# Public Comment Submittal on the Draft Environmental Impact Statement for Department of Energy Activities in Support of Commercial Production of High-Assay Low-Enriched Uranium (HALEU), DOE/EIS-0559

## Comment submittal by Tami Thatcher, April 22, 2024. (Revision 1)

*Comments are due April 22, 2024 and may be sent to HALEU-EIS@nuclear.energy.gov*

**Summary**

In March 2024, the Department of Energy issued for public comment the Draft Environmental Impact Statement (EIS) in support of commercial production of high-assay low-enriched uranium (HALEU). [1] HALEU is uranium enriched up to as high as 20 percent in uranium-235, and is generally higher enrichment than the fuel used in current light-water reactors which is below 5 percent enriched. Higher enrichment allows longer operation without refueling, but with longer operation in a reactor, more fission products are generated. The higher enrichment complicates disposal and it also creates a nuclear weapons material proliferation problem which is the concern that the material may be stolen and used in a nuclear weapon.

Because of the enormous cost and the inevitable radiological harm from increased HALEU production, I opposed DOE's Proposed Action and I urge DOE to choose the No Action Alternative, "where no sufficient domestic commercial supply of HALEU is available."

Far more innovation is possible in using other technologies such as storage and efficiency improvements than described in the Draft HALEU EIS for the No Action Alternative. However, time is running out and money is scarce. The DOE's advanced reactor schemes and HALEU promotion take too long and are too expensive to combat climate change. The nuclear reactor and HALEU promotion must be evaluated with consideration of how long it will take to deploy and how much it will cost, not only for construction but also for permanent disposition of the spent nuclear fuel created.

The Draft HALEU EIS states that "One of the aspects of a clean energy future is sustainment and expanded development of safe and affordable nuclear power." This is biased, speculative conjecture. Nuclear energy is highly radiologically polluting even without an accident. Nuclear energy, even when ignoring the cost of attempting to manage and dispose of spent nuclear fuel as the Draft HALEU EIS does and the nuclear industry does, is simply not affordable.

The Draft HALEU EIS relies on other biased and inadequate EISs such as the U.S. Nuclear Regulatory Commission's 2014 Generic "Continued Storage" EIS that updated its previous "Waste Confidence" EIS by assuming that spent nuclear fuel will be repackaged before canisters fail, all without any funding source or planning. This assumption allowed the NRC's "Continued Storage" of spent nuclear fuel EIS to side step conducting economic and national security

[1] U.S. Department of Energy, *Draft Environmental Impact Statement for Department of Energy Activities in Support of Commercial Production of High-Assay Low-Enriched Uranium (HALEU)*, DOE/EIS-0559, March 2024. https://www.energy.gov/ne/haleu-environmental-impact-statement Public comment is open until April 22, 2024 and comments may be sent to HALEU-EIS@nuclear.energy.gov

consequences, and human health and environmental consequences of failure to isolate radionuclides from spent nuclear fuel from the biosphere.

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

The radioactive waste in spent nuclear fuel remains toxic and hazardous to humans and other living things for millennia. But obtaining permanent disposal for spent nuclear fuel remains more elusive today than it was 20 years ago despite decades of effort. Between 1983 and 2010, about $15 billion was spent investigating and attempting to design and license a repository at Yucca Mountain that was never built.

The Draft HALEU EIS acknowledges that the Department of Energy's program for a geologic repository for spent nuclear fuel at Yucca Mountain, Nevada, has been terminated. Empty statements are made that DOE remains committed to meeting its obligations to manage and, ultimately, dispose of spent nuclear fuel. The Yucca Mountain repository program was terminated in 2010. The DOE has continued conducting limited and generic repository research since 2010 and yet appears no closer to designing, licensing, and operating a repository.

The DOE is not admitting how many repositories it actually needs now without the new reactors DOE is promoting. The DOE is not providing a viable or affordable concept for disposing of spent nuclear fuel. The proposed advanced reactors may require much more space in a repository, due to higher enrichment and other characteristics. Honest and realistic evaluation of the increased amount of spent nuclear fuel and the increased technical challenges of the proposed varieties of spent nuclear fuel must be included in any useful EIS that meets the intent of conducting an environmental impact statement, which should be to protect humans and the environment.

The Draft HALEU EIS is claiming that storage of spent nuclear fuel is safe and yet by the DOE's own admission, there is not enough information to conclude that long term storage (greater than a few decades) of spent nuclear fuel is safe. Nor is there enough information to conclude that transportation of spent nuclear fuel can be conducted safely after long term storage.

The cost of spent nuclear fuel disposal has been estimated by the Department of Energy in 2019 as $168 billion and yet was low-balled in many ways. The DOE's existing cost estimate for only a portion of the nation's existing spent nuclear fuel does not include the cost of the increased nuclear reactors now being promoted by the Department of Energy. Many of the proposed reactors will produce spent nuclear fuel that may require disproportionately more space in a repository because of the higher enrichment and other characteristics. The increase in the amount of spent nuclear fuel to dispose of because of DOE's promotion of more nuclear energy must be addressed and not swept aside as it is in the Draft HALEU EIS.

Spent nuclear fuel and high-level waste disposal are the foundation of the U.S. nuclear industry's spent nuclear fuel management promises. The Department of Energy has made reference to its repository program at Yucca Mountain in many of its Environmental Impact Statements. Despite this, the Department of Energy makes no progress toward a permanent solution for the radioactive waste, the spent nuclear fuel, that is poised to contaminate air, land and water for millennia. The Department of Energy seeks endless and expensive schemes to make more waste, as the work to attempt to figure out how to confine the waste for millennia languishes. Even the work to safely confine the waste for a few decades languishes.

This Department of Energy's Draft HALEU EIS actively avoids evaluation of the complications and costs of various reactor fuels that would use HALEU feedstock. The feasibility, cost and technical difficulty are treated by DOE as non-problems until the costs and difficulties lead to years of expense and failure. There is a steadfast refusal by the Department of Energy to learn from past and ongoing mistakes. But not every problem is actually solved by changing the name of the facility, by sanitizing the facts about the contamination, by failure to monitor the contamination, or by denial of the source of the illnesses and excess deaths. See the former Portsmouth Gaseous Diffusion Plant, now renamed the American Centrifuge Plant, near Piketon, Ohio.

According to the Government Accountability Office, "Cleaning up 3 plants where uranium was enriched will cost billions of dollars and span decades. These sites – near Oak Ridge, Tennessee, Paducah, Kentucky; and Portsmouth, Ohio [actually near Piketon, Ohio] – are contaminated with radioactive and hazardous materials. [2]

The Draft HALEU EIS relies on the U.S. Nuclear Regulatory Commission's 2014 Generic EIS for "Continued Storage" of spent nuclear fuel. [3] That generic EIS uses magical thinking to avoid stating that actual environmental and human health devastation of failing to confine the radioactive spent nuclear fuel.

The NRC's 2014 generic EIS for Continued Storage of spent nuclear fuel simply assumed that Dry Transfer Facilities would be used at every location spent nuclear fuel is stored, and would repackage the spent nuclear fuel as many times as needed, and about every 100 years. In 2024, no Dry Transfer Facility has been designed. There is no cost estimate being provided for the design, construction and operation of 70 plus or so of these Dry Transfer Facilities. Each one is likely to be very costly and the electric utilities don't want to pay for it. Dry Transfer Facilities

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[2] U.S. Government Accountability Office, *NUCLEAR CLEANUP Actions Needed to Improve Cleanup Efforts at DOE's Three Former Gaseous Diffusion Plants*, GAO-20-63, December 2019. https://www.gao.gov/products/gao-20-6

[3] Nuclear Regulatory Commission, *Generic Environmental Impact Statement for Continued Storage of Spent Nuclear Fuel*, U.S. Nuclear Regulatory Commission Office of Nuclear Material Safety and Safeguards, NUREG-2157, 2014.

will be needed and will entail high radiation exposures to workers and may also involve radiological releases affecting the public.

Accidents from spent nuclear fuel storage and from failure to repackage spent nuclear fuel prior to canister breach must be included in the HALEU EIS. The U.S. Nuclear Regulatory Commission has ignored aging effects and canister corrosion that threaten the safety of spent nuclear fuel storage by arguing that the limited years of the license period are its only concern.

The Department of Energy has itself acknowledged that it does not have a technical basis for assessing the radiological consequences of spent nuclear fuel storage canister breach such as from expected chloride-induced stress corrosion cracking.

Spent nuclear fuel canister aging and degradation in the face of ongoing repository delays is going to require repackaging the spent nuclear fuel at existing SNF storage sites and yet no method has been designed for repackaging the spent nuclear fuel. The Draft HALEU EIS needs to explain who will pay for the cost of spent nuclear fuel repackaging that will be needed as decades continue to go by without a repository.

**The cost of attempting to design, license and operate one or several repositories for spent nuclear fuel is not being admitted and there has been no money collected via the Nuclear Waste Fund since 2014 because the DOE has no repository program.**

The electric utilities have been permitted use methods of spent nuclear fuel storage that complicate repackaging, complicate transportation and complicate disposal, all with the U.S. Nuclear Regulatory Commission's approval. The utilities don't worry about cost as long as it comes from the U.S. taxpayer and not from them.

Future generations will likely be stuck with needing billion-dollar-each repackaging facilities at each of the 75 commercial power plant sites. DOE's HALEU production aims to create far more stranded fuel sites as small and micro reactors are deployed and no place is designated for this spent nuclear fuel to go. The Draft HALEU EIS states that HALEU spent nuclear fuel is to be stored on-site at the reactor generating the spent nuclear fuel (Section 2.1.7.3). For the tri-structural isotropic (TRISO) coated particle fuel for advanced nuclear reactors including several proposed mobile reactors that are to be deployed, this spent nuclear fuel will be located near your home, school, hospital — and the spent nuclear fuel may be staying more permanently than the residents.

The NRC's 2014 generic EIS also presumes safe transport of spent nuclear fuel. Yet, the NRC has allowed increasingly high uranium-235 enrichment and higher burnup fuels. This high burnup fuel, over 45 GWD/MTU for example, has been loaded into dry storage canisters without meeting transportation requirements for the Certificate of Compliance. And now the pressure will be on the NRC **to grant exemptions** to transportation safety requirements for spent nuclear fuel. [4] [5] Who can say what the level of safety will be?

There is an existing supply of 14.9 metric tons (MT) of HALEU from DOE facilities. The Proposed Action states that it seeks to produce 50 MT/year for a total of 290 MT and also states that **it expects about 500 MT per year to be produced by 2050**. (See page 29 of the Draft HALEU EIS.) Yet, the Draft HALEU EIS that relies on the NRC's 2014 generic EIS had only assumed up to 290 metric tons of HALEU in total.

The Draft HALEU EIS claims that reactor operations, spent nuclear fuel storage and disposal are reasonably foreseeable activities that could result from implementation of the Proposed Action. If the HALEU is not used, the entire effort will be a waste of money and time, and will also result in radiological pollution from the mining, milling, conversion and enrichment processes to make the HALEU.

If reactors do get licensed, designed and built, then 500 MT per year of spent nuclear fuel requiring storage and disposal would be created. Many of the proposed advanced reactor designs, such as the high-temperature gas-cooled reactors that use TRISO fuel are not likely to ever be reprocessed. Tri-structural isotropic or TRISO fuel is solid coated particle fuel in pebble style or prismatic block fuel elements. The TRISO fuel pebbles are coated with silicon carbide. No method has been developed for TRISO fuel reprocessing and it may not be possible or affordable. Therefore, the burden of disposal of TRISO spent fuel made from HALEU and other HALEU fuels must be acknowledged. The burden of spent nuclear fuels from the various advanced reactor designs needs to be acknowledged. The high enrichment of HALEU will mean that the fuel requires more containers and more space in a disposal repository.

In the U.S., reprocessing of commercial spent nuclear fuel was conducted at West Valley, New York. The result was uneconomical and environmentally damaging while creating weapons material proliferation risks — even if renamed "recycling." [6] HALEU production inherently increases weapons material proliferation concerns. The cost and the radiological polluting of reprocessing has not been adequately addressed in the Draft HALEU EIS or the EISs it cites. In addition, it needs to be made clear when uranium-235 is sought, or plutonium-239 is sought. Because it is laughable to want to reprocess in order to get more plutonium-239 when the DOE is seeking to dispose of several metric tons of surplus plutonium and at great cost. The expense and risk posed by the aging storage of depleted uranium that there is already far too much of is also not adequately addressed.

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[4] U.S. Nuclear Waste Technical Review Board, *Preparing for Nuclear Waste Transportation – Technical Issues that Need to be Addressed in Preparing for a Nationwide Effort to Transport Spent Nuclear Fuel and High-Level Radioactive Waste*, A Report to the U.S. Congress and the Secretary of Energy, September 2019. See Figure A-1.

[5] U.S. Nuclear Waste Technical Review Board, *Evaluation of the U.S. Department of Energy Research and Development Activities on the Disposition of Commercial Spent Nuclear Fuel in Dual-Purpose Canisters,* February 2024. https://www.nwtrb.gov/our-work/reports/evaluation-of-the-u.s.-department-of-energy-research-and-development-activities-on-the-disposition-of-commercial-spent-nuclear-fuel-in-dual-purpose-canisters-(february-2024)

[6] John C Wagner, *House Energy and Commerce Committee, American Nuclear Energy Expansion: Spent Fuel Policy and Innovation Hearing Testimony Summary*, April 10, 2024.

When it comes to uranium mining and milling, little progress has been made in cleaning up uranium mines and mill tailings sites. "The site remediation costs have exceeded costs originally envisioned by Congress, the agencies, and the licensees due to an evolving understanding of the complexities and risks posed by unintended releases of contaminants from uranium mill tailings." [7] Replace the words uranium mill tailings, as needed for every activity associated with the uranium fuel cycle, and the same statement can be applied to every activity being proposed by the Department of Energy in its Draft HALEU EIS. These are either already forever contamination sites or are destined to become a forever contamination site.

Despite decades of studying the effects of ionizing radiation on human health, the last several decades can be remembered for what the Department of Energy and the nuclear industry in the U.S. have refused to learn about the harm of radiation on human health. The evidence is there that chronic low doses of radiation especially from ingestion of contaminated food is especially harmful to the child developing in utero and to children. [8] Following nuclear power plant closures, decreases in the radioactivity of milk has been noted and reductions in infant deaths and incidence of childhood cancer. [9]

The nuclear industry continues to turn a blind eye to the harm it has caused and to any information that would cause it to need to rein in its generous spread of radiological contamination.

No one who cares about actual solutions for climate change would ever support DOE's costly, polluting, slow and unsafe nuclear reactor schemes. DOE's Proposed Action in an unstated way, embraces the scenario that HALEU is not actually used in reactors to any significant degree, in order to avoid explaining the reactor safety risks and the risks and costs of additional spent nuclear fuel disposal.

**HALEU Production is Highly Polluting**

As the Draft HALEU EIS Proposed Action would include, the DOE wants to facilitate the establishment of highly polluting and unaffordable commercial HALEU fuel production. The acquisition of HALEU fuel would be made available to commercial use or demonstration projects, such as TerraPower Natrium nuclear reactor and X-energy high-temperature gas-cooled reactors.

The Department of Energy's Proposed Action, states in several places that under the Proposed Action, DOE seeks to acquire HALEU enriched to "at least 19.75 and less than 20 weight percent U-235." (See the Draft EIS Summary including page 3, page 10 and also Figure

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[7] Congressional Research Service, Prepared for Members and Committees of Congress, *Long-Term Federal Management of Uranium Mill Tailings: Background and Issues for Congress*, R45880, February 22, 2021.

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

[9] Joseph J. Mangano, Jay M. Gould, Ernest J. Sternglass, Janette D. Sherman, Jerry Brown and William McDonnell, Radiation and Public Health Project, "Infant Death and Childhood Cancer Reductions after Nuclear Plant Closings in the United States," *Archives of Environmental Health*, Vol. 57 (No.1), January/February 2002.

F.1-1.) Despite this erroneous error, it seems that DOE is actually seeking “a program to support the availability of uranium enriched to greater than 5 and less than 20 weight percent uranium-235.” (See its June 5, 2023 Federal Register Notice.)

The HALEU production will include uranium mining and milling, conversion of uranium ore into uranium hexafluoride, uranium enrichment, uranium deconversion from uranium hexafluoride to others forms such as metal and oxide forms, transportation, and storage.

The Draft HALEU EIS states that it is reasonably foreseeable that the following activities could result: fuel fabrication, use in nuclear reactors, and spent fuel storage and disposition. But the Draft HALEU EIS only makes pathetic statements pertaining to DOE’s commitment to spent nuclear fuel disposal. The Department of Energy has no spent nuclear fuel disposal program.

The Department of Energy has not cleaned up its radiological contamination or its waste from spent nuclear fuel reprocessing for weapons programs. The DOE’s pattern of not cleaning up its messes and putting workers and communities at risk continues. No one who understands DOE’s actual history and status of its lack of cleanup would be in favor of this expensive and radiologically contaminating HALEU Proposed Action. Extensive problems remain still unsolved at DOE’s Hanford Site, Savannah River Site, Idaho National Laboratory and many other sites.

The Department of Energy has failed for the last two decades to provide any meaningful help to combat climate change. The deployment of a few micro-reactors will not make any meaningful difference to reduce the use of fossil fuels. The speculative gamble of TerraPower’s sodium-cooled fast reactor is likely to mean in about twenty years from now, a single reactor might intermittently operate, with the risk of catastrophic failure.

## More About Highly Polluting HALEU Production and DOE’s Disinformation

The Department of Energy wants to encourage commercial producers to invest in the necessary fuel cycle infrastructure and gear up production to provide the expected amount of HALEU needed for commercial use or demonstration projects.

The production of HALEU under DOE’s Proposed Action is acknowledged by DOE to require the following:

- Uranium mining and milling
- Conversion of uranium ore into uranium hexafluoride
- Uranium enrichment to HALEU
- Deconversion of uranium hexafluoride to oxides or metal
- HALEU storage
- Transportation of uranium between activity locations

The use of HALEU will also involve fuel fabrication, and its use in nuclear reactors will generate spent nuclear fuel that require continued storage and either disposal or reprocessing.

All of these activities for HALEU involve the poisoning the workers, the public and the environment with radioactive materials. Some of the poisoning happens sooner, some of it later.

The Department of Energy and other nuclear boosters are making several incorrect claims:

1. Myth: *Nuclear energy is needed to combat climate change*. In fact, nuclear energy is too slow to deploy and also so expensive, that it impedes the ability to combat climate change.
2. Myth: *Nuclear energy is affordable.* In fact, the construction costs alone make nuclear energy unaffordable. But the cost of spent nuclear fuel storage for decades and who knows for how long, and the cost of nuclear fuel disposal also must be considered. The cost of spent nuclear fuel disposal is being low-balled by the Department of Energy, and reported by the U.S. Government Accountability Office as though the cost estimates had any credibility. The Department of Energy has no program to site any repository and continues to have no plan to site one (or more). The costs of the repositories we already need, will be the burden of future generations. The Department of Energy and nuclear boosters love to say that reprocessing spent nuclear fuel is the solution, but they don't admit the cost of reprocessing let alone the radiological pollution and resulting waste to dispose of. And when reprocessing might be conducted on certain spent nuclear fuel, they don't admit that how the bulk of the spent nuclear fuel will remain, still needing disposal.
3. Myth: *Nuclear energy has a small footprint*. The land where many nuclear reactors have operated is increasingly becoming the permanent dumping ground for radioactive materials. Also, the spent nuclear fuel is stranded at nuclear reactor sites and as spent nuclear fuel in dry storage degrades and the casks or canisters degrade, this spent nuclear fuel poses increasing storage and transportation safety challenges. The routine airborne releases and the groundwater releases depend on the reactor type, but can be spread far and wide, entering the food chain and entering our bodies. Accidents involving a nuclear reactor, spent fuel in a pool or in dry storage, transportation accidents, or sabotage can involve permanent contamination of vast areas of land. Spent nuclear fuel disposal will also require large repositories and even with reasonably expected performance of the repository, will trickle out radioactive contamination for over a million years.
4. Myth: *Nuclear energy is needed for reliable base-load power*. In fact, the nuclear reactors expected to use HALEU like the TerraPower Natrium, a liquid-metal cooled fast neutron reactor, have a record of frequent and long outages. And high-temperature gas-cooled reactors, like X-energy wants to build that also use HALEU, also have a poor operating record. The Fort St. Vrain reactor in Colorado was a high-temperature gas-cooled reactor that had frequent maintenance problems. The reality is that fossil-fueled plants will remain online to provide power for these unreliable so-called "advanced" nuclear reactors.
5. Myth: *Nuclear energy is clean*. In fact, with routine activities from mining, milling, fuel fabrication, nuclear reactor operation, fuel reprocessing, and radioactive waste disposal, nuclear energy has caused countless radiologically contaminated sites across the U.S. Cancer rates can be shown to increase near every operating nuclear reactor. [10]

[10] Jay M. Gould with members of the Radiation and Public Health Project, Ernest J. Sternglass, Joseph U. Mangano, and William McDonnell, *The Enemy Within – The High Cost of Living Near Nuclear Reactors – Breast Cancer,*

> Radiological releases contaminate air, soil, and water and enter the food chain. The radioactive particles enter our bodies, in chronic exposures, and especially harm women, children and the unborn developing child. [11] Accidents involving nuclear material are excluded from home and auto insurance policies. 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. [12] See the 2021 report by the U.S. Nuclear Regulatory Commission discussing the Price-Anderson Act [13] and the 2023 report by the Department of Energy. [14]

When nuclear boosters promote nuclear energy as "small footprint," they tend to leave out the space required for spent nuclear fuel disposal as well as other radioactive waste disposal. **The U.S. already has over twice as much spent nuclear fuel (existing now or expected to be produced from currently licensed reactors) than was allotted for the Yucca Mountain repository.**

## DOE Engaging in Fast Reactor Disinformation

The Department of Energy is giving money to Bill Gates' backed TerraPower, that is planning to build a 345-MWe sodium-cooled fast reactor, called "Natrium," in Kemmerer, Wyoming, that scales up the INL's former 20 MWe EBR II sodium-cooled reactor. The Natrium reactor will be accompanied by a molten salt-based energy system. [15] TerraPower claims Natrium can be running by 2030 – which appears unrealistic. INL is collaborating with the nuclear fuel design, despite the news that the fuel material will be imported from Russia, rather than INL's HALEU from EBR-II from its Materials and Fuels Complex. [16] [17]

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*Aids, Low Birthweights, and Other Radiation-Induced Immune Deficiency Effects*, Four Walls Eight Windows, 1996. ISBN 1-56858-066-5. See pages 131 and 281.

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

[12] 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."

[13] 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

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

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

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

[17] Environmental Defense Institute, April 2022 newsletter article, "HALEU Fuel for the TerraPower's Proposed Sodium-Cooled Natrium Nuclear Plant Could be Impacted by Ban on Russian Imports of Low-Enriched Uranium."

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

A vast amount of misinformation is coming directly from the Department of Energy, like misleading claims that a sodium-cooled fast reactor can burn spent nuclear fuel, see https://www.energy.gov/ne/articles/3-advanced-reactor-systems-watch-2030 where DOE implies that sodium-cooled fast reactors can burn spent nuclear fuel from current reactors. If sodium-cooled fast reactors could burn the vast amounts of spent nuclear fuel from US commercial nuclear reactors, then HALEU production would not be needed, would it? False claims by the Department of Energy have become the norm.

While the Department of Energy prefers to call spent nuclear fuel a "resource" rather than a waste, the Department of Energy actively avoids admitting the full costs of spent nuclear fuel management and disposal. While it is true and has been known for decades that plutonium is created when uranium-238 absorbs a neutron and plutonium can also fission in a nuclear reactor, the Department of Energy's claims that a sodium-cooled fast reactor can burn "nuclear waste" are misleading. The Natrium reactor will produce more nuclear waste than it can burn and cannot use but perhaps a tiny fraction of the existing nuclear waste for its fuel.

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

Construction has not yet started on the 325 megawatt-electric (MWe) Natrium sodium-cooled fast reactor nuclear plant. Sodium-cooled fast reactors are the least safe to operate, create the comparatively far more radioactive waste disposal problems and will require costly conditioning to remove the salt before disposal via pyroprocessing.

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

The higher the fissile content in the spent fuel, the greater the criticality hazard for transportation, storage and disposal. The criticality risk may not peak until 25,000 years after removed from a reactor, despite the lack of regulations for criticality beyond 10,000 years by the U.S. Environmental Protection Agency.

About half of the money to build the $4 billion Natrium reactor is coming from the Department of Energy. And now Natrium backers are seeking lawmakers to provide another $2.1 billion to support HALEU fuel production.

HALEU fuel production releases airborne radiological contamination and is expensive even when aided by existing highly enriched uranium-235 material already accumulated by the U.S. Department of Energy, such as from the EBR-II reactor research. The pyroprocessing of EBR-II fuel in Idaho is causing excessively high airborne radiological releases and is being paid for by taxpayers.

### Technical Immaturity of Spent Nuclear Fuel Repository Concepts and Absence of a Repository Siting Program Must Be Evaluated

The Department of Energy mischaracterizes the magnitude of the unsolved technical challenges for finding a permanent solution to the radioactive waste problem posed from nuclear energy. The Department of Energy's recent "Liftoff" document implies that the spent nuclear fuel problem isn't a big problem because the volume of spent nuclear fuel "is quite small" and stating that the volume of spent nuclear fuel "could fit on a single football field at a depth of less than 10 yards." [18]

**The fact is that the Department of Energy was needing 41 miles of waste emplacement tunnels (or drifts) at the proposed Yucca Mountain repository as limited by law to 70,000 metric tons of spent nuclear fuel.** And this assumed repackaging and positioning the waste to limit the thermal heat load. [19] The football field analogy is highly misleading. And the U.S. already will have about 140,000 metric tons of spent nuclear fuel to dispose of, even without any new reactors going online.

Despite the much photographed Yucca Mountain, the Yucca Mountain repository was never granted a license to construct, was never built, and never had a technically sound basis for confining the radioactive waste.

Typical commercial nuclear spent fuel is enriched to less of 5 percent enriched. HALEU is expected to be enriched to "at least 19.75 and less than 20 weight percent uranium-235." **The use of high-assay low-enriched uranium (HALEU) inherently means enriched uranium-235 is more available for diversion to nuclear weapons and creates nuclear material security problems.** So much for being "secure."

**The higher enriched HALEU fuels will require disproportionately more space in a disposal repository.** HALEU would be used to make TRISO fuels proposed for high-temperature gas-cooled reactors and for the fuel for the TerraPower Natrium liquid-metal fast reactor.

The TRISO fuel would be more difficult to reprocess than many other fuels because of various silicon impurities and high loadings of carbon fines, [20] and no process has been developed to reprocess TRISO fuel. The cost of reprocessing, the airborne polluting while

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[18] U.S. Department of Energy webpage, Pathways to Commercial Liftoff: Advanced Nuclear, March 2023. https://www.energy.gov/lpo/articles/sector-spotlight-advanced-nuclear See page 35.

[19] U.S. Department of Energy, *Draft Supplemental Environmental Impact Statement for a Geologic Repository for the Disposal of Spent Nuclear Fuel and High-Level Radioactive Waste at Yucca Mountain, Nye County, Nevada*, DOE/EIS-0250F-S1D, October 2007. https://www.energy.gov/sites/prod/files/EIS-0250-S1-DEIS-Summary-2007_0.pdf

[20] Charles W. Forsberg and David L. Moses, Oak Ridge National Laboratory, *Safeguards Challenges for Pebble-Bed Reactors Designed by People's Republic of China*, ORNL/TM-2008/229, November 2009.

reprocessing, the extra radioactive waste generated by reprocessing [21] and the weapons material theft are problems with reprocessing spent fuel.

Similar TRISO spent fuel languishes in the U.S. Fort St. Vrain spent nuclear fuel and also in Germany, and remains costly to store decades after the reactors were shuttered. So much for being "affordable." There may be safety advantages to the TRISO fueled Xe-100 reactor, but information isn't available to make much of an assessment.

The Department of Energy conducted a study completed in 2023 about Xe-100 reactor impacts on a repository, but that report, mentioned at the August 2023 U.S. Nuclear Waste Technical Review Board Meeting, is still withheld from the public. [22] Apparently, the waste disposal characteristics of Xe-100's spent fuel are not something the public should be told about.

The difficulty in disposal of TRISO fuel and reactor internals will depend on whether or not the graphite can be disposed of with the spent fuel and whether or not the graphite exceeds Class-C low-level radiative waste criteria. In addition, when the carbide in TRISO fuel is exposed to water, flammable gases are generated, which may be significant. Also, the more highly enriched the fuel, above 3 to 5 percent, additional measures may be needed to ensure criticality control after disposal, particularly if the fuel is separated from the graphite blocks. [23]

X-energy's design is for a 60-year reactor design life and for an 80-year spent fuel storage design. X-energy is stating that **"X-energy has engaged with the DOE to strategize their acceptance of all spent fuel within the 80-year period."** [24] **But this statement is no guarantee that there will be a permanent repository in 80 years.**

The Bill Gates TerraPower Natrium reactor would also use HALEU fuel but its spent nuclear fuel may require processing prior to placement in a repository. The metallic sodium-bonded fuel may require treatment to remove metallic sodium. [25] That reprocessing, dry pyroprocessing, will be costly and will release radionuclides to the skies. Pyroprocessing has been conducted only on a small scale, and has left radioactive waste yet to be disposed of.

Advanced reactor designs using HALEU fuels may differ substantially from existing commercial spent nuclear fuels currently stored. The Natrium reactor, X-Energy reactor, and a variety of others are being proposed. The Department of Energy is eager to encourage any and all proposed reactors. **And for each reactor and its fuel design and use, the HALEU fuels may need different handling, storage, transportation and disposal options. These new fuels**

[21] *Blue Ribbon Commission on America's Nuclear Future, Report to the Secretary of Energy*, 2012.

[22] Brady Hanson, Pacific Northwest National Laboratory, Laura Price, Sandia National Laboratory and others, *Report of the Back-End Management of Advanced Reactors (BEMAR) IPT on the X-energy's Xe-100 Reactor*, April 25, 2023, Revision 1. CUI Categories: SP-EXPT-SP-PROPIN/PRIVILEGE. Report front cover only was provided at the August 2023 NWTRB meeting presentation by Ned Larson, U.S. Department of Energy.

[23] Laura Price, Sandia National Laboratories, *Using Past Experience to Inform Management of Waste from Advanced Reactors and Advanced Fuels*, SAND2022-10873C, 2022. https://www.osti.gov [2004321.pdf]

[24] X-energy, Letter from X-energy to U.S. Nuclear Regulatory Commission, "Submittal of X Energy, LLC (X-energy) Xe-100 White Paper Slide Deck, 'Spent Fuel Management White Paper,'" 2023-XE-NRC-002, January 10, 2023. https://www.nrc.gov/docs/ML2301/ML23011A324.pdf Project No. 99902071.

[25] 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.

**present a challenge to Department of Energy research programs that are supposed to provide a technical basis for storage and disposal. DOE acknowledges that it has fallen behind and expects to only fall further and further behind.** [26]

The DOE's EIS contains disinformation about the dismal state of DOE's spent nuclear fuel disposal program. The HALEU EIS includes one paragraph to address disposal of spent nuclear fuel. Paragraph 3.7.33 states:

> "The program for a geologic repository for SNF at Yucca Mountain, Nevada, has been terminated. However, DOE remains committed to meeting its obligations under the Nuclear Waste Policy Act to dispose of SNF (DOE, 2022). In the interim, as described above, SNF is being safely stored."

It is correct that the proposed and never granted a license-to-construct repository at Yucca Mountain was defunded in 2010. But the statement that "DOE remains committed to meeting its obligations under the Nuclear Waste Policy Act to dispose of SNF" references a **footnote** in an Environmental Impact Statement for the Versatile Test Reactor (DOE/EIS-0542).

That VTR EIS footnote states:

> "DOE remains committed to meeting its obligations to manage and, ultimately dispose of spent nuclear fuel."

Isn't it odd that the only way DOE could offer any statement of its commitment to dispose of commercial spent nuclear fuel was to refer to a footnote in another EIS for a research reactor that does not generate commercial spent nuclear fuel, stating only the DOE remains committed to meeting its obligations to manage and, ultimately dispose of spent nuclear fuel?

**Saying that the DOE remains committed to meeting its obligations under the Nuclear Waste Policy Act to dispose of SNF is as empty as the promise DOE made, in the Standard Contract with electric utilities that operated commercial nuclear reactors, that DOE would begin taking ownership of commercial spent nuclear fuel in 1998.**

There is no reason to have confidence that the DOE has a commitment to meet its obligations under the Nuclear Waste Policy Act. The Department of Energy, despite promising to open a spent nuclear fuel repository by 1998, and then by 2010, has utterly failed to do so. Furthermore, the Department of Energy's proposed conceptual design for the Yucca Mountain repository was incomplete and technically unsound. It had assumed disposal in canisters that were not being used by commercial nuclear utilities, it assumed technically unsound corrosion rates to lengthen the time to container failure, it squashed water infiltration rates through the repository to lower the trickle out of radionuclides and it assumed titanium drip shields would be installed despite no way to actually install them.

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[26] 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.

The Department of Energy publishes an annual report of the inventory of commercial spent nuclear fuel and Government-owned spent nuclear fuel. [27] The Department of Energy makes the disclaimer in its report of spent nuclear fuel inventory, including:

> "No inferences should be drawn from this report regarding future actions by DOE, which are limited both by the terms of the Standard Contract and Congressional appropriations for the Department to fulfill its obligations under the Nuclear Waste Policy Act including licensing and construction of a spent nuclear fuel repository."

The DOE's draft HALEU EIS misrepresents the DOE's spent fuel management and disposal problem. The DOE's draft HALEU EIS ignores the unsolved existing spent nuclear disposal problem, and ignores the messes DOE made, starting decades ago and still has not cleaned up, like the DOE's Hanford site in Washington state. [28] [29] There are many contaminated sites at basically every location the Department of Energy conducted any activity associated with nuclear reactors or their fuel.

The DOE's draft HALEU EIS states, without any technical basis, on page 20 of the Summary, that "In a geologic repository, the SNF would be irretrievably stored underground in sealed tunnels." Given that there is no repository sited, no repository design, there is no basis for knowing that the repository would have "tunnels." There is no statement of how many years could elapse before the repository would be sealed. What is the basis for assuming that there is no period of time that could allow the waste to be retrievable. The Draft HALEU EIS has no technical basis for its stated claims.

Apparently, the statements were made in order to make the potential weapons material appear to be protected from theft. The Draft HALEU EIS needs to specifically cite credible sources of information for its statements and also clarify when (after how many years), after waste emplacement in a repository, the repository would be "sealed." It should be noted that the proposed Yucca Mountain repository would have remained unsealed for many years for ventilation and also for the eventual installation of titanium drip shields that were relied upon to achieve the estimated low migration of radionuclides from the waste over time, as water infiltrates the corroded waste.

The Department of Energy, in 2014, had to cease collecting fees for geologic disposal, because DOE has no repository program. Now in 2024, DOE still has no program for geologic disposal. The DOE has **continued to ignore the Nuclear Waste Policy Act** in its proceeding to attempt to cite consolidated interim storage. The DOE has **continued to ignore the Nuclear Waste Policy Act** with regard to the limit on the amount of spent fuel that can be disposed of at

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[27] U.S. Department of Energy, Prepared by Office of Nuclear Energy, *Spent Nuclear Fuel and Reprocessing Waste Inventory: Spent Fuel and Waste Disposition*, PNNL-33938, FCRD-NFST-2013-000263, November 2022. https://www.osti.gov/biblio/1974547 (Inventory ending calendar year 2021.)

[28] US Government Accountability Office, "Hanford Waste Treatment Plant – DOE Needs to Take Further Actions to Address Weaknesses in Its Quality Assurance Program," GAO-18-241, April 2018. https://www.gao.gov/assets/700/691422.pdf

[29] Annette Cary, *Tri-City Herald*, "Feds bash Hanford nuclear waste plant troubles, question DOE priorities," April 24, 2018. http://www.tri-cityherald.com/news/local/hanford/article209749064.html "The multi-billion-dollar Hanford vitrification plant has been under construction since 2002."

Yucca Mountain, 70,000 metric tons, and the U.S. is on track to create about twice that with the already generated or expected to be generated spent nuclear fuel.

**Cost of a Spent Nuclear Fuel Repository Program Must Be Evaluated**

The DOE cost estimates for a spent nuclear fuel repository have been provided as recently as 2019, on the assumption that somewhere, somehow, one or several repositories will be sited, designed and operated. The DOE's cost estimates for addressing the 140,000 MT of spent nuclear fuel is already likely to low by many multiples. The addition of HALEU spent nuclear fuel, of 500 MT/year will not be insignificant especially when the specific characteristics and the volume and number of containers is considered.

Nuclear promoters pathologically repeat nonsense about the cost and the problem of spent nuclear fuel disposal. An example is from Oliver Stone who made a documentary promoting nuclear energy. In an interview, Stone when asked stated that "nuclear waste is 'not an issue' and is 'completely handleable.'" [30]

The actual cost of attempting an experiment to see if the radioactive spent nuclear fuel can be successfully isolated will be cripplingly expensive and is also doomed to fail.

In 2009, the GAO reported its own estimate of the cost to dispose of 153,000 metric tons of spent nuclear fuel and high-level waste by 2055 being from $41 billion to $67 billion (in 2009 dollars). Adding in the already spent $14 billion on Yucca Mountain, this totaled a maximum of $81 billion, over a 143-year period until repository closure. **This estimate included both spent nuclear fuel generated by commercial power reactors, and DOE-managed spent fuel and high-level waste from power, research and navy reactors and high-level waste.** [31] A similar but even higher estimate came from the DOE's 2008 estimate for Yucca Mountain: $96 billion (in 2007 dollars) from 1983 through expected closure in 2133. [32] [33]

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.** [34]

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[30] Cliff Conner, *Science for the People Magazine*, "Here We Go Again: Yet Another "Nuclear Renaissance," December 29, 2023. https://magazine.scienceforthepeople.org/online/here-we-go-again/ And also "Oliver Stone says nuclear power is 'the only option' for society," *Independent*, May 2, 2023.

[31] U.S. Government Accountability Office (GAO), "Report to Congressional Addresses, Nuclear Waste Management – Key Attributes, Challenges and Costs of the Yucca Mountain Repository and Two Potential Alternatives," GAO-10-48, November 2009. https://www.gao.gov

[32] World Nuclear News, "Yucca Mountain cost estimate rises to $96 billion," August 6, 2008. https://www.world-nuclear-news.org/wr-yucca_mountain_cost_estimate_rises_to_96_billion_dollars-0608085.html

[33] U.S. Department of Energy, "Analysis of the Total System Life Cycle Cost of the Civilian Radioactive Waste Management Program, Fiscal Year 2007, DOE/RW-0591, July 2008.

[34] 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-

GAO-21-603 cites a 2019 Sandia National Laboratory [35] 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 [36] 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 technical challenges and the high costs and highly uncertain 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.

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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.

[35] 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

[36] 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 current lack of technical solutions to repackage spent nuclear fuel stored in welded-closed thin-walled canisters —which were not intended for disposal — are another reason that the cost of spent nuclear fuel disposal presented in GAO-21-603 is a gross underestimate.

In the Yucca Mountain repository design initially proposed in 2002, [37] it was assumed by DOE that a smaller amount of spent nuclear fuel would be loaded into a corrosion-resistant TAD canister, and the fuel being used in the 1990s and before was not much of a criticality risk. But, with the increased use of higher and higher burnup fuels, there are many existing spent nuclear fuel dry storage canisters that would have a nuclear criticality if water entered the canister.

In a geologic repository, the existing thin-walled stainless steel canisters would be breached by corrosion quickly, far sooner than the more corrosion resistant TAD canisters that were never used. [38] The utilities considered the TAD relatively expensive and opted for the cheapest dry storage systems licensed by the NRC. I suppose the utilities were and still are expecting the U.S. taxpayer to sort out the mess sometime in the future.

So, for a number of reasons, the DOE seeks the shortcut of not repackaging the existing canisters of commercial spent nuclear fuel. Obvious problems for direct disposal of existing spent nuclear fuel dry storage canisters are that the thin-walled welded-closed canisters were never designed for repository disposal and these canisters face serious corrosion issues within a shorter time frame than was stated for the TAD. [39] [40]

The commercial spent nuclear fuel canisters pose a number of challenges for repository disposal. The spent nuclear fuel dry storage canisters have been loaded with an increased number of spent fuel assemblies and canisters have gotten larger and heavier. There is a higher thermal load per canister, as well, due to the higher amount of decay heat. This requires more cooling time before being placed in a repository. Typical commercial spent nuclear fuel is less than 5 percent enriched and the higher enriched HALEU fuel will only add to the technical challenges, complexity and cost of spent nuclear fuel disposal. The greater variety of advanced reactor types and fuels and storage systems, the greater the complexity. This makes inadequate research, and

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[37] Department of Energy, *Final 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*, Office of Civilian Radioactive Waste Management, DOE/EIS-0250, February 2002. https://www.energy.gov/nepa/articles/eis-0250-final-environmental-impact-statement

[38] Department of Energy, Office of Nuclear Energy, Standardized Transportation, Aging, and Disposal (STAD) Canister Design, Presentation to the Nuclear Waste Technical Review Board, June 24, 2015. https://www.nwtrb.gov/meetings/past-meetings/summer-2015-board-meeting---june-24-2015 Both the earlier "TAD" and the later "STAD" are described in this presentation. None have actually been used. There are 189 bare fuel casks (10.4 percent of dry storage in 2015), 12 welded metal canisters in Holtec Hi-Star 100 transport overpacks (1.0 percent of dry storage in 2015), and 1,865 welded closed canisters (88.6 percent of dry storage in 2015. Of the 1865 canisters, 37 percent were Transnuclear, 41 percent were Holtec, and 20 percent were NAC.

[39] E. Hardin et al., *Summary of Investigations on Technical Feasibility of Direct Disposal of Dual-Purpose Canisters*, Prepared for the U.S. Department of Energy, FCRD-UFD-2015-000129, Rev. 1; SAND2015-8712R, May 2015.

[40] E. Hardin, "Dual-Purpose Canister Direct Disposal Technical Feasibility Evaluation: Introduction and Summary," Presentation at the Used Fuel Disposition Annual Working Group Meeting, Law Vegas, Nevada, June 11, 2015.

mistakes from inadequate reviews more likely. The inherently most costly approach is to create chaos from the wide variety of advanced reactor fuels and the ever-present incentive to cut corners will result in inadequate professionals who understand the designs and the hazards. For example, a lot of waste drums had been packaged in Idaho at the Idaho Cleanup Project, but a unique waste stream resulted in four drums expelling their contents [41] in a way that could have done far more damage that it did. At the Waste Isolation Pilot Plant (WIPP), it was understood and a requirement that nitrates not be mixed with organic material – despite that, the Los Alamos National Lab packaged many drums with organic absorbent material and one exploded at WIIPP. The EIS must address the added burden of more spent nuclear fuel, the higher enrichment and especially, the wide variety of spent nuclear fuels from advanced nuclear reactors.

## Disproportionately High Volumes of Repository Waste from Advanced Nuclear Projects Must Be Evaluated

The Department of Energy's push for advanced reactors and small modular reactors (SMRs) has been going on for over a decade and the SMRs can greatly exacerbate the needed repository size. **The small modular reactors will require disproportionately more containers and more space in a repository, according to independent evaluations.** 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. [42]

The Department of Energy and its nuclear boosters like to say that spent fuel reprocessing is the answer to the nuclear waste problem. But they don't like to discuss the unaffordable cost, the high radiological emissions, or the increased overall volumes of radioactive waste associated with reprocessing.

The Bill Gates' TerraPower Natrium fast neutron reactor slated for Kemmerer, Wyoming, will require costly and polluting reprocessing due to the sodium-bonded fuel and will exacerbate weapons material proliferation risks. It will also take so long to deploy Natrium as to be irrelevant to combating climate change.

In March 2023, the Department of Energy proposed to increase nuclear energy electricity production in the U.S. by a factor of three. [43] The 2021 GAO report does not include the spent nuclear fuel from any new nuclear plants and the proposed use of nuclear reactors for purposes other than electricity generation. With more than 140,000 metric tons of commercial spent fuel that is more than double the current statutory limit for Yucca Mountain and the need for a DOE-

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

[42] 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.

[43] U.S. Department of Energy webpage, Pathways to Commercial Liftoff: Advanced Nuclear, March 2023. https://www.energy.gov/lpo/articles/sector-spotlight-advanced-nuclear DOE discusses deploying about 300 gigawatts (GW) by 2050, with current U.S. nuclear capacity of about 100 GW. See also the related COP28 announcement at https://www.energy.gov/articles/cop28-countries-launch-declaration-triple-nuclear-energy-capacity-2050-recognizing-key

managed spent nuclear fuel and high-level waste repository, the promoted new nuclear energy would mean many more repositories the size and cost of a Yucca Mountain repository — that does not exist.

The reality is that the Yucca Mountain or any other repository is basically an experiment and one that when problems occur, is going to be even more expensive.

Spent nuclear fuel and high-level waste disposal are the foundation of the U.S. nuclear industry's spent nuclear fuel management promises. The Department of Energy has made reference to its repository program at Yucca Mountain in many of its Environmental Impact Statements. Despite this, the Department of Energy makes no progress toward a permanent solution for the radioactive waste, the spent nuclear fuel, that is poised to contaminate air, land and water for millennia. The Department of Energy seeks endless and expensive schemes to make more waste, as the work to attempt to figure out how to confine the waste for millennia languishes. Even the work to safely confine the waste for a few decades languishes.

### The Current Lack of Adequate Technical Basis to Conclude SNF Storage is Safe Must Be Evaluated

The claim is made in the DOE's HALEU EIS that "SNF is being safely stored." By DOE's own experts, the safety of long-term storage of spent nuclear fuel currently **lacks adequate technical basis**. And the problem is compounded by the higher burnup fuels being used by commercial nuclear utilities.

The Department of Energy acknowledged the gaps in the technical basis for continued storage of spent nuclear fuel, first in 2012. [44] 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. [45] **Each new fuel type 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.** [46]

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.

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[44] 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.

[45] 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.

[46] 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.

With regard to the various proposed advanced reactor fuels being proposed that would use HALEU (up to almost 20 percent enrichment), there is limited experience with TRISO fuels and sodium fuels. But that experience is with lower fuel burnup than is now being proposed and in a variety of ways, the existing experience just isn't adequate. The pattern continues to be repeated: design and build a variety of nuclear reactors and then as an after-thought, deal with storage and disposal issues as research about how to safely storage and dispose of spent nuclear fuel falls farther and farther behind.

Experience with TRISO fuels has shown that gases can leak from the fuels, moisture issues can compromise containers, and radioactive gases can be released to the environment. Continued storage of TRISO fuel is expensive (see the millions of dollars annually to continue to store Fort St. Vrain spent fuel in Idaho and Colorado).

Experience with fast reactor spent nuclear fuel repeats the pattern of the nuclear industry to design inadequate spent nuclear fuel storage. The inadequacy the spent nuclear fuel storage designs is only revealed over time. At the Idaho National Laboratory, EBR-II fuel was placed in a spent fuel pool inside container systems. Over time and unexpectedly, these containers leaked. Also, the water chemistry of the pool was not maintained in order to protect the containers (or their contents). The spent fuel from the EBR-II is sodium-bonded and the sodium creates additional hazards. Any moisture that contacts metal uranium fuel, moisture and oxygen are expected to react with sodium, producing $Na_2O$, NaOH, and hydrogen. Moisture and $O_2$ also may react with uranium metal, forming uranium oxides and pyrophoric hydrides. Pyroprocessing to remove the sodium is a slow and expensive process and also releases extensive airborne radiological contamination. [47] [48]

The INL's radiological releases to the environment are already increasing by a factor of more than 170, for its HALEU processing at the Materials and Fuels Complex, see Table 1.

[47] Nathan Hall et al., Center for Nuclear Waste Regulatory Analyses, San Antonio, Texas, *Potential Challenges with Storage of Spent (Irradiated) Advanced Reactor Fuel Types*, Prepared for the U.S. Nuclear Regulatory Commission, August 2019. https://www.nrc.gov/docs/ML2002/ML20022A217.pdf

[48] Nathan Hall et al., Center for Nuclear Waste Regulatory Analyses, San Antonio, Texas, *Storage Experience with Spent (Irradiated) Advanced Reactor Fuel Types*, Prepared for the U.S. Nuclear Regulatory Commission, April 2019. ML20211L885 https://www.nrc.gov/docs/ML2021/ML20211L885.pdf

**Table 1.** Estimated annual air pathway dose (mrem) from normal operations to the maximally exposed offsite individual from proposed projects, adapted from the estimated dose from expanding capabilities at the Ranges based on DOE/EA-2063.

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

**Table notes:**

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

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

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

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

e. Sum of doses from New Explosive Test Area and Radiological Training Pad calculated at separate locations northeast of MFC near Mud Lake. **Dose at Frenchman's Cabin likely much lower.**

**PLEASE NOTE THAT THE PUBLIC AT MUD LAKE IS CLOSER TO THE RELEASE THAN TO FRENCHMAN'S CABIN.**

f. Dose at MEI location (Frenchman's Cabin) from 2018 INL emissions (DOE 2019a). The 10-year (2008 through 2017) average dose is 0.05 mrem/year.

**PLEASE NOTE THAT MANY RADIOLOGICAL RELEASES ARE IGNORED AND NOT INCLUDED IN THE RELEASE ESTIMATES IN NESHAPS REPORTING.**

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

h. Receptor location unknown.

**Known Consolidated Interim Storage Problems Must Be Disclosed and Must Be Evaluated**

The Draft HALEU EIS cites the EISs for two proposed consolidated interim storage sites but fails to mention the many challenges each face. DOE must evaluate how incompatible those two proposed consolidated storage facilities are with the proposed advanced reactor spent fuels.

The Department of Energy's Draft Environmental Impact Statement for HALEU issued in March 2024 [49] (in both Volume 1 and Volume 2) lists the two proposed consolidated "interim" storage sites granted licenses by the NRC: Holtec International in Lea County, New Mexico and Interim Storage Partners, Andrews, Texas. [50] [51] **The DOE failed to mention that both New Mexico and Texas have passed bills prohibiting consolidated storage of spent nuclear fuel.** The DOE also failed to mention that the court in Texas found that NRC did not have the authority to authorize away-from-reactor consolidated storage because Congress made requirements in the Nuclear Waste Policy Act that the NRC ignored. The Environmental Impact Statements for those consolidated interim storage (CIS) facilities is limited to the NRC licensing period for those facilities, and what happens after the licenses expire and over time as spent nuclear fuel degrades and storage canisters are breached, is not evaluated. Thus, the Draft HALEU EIS citing these other CIS EISs that do not consider what happens after a perhaps 40-year NRC license for spent nuclear fuel storage expires should there be no repository to send the spent fuel to or the canisters are not safe to ship or the canisters begin to breach from corrosion. The lack of viable long-term consideration of human health and the environment of consolidated interim storage of spent nuclear fuel safety exemplifies the lacking consideration beyond more than perhaps a handful of years that is rampant throughout the Draft HALEU EIS.

The Department of Energy is promoting its consent-based siting of consolidated interim [forever] storage parking lot dumps without siting one or more geologic repositories. [52]

When the Department of Energy's Draft HALEU EIS ignores the status of new laws and court cases regarding the consolidated interim storage facilities proposed for New Mexico and Texas, it reveals a disregard for the law. DOE ignores the regulatory and court status of these two facilities because DOE wants to people have the mistaken impression that these two proposed CISs are a solution for spent nuclear fuel management.

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[49] U.S. Department of Energy, *Draft Environmental Impact Statement for Department of Energy Activities in Support of Commercial Production of High-Assay Low-Enriched Uranium (HALEU)*, DOE/EIS-0559, March 2024. https://www.energy.gov/ne/haleu-environmental-impact-statement Public comment is open until April 22, 2024 and comments may be sent to HALEU-EIS@nuclear.energy.gov

[50] U.S. Nuclear Regulatory Commission, *Federal Register*, Vol. 86, No. 178, "Interim Storage Partners, LLC; WCS Consolidated Interim Storage Facility; Issuance of Materials License and Record of Decision," September 17, 2021. This is the consolidated storage facility proposed for Andrews County, Texas. (The consolidated storage facility could store up to 40,000 metric tons heavy metal.)

[51] U.S. Nuclear Regulatory Commission, *Federal Register*, Vol. 88, No. 92, "Holtec International; HI-STORE Consolidated Interim Storage Facility," May 12, 2023. (The consolidated storage facility could store up to 100,000 metric tons heavy metal.)

[52] U.S. Department of Energy, Office of Nuclear Energy, *Consent-Based Siting Process for Federal Consolidated Interim Storage of Spent Nuclear Fuel*, April 2023.

The Department of Energy admitted at the August 2023 NWTRB meeting that it planned to give information to the newly forming "consortia" of universities, businesses and others and that citizens would not have access to the information given to the consortia. **Importantly, the communities being bribed and connived into hosting "temporary" interim consolidated storage sites would NOT have access to the information shared with the consortia.** The Department of Energy's approach to siting consolidated interim storage was to proceed with no planning for obtaining a permanent geological repository or for obtaining reprocessing capability. The DOE understands the imperative to withhold the truth about the risks and health harm of storing spent nuclear fuel for unknown decades to come. **The DOE stated that it would use carefully filtered messaging in order to persuade the community's leaders.**

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.

The Draft HALEU EIS in Table A-10 states that the impact of terrorism or sabotage on spent nuclear fuel storage would be SMALL. But this assessment is doubtful for even a small amount of spent nuclear fuel and it is incorrect for consolidated interim storage. The more spent nuclear fuel there is, the greater the risk of terrorism. Despite this, Price-Anderson Act liability coverage may not apply, depending on ownership, see Table 2.

The Nuclear Regulatory Commission has already been too lax concerning adequate licensing reviews and nuclear facility oversight. But with continued pressure on the NRC to further loosen reviews and oversight and speed up licensing, no EIS can assume any competent level of NRC licensing or regulatory oversight and this must also be considered in the Draft HALEU EIS and the cited EISs.

**Table 2.** 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:<br><br>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:<br><br>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**<br>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. https://www.nrc.gov/docs/ML2133/ML21335A064.pdf. Note that in the event there is no coverage, Congress could decide to provide coverage after an accident.

## Communities Must Be Told How Many Years Spent Nuclear Fuel Will Remain at Stranded Fuel Sites, Consolidated Storage and the Newly Created Stranded Fuel Sites from Various Mobile-Micro and Small Reactors - and This Must Be Evaluated

How long does spent nuclear fuel (SNF) required to cool before it can be transported? And how long can SNF canister or other containers be expected to retain integrity due to aging and corrosion problems?

These are basic questions that DOE and NRC are avoiding. Communities currently with stranded spent nuclear fuel are not being told how many decades may have to pass before spent nuclear fuel can be transported, even if there is a place to transport the fuel to. And the possible need for Dry Storage Transfer facilities and who will pay for them, is not being discussed.

Because the DOE's Draft HALEU EIS is not providing realistic and known problems of SNF currently at stranded nuclear sites, DOE needs to be called out for its deception. The safety problems with long term storage of spent nuclear fuel is especially important as DOE is not making progress on a repository and probably never will. This is especially important as DOE seeks consolidated storage of spent nuclear fuel from a willing-to-be-bribed host community.

The DOE's Draft HALEU EIS is ignoring that it is promoting the creation of micro-mobile reactors and various small reactors that will create stranded spent nuclear fuel sites virtually every place they are used. There is no plan for where the spent fuel for these new reactors will go. These reactors can show up anywhere – next to hospitals, schools, farmland – and may never leave. The Draft HALEU EIS points to the NRC's 2014 generic EIS which assumes that Dry Transfer Systems magically pop up when needed but no one knows who will design and pay for it. The Draft HALEU EIS is clearly inadequate and must evaluate the current state of impending crisis with the need to repackage spent nuclear fuel and that absence of a repository program for any of the nation's spent nuclear fuel. That the Draft HALEU EIS does not even acknowledge that DOE has no idea how or where to dispose of the spent nuclear fuel the nation already has, does not excuse the Draft HALEU EIS from that way it has ignored that its HALEU production is seeking to make far more spent nuclear fuel and it may be fuel that requires far more space in a repository. TRISO-fueled high-temperature gas-cooled reactors, for example, will require far more space in a repository and there is no reason to expect TRISO fuel is practical to reprocess. The Natrium reactor spent fuel will likely require expensive and polluting pyroprocessing prior to disposal. So, the costs of nuclear energy, that currently focus on construction and operating costs while ignoring spent nuclear fuel management and disposition costs is completely untenable – and must be evaluated in the HALEU EIS.

The spent nuclear fuel from traditional light-water reactors (pressurized water reactors and boiling water reactors) is transferred to a spent fuel pool after use in a reactor. The fuel cools and after adequate cooling, may be transferred to dry storage in either a cask or canister. Additional time to allow cooling of the fuel from the reduction of radioactive decay-generated heat may be needed before the fuel can be transported, depending on canister and the number of assemblies in the canister. The cooling time needed also depends on the initial fuel enrichment in uranium-235 and on the operating time in the reactor because longer operating time in the reactor produces more fission products.

Higher initial fuel enrichment and higher fuel burnup in the reactor create a thermally hotter fuel because of more fission products. The cooling time needed before the fuel can be placed in dry storage depends on the dry storage system. The cooling time needed prior to transportation depends on the transportation packaging.

When the spent nuclear fuel burnup is below about 35 Gigawatt-Days/Metric-ton (GWD/MTU), the fuel required about 5 years of cooling in the spent fuel pool before it could be placed in dry storage. But by the year 2000, most of the U.S. spent nuclear fuel at PWRs and BWRs exceeded 35 GWD-MTU. Fuel burnup above 45 GWD/MTU is considered "high" and fuel burnup has been climbing to levels above 55 GWD/MTU. At burnups of 55 GWD/MTU, the fuel may require 30 years of cooling in a pool before it can be placed in dry storage.

A 2013 presentation by Sandia National Laboratories provides charts of needed cooling times and the time before spent nuclear fuel can be transported. Less information was provided about the cooling times needed for higher fuel burnups. [53]

With higher fuel burnups, radioactively and thermally hotter fuels have been placed in dry storage and there may be decades of cooling in dry storage needed before the fuel, as packaged in canisters, could meet transportation requirements. **The length of time needed before high burnup spent nuclear fuel may need to cool before allowed for transportation may decades, over 40 years.** So, some communities with reactors that operated after about year 2000 who are hoping that consolidated interim storage means fuel will be leaving their community may be surprised to learn how long cooling may be required before the high burnup spent nuclear fuel could be transported.

For some casks or canisters, transportation licensing of the container was never obtained. There are 74 sites with spent nuclear fuel. As an example, at 12 shutdown plant sites, 17 different canister designs were used, 8 different storage overpack designs and 8 different transport overpack designs. [54] Not all dry storage systems were designed and licensed for transportation and so there are licensing challenges. If a cask or canister cannot be licensed for transportation, it

[53] Christine Stockman and Elena Kalinina, Sandia National Laboratories, For the Department of Energy's National Nuclear Security Administration, *Cooling Times for Storage and Transportation of Spent Nuclear Fuel*, SAND2013-1698C, February 25, 2013.

[54] Jeffery Williams, U.S. Department of Energy, "Nuclear Fuels Storage and Transportation Planning Project," U.S. Nuclear Waste Technical Review Board Workshop, November 18-19, 2013.

would have to be repackaged. But the spent fuel pool may be gone and there is then a need for a Dry Transfer System but one hasn't been designed or built.

There's yet another problem regarding transportation of spent nuclear fuel. While higher enriched fuels that allowed higher fuel burnup were used, some of the spent fuel characteristics placed in the canisters may not meet existing transportation Certificate of Compliance requirements pertaining to 10 CFR 71 transportation requirements. (See Williams, 2013)

Existing requirements for transportation have not been met as the utilities loaded the spent fuel into the canisters, despite the canister having a transportation license. For example, higher initial uranium-235 enrichment, coupled with low operating time in the reactor means higher reactivity of the fuel. This means increased ability for a criticality and larger criticality power excursion event should water enter the canister. One limited study found that half of the canisters had been loaded with spent fuel with a combination of conditions that increases criticality risk: high initial enrichment and <u>low</u> burnup in the reactor. The canisters were loaded with spent nuclear fuel that did not meet the required conditions for the Certificate of Compliance for the canister. [55] What were these utilities thinking?

The 2019 NWTRB report found that "For an unknown but significant number of commercial SNF storage cask and canister types that are already approved for transportation, the CoCs for transporting the casks and canisters must be amended and NRC-approved to broaden the scope of allowable contents (e.g., a wider range of fuel types, higher initial enrichments, and higher fuel assembly burnups)." The implications, according to the NWTRB, are that unless the Certificate of Compliance for transportation can provide a technical case that supports the safe transportation of the SNF and gain NRC approval for its transportation, or be granted an exemption by NRC from some of the transportation requirements, the SNF would have to be removed from the welded canisters and repackaged into canisters or bare fuel casks that are approved by the NRC for transportation. [56]

In its 2024 report, the NWTRB [57] again noted that "some loaded DPCs [dual-storage canisters] currently in storage are known to include contents [spent nuclear fuel] that do not meet the requirements of the associated Certificate of Compliance for transportation." The Board recommended that "The implications (time, effort, and cost) of identifying and finding a resolution for commercial SNF canisters approved by the NRC for storage, but which include

[55] U.S. Nuclear Waste Technical Review Board, *Preparing for Nuclear Waste Transportation – Technical Issues that Need to be Addressed in Preparing for a Nationwide Effort to Transport Spent Nuclear Fuel and High-Level Radioactive Waste*, A Report to the U.S. Congress and the Secretary of Energy, September 2019. See Figure A-1.

[56] U.S. Nuclear Waste Technical Review Board, *Preparing for Nuclear Waste Transportation – Technical Issues that Need to be Addressed in Preparing for a Nationwide Effort to Transport Spent Nuclear Fuel and High-Level Radioactive Waste*, A Report to the U.S. Congress and the Secretary of Energy, September 2019. See page 15.

[57] U.S. Nuclear Waste Technical Review Board, *Evaluation of the U.S. Department of Energy Research and Development Activities on the Disposition of Commercial Spent Nuclear Fuel in Dual-Purpose Canisters*, February 2024. https://www.nwtrb.gov/our-work/reports/evaluation-of-the-u.s.-department-of-energy-research-and-development-activities-on-the-disposition-of-commercial-spent-nuclear-fuel-in-dual-purpose-canisters-(february-2024)

contents not currently approved by the NRC for transportation." The Board recommended that the Department of Energy give higher priority to the issue. The NRC had granted licenses of the higher burnup fuel, without consideration of added storage, transportation or disposal implications. The electricity utilities had loaded combinations of high spent fuel into canisters such that transportation CoCs were not complied with. So, now the NWTRB recommends that DOE should give that a higher priority to this problem. The U.S. Government Accountability Office reports DOE's rosy transportation and disposal cost estimates from the Department of Energy. There is massive dysfunction throughout the nuclear enterprise in the U.S., from the Department of Energy, the Nuclear Regulatory Commission, and it also includes the agencies Congress relies on for getting information from, including the U.S. Nuclear Waste Technical Review Board and the U.S. Government Accountability Office.

If the U.S. Congress actually had a clue as the already built-in costs of spent nuclear fuel management and disposal in this country, there is no way it would giving out more taxpayer money to make more and more liabilities.

**Uranium Fuel Cycle Activities That Create Numerous Contaminated Sites Must Be Evaluated (And the EIS Must Admit How Many Become Forever Contaminated)**

Countless radiologically contaminated sites have been created from uranium fuel cycle activities and often involving the Department of Energy (or its predecessor, the Atomic Energy Commission). The cleanup of these sites is recognized as costing hundreds of billions of dollars over several decades. [58] Despite the cost, many sites never attempt to conduct cleanup to Environmental Protection Agency (EPA) CERCLA cleanup standards – it would simply cost too much. Instead, fences are put around waste sites, rocks are placed over buried waste and the cleanup is deemed acceptable only as long as no one lives at the contaminated site, basically, forever. [59] The characterization of the radionuclide contamination that remains and the length of time that the land remains unsafe to live on or grow food on, is deliberately obscured, as cleanup efforts are deemed completed. The Department of Energy Environmental Management program over about 100 "EM sites" may call a cleanup complete by simply acknowledging that it would be too costly to clean up an area, and therefore, simply deem the cleanup complete by assuming no one ever lives there in the future. (See a map of nationwide EM sites in Idaho Cleanup Project

[58] National Academies of Sciences, Engineering, and Medicine, *Leveraging Advances in Modern Science to Revitalize Low-Dose Radiation Research in the United States*, Washington, DC: The National Academies Press, 2022. http://nap.nationalacademies.org/26434 or https://doi.org/10.17226/26434. On page 93 it is admitted that cleanup costs are expected to cost billions of dollars over several decades. However this report implies that cleanup standards can be met yet does not actually disclose how often these are not met. The report implies that loosening the cleanup standards is the way to save money but the reality is that often, no attempt is made to meet existing cleanup standards. The NAS report is an example of why even NAS has a pervasive, unstated and biased leaning to aid the nuclear industry as it withholds information about the truth regarding cost, public health and the environment.

[59] Tami Thatcher, Environmental Defense Institute Special Report, "The "Forever" Contamination Sites at the Idaho National Laboratory," 2017. www.environmental-defense-institute.org/publications/EarthDayINLreport.pdf

Citizens Advisory Board, presentation by the Department of Energy, "EM Corporate Transuranic (TRU) Strategy," February 22, 2024.)

The Department of Energy has been able to disown some of its contaminated sites by shifting them to other agencies like the Army Corp of Engineers, like the Westlake Landfill in Missouri. The U.S. Environmental Protection Agency has often reassured residents of the safety near the neighborhoods still affected by uranium fuel cycle activities from decades ago. The Department of Energy passed the problem over to the Army Corp of Engineers, who started shipping the contaminated soil know as Formerly Utilized Sites Remedial Action Program (FUSRAP) to the US Ecology Idaho facility.

In June 2018, the Agency for Toxic Substances and Disease Registry (ATSDR), the federal public health agency of the U.S. Department of Health and Human Services, published a report evaluating the exposures to people living near Coldwater Creek where uranium processing wastes were improperly stored and disposed of in St. Louis, Missouri. [60] The radioactive contamination included uranium-238 and higher amounts of thorium-230 and its daughter product radium-226 than from unprocessed uranium ore because of the uranium extraction processing.

The ATSDR agency found that the Army Corps of Engineers' Formerly Utilized Site Remedial Action Program (FUSRAP) has been characterizing and cleaning up contaminated area since 1998. But soil concentrations of radiological contaminants still remain higher than remedial goals. Background levels of thorium-230 should have been about 1 to 3 picocuries/gram (pCi/g) but were frequently detected above FUSRAP's remedial goal of 14-15 pCi/g. Thorium-230 levels have been as high as 54.5 pCi/g and recently as high as 27.3 pCi/g.

The ATSDR concluded that there was not enough sampling data to actually evaluate pathways of exposure.

The Missouri Department of Health (MDOH), now known as the Missouri Department of Health and Senior Services (MDHSS) had reviewed cancer incidence and mortality data from August 1984 to September 1988 around several sites, but at that time did not calculate the observed and expected cancer rates because about 15 percent of hospitals were not yet in compliance with new cancer reporting laws. Subsequently, in a later review, MDOH concluded that radiation induction could not be ruled out. Then in March 2013, MDHSS reviewed 1996-2004 cancer incidence data from six ZIP codes adjacent to Coldwater Creek and **they found statistically significantly elevated rates of incidence of several types of cancer** including female breast, colon, prostate, and kidney cancer, compared to the Missouri state rates. Then an updated analysis **found that childhood brain and other nervous system cancers were statistically significantly elevated** compared to the Missouri state rates. And they found that the

[60] Agency for Toxic Substances and Disease Registry, Public Health Assessment for Evaluation of Community Exposures Related to Coldwater Creek St Louis Airport/Hazelwood Interim Storage Site (HISS)/Futura Coatings NPL Site North St Louis County Missouri, EPA Facility ID MOD980633176, June 18, 2018. https://www.atsdr.cdc.gov/sites/coldwater_creek/docs/ColdwaterCreek-508.pdf

incidence of leukemia, female breast, colon, kidney, and bladder cancer were statistically significantly elevated compared to the Missouri state rates.

It is interesting to note that the Center for Disease Control's National Program of Cancer Registries provide cancer statistics only on a state-wide basis since 1994 and not on a county basis, making contamination areas nearly impossible to trend by readily available cancer data in the U.S. available to the public. (See https://www.cdc.gov/cancer/npcr/public-use/index.htm).

**In light of the elevated cancer rates, the ATSDR then applied radiation health models based on the International Commission of Radiological Protection (ICRP) that are known to underestimate the health risk.** Combined with inadequate monitoring of the radiation levels, it is almost a miracle that ATSDR concluded that the elevated cancers *COULD* have been caused by the radioactive contamination.

**The ATSDR folks don't seem to know that their radiation models are inadequate especially for inhaled and ingested radionuclides and underestimate the cancer risk by a factor of 100 or more.** It is amazing that the ATSDR didn't state that the cancers could not have been caused by the radiation, as it so often case because of the understated harm from official radiation health modeling. For more about the inadequacy of radiation health harm estimates as currently estimated in the U.S., see our Environmental Defense Institute newsletter article from September, "Just Two Problems with U.S. Radiation Protection: Radiation Dose Underestimated and the Harm Underestimated." [61]

The entire charade by the U.S. agencies from the Department of Energy, to the Environmental Protection Agency, to ATSDR would be hilarious if it were not so much illness and so many lives lost.

Let's recap the uranium fuel cycle debacle around St Louis: The Department of Energy (formerly known as the Atomic Energy Commission) processed uranium and the waste was improperly stored and disposed of and for decades. No federal or state agency saw to it that proper monitoring was conducted, even after citizens were begging them to address the issue. Elevated cancers are happening but denied for years. Elevated cancer rates are now recognized by the state of Missouri. And ATSDR applied their inadequate radiation model with inadequate data and actually says the elevated cancer rates *COULD* have been caused by the years of living with the radioactive contamination.

When it comes to uranium mining and milling, in some cases, like in Moab, Utah, mill tailings are being moved from a very dangerous site to a less dangerous site, as great expense. But in general, little progress has been made in cleaning up uranium mines and mill tailings sites. "The site remediation costs have exceeded costs originally envisioned by Congress, the agencies, and the licensees due to an evolving understanding of the complexities and risks posed by

[61] Environmental Defense Institute September 2018 newsletter article by Tami Thatcher "Just Two Problems with U.S. Radiation Protection: Radiation Dose Underestimated and the Harm Underestimated" at http://environmental-defense-institute.org/publications/News.18.September.pdf

unintended releases of contaminants from uranium mill tailings." [62] Replace the words uranium mill tailings, as needed for every activity associated with the uranium fuel cycle, and the same statement can be applied to every activity being proposed by the Department of Energy in its Draft HALEU EIS. These are either already forever contamination sites or are destined to become a forever contamination site.

"Cleanup" typically means take care of some of the most egregious wastes left unattended — and cover them up or shift the waste to another location. In Idaho, radioactive waste that includes all types of radioactive waste including plutonium, is accepted for disposal at a facility near Boise on the western side of the state that is not even a radioactive waste landfill. That landfill started by accepting radioactively contaminated soils from uranium fuel cycle activities (FUSRAP soils) and expanded from there. Acceptance criteria are extremely flexible and monitoring is extremely lax when the State's leaders want it that way. On the eastern side of the state, the Idaho National Laboratory continues ramping up its airborne radiological emissions. Does Idaho care about the health of its children? Not so much. And can you guess what score Idaho earns for reporting of birth defects? You guessed it. Grade F. [63]

Bankrupt companies leave the uranium mines and mill tailings waste behind even if the U.S. Nuclear Regulatory Commission licensed it and the new owner becomes the Department of Energy, funded by U.S. taxpayers. Remediation is an optimistic term applied to what will never return damaged landscape to a healthy environment. For example, the movement of uranium mill tailings away from the Colorado River near Moab, Utah required the Department of Energy to take ownership of the site and a nearly billion-dollar effort to move the toxic tailings. [64]

"Mining and milling operations have disproportionately affected indigenous populations around the globe. For example, in the U.S. nearly one-third of all mill tailings from abandoned mill operations are on the lands of the Navajo nation alone." [65]

Uranium enrichment is the process of increasing the amount of U-235 to a higher proportion than is naturally present. Nuclear power plants typically use 3 to 5 percent enrichment. Weapons, some research reactors, and U.S. naval reactors use "highly enriched uranium" (HEU) with over 90 percent U-235. Most enrichment techniques require that uranium first be put in the chemical form uranium hexafluoride ($UF_6$).

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[62] Congressional Research Service, Prepared for Members and Committees of Congress, *Long-Term Federal Management of Uranium Mill Tailings: Background and Issues for Congress*, R45880, February 22, 2021.

[63] Trust for America's Health, *Birth Defects Tracking and Prevention; Too Many States Are Not Making the Grade*, 2002. https://collections.nlm.nih.gov/catalog/nlm:nlmuid-101143813-pdf And it should come as no surprise that Idaho rates a grade "F" for tracking and prevention of birth defects because elevated rates of birth defects can be expected with increasing environmental radiological contamination.

[64] US Department of Energy, Factsheet "Overview of Moab [Uranium Mill Tailings Remedial Action ] UMTRA Project," 2017. http://www.gjem.energy.gov/moab/documents/factsheets/20170316OVERVIEW.pdf See also *Citizens Monitoring and Technical Assessment Fund*, "A Short History of the Moab Project and The White Mesa Mill Alternative," http://www2.clarku.edu/mtafund/prodlib/dine/round5/Short_History.pdf

[65] Arjun Makhijani and Scott Sleska, *The Nuclear Power Deception – U.S. Nuclear Mythology from Electricity "Too Cheap to meter" to "Inherently Safe" Reactors*, 1999, by the Institute for Energy and Environmental Research, The Apex Press, ISBN 0-945257-75-9.

According to the Government Accountability Office, "Cleaning up 3 plants where uranium was enriched will cost billions of dollars and span decades. These sites – near Oak Ridge, Tennessee, Paducah, Kentucky; and Portsmouth, Ohio [actually near Piketon, Ohio] – are contaminated with radioactive and hazardous materials. [66]

A major hazard in uranium enrichment processes comes from the chemically toxic and radioactive uranium hexafluoride. The enrichment process creates waste in the form of depleted uranium that is still radioactive but has less U-235 than natural uranium. While there are some military uses for depleted uranium for tank armor plating and armor-piercing conventional weapons, the disposal of large amounts of depleted uranium poses a long-lived radioactive waste stream that requires isolation from groundwater and the environment. Regulations for depleted uranium disposal are not assuring protection of the environment. Future generations will likely face significant risks from uranium mining, milling, and processing activities. Former generations have already been given cancer and other illnesses at site related to uranium fuel cycle activities, whether in Ohio's Portsmouth site, Missouri's Westlake Landfill, and countless other sites. The historical contamination, remaining contamination, the illnesses and cost of attempted cleanup is obscured in terse, colorful and sanitized factsheets by the Department of Energy (see https://www.energy.gov/environmental-cleanup ) and see federal superfund sites on the ever-evolving U.S. Environmental Protection Agency website.

I note that the Portsmouth uranium enrichment plant continued to use hexavalent chromium until the early 1990s as a corrosion inhibitor. [67] The use of hexavalent chromium at the Department of Energy site in Idaho was stopped by 1982, after extensive groundwater contamination. Hexavalent chromium damages DNA and children would be vulnerable and even more vulnerable if the parent had been exposed. Chemical and radiological exposures may need to be considered in light of increasing cancer and infant mortality rates in Pike County. [68] Throughout the uranium fuel cycle, the deaths stack up but the reason often is not acknowledged.

**Cited DOE or NRC EISs Do not Provide a Sound Basis for Safety or Project Viability**

Many, if not all, of DOE's and NRC's EISs contain enormous technical flaws. These flaws typically do not get formally revealed, like the DOE's Yucca Mountain EIS that contained flawed analysis of the longevity of spent nuclear fuel casks and canisters as lasting over 1100 years. In reality, there isn't data to conclude the canisters last even 80 years.

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[66] U.S. Government Accountability Office, *NUCLEAR CLEANUP Actions Needed to Improve Cleanup Efforts at DOE's Three Former Gaseous Diffusion Plants*, GAO-20-63, December 2019. https://www.gao.gov/products/gao-20-6

[67] Fluor-BWXT Portsmouth, LLC, *U.S. Department of Energy Portsmouth Gaseous Diffusion Plant Annual Site Environmental Report - 2020, Piketon, Ohio*, DOE/PPPO/03-1034&D1, September 2021.

[68] Joseph J. Mangano, Radiation and Public Health Project, *Mortality/Morbidity Study, 7 Counties Downwind of the Portsmouth Nuclear Site*, May 12, 2023. https://docs.google.com/viewer?url=https://local12.com/resources/pdf/fb76de1b-2b63-4f6f-a44a-89e64b25ae4e-Portsmouth2ndreportfinal002002.pdf&embedded=true

While the DOE was well aware of chlorides in the atmosphere and acknowledged that fact in 2002, the DOE ignored the chloride-induced stress corrosion cracking mechanism in the stainless steel of spent nuclear fuel dry storage canisters. [69] The spent nuclear fuel that was packaged for dry storage, was placed in a variety of dry storage systems, but prevalently, was placed in thin-walled welded-closed stainless steel canisters, usually 0.5 inch thick. The canisters are placed in concrete vaults but they have continuous natural circulation of atmospheric air to cool the canister and are exposed to atmospheric chlorides during storage.

The dry storage systems used by the commercial nuclear power industry were licensed by the U.S. Nuclear Regulatory Commission, initially for twenty years. Canister aging mechanisms were ignored as the licensing was granted beginning in the late 1980s and only in 2012 did the NRC formally acknowledge that the stainless-steel canisters were susceptible to stress corrosion cracking. [70] [71]

The theoretical time for chloride-induced stress corrosion cracking to proceed is dependent upon several factors unique to each individual spent nuclear fuel canister. There are variables include canister temperature, atmospheric humidity, atmospheric levels of chlorides from sea salt or magnesium chloride or other source, and canister metal wall thickness and metal stresses. [72] The canister temperature depends on how long the spent fuel aged prior to packaging, the length of time in dry storage as the decay heat falls, and on the fuel burnup which affects the decay heat initially and its trend over time. The need to predict how long it will take for chloride-induced stress corrosion cracking to initiate and then how long it will take for the cracking to compromise canister integrity has been recognized now for over a decade.

**The U.S. Nuclear Regulatory Commission who licensed the dry storage systems, did so, without stating important corrosion mechanisms, without having any way to conduct meaningful corrosion or material degradation inspections, and without any way of repairing or repackaging a canister that was degraded or failed.**

In 2002, the Department of Energy issued its wildly incorrect prediction that dry storage systems in use at commercial nuclear power plants would last for over 1100 years before

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[69] U.S. Department of Energy, *Final 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*, Office of Civilian Radioactive Waste Management, DOE/EIS-0250, February 2002. https://www.energy.gov/nepa/articles/eis-0250-final-environmental-impact-statement See Appendix K for the "Long-Term Radiological Impact Analysis for the No-Action Alternative."

[70] U.S. Nuclear Regulatory Commission, *Potential Chloride-Induced Stress Corrosion Cracking of Austenitic Stainless Steel and Maintenance of Dry Cask Storage System Canisters*, Information Notice 2012-20, 2012. https://www.nrc.gov/docs/ML1231/ML12319A440.pdf

[71] U. S. Nuclear Regulatory Commission, *Identification and Prioritization of the Technical Information Needs Affecting Potential Regulation of Extended Storage and Transportation of Spent Nuclear Fuel – Draft Report for Comment*, May 2012. ML120580143. This report contains tables ranking the level of knowledge and safety risk of spent nuclear fuel in storage and the dry storage systems. Stainless steel atmospheric stress corrosion cracking is acknowledged to have "low" level of knowledge and high research priority.

[72] G. Oberson et al., "U.S. NRC-Sponsored Research on Stress Corrosion Cracking Susceptibility of Dry Storage Canister Materials in Marine Environments – 13344." WM2013 Conference. February 24-28, 2013. Phoenix, Arizona.

breaching. [73] That analysis as well as the NRC's licensing of dry storage spent nuclear fuel canisters had ignored **chloride-induced stress corrosion cracking, which can be initiated within weeks [74] and then can progress the metal degradation from partial-cracking to through-wall within about 20 to 40 years. [75]**

Concerning the safety of dry storage of spent nuclear fuel is the concept of repackaging the dry storage canisters (and in some cases, dry storage casks). The U.S. Nuclear Regulatory Commission assumed in its 2014 "continued storage" Environmental Impact Statement that Dry Transfer Stations would appear when and where needed. [76] But it has never been stated who would pay for these systems and so far, no system has been designed.

Following over a decade since the problem of stress corrosion cracking was formally identified, the status of stress corrosion research can be summed up in a Sandia National Laboratories report from 2021 and related 2022 presentation: [77] [78] they are still studying the problem and have yet to provide an estimated time for damage to spent nuclear fuel dry storage canisters.

Stress corrosion cracking through stainless steel can include multiple cracks progressing through the metal, leaving a rotted metal canister and breaching the canister. The welds on the canister are particularly susceptible, and there are welds around each end and in multiple long welds along the length of the canister. Canisters are filled with helium before closure. A breach will let the helium out and air (oxygen) in. Oxygen entry to the canister may accelerate spent nuclear fuel degradation. The more compromised the fuel cladding, the more that oxygen ingress may degrade the fuel.

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[73] U.S. Department of Energy, *Final 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*, Office of Civilian Radioactive Waste Management, DOE/EIS-0250, February 2002. https://www.energy.gov/nepa/articles/eis-0250-final-environmental-impact-statement See Appendix K for the "Long-Term Radiological Impact Analysis for the No-Action Alternative."

[74] U.S. Nuclear Regulatory Commission, *Atmospheric Stress Corrosion Cracking Susceptibility of Welded and Unwelded 304, 304L, and 316L Austenitic Stainless Steels Commonly Used for Dry Cask Storage Containers Exposed to Marine Environments*, NUREG/CR-7030, October 2010. This report estimated that the onset of stress corrosion cracking, under ideal conditions, would be expected to take between 32 and 128 weeks. But this estimate does not take into account the operating history of the dry storage cask or canister and the local environment at each location.

[75] Electric Power Research Institute (EPRI), *Flaw Growth and Flaw Tolerance Assessment for Dry Cask Storage Canisters*, 3002002785, October 2014. https://www.epri.com/research/products/000000003002002785 Figures 3-9 and 3-10, Crack depth vs. Time for two dry storage locations gave the prediction of 20 to 40 years for 100 percent crack depth.

[76] U.S. Nuclear Regulatory Commission, *Generic Environmental Impact Statement for Continued Storage of Spent Nuclear Fuel*, NUREG-2157, September 2014. https://www.nrc.gov/reading-rm/doc-collections/nuregs/staff/sr2157/index.html

[77] C. Bryan et al., *FY21 Status Report: SNF Interim Storage Canister Corrosion and Surface Environment Investigations*, M2SF-21SN010207056/SAND21-12903 R. Albuquerque, New Mexico: Sandia National Laboratories, September 2021. https://www.osti.gov/biblio/1825847

[78] C. Bryan et al., "Stress Corrosion Cracking Research at Sandia National Labs," Electric Power Research Institute (EPRI) Extended Stroage Collaboration Program (ESCP) Winter 2022 Meeting, Charlotte, South Caroline, November 7-10, 2022. (Presentation found at NWTRB website for 2022 meetings.)

According to the NWTRB 2010 report, "a breach of the main canister may allow the release of radioactive material. Fuel previously oxidized to the $U_3O_8$ form 'is a fine powder that spalls from the fuel surface. The release of fines and/or fuel relocation from the split cladding must be evaluated if $U_3O_8$ formation is suspected. The extent of oxidation of irradiated $UO_2$ is a time and temperature-dependent phenomenon.'" [79]

Zirconium, plutonium and uranium are known to be pyrophoric. For example, uranium in the form of fine powder may be pyrophoric. [80]

A survey of the previous studies and research needs conducted by EPRI in 2017 [81] states that "The potential consequences associated with unmitigated CISCC [chloride induced stress corrosion cracking] of canisters have not been specifically analyzed." The EPRI review stated that: "Additional analysis may be required to determine bounding values of residual water content, burnup, heat load at start of storage, and storage duration prior to air ingress for which the potential for fuel oxidation and flammable hydrogen concentration can be eliminated as a concern, thereby avoiding the need to consider them as part of a consequence evaluation."

The Department of Energy merely acknowledges even in 2022 that the consequences of canister breach remain uncertain and are still being studied. [82]

**The NWTRB's 2024 report acknowledges that the NRC's regulations concerning dry storage of spent nuclear fuel do not currently address storage for extended periods.** [83] Neither the Department of Energy nor the Nuclear Regulatory Commission have been willing to provide an estimate of the period of time it will take for partial- or through-wall canister metal corrosion such as from chloride-induced stress corrosion cracking which is known to be applicable to spent nuclear fuel dry storage canisters. Previous studies have indicated that stress corrosion cracking may cause through-wall cracking of the roughly 0.5-inch-thick stainless-steel

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[79] U.S. Nuclear Waste Technical Review Board (NWTRB), *Evaluation of the Technical Basis for Extended Dry Storage and Transportation of Used Nuclear Fuel*, Arlington, Virginia, December 2010. This is a useful report generally, but its criticality discussion is inadequate, particularly for high burnup fuels used in light-water reactors since about 1999.

[80] T. C. Totemeier, Argonne National Laboratory, *A review of the corrosion and pyrophoricity behavior of uranium and plutonium*, ANL-ED-95-2, June 1, 1995. https://www.osti.gov/biblio/97298

[81] 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.)

[82] C. Bryan et al., "Stress Corrosion Cracking Research at Sandia National Labs," Electric Power Research Institute (EPRI) Extended Stroage Collaboration Program (ESCP) Winter 2022 Meeting, Charlotte, South Caroline, November 7-10, 2022. (Presentation found at NWTRB website for 2022 meetings.)

[83] U.S. Nuclear Waste Technical Review Board, *Evaluation of the U.S. Department of Energy Research and Development Activities on the Disposition of Commercial Spent Nuclear Fuel in Dual-Purpose Canisters*, February 2024. https://www.nwtrb.gov/our-work/reports/evaluation-of-the-u.s.-department-of-energy-research-and-development-activities-on-the-disposition-of-commercial-spent-nuclear-fuel-in-dual-purpose-canisters-(february-2024)

canisters of spent nuclear fuel within as little as two or three decades after being loaded. [84] [85] No technical valid analysis is being provided that supports that the canisters are safe for 80 years, let alone after 80 years.

When DOE is promoting advanced nuclear reactors or HALEU fuel, the Department of Energy behaves as though cost is of no concern. When maintaining nuclear facilities in order to protect workers and the public is needed in order to meet DOE's own regulations, then the DOE uses cost as the excuse for continuing unsafe operations. When cleanup is needed, the DOE uses cost as the reason why the many sites will forever be too contaminated to live at. The cleanup that is supposed to be conducted, like taking care of leaking chemically and radiologically high-level waste in tanks at the DOE's Hanford site since the 1940s, the DOE fails to protect workers, the public and the environment. And despite having an Environmental Impact Statement for vitrifying the liquid waste at Hanford, after twenty years of attempting to build a vitrification plant, there still is no vitrification plant and the DOE continues adding liquid radioactive waste to the tanks.

In Idaho, despite having an Environmental Impact Statement and Record of Decision for the high-level waste called calcine, the DOE now states that the previously selected treatment is not technically mature and that they will do more research and that leaving the waste over the Snake River Plain aquifer remains an option.

At every Department of Energy site, including the Idaho National Laboratory, Hanford, Savannah River Site, and Oak Ridge National Laboratory, there are EISs claiming that the spent nuclear fuel and the high-level waste at those sites will go to DOE's repository at Yucca Mountain. But there is no Yucca Mountain repository and there is no program to site, license, build or operate a repository and now additional repositories are needed.

The Department of Energy's Environmental Impact Statements have historically been riddled with assumptions that were speculative and lacked adequate technical basis. There does not appear to be a learning curve even within the last approximately 20 years because the DOE's Yucca Mountain EIS, the Idaho calcine EIS and other EISs are typically inadequate. That this Draft HALEU EIS lists a variety of EISs does not provide proof of safety or of technical adequacy. Anyone who knows what is actually in those EISs and what the actual status is, takes no reassurance for the list of EISs in the Draft HALEU EIS.

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[84] U.S. Nuclear Regulatory Commission, *Atmospheric Stress Corrosion Cracking Susceptibility of Welded and Unwelded 304, 304L, and 316L Austenitic Stainless Steels Commonly Used for Dry Cask Storage Containers Exposed to Marine Environments*, NUREG/CR-7030, October 2010. This report estimated that the onset of stress corrosion cracking, under ideal conditions, would be expected to take between 32 and 128 weeks. But this estimate does not take into account the operating history of the dry storage cask or canister and the local environment at each location.

[85] Electric Power Research Institute (EPRI), *Flaw Growth and Flaw Tolerance Assessment for Dry Cask Storage Canisters*, 3002002785, October 2014. https://www.epri.com/research/products/000000003002002785 Figures 3-9 and 3-10, Crack depth vs. Time for two dry storage locations gave the prediction of 20 to 40 years for 100 percent crack depth.

The Portsmouth Site in Ohio was one location where uranium fuel cycle enrichment took place. The facility spread airborne radioactivity to its neighbors, including the local middle school. The radionuclides were not just from uranium. The reason for this was the introduction of contaminated uranium from reprocessing and a refusal by DOE to acknowledge the extensive contamination from the expanded variety of radionuclides. The DOE typically does not monitor for uranium, preferring to pretend that elevated levels of uranium and its decay progeny are "naturally occurring." But despite the neptunium and americium that are not part of the uranium decay series, the operations at Portsmouth addressed the problem in the DOE way - by the deliberate lack of meaningful radiological monitoring.

Naturally-occurring uranium includes only uranium-238, uranium-235 and also uranium-234. While Y-12 and Portsmouth Gaseous Diffusion Plant, an enrichment facility, expected to receive highly enriched uranium, meaning that there was more uranium-235 than uranium-238 than would be naturally occurring, it appears that neither Y-12 nor the Portsmouth personnel understood *the additional radionuclide contaminants* in the uranium product they were receiving. **The radiological contamination from Portsmouth is a recent example of the Department of Energy ignoring and spreading its radiological mess, unbeknownst to workers and the nearby public.**

The recycled uranium from the INL contained contaminants including plutonium, neptunium and technetium, as well as uranium-236. The extent of the contaminants depended on the type of fuel being reprocessed as well as the reprocessing methods used and all of the fuels included technetium-99 contamination.

As an example, the levels of contaminants in the recycled product from INTEC (or ICPP), the plutonium, neptunium and technetium, "were not recorded explicitly during ICPP operations from 1953 through 1992." [86]

It appears that much of this contamination was not monitored by the receiving facilities of Y-12 at Oak Ridge, Tennessee or the Portsmouth Gaseous Diffusion Plant in Ohio. The long radioactive half-lives of plutonium and technetium mean that soil and groundwater contamination have occurred.

Small amounts of naturally occurring thorium-232 decay to produce daughter progeny of thallium-208 with its high energy gamma emission. But there are various ways that excessive thallium-208 is produced from reactor or recycled fuels. For example, reactor-made uranium-236 and uranium-232 each decay to thallium-208, with its high energy gamma emission.

The thallium-208 emission is particularly problematic for processes or fuel fabrication that had not been designed to provide radiation shielding.

[86] L.C. Lewis et al., Prepared for U.S. Department of Energy, Environmental Management, DOE Idaho Operations Office, *Idaho National Engineering and Environmental Laboratory Site Report on the Production and Use of Recycled Uranium*, INEEL/EXT-2000-00959, September 2000. https://www.osti.gov/servlets/purl/768760

According to a 2015 U.S. Department of Energy Report to Congress, *Tritium and Enriched Uranium Management Plan Through 2060*, [87] the solvent extraction step in spent nuclear fuel reprocessing cannot remove the uranium-236. **The report also notes that the recovered enriched uranium product from reprocessing contains unacceptably high concentrations of undesirable isotope such as uranium-232 and uranium-236.** Furthermore, the uranium-236 as a contaminant in new fuel is a neutron absorber creating "off specification" fuel, thus would require the fuel to have higher uranium-235 enrichment and alter the performance characteristics of the fuel. The report acknowledges that the presence of these isotopes would increase the complexity and cost of fuel fabrication and reactor operations. **But as usual, proper monitoring didn't happen and workers and the public were not protected. The DOE simply assumed no one would notice the elevated radiological contamination.**

See Table 3 for radionuclide contaminants sent to Portsmouth from the Idaho National Laboratory. Other radiological contamination like americium-241 was also likely to have been sent to the Portsmouth enrichment plant, but plant managers and workers were not even told and the monitoring was deliberately inadequate.

The Portsmouth Gaseous Diffusion Plant in Pike County, Ohio had a cancer incidence in 2010-2019 that was 15 percent higher than the U.S, the highest rate of all 88 Ohio counties. In the 1950s and 1960s, Pike county's cancer mortality was 12 percent below the U.S., with the gap closing by 1993. In 2009-2020, the cancer death rate in Pike County exceeded the U.S. by about 50 percent for all age groups, except for persons over age 75. For 2017 to 2020, for persons age 0 to 74, the all-cause mortality in the county was 85 percent, nearly twice that of the U.S. [88]

No wonder the name of the Portsmouth Gaseous Diffusion Plant in Pike County, Ohio has been changed to the American Centrifuge Plant, LLC, a subsidiary of Centrus Energy Corporation. The shoddy operating and dumping practices of the Portsmouth plant has left contaminated groundwater plumes and excessive cancers to workers and the public, yet it was all conducted in accordance with government requirements and the promise of adequate monitoring.

Carefully worded documents deny that Portsmouth is the cause of cancer, all without a complete picture of the past contamination or the actual dose to humans, as if by design. [89] The U.S. Department of Health and Human Services writes as if there were no radiological releases from Portsmouth, during its operation or during cleanup, even though that is untrue. And the agency ignores the particle size, solubility and chemical form of contamination which would affect its harm in the human body. In fact, the radionuclide dose coefficients selected for the dose evaluation would likely grossly underestimate the actual harm for a variety of reasons and is unreliable. The denial of nuclear facilities being the cause of contamination and of health harm is

[87] U.S. Department of Energy, Report to Congress, *Tritium and Enriched Uranium Management Plan Through 2060*, October 2015. http://fissilematerials.org/library/doe15b.pdf

[88] Joseph J. Mangano, Radiation and Public Health Project, *Health Risk to Local Residents for the Portsmouth Gaseous Diffusion Plant*, August 15, 2022.

[89] U.S. Department of Health and Human Services, *Health Consultation – Evaluation of Environmental Radiological Sampling Data Collected from 2016 to 2022 Near the Portsmouth Site, U.S. Department of Energy Portsmouth Site (Formally known as Portsmouth Gaseous Diffusion Plant)*, March 29, 2024.

something that the Government agencies do excel at. Portsmouth plant also released chemicals, including hexavalent chromium until the early 1990s, discussed previously.

**Table 3.** Radionuclide contaminants in INL reprocessed fuel shipped to Y-12 and Portsmouth.

| Radionuclide | Range, Weight | Comments |
|---|---|---|
| Plutonium | 0.001 ppb to 300 ppb | Pu-239 maximum 35.3 ppb,<br>Pu-238 maximum 0.12 ppb<br>The americium-241 is present in the dissolver product but is not discussed in the source report as being in the final reprocessed fuel product. |
| Neptunium-237 | 1.2 to 4 ppm | |
| Technetium-99 | 0.018 to 1.8 ppb | Technetium is very long-lived and very mobile in the environment. |
| Uranium-236 | 8.42 to 15.81 percent, Aluminum and Zirconium fuels | Uranium-236 results in significant radiation exposures due to decay product uranium-232 and its decay progeny, particularly thallium-208 with its 2.6 MeV (mega electron volt) gamma emission.<br>Other manmade uranium isotopes are present in the dissolver product but are not discussed in the source report as being in the final reprocessed fuel product. |

Table Source: L.C. Lewis et al., Prepared for U.S. Department of Energy, Environmental Management, DOE Idaho Operations Office, *Idaho National Engineering and Environmental Laboratory Site Report on the Production and Use of Recycled Uranium*, INEEL/EXT-2000-00959, September 2000. https://www.osti.gov/servlets/purl/768760

## DOE's Projects Often Experience Cost Overruns Before Complete Collapse

The Department of Energy's project for conversion of 34 metric tons of surplus plutonium to mixed oxide fuel at the now cancelled Savannah River Site Mixed-Oxide Fuel Fabrication Facility was originally estimated to cost $1.4 billion to construct and be operating in 2004. By 2016, it was estimated to cost $17.2 billion and be completed by 2048. [90] [91] The Department of Energy sunk almost $8 billion into the MOX facility which was cancelled in 2018. The U.S. Government Accountability Office reports that the approaches for managing or disposal of Department of Energy's roughly 57 metric tons (MT) of surplus plutonium has gyrated considerably over the last 20 years, and remains uncertain.

[90] Douglas Birch and R. Jeffrey Smith, *Center for Public Integrity*, "Nuclear Waste: A $1 Billion Energy Department Project Overshoots Its Budget by 600 Percent," June 25, 2013. https://publicintegrity.org/national-security/nuclear-waste-a-1-billion-energy-department-project-overshoots-its-budget-by-600-percent/

[91] U.S. Government Accountability Office, "Surplus Plutonium Disposition," GAO-20-166, October 2019. https://www.gao.gov/assets/710/702239.pdf

Only after spending billions of dollars, the Department of Energy decided to cancel the MOX fuel project. No U.S. nuclear reactor had agreed to take the MOX fuel and the cost and schedule had spiraled out of control.

Rather than fabricating MOX fuel, 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. [92] 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. [93] 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. [94] [95]

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

The DOE likes to imply that reprocessing spent nuclear fuel is the answer to the disposal problem. But DOE has cancelled reprocessing of high enriched fuels to recover uranium-235. And commercial spent nuclear fuel reprocessing to recover plutonium-239 was polluting and not economical. Plutonium-239 forms in a reactor that contains uranium-238 when the uranium-238 absorbs a neutron during reactor operation. The nation already has a problem trying to dispose of its surplus plutonium, so why would it make any sense to reprocess the nation's spent nuclear fuel to obtain plutonium? It is particularly troubling when DOE makes false and misleading claims that it can use reprocessing to solve the problem of the mountain (about 140,000 MT) of spent nuclear fuel the nation has already.

The Department of Energy has provided millions of dollars toward a small modular reactor called NuScale. On November 8, 2023, cancellation of the NuScale small modular reactor project slated for Idaho by the Utah Associated Municipal Power Systems (UAMPS) was

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

[93] 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.

[94] 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.

[95] 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

announced. UAMPS was unable to find enough electricity subscribers for the project because of its already noncompetitive estimated costs. The project is also called the "Carbon Free Power Project." Future spiraling cost increases would have been likely had construction begun, and ratepayers would have been on the hook for future cost increases had the project continued.

NuScale had begun the process of licensing the small modular reactor design in 2008 and had been granted a standard design approval (SDA) for the 50 MW-electric (MWe), per module, design in September 2020. [96] This project wasted a tremendous amount of time and money and would have wasted far more of each had it continued, I believe, because some aspects of its unique design such as the helical steam generators remained undesigned and unproven.

## Full Extent of Health Harm from Radiation to Workers and the Public Must Be Evaluated

The Draft HALEU EIS points to various EISs rather than conducting any evaluations. DOE and NRC EISs have a history of lacking adequate technical basis. All EISs that have evaluated radiation health effects have failed to acknowledge the full range of adverse health effects as they use a protection model calibrated for the outcome of cancer.

Although a tardy and incomplete report, the National Academy of Sciences stated in 2022 that "There is also increasing evidence that low-dose radiation exposure may be associated with non-cancer health outcomes such as cardiovascular disease, neurological disorders, immune dysfunction, and cataracts." [97] While the 2022 NAS report does contain some useful information, it reveals that NAS is far more interested in the health of the nuclear industry than the health of humans. The 2022 NAS report, by ignoring the airborne radiation long known to be released from pressurized water and boiling water reactors, has ignored the tremendous problem in internal radiation. The 2022 NAS report ignores the known occurrence of nuclear reactor radiological airborne emissions that historically have contaminated air, food and water. Cows graze on contaminated pastures and then the milk that mothers and children drink is contaminated. Monitoring of milk was conducted and yet limits on radioactive contamination was not based on sound science, certainly not for the developing child in utero.

Some radiological releases from nuclear reactor operations are ongoing and other releases are sporadic. Monitoring programs, even when properly designed, tend to be conducted in a manner to conceal the full extent of radiological contamination. This is certainly the case around all Department of Energy national laboratories. Contamination monitoring around commercial nuclear power plants is even less reliable. Open up the boiling water reactor for an outage or crack a number of steam generator tubes at a pressurized water reactor releases radionuclides to the atmosphere. The subsequent ingestion of radiologically contaminated milk by the pregnant

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[96] Arjun Makhijani and M.V. Ramana, Prepared for Environmental Working Group, *Questions for NuScale VOYGR Reactor Certification: When Will It Be Done? And then, Will It Be Safe?*," April 9, 2023.

[97] National Academies of Sciences, Engineering, and Medicine, *Leveraging Advances in Modern Science to Revitalize Low-Dose Radiation Research in the United States*, Washington, DC: The National Academies Press, 2022. http://nap.nationalacademies.org/26434 or https://doi.org/10.17226/26434.

mother can result in fetal death, birth defects or reduced intelligence of the child, from nuclear reactor operation similar to the experience with nuclear weapons fallout from the Department of Energy's weapons testing.

The Energy Employee Occupational Illness Compensation Program Act (EEOICPA) has not been mentioned in the Draft HALEU EIS but needs to be discussed. This program is limited and does not address workers in NRC-licensed facilities. **This program, enacted in 2000, has paid out about $43 billion in compensation to people harmed by DOE's programs involving the uranium fuel cycle and much of it caused by radiation exposure.** [98]

The EEOICPA provides compensation to eligible Department of Energy nuclear workers and their eligible survivors for certain diseases, including radiogenic cancers. Uranium miners, millers and ore transporters who worked from 1942 to 1971 are also eligible for benefits under the EEOICPA via the Radiation Exposure Compensation Act. The Department of Energy programs for developing nuclear weapons and for nuclear reactor research included these activities that poisoned people: mining, milling, conversion, enrichment, fuel fabrication, nuclear reactor operation, spent fuel reprocessing and nuclear waste transportation and radioactive waste disposal. One might find that some of the problems due to inadequate monitoring of radiation exposure may have been fixed. But generally, the problems are of these radiologically polluting operations continue to harm workers and also the public.

Major Department of Energy laboratories needing EEOICPA compensation include the Idaho National Laboratory, Hanford site in Washington, Savannah River Site in South Carolina, Oak Ridge National Laboratory in Tennessee, and the Los Alamos National Laboratories in New Mexico. In addition to these five sites, there are about 130 other sites involved with Department of Energy, usually involving uranium fuel cycle work, where the workers also are eligible for EEOICAP compensation (see https://www.cdc.gov/niosh/ocas/worksite.html) The dismal record of the DOE for causing harm to workers and leaving land permanently contaminated needs to be included in the HALEU EIS.

In addition, the Draft HALEU EIS uses a harmfully high yet allowable for routine continuous radiation doses to every member of the public, no matter their age or vulnerability, as 100 millirem per year per DOE Order 458.1, Chg 4 *Radiation Protection of the Public and the Environment*. This level of dose is being treated by the Department of Energy as though it is a benign dose: it would devastate children, especially the child developing in utero. Even the EPA and NRC aspire to keep such doses below 25 or 15 millirem/yr. The Department of Energy continues an unscientifically based radiation protection dose to the public of 100 millirem/yr and apply this dose to each of several exposure pathways, not considering all the pathways together. In other words, give the embryo 100 mrem/yr from milk, and another 100 mrem/yr from water, and another 100 mrem/yr from the spent nuclear fuel shipments going by, etc. In each case, the

[98] National Academies of Sciences, Engineering, and Medicine, *Leveraging Advances in Modern Science to Revitalize Low-Dose Radiation Research in the United States*, Washington, DC: The National Academies Press, 2022. http://nap.nationalacademies.org/26434 or https://doi.org/10.17226/26434.

DOE's analysis would say each release was acceptable because it was below the DOE Order 458.1's allowable 100 mrem/yr routine dose to the public.

In terms of accidents, the Department of Energy has its own regulations that require it to keep accident doses below 25 rem to the public. Obviously, this is a life-shortening cancer-causing dose to adults and lethal to vulnerable populations. But even this deadly dose was deemed just too inconvenient and too expensive by the Department of Energy. At the Department of Energy's Los Alamos National Laboratory, the DOE [and National Nuclear Security Administration, (NNSA)] decided to ignore the DOE's own regulations and not attempt to design systems and barriers to prevent accidents involving radiation doses to the public exceeding 25 rem and contamination that would cause permanent evacuation.

An August 2022 letter from the DNFSB to DOE states that the National Nuclear Security Administration (NNSA) has, for LANL in New Mexico, accepted **the extraordinarily high mitigated offsite dose consequences range from 490 to 3175 rem, via the "exigent circumstances processes."** Typically, radiation doses above about 400 rem are considered lethal. Vast areas would become permanently uninhabitable with plutonium and citizens will die because of the extraordinary and irresponsible lack of adequate safety mitigations.

The Department of Energy can cite its own regulations and yet at any time they chose, DOE can decide not to comply with its own regulations. Reasonable-sounding regulations are paraded in documentation such as in the many Environmental Impact Statements for NEPA including those cited by the Draft HALEU EIS. It is implied that these agencies actually comply with these regulations rather than exempt themselves from complying.

Rather than comply with 10 CFR 830 for Department of Energy nuclear facilities and meet the intent of these regulations to protect the offsite public, DOE and/or NNSA can and have invoked the "exigent circumstances processes." At LANL's PF-4, rather than ensure the offsite public dose remains well below 25 rem, the DOE is accepting the offsite public dose **consequences range from 490 to 3175 rem.** Despite the mitigated radiation doses to the offsite public being far above 25 rem, they are refusing to upgrade the confinement ventilation system or glove boxes. They are also refusing to implement meaningful and enforced combustible loading limits and by reducing the amount of material at risk, the grams of material in vulnerability storage or processes, to reduce the risk. [99] [100]

With needed safety upgrades, cost is used as the excuse to put workers and the public at risk. With nuclear industry contracts, false promises, and the HALEU schemes, the enormous cost doesn't seem to matter. [101]

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[99] Public Comment Submittal from Tami Thatcher to the Defense Nuclear Facilities Safety Board (DNFSB) Regarding the Public Hearing on Los Alamos National Laboratory held in Santa Fe, New Mexico on November 16, 2022, at http://www.environmental-defense-institute.org/publications/CommentDNFSB2022.pdf

[100] Defense Nuclear Facilities Safety Board letter to the Department of Energy, Secretary Jennifer Granholm, dated August 11, 2022, which transmits the DNFSB Staff Report "Receipt and Repackaging of Large Amounts of Heat Source Plutonium at the Los Alamos National Laboratory Plutonium Facility," May 27, 2022, at DNFSB.gov

[101] Defense Nuclear Facilities Safety Review Board website at dnfsb.gov, November 16, 2022 meeting on the Los Alamos National Laboratory, see meeting agenda, videos, exhibits for cleanup and increased pit production and

**The Department of Energy's History of Withholding Unfavorable Epidemiology Makes Any EIS Finding Regarding Human Health by DOE Not Credible**

The Department of Energy had asserted that its activities had not threatened human health, even from its Nevada Weapons Testing. Ultimately in 1990, Congress finally enacted the Radiation Compensation Exposure Act to compensate a portion of the people harmed by DOE. Efforts to expand coverage to all affected populations have been attempted for years, including in 2024. The government as long denied the extent of the harm and the Radiation Exposure and Compensation Act has not been expanded to downwinders in New Mexico [102] or downwinders in Montana and other states including Idaho. [103]

The Department of Energy had withheld epidemiological results such as of increased leukemia in children in Utah from the nuclear weapons testing conducted at the Nevada Test Site that began in the 1950s. [104] Former Secretary of Energy Watkins appointed a panel to investigate the DOE epidemiology program. The Secretarial Panel for the Evaluation of Epidemiologic Research Activities (SPEERA) held public hearings from September 1989 to March 1990. Among the recommendations contained in its final report, the SPEERA advocated the removal of some epidemiologic functions from DOE control through a Memorandum of Understanding (MOU) between the Secretary of Energy and the Secretary of Health and Human Services, because of DOE's dishonest behavior.

The Department of Energy had also sought to manipulate epidemiology to lower the cancer rates in radiation workers. [105] The DOE's history of concealing unfavorable epidemiology results ended DOE's direct control of epidemiologic studies. [106] [107]

In addition, the DOE's Low Dose Radiation Research Program that conducted research from 1998 until defunded in 2011, had emphasized only the positive effects of radiation, emphasizing

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other information on the dnfsb.gov webpage https://www.dnfsb.gov/public-hearings-meetings/november-16-2022-public-hearing.

[102] Daneille Prokop and Marisa Demarco, *Idaho Capital Sun*, "'They scrapped us': The Trinity downwinders and New Mexico mine workers who remain unrecognized," January 16, 2024. https://idahocapitalsun.com/2024/01/16/they-scrapped-us-the-trinity-downwinders-and-new-mexico-mine-workers-who-remain-unrecognized/?emci=1009a06f-f5b3-ee11-bea1-0022482237da&emdi=a0a1c99b-77b4-ee11-bea1-0022482237da&ceid=112318

[103] Blair Miller, *Idaho Capital Sun*, "'What do we have to do?': Awareness of historic nuclear radiation grows in Montana neighborhood," January 12, 2024. https://idahocapitalsun.com/2024/01/12/what-do-we-have-to-do-awareness-of-historic-nuclear-radiation-grows-in-montana-neighborhoods/

[104] Philip L. Fradkin, *Fallout – An American Tragedy*, Johnson Books, 2004, 1989. ISBN 1-55566-331-1

[105] Gayle Greene, *The Woman Who Knew Too Much – Alice Stewart and the Secrets of Radiation*, University of Michigan, 1999. ISBN 0-472-08783-5. The Department of Energy support for and subsequent squelching of Hanford radiation worker epidemiology studies are described in Gayle Greene's *The Woman Who Knew Too Much – Alice Stewart and the Secrets of Radiation*.

[106] H. J. Geiger, *Dead Reckoning – A Critical Review of the Department of Energy's Epidemiologic Research*, Physicians for Social Responsibility, 1992.

[107] S. Wing, "A Critical Review of the Department of Energy Efforts to Investigate the Human Health Effects of Plutonium," Berger-Montague, 1996.

any finding of cell repair and laboratory cell studies showing hormesis (beneficial effects of radiation), but kept quiet about the negative effects of radiation.

The DOE's Low Dose Program, when faced with the reality that its limited study of animals and cell cultures did not override existing human epidemiology, also had to face the issue that if conducted in a credible scientific manner, it was likely to find greater human health harm and would lead to tighter radiological standards. Thus, DOE stopped pushing its Low Dose Research because it had no reason to push the program unless it would lead to reduced radiological standards. The health of the nuclear industry has always been DOE's primary concern, not human health.

It should be remembered that the Department of Energy did not seek the creation of the Energy Employee Occupational Illness Compensation Program Act (EEOICPA). And despite the fact that the program has never completed studies to acknowledge inadequate radiological monitoring and has denied coverage to a large portion of workers, this program, enacted in 2000, has paid out about $43 billion in compensation to people harmed by DOE's programs involving the uranium fuel cycle and much of it caused by radiation exposure. [108]

### The U.S. Nuclear Regulatory Commission Cancelled Meaningful Epidemiology Because They Knew that the Truth Would Kill Nuclear Energy

The U.S. NRC cancelled what would have been the first meaningful epidemiology study of health effects near US nuclear reactors, [109] despite the German epidemiology study of children living near nuclear plants have roughly double the incidence of cancer and leukemia and similar findings resulted from the study of clusters of childhood leukemia near nuclear sites including Sellafield, Dounreay and La Hague where an excess of 300-fold infant leukemia were found. [110] [111] [112]

Airborne radiological releases from nuclear power plants affect downwind residents but contaminated foods are distributed unevenly. Radioactive contamination that lands on pastures grazed by dairy cattle results in radioactively contaminated milk. Radioactive contamination also affects garden produce. Thus, the inhalation and ingestion of radionuclides varies according to

[108] National Academies of Sciences, Engineering, and Medicine, *Leveraging Advances in Modern Science to Revitalize Low-Dose Radiation Research in the United States*, Washington, DC: The National Academies Press, 2022. http://nap.nationalacademies.org/26434 or https://doi.org/10.17226/26434.

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

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

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

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

location as well as diet. The harm depends on gender and the age of exposure and it is known that women are more vulnerable than men, and children are more vulnerable than adults. Radiological sampling of milk that was conducted in the U.S. allowed levels of radioactivity that we now know were harmful. Diminishing radioactivity levels in the diet were accompanied by immediate and significant morbidity and mortality reductions among infants and young children, from 1965 to 1970. Following nuclear power plant closures, decreases in the radioactivity of milk has been noted and reductions in deaths among infants who had lived downwind and within 64 km of each nuclear plant. Cancer incidence in children younger than 5 years of age were also noted to fall significantly after the shutdowns. [113]

### DOE and NRC Ignore the Fact That Low Doses of Ionizing Radiation Cause Increased Infant Mortality and This Must Be Evaluated

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. [114]

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. [115]

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. [116]

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

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[113] Joseph J. Mangano, Jay M. Gould, Ernest J. Sternglass, Janette D. Sherman, Jerry Brown and William McDonnell, Radiation and Public Health Project, "Infant Death and Childhood Cancer Reductions after Nuclear Plant Closings in the United States," *Archives of Environmental Health*, Vol. 57 (No.1), January/February 2002.

[114] 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*.

[115] 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.

[116] 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.

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. [117]

## Radiation-Induced Birth Defects Ignored or Not Reported by U.S. Agencies and Must Be Evaluated

*Time* magazine recently 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 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*. [118]

Birth defects were omitted from studies of the Marshallese people that the U.S. exposed in nuclear weapons tests in the Marshall Islands. [119]

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. [120]

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.

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[117] 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

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

[119] 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.

[120] 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 nuclear industry, including the Department of Energy, is wrong to use the International Commission on Radiological Protection (ICRP) treatment of heritable disease. While the ICRP continues to say that "Radiation induced heritable disease has not been demonstrated in human populations," Chis Busby writes that evidence of genetic effects *has* been found in humans and at very low radiation doses. [121] [122]

The ICRP maintains that human evidence of genetic effects due to radiation does not exist. The ICRP then uses the study of external radiation on mice to estimate the heritable risks for humans. One study was conducted using internal radionuclides on mice and the study noted that "detailed research on internal radiation exposure has hardly ever been reported in the past." [123] **This limited study of microcephaly in mice found that far lower doses of internal radiation caused the same effect as higher doses of external radiation.**

It has been known now for a few decades that radiation exposure to the developing embryo and fetus "can cause growth retardation; embryonic, neonatal, or fetal death; congenital malformations; and functional impairment such as mental retardation." [124]

In 2007, the International Commission of Radiological Protection (ICRP) lowered its estimate of the risk of genetic harm of congenital malformations by 6-fold, from 1.3E-4 per rem to 0.2E-4 per rem. Based on the belief that the study of the Japanese bomb survivors did not detect genetic effects, **the ICRP genetic effect estimate for humans is based on studies of external radiation of mice.**

The ICRP estimate of risk of congenital malformations is a fraction of its predicted cancer risk for cancer mortality (or latent cancer fatality). The ICRP latent cancer fatality risk was 5.0E-4 LCF per rem (1991 estimate), close to the cancer mortality rate used in the Department of Energy's Versatile Test Reactor EIS of 6.0E-4 LCF per rem. [125]

While the studies of genetic injury to the Japan bombing survivors declared that they found no evidence of genetic damage, other researchers have found those studies to have been highly flawed. A report published in 2016 by Schmitz-Feuerhake, Busby and Pfugbeil summarizes

[121] Chris Busby, *The Ecologist*, "It's not just cancer! Radiation, genomic instability and heritable genetic damage," March 17, 2016. https://theecologist.org/2016/mar/17/its-not-just-cancer-radiation-genomic-instability-and-heritable-genetic-damage

[122] Chris Busby, Scientific Secretary, European Committee on Radiation Risk, Presentation, "Radioactive discharges from the proposed Forsmark nuclear waste disposal project in Sweden and European Law," September 8, 2017. Online pdf 646_Nacka_TR_M1333-11_Aktbil_646_Christopher_Busby_presentation_170908

[123] Yukihisa Miyachi, J-STAGE, "Microcephaly Due to Low-dose Intrauterine Radiation Exposure Caused by 33P Beta Administration to Pregnant Mice," 2019 Volume 68 Issue 3 Pages 105-113. https://www.jstage.jst.go.jp/article/radioisotopes/68/3/68_680303/_article/-char/en

[124] Eric J. Hall, *Radiobiology for the Radiologist*, 5th ed., 2000, p. 190.

[125] U.S. Department of Energy's Versatile Test Reactor Draft Environmental Impact Statement (VTR EIS) (DOE/EIS-0542) (Announced December 21, 2020). A copy of the Draft VTR EIS can be downloaded at https://www.energy.gov/nepa or https://www.energy.gov/ne/nuclear-reactor-technologies/versatile-test-reactor. (See discussion in VTR EIS Appendix C, page C-4).

numerous human epidemiology studies of congenital malformations due to radiation exposure. [126]

The 2016 report disputes the ICRP genetic risk estimate and finds that diverse human epidemiological evidence supports a far higher genetic risk for congenital malformations. **Nearly all types of hereditary defects were found at doses as low as 100 mrem.** The pregnancies are less viable at higher doses and so the rate of birth defects appears to stay steady or falls off at doses above 1000 mrem or 1 rem. The 2016 report found the excess relative risk for congenital malformations of 0.5 per 100 mrem at 100 mrem falling to 0.1 per 100 mrem at 1000 mrem.

The 2016 report's result for excess relative risk of congenital malformations of 5.0 per rem is 250,000-fold higher than the ICRP estimate of 0.2E-4 per rem which ICRP appears to assume has a linear dose response. (See the August 2021 Environmental Defense Institute newsletter.)

### Actual Harm to Radiation Workers Must Be Evaluated

Radiation worker training today still implies that a 5-rem annual dose would not be harmful even though radiation worker epidemiology has indicated elevated health risks at doses ten times less than 5 rem annually. [127] [128] Radiation workers are still not warned of reproductive health risks such as sterility or increased risk of birth defects. [129] [130] I have witnessed the shortened life spans of workers at the Idaho National Laboratory, all of whom trusted that they were not getting excessive or health-damaging levels of radiation.

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[126] Inge Schmitz-Feurerhake, Christopher Busby, and Sebastian Pflugbeil, *Environmental Health and Toxicology, Genetic radiation risks: a neglected topic in the low dose debate*, January 20, 2016. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4870760/ The 2016 report found the "excess relative risk for congenital malformations of 0.5 per mSv at 1 mSv falling to 0.1 per mSv at 10 mSv exposure and thereafter remaining roughly constant."

[127] Richardson, David B., et al., "Risk of cancer from occupational exposure to ionizing radiation: retrospective cohort study of workers in France, the United Kingdom, and the United States (INWORKS), BMJ, v. 351 (October 15, 2015), at http://www.bmj.com/content/351/bmj.h5359 Richardson et al 2015 . This epidemiology study that included a cohort of over 300,000 nuclear industry workers has found clear evidence of solid cancer risk increases despite the average exposure to workers being about 2 rem and the median exposure was just 410 millirem. Also see December 2015 EDI newsletter.

[128] Email communication with INL's public relations and Director Mark Peters confirmed that radiation worker training did not include training about recent epidemiology indicating higher health risk following Peter's editorial in the Post Register on January 3. 2016 that promised more transparency, "New INL director looks ahead."

[129] See the September EDI newsletter p. 2 and 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.

[130] "Health Risks from Exposure to Low Levels of Ionizing Radiation BEIR VII – Phase 2, The National Academies Press, 2006, http://www.nap.edu/catalog.php?record_id=11340 The BEIR VII report reaffirmed the conclusion of the prior report that every exposure to radiation produces a corresponding increase in cancer risk. The BEIR VII report found increased sensitivity to radiation in children and women. Cancer risk incidence figures for solid tumors for women are about double those for men. And the same radiation in the first year of life for boys produces three to four times the cancer risk as exposure between the ages of 20 and 50. Female infants have almost double the risk as male infants. BEIR VII findings are not included in Department of Energy radiation worker training, nor are the findings included in public radiation protection standards.

Most workers do not understand the wide latitude allowed in making assumptions that can bias radiation dose estimates, nor the large uncertainty in the dose estimates. [131]

Investigations conducted of historical INL operations for energy worker illness compensation during the last two years have found shattering revelations about inadequate worker protections at the INL especially regarding inhalation of alpha emitters such as plutonium and the inability to estimate what doses these workers had received. The investigations partially include the early decades of INL operation until the 1980s but have not investigated all years of operation. [132] [133] [134] [135] [136] [137] [138] [139] Yet, as these studies for the National Institute for Occupational Safety and Health have begun to allow more workers to obtain compensation, many more studies need to be completed for various INL facilities and various years of operation. Roughly two thirds of INL illness compensation claims have been denied and these workers or their eligible survivors may die before the studies are complete.

The Department of Energy support for and subsequent squelching of Hanford radiation worker epidemiology studies are described in Gayle Greene's *The Woman Who Knew Too Much – Alice Stewart and the Secrets of Radiation*. [140] Alice Stewart is famous for the unexpected finding that very small external x-ray medical radiation doses to pregnant woman in the 1950s increased the risk of childhood cancer and leukemia.

The compensation program cannot ever compensate fully for the loss of life and loss of quality of life. And many of those workers who were made ill will be denied compensation because of DOE's inadequate radiation monitoring, inadequate record-keeping, and destruction of records.

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[131] "See the March 2017 EDI newsletter "How DOE underestimates the harm of plutonium inhalation," at http://www.environmental-defense-institute.org/publications/News.17.March.pdf and other newsletters.

[132] See the EDI September 2017 newsletter and the Advisory Board on Radiation and Worker health meetings webpage for August 2017 at https://www.cdc.gov/niosh/ocas/pubmtgs.html See the NIOSH/DCAS: Idaho Laboratory SEC Evaluation Report SEC-00238 from that page at https://www.cdc.gov/niosh/ocas/pdfs/abrwh/pres/2017/dc-inlsec238-082317.pdf

[133] See the July 20, 2017 presentation to the NIOSH radiation board (See August 14, 2017 board meeting) describing various problems at the Idaho National Laboratory's INTEC prior to 1981 at https://www.cdc.gov/niosh/ocas/pdfs/sec/inl/inler-238-r0.pdf

[134] INL May 2, 2016 NIOSH Radiation Advisory board recommended Special Exposure Cohort: https://www.cdc.gov/niosh/ocas/pdfs/abrwh/secrecs/bdrecinl-219.pdf

[135] ANL-West May 2, 2016 NIOSH Radiation Advisory board recommended Special Exposure Cohort: https://www.cdc.gov/niosh/ocas/pdfs/abrwh/secrecs/bdrecanlw-224.pdf

[136] See p. 19 of "INL SEC Proposed Class – Update SEC00219" at https://www.cdc.gov/niosh/ocas/pdfs/abrwh/pres/2015/dc-inlsec219-111015.pdf

[137] See EDI's June 2017 newsletter article "Why so wrong for so long?" at http://www.environmental-defense-institute.org/publications/News.17.June.pdf

[138] SC&A, Inc., "Draft Review of NIOSH's Evaluation Report for Petition SEC-00219, Idaho National Laboratory: Burial Ground, 1952-1970," SCA-TR-2017-SEC007, May 2017.

[139] Department of Labor presentation August 2017 https://www.cdc.gov/niosh/ocas/pdfs/abrwh/pres/2017/dol-update-082317.pdf p. 10-12.

[140] Gayle Greene, *The Woman Who Knew Too Much – Alice Stewart and the Secrets of Radiation*, University of Michigan, 1999. ISBN 0-472-08783-5.

## Conclusion

The Department of Energy's Draft HALEU EIS intentionally obscures the truth about the harm to workers and the public and to the environment from increased HALEU production as well as subsequent hoped-for increased nuclear reactor operation and generation of spent nuclear fuel. The Draft HALEU EIS implies that only a small amount of HALEU will be produced and gears the EIS toward the smallest total amount of 290 MT while aiming for 500 MT per year and ignoring those environmental consequences and inevitable crippling costs of spent nuclear fuel management.

The Draft HALEU EIS hides the known deficiencies and problems regarding the lack of a repository for spent nuclear fuel and the likelihood that there won't be the one or more repositories needed within a hundred years. The cost of attempting to design, license, build and operate a repository also is not being recognized for the unaffordable and doomed to fail experiment that the endeavor is. The specific technical challenges of disposing of or of reprocessing and disposal, have been actively ignored by the Department of Energy and must be evaluated in the EIS.

**The Draft HALEU EIS makes unsubstantiated claims about the safety of the storage of spent nuclear fuel when the DOE knows full well that there is inadequate technical basis upon which to make such claims.** In fact, the atmospheric chloride-induced stress corrosion cracking is expected to cause through-wall cracking of the spent nuclear fuel canisters. It is only a matter of <u>when</u> this will occur. The Department of Energy has itself acknowledged that it does not have a technical basis for assessing the radiological consequences of spent nuclear fuel storage canister breach such as from expected chloride-induced stress corrosion cracking. The U.S. Nuclear Regulatory Commission has licensed spent nuclear fuel dry storage in locations like San Onofre, California, that are particularly vulnerable to chloride-induced stress corrosion cracking, despite knowing of the vulnerability and knowing that no method to detect or repair canister cracking exists. With the deployment of mobile reactors that seek to use HALEU fuels, there were be far more spent nuclear fuel storage locations and greater complexity of widely varying spent nuclear fuel storage systems. Serious safety challenges pose far greater harm than acknowledged in the Draft HALEU EIS and the enormous economic cost of shifting toward the costliest way to generate electricity is lacking from the evaluation in the HALEU EIS. Cradle-to-grave costs of HALEU and that includes the cost of spent nuclear fuel management and disposition (disposal) must be evaluated and not just for token quantities of HALEU production.

The prediction of when spent nuclear fuel canister integrity will fail depends on factors specific to each canister: the canister design, the atmospheric humidity and chloride level, the temperature of the canister surface, and others. The licensing of spent nuclear fuel dry storage by the U.S. Nuclear Regulatory Commission has not assured safe storage of spent nuclear fuel. Indeed, the NRC granted licenses for dry storage when expecting that the canisters would only need to survive for about twenty years before being accepted for disposal. The NRC has not yet determined any way to conduct meaningful inspection of spent nuclear fuel canisters and has no method developed for repairing or repackaging spent nuclear fuel canisters.

The NRC has regularly licensed nuclear reactors despite the lack of adequate analyses upon which to base the expectation of safety. One such example resulted in the accident at Three Mile Island Unit 2. Based on its own track record, no confidence regarding safety should be placed on the licensing of reactors or spent nuclear fuel storage by the U.S. Nuclear Regulatory Commission. The NRC's adopted radiation protection standards have failed the public near every nuclear power plant and also other uranium fuel cycle facilities. Pregnant mothers in particular are not told of the contamination they are receiving in air, water, milk, lettuce and other foods affected by releases from nuclear power plants. And there is ample evidence that the nuclear industry is actively ignoring.

Each new reactor and reactor fuel design creates a host of unanswered research questions regarding the storage, transportation and disposal of the spent nuclear fuel. The DOE, by its own admission, has already fallen far behind in needed research to determine how long the spent nuclear fuel we already have, can remain safely stored or how long it can be stored before it can still be safely transported.

Each new fuel and new burnup level requires specific studies regarding disposal. The increased difficulty of disposing of new varieties of spent fuel was not acknowledged but it will be costly and there may be surprises. For example, far more containers of spent nuclear fuel may be required for the repository, disproportionately more containers for each metric ton of spent nuclear fuel.

The forty-first annual report of the Cancer Data Registry of Idaho (CDRI) was issued in December 2019 for the year 2017. [141] The Idaho National Laboratory bordered by the counties of Bonneville, Bingham, Butte, Madison and others. Bonneville County has very high thyroid cancer rates, about double the state average. Now let's look at Bingham and Madison County. This is interesting: Madison County has lower cancer rates that the state average for just about everything — except thyroid cancer, the adjusted rate. Madison County has double the state average thyroid rate. Bingham County also has about double the state average thyroid cancer rate. Bingham County also has elevated rates of colorectal, Hodgkin Lymphoma, kidney, liver, myeloma, non-Hodgkin Lymphoma, ovary, pancreas, stomach, and male childhood cancer. Butte County, closest to the INL, has three times the state average thyroid cancer rate and many other grossly elevated cancer rates. [142] The estimated whole-body doses from INL's radiological

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

[142] A fact sheet from the Cancer Data Registry of Idaho, Idaho Hospital Association, Cancer Incidence 2013-2017, see Bingham, Butte and Madison Counties at
https://www.idcancer.org/ContentFiles/special/CountyProfiles/BINGHAM.pdf
https://www.idcancer.org/ContentFiles/special/CountyProfiles/BUTTE.pdf and
https://www.idcancer.org/ContentFiles/special/CountyProfiles/MADISON.pdf

airborne releases are less than 1 millirem/yr. The U.S. Nuclear Regulatory Commission states that the airborne releases from commercial nuclear power plants in the U.S. give a less than 0.01 millirem/yr whole body dose (see https://www.nrc.gov/about-nrc/radiation/related-info/faq.htm) So, what is going on?

The airborne radiological releases can contain a variety of radionuclides such as iodine-131, strontium-90, cesium-137, tritium and many others. Each radionuclide inhaled or ingested behaves in a particular way giving off radioactive decays. And each radionuclide may have a particular affinity for different organs in the body. Conceptually, the whole-body dose is designed to allow a convenient comparison of a combination of radionuclides. Basically, the whole-body dose scales the organ doses on the basis of how likely you would die from cancer in that organ. So, you really don't need your thyroid, gonads, breasts all that much… The problem is that cancer is not the only adverse health outcome of radiation intakes and exposure. The other problem is that a fetus/embryo needs a healthy thyroid in order to be ready to breath when born and to be healthy. Radioactive iodine does not just give thyroid cancer, it hampers the fetus/embryo's ability to develop and survive. Strontium-90, cesium-137, uranium, plutonium and other radionuclides also cause birth defects.

The problem with being focused on "effective" whole body dose while ignoring each organ dose is that it can sound like the dose you received was low and yet that dose to that organ can be far higher than the organ would receive from natural background radiation.

Given the already elevated cancer rates around the Idaho National Laboratory now, think about the INL's proposed and now occurring elevated levels of radionuclide emissions. And yet, there is no investigation of why southeast Idaho has elevated rates of certain cancers.

The Department of Energy and Nuclear Regulatory Commission allowable limits on radiological exposures and radiological releases allow radiation doses that we now know are harmful to workers and to the public. [143] [144] [145] The nuclear industry actively biases their studies and actively ignores the tragic lessons from the Department of Energy's nuclear weapons testing and from U.S. uranium fuel cycle activities. [146] In the face of this, the Department of Energy's

[143] Joseph J. Mangano, Jay M. Gould, Ernest J. Sternglass, Janette D. Sherman, Jerry Brown and William McDonnell, Radiation and Public Health Project, "Infant Death and Childhood Cancer Reductions after Nuclear Plant Closings in the United States," *Archives of Environmental Health*, Vol. 57 (No.1), January/February 2002.

[144] 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*.

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

[146] U.S. Nuclear Regulatory Commission, *Generic Environmental Impact Statement for Advanced Nuclear Reactors*, Office of Nuclear Material Safety and Safeguards. NUREG-2249. Draft for Comment, 2021. https://www.nrc.gov/docs/ML2122/ML21222A055.pdf This hands off to other older and inadequate Environmental Impact Statements and is understating the harm to human health and the environment.

Draft HALEU EIS and all of the EISs it cites, are all inadequately protective of human health. Also, the cost of these boondoggles is not affordable and diverts scarce resources away from programs that could actually help to combat climate change.

The Department of Energy continues to use a harmfully high yet allowable for routine continuous radiation doses to every member of the public, no matter their age or vulnerability, as 100 millirem per year per DOE Order 458.1, Chg 4 *Radiation Protection of the Public and the Environment*. This level of dose is being treated by the Department of Energy as though it is a benign dose: it would devastate children, especially the child developing in utero.

The HALEU production and advanced nuclear reactor boondoggle could be fatal to the U.S., with regard to human health, environment, economic, and national security considerations. That the DOE's Draft HALEU EIS does not admit any of the many serious problems with HALEU production is simply another example of an inadequate EIS by DOE.

The Draft HALEU EIS has deliberately obscured known information and history of harm from the uranium fuel cycle and has not been forthcoming about suspected problems and difficulties. The Draft HALEU EIS is a completely inadequate document. The extent to which so-called cleanup efforts do not meet cleanup standards and require attempts by fences or signs to restrict human access to areas is not being admitted. The costs of cleanup of HALEU contamination from mining, milling, conversion, enrichment, fuel fabrication is not adequately addressed in the Draft HALEU EIS.

The cost of sought-after reactor operations that create vast quantities and varieties of spent nuclear fuel that will requirement storage and permanent disposal is not adequately addressed in the Draft HALEU EIS. The hazards of the routine levels of radiological contamination and from accidents are not adequately addressed in the Draft HALEU EIS or the EISs it cites.

That Congress is supporting such an economically unviable Department of Energy promotion of advanced nuclear reactors and HALEU production is a product of how uninformed and misinformed Congress is. Congress will need to take far more steps to assure that they obtain the full picture of the problems now facing the nuclear industry regarding spent nuclear fuel storage and disposal. If the problems now faced were understood, Congress would not be keen on promoting HALEU production, ramping up nuclear energy or making more radioactive waste because it is unsustainable and unaffordable.

*Tami Thatcher has a Bachelor of Science degree in Mechanical Engineering and worked as an Advisory Engineer for a Department of Energy contractor, specializing in nuclear facility probabilistic risk assessment and safety analysis. For over a decade, she has studied and written about nuclear energy accidents and risks, Department of Energy nuclear facility accidents and risks, environmental contamination around the Idaho National Laboratory, radiation protection issues for workers and the public, INL legacy cleanup issues, and spent nuclear fuel and high-level waste storage and disposal issues.*