukushima in Operation Tomodachi to matched control group of 65,269 naval personnel. The period of analysis was from 2011 to 2013, less than three years, only 2.55 years.

If there was no particular harm from exposure to Fukushima fallout, the study should have found that the cancer rates for the 4,843 personnel near Fukushima were about the same as the matched control group of over 65,000 naval personnel.

But that's not what the DTRA study found. The study found that those personnel exposed to Fukushima fallout had a significantly lower rate of cancer incidence. The DTRA study stated that the cancer incidence rate for naval personnel exposed to Fukushima fallout "was nearly 50 percent lower" than the rate of cancer incidence in the over 65,000 personnel not exposed to Fukushima. [70] So, the navy was pleased with its analysis.

But a professor in the United Kingdom took a look at the data for the 65,000 personnel and compared the data to the U.S. national cancer rates.

Christopher Busby found that if the 4,843 personnel and the "unexposed to Fukushima" control group of 65,269 were compared after adjusting for age, there was actually only 30 percent more cancers in the control group, not 50 percent. Busby also noted that the records from 76 personnel were removed from the 4,843 personnel. Had only 15 more cancers occurred from the 76 missing individuals, the Fukushima exposed group would have equaled the control group. [71] But it was too much trouble for the Navy to track down medical records for 76 missing individuals.

It must also be stated that the limited three-year period following Fukushima exposure means that many of those cancers may have not had time to manifest. The cancer rates of the Fukushima-exposed naval personnel may yet indeed exceed that of the 65,000 naval personnel not exposed to Fukushima.

The Fukushima-exposed naval personnel having significantly less cancers than the control group is telling us something is fishy and the Navy's willingness to not explain that the

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[69] Naval Nuclear Propulsion Program, Department of the Navy, *Occupational Radiation Exposure from U.S. Naval Nuclear Plants and Their Support Facilities*, Report NT-22-2, May 2022.

[70] Dose Assessment and Recording Working Group (DARWG) with support from the Defense Threat Reduction Agency (DTRA), Submitted by the Office of the Assistant Secretary of Defense for Health Affairs, Final Report to the Congressional Defense Committees in Response to the Joint Explanatory Statement Accompanying the Department of Defense Appropriations Act, 2014, page 90, "Radiation Exposure," June 2014. https://www.health.mil/Reference-Center/Reports/2014/06/19/Radiation-Exposure-Report

[71] Christopher Busby, *Cancer Investigation*, "High Cancer Risk in US Naval Personnel Serving in Nuclear Powered Ships," January 2020. https://doi.org/10.1080/07357907.2020.1731526

Fukushima exposed personnel were not evaluated with a long enough follow-up time shows either incompetence or dishonesty.

Sorting out how much is due to the inadequacy of radiation monitoring, the underreporting of radiation doses, particularly the inadequacy of the internal radiation monitoring and the especially the underestimation of cancers from internal radiation by currently used radiation health models is still needed.

The radiation doses, job descriptions, and medical records for 65,000 adults would provide a very important source of information for low-dose radiation studies and it points to a very large underestimate of harm from chronic exposure to radiation coupled with internal contamination from inhalation or ingestion of radioactive material. But not unsurprisingly, the nuclear industry isn't interested in this bombshell revelation that naval personnel with low radiation doses have 9.2 times the cancer incidence compared to the U.S. population.

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