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Senate Seeks “Pilot Program” for Consolidated Interim Storage of Spent Nuclear Fuel as Nevada Senator Dean Heller Blocks Bills from the House That Would Ram Through Yucca Mountain Licensing

Despite the eagerness of the House to ramrod the licensing for the Yucca Mountain repository, so far, the senate has blocked all money it for 2019.

It’s not just a roller coaster ride, it’s been whiplash trying to follow the house and senate bills for ramming through a spent fuel repository at Yucca Mountain ¹ — then leaving Yucca out — and ramming through Consolidated Interim Storage. ² Various versions of several bills have thrown States rights, radiation protections standards, and the National Environmental Protection Act (NEPA) under the bus whether “minibus” or “omnibus” bills.

The House passed H.R. 3053, the Nuclear Waste Policy Amendments Act, to strip the State of Nevada of any rights to block the repository at Yucca Mountain. The draconian H.R. 3053 bill unravels laws to protect human health and the environment. But Senator Heller put a hold on the bill in the Senate and he urged a consent-based approach such as his Nuclear Waste Informed Consent Act. ³

The House passed bills including funding the Department of Energy’s request for \$120 million in the Energy and Water Appropriations bill, the Nuclear Regulatory Commission’s budget request for \$48 million for Yucca Mountain licensing, and \$30 million for storing defense nuclear waste at YM. ⁴ **But the Senate removed this funding from all these 2019 appropriations.**

¹ H. R. 3053 – Nuclear Waste Policy Amendments Act of 2018, 115th Congress (2017-2018). The proposed bill would take rights away from the State of Nevada. It would also allow Monitored Retrieval Storage to be allowed without having a permanent repository. <https://www.congress.gov/bill/115th-congress/house-bill/3053?q=%7B%22search%22%3A%5B%22yucca+mountain%22%5D%7D&r=6>

² S. 2975 – Energy and Water Development and Related Agencies Appropriations Act, 2019, 115th Congress (2017-2018) <https://www.congress.gov/bill/115th-congress/senate-bill/2975/text> The proposed bill allows the Department of Energy to open Consolidated Interim Storage for spent nuclear fuel, calling it a “Pilot Program.”

³ Dean Heller, U.S. Senator for Nevada, Press Release, “Heller Successfully Keeps Funding for Yucca Mountain Out of Appropriations Bill Approved by the U.S. Senate,” June 25, 2018. <https://www.heller.senate.gov/public/index.cfm/pressreleases?ID=C40DDA0C-C62B-4355-8E99-8B79E48CA3F2>

⁴ National Defense Authorization Act bill included storage of defense waste at Yucca Mountain.

Consolidated interim storage bill H.R. 5895 has been signed by both the House and Senate, but there are huge differences between the House version and the amended version approved by the Senate. Can the differences be resolved? The House version prohibits consolidated interim storage but the Senate version funds developing 1 or more consolidated interim storage sites.

In the Senate version (Engrossed Amendment Senate (06/25/2018), Bill H.R. 5895 includes: “Notwithstanding any provision of the Nuclear Waste Policy Act of 1982, (42 U.S.C. 10101 et seq.), the Secretary is authorized, in the current fiscal year and subsequent fiscal years, to conduct a pilot program to license, construct, and operate 1 or more Federal consolidated storage facilities to provide interim storage as needed for spent nuclear fuel and high-level radioactive waste, with priority for storage given to spent nuclear fuel located on sites without an operating nuclear reactor.” Note that “notwithstanding” in this wording means “in spite of” and so erases any conflicting Nuclear Waste Policy Act law.⁵

There are efforts being made in states with stranded spent nuclear fuel, such as for the closed San Onofre nuclear plant in California, to find ways to ship their spent nuclear fuel to a disposal site or to a Consolidated Interim Storage site like the one proposed by Holtec in New Mexico. Waste Control Specialists are also proposing a site in Andrews, Texas.

Should a disposal site or interim storage site open, the next problem will be preparing casks, transporters, trucks and trains for transporting in some cases very oversized loads. Getting the dry storage spent nuclear fuel from where it is stored to the rail or truck to transport poses different problems at various nuclear sites. Then the transportation of spent nuclear fuel through cities and towns to these sites will be giving a radiation dose to everyone the shipments pass en route. An accident involving a fire or derailment may pose the risk of an airborne release of radionuclides from the cask that could not be remediated. There are differences between past shipments and the proposed shipments of commercial reactor spent nuclear fuel including the routes, shipment cask design and weight of the casks to be transported.^{6 7 8} For example, the naval submarine spent fuel shipments using the M-140 fit on a typical rail car. But the Department of Energy is having to design a special rail car, the Atlas railcar, for the oversized spent fuel casks used at some stranded fuel sites. In the recent decade, several train accidents in the U.S. involving derailment and/or oil tanker fires were very severe. High temperature fires burning longer than 30-minutes are more severe than spent fuel transportation casks were

⁵ H. R. 5895 – “Energy and Water, Legislative Branch, and Military Construction and Veterans Affairs Appropriations Act, 2019.” <https://www.congress.gov/bill/115th-congress/house-bill/5895/text> One version of the proposed bill allows the Department of Energy to submit a report on the potential of locating a reprocessing or recycling facility for spent nuclear fuel near the Yucca Mountain site. The “Engrossed Amendment Senate (06/25/2018) does not have the reprocessing/recycling included.

⁶ U.S. Nuclear Waste Technical Review Board at <http://www.nwtrb.gov/> See the webcast for the June 13, 2018 meeting on dry storage and transportation at <https://www.webcaster4.com/Webcast/Page/909/25406>

⁷ Department of Energy presentation to the Nuclear Waste Technical Review Board meeting in Idaho Falls on June 13, 2018. Transportation cask attributes listed 17 cask weights ranging from 187,200 lb to 420,769 lb.

⁸ Naval spent fuel experience is primarily using the M-140 cask that is 175 tons loaded and 16.2 ft tall. The new larger carrier fuel cask, the M290 is 260 tons loaded and 30.1 ft long. <https://www.nrc.gov/docs/ML0932/ML093200020.pdf>

designed to withstand. There is currently no way to avoid sending spent fuel casks along with any number of oil tankers connected in route.

The Nuclear Regulatory Commission has licensed dry storage facilities without adequate technical basis for design of the spent fuel canisters. The industry has been, belatedly, studying the susceptibility of the spent nuclear fuel dry storage canisters to chloride-induced stress corrosion cracking.^{9 10 11} Neither the Holtec facility planned for New Mexico nor dry storage of spent nuclear fuel around the country have the capability to conduct effective inspections to detect canister cracking, no capability to repair a partially or fully cracked canister, and no capability to isolate a canister.¹² You'll know you have a leaker if you are monitoring the radionuclides blowing in the wind. The nuclear industry has also reduced air monitoring around canisters to only once a quarter and only at the air inlet and not the air outlet of the dry storage units. More about spent nuclear fuel dry storage canisters in the following article.

I fear that once the spent nuclear fuel is at a consolidated interim storage site, it will force that state to open a permanent repository. New Mexico, while accepting the burial of transuranic defense waste at WIPP, has opposed burial of spent nuclear fuel. But once the airborne radionuclides are blowing in the wind from leaking canisters, and there is no way to transport damaged canisters or the aging fuel in the canisters, New Mexico might be forced to allow burial of spent fuel in underground salt.

The Department of Energy has been forced via legal settlements to pay nuclear utilities billions of dollars for the department's failure to take spent nuclear fuel by 1998 as promised. Utilities were to have to move their spent nuclear fuel to the rail way or roadway to have the Department of Energy take it from there. Utilities and rate payers want out of the expense of dry fuel storage at stranded fuel sites and the costs involved with getting the spent fuel to the road or railway to transfer ownership to the Department of Energy.

⁹ J. Renshaw and S. Chu, Electric Power Research Institute (EPRI), Presentation: "Monitoring and Aging Management of Spent Fuel," 33rd INMM Spent Fuel Management Seminar, January 24, 2018. https://www.inmm.org/INMM/media/Documents/Presenations/Spent%20Fuel%20Seminar/2018%20Spent%20Fuel%20Seminar/1-24-18_0950-2-Renshaw-Monitoring-and-Aging-Management-of-Spent-Fuel.pdf

¹⁰ Electric Power Research Institute (EPRI), *Aging Management Guidance to Address Potential Chloride-Induced Stress Corrosion Cracking of Welded Stainless Steel Canisters*, March 2017, 3002008193 on www.epri.com, Publicly Available.

¹¹ Electric Power Research Institute (EPRI), *Welding and Repair Technology Center: Friction Stir Welding of Degraded Dry Cask Storage System Canisters*, August 2017, 3002010734 on www.epri.com, Publicly Available.

¹² Myron M. Kaczmarzky, Holtec, presentation to the Nuclear Waste Technical Review Board meeting in Idaho Falls on June 13, 2018, "Integrated Planning for Packaging, Transportation, and Storage of Commercial SNF at an Interim Storage Facility." They were planning on a version of H.R. 3053 to expand Yucca Mountain from 70,000 to 110,000 metric tons, give DOE full control of public land, authorize the DOE to store SNF at an NRC-licensed interim storage facility owned by a nonfederal entity.

Included in H.R. 5895 bill that passed the senate is fifteen million dollars for conducting nuclear fuel recycling at the Idaho National Laboratory.^{13 14} Highly enriched uranium-235 fuel used by the Navy would be reprocessed and then the recovered uranium-235 would be blended with uranium-238 to a lower enrichment. The airborne releases from the reprocessing have not been discussed. The blended fuel is to be studied in the proposed Small Modular NuScale reactor, a light water reactor design which is being called an advanced reactor.

Spent Nuclear Fuel Dry Storage Safety Issues Largely Ignored

The poster child for stranded nuclear waste could be the San Onofre Generating Station (SONGS) that has permanently shut down its nuclear reactors. There is spent nuclear fuel in dry storage placed in dry storage sixteen years ago and a newer dry storage facility built by Holtec that is only about 100 ft from the coastline.

Donna Gilmore, who lives near San Onofre and developed the San Onofre Safety website, has been researching and writing about the safety issues of spent nuclear fuel dry fuel storage.¹⁵

The thin-walled canisters used extensively in the United States were approved by the U.S. Nuclear Regulatory Commission despite not having defensible analysis to estimate how long the canisters would maintain their integrity. Chloride-induced stress corrosion cracking is an important failure mode for stainless steel. It has now been admitted for Diablo Canyon that the conditions for stress corrosion cracking of the canisters are present. Also lacking prior to NRC's canister design licensing was any published analysis of the consequences of a through wall crack or other accident scenarios. A 2017 EPRI report stated that "The potential consequences associated with unmitigated [chloride-induced stress corrosion cracking] CISCC of canisters have not been specifically analyzed. The CISCC degradation scenario could include through-wall cracking, followed by loss of inert backfill overpressure, air ingress, and reduced heat removal capacity."¹⁶

At the June 13 meeting of the U.S. Nuclear Waste Technical Review Board held in Idaho Falls, NRC's Darrel Dun stated that only a finite number of canisters would have problems. He also stated that the canisters can be inspected, but he admitted that the canisters in dry storage less than 20 years and prior to re-licensing had not been inspected at San Onofre, but that the

¹³ Nathan Brown, *The Idaho Falls Post Register*, "Senate approves naval nuclear fuel recycling – Planned small reactors at INL could benefit from proposal," June 21, 2018. The \$15 million amendment for recycling naval fuel was added to the 2019 Energy and Water Appropriations bill.

¹⁴ Nathan Brown, *The Idaho Falls Post Register*, "Bill with nuclear fuel recycling passes Senate – Funding could give boost to small reactor project," June 27, 2018. (This the Engrossed Amendment Senate version of H.R. 5895 of 06/08/2018.)

¹⁵ See SanOnofreSafety.org

¹⁶ Electric Power Research Institute (EPRI), *Dry Cask Storage Welded Stainless Steel Canister Breach Consequence Analysis Scoping Study*, November 2017, 3002008192 on www.epri.com, Publicly Available. It states that the amount of radioactive gas that may escape a spent fuel canister with a through wall crack has been previously estimated as from less than 1 percent per year to 60 percent per year.

NRC was studying ways that inspections could be performed. It is supposed to be reassuring that the NRC is now trying to find ways to inspect the spent fuel dry storage canisters for cracks.

The Nuclear Regulatory Commission has licensed dry storage facilities without adequate technical basis for knowing how to prevent, detect, or remedy stress corrosion cracking of the spent fuel dry storage canisters.

How would you like to have these canisters in your backyard and then learn that NRC is only recently studying how to inspect for crack development? Oh, and by the way, they have not figured out what to do if a crack develops. Oh, and by the way, they have not published an analysis of the consequences of a through-wall crack in a canister.¹⁷

At dry fuel storage sites around the U.S. as well as at the facility proposed by Holtec, so far there is no way for canisters to be effectively inspected for cracking.¹⁸ Holtec has pointed to NUREG-1864 as the probabilistic risk assessment for dry cask storage despite the fact that it omits consideration of aging effects, stress corrosion cracking, sabotage, etc. Holtec has no provision for isolating a canister leaking radionuclides. They have no way to transport a compromised canister. The NRC also assures people that the number of compromised canisters *will be limited and the corrective actions necessary to return to normal operations will be taken.*¹⁹ NRC has no specific estimates of the risk (likelihood or consequence) of canister cracking and has no specific plans to address isolating or repairing a cracked canister. NRC's Dunn confirmed that the NRC does not have an analysis documenting the consequences of a cracked canister.

Stainless steel has long been known to be susceptible to chloride-induced stress corrosion cracking. So, it should come as no surprise that the stainless-steel canisters are susceptible to chloride-induced stress corrosion cracking.²⁰ Estimates are that through wall cracking may occur within 16 years once crack growth begins.²¹ Ocean-side environments are an obvious

¹⁷ This "Pilot" analysis left out aging and sabotage and wrongly assumed there was no corrosion mechanism to break a canister. A. Malliakos, NRC Project Manager, "A Pilot Probabilistic Risk Assessment of a Dry Cask Storage System at a Nuclear Power Plant," NUREG-1864, Published March 2007.

<https://www.nrc.gov/docs/ML0713/ML071340012.pdf> But that's OK – it was only a Pilot study...

¹⁸ Krishna P. Singh, Ph.D. and John Zhai, Ph.D., Holtec, "The Multipurpose Canister: A Bulwark of Safety in the Post-9/11 Age," 2003. (begins on 8th page of the link which is compiled by Dr. Fred Bidrawn, Ph.D., Revision 1 March 28, 2018.) <https://publicwatchdogs.org/wp-content/uploads/2018/06/holtec-response-to-queries-on-shim.pdf>

¹⁹ Darrell Dunn, U.S. Nuclear Regulatory Commission presentation to the Nuclear Waste Technical Review Board (NWTRB) meeting held in Idaho Falls on June 13, 2018. "NRC Perspective on a National Program to Transport Spent Nuclear Fuel and Radioactive Materials,"

²⁰ Nuclear Regulatory Commission, Darrell S. Dunn, August 5, 2014 "Chloride-Induced Stress Corrosion Cracking Tests and Example Aging Management Program," August 5, 2014 <https://www.nrc.gov/docs/ML1425/ML14258A082.pdf>

²¹ Kristina L. Banovac, NRC to Anthony Hsia, NRC, Memorandum: Summary of August 5, 2014, Public Meeting with the Nuclear Energy Institute on Chloride Induced Stress Corrosion Cracking Regulatory Issue Resolution Protocol, September 9, 2014. <https://sanonofresafety.files.wordpress.com/2013/06/ml14258a081-8-5-14meetingsummary.pdf> or <https://www.nrc.gov/docs/ML1425/ML14258A081.pdf> "Based on estimated crack growth rates as a function of temperature and assuming the conditions necessary for stress corrosion cracking continue to be present, the shortest time that a crack could propagate and go through-wall was determined to be 16 years after crack initiation."

condition for this; but, based on my experience of witnessing stainless steel stress corrosion cracking from exposure to groundwater at the Idaho National Laboratory, groundwater can also contain enough chloride to induce stress corrosion cracking. Remote cameras can be used to inspect canister, in theory. But how do you inspect dusty canisters? If they were washed off with groundwater containing chlorides, stress corrosion cracking could result. **The duration of time — the number of decades — that canisters are to be stored at a facility with no provisions for adequate canister inspection and no provision for repairing a canister is currently unknown. The NRC licensed the canisters without having an adequate technical basis for understanding the susceptibility to stress corrosion cracking in various environments.**

Department of Energy’s Effort to Reclassify Nuclear Waste May Leave High Level Waste in Idaho

The Idaho Cleanup Project Citizens Advisory Board meeting held in Idaho Falls on June 21 included an agenda item “Report from EM SSAB Chairs Meeting.”²² What this agenda item actually included was the distribution of a handout to CAB members but not the public, and a vote by the CAB concerning the proposal on the handout.

When the vote passed by consensus, and due to a schedule change, this was prior to the noon break, I asked some CAB members what they had just voted on. No motion had been stated verbally of the motion being voted on for the members of the attending public.

The CAB members were not actually clear about what they had just voted on. But more importantly, there were no presentations on the topic and no public comment on the topic prior to the vote. The CAB members did not know the implications of the vote, which on the surface, seemed reasonable.

The limited discussion of the topic included no discussion of high level waste. The limited discussion gave an example of an existing practice with the current waste classification system as support for the Department of Energy’s analysis of changing the waste classification system. Currently, waste that has low enough concentrations of transuranic waste can be sent to a low-level radiation active waste facility in Clive, Utah rather than to WIPP in New Mexico.

The actual intent of the radioactive waste reclassification effort had been stated, during discussion, at two prior Idaho Leadership in Nuclear Energy (LINE) meetings: to avoid packaging the Idaho National Laboratory’s high level calcine waste and to avoid finding a geologic repository for this waste. The Idaho LINE commission is unthinkingly mouthing whatever the DOE utters as it actively allows DOE to undercut Idaho’s cleanup.

²² Idaho Cleanup Project Citizens Advisory Board (formerly the Idaho National Laboratory Citizens Advisory Board) meeting schedules and presentations at <https://energy.gov/em/icpcab/idaho-cleanup-project-citizens-advisory-board-icp-cab> Meeting held June 21, 2018.

This stealth operation by the CAB was directed by the Department of Energy in order to be able to say that various Citizens Advisory Boards around the DOE Complex approved of DOE's intent to rewrite its radioactive waste classification regulations. After the noon break, the DOE made the handout available to the audience at the meeting. The key reference is to a Department of Energy group of nameless authors known as the Energy Communities Alliance.²³ **The DOE's target regarding Idaho is to reclassify the sodium bearing waste and the calcine high-level wastes.** The CAB was not told of either of these objectives when it voted its support for DOE's review of waste classification nor are either of these two objectives mentioned in the handout given to the CAB members.

The Energy Communities Alliance document, however, does clarify that DOE's intent for the waste reclassification is to reclassify the sodium bearing waste and the calcine waste. The possibility of reclassifying the sodium bearing waste to TRU waste still may not result in WIPP accepting the solidified sodium bearing waste. The intention for the calcine waste has not been stated.

However, when high-level waste is reclassified, there are basically two choices, basically: TRU waste or Low-Level Waste. Low-level waste is such a broad category from class A waste that decays away within a hundred years to greater-than-class-C waste. Existing low-level radiative waste facilities may not be able to accept this highly radiotoxic but re-classified long-lived "low-level" radioactive waste.

An example of the Department of Energy's reclassification efforts includes its technically indefensible creation of "low activity waste" or LAW. Not even nuclear industry friendly U.S. Nuclear Regulatory Commission would endorse DOE's "low activity waste" waste scheme which has resulted in high level waste staying onsite site at Hanford and the Savannah River Site.

Low activity radionuclides can include plutonium, neptunium, technetium and others that have high radiotoxicity and can also be highly mobile in groundwater. (See our Environmental Defense Institute newsletter for June.) The public and the CAB are easy to fool, and watching it take place was not a pretty site.

The ICP CAB chair, alone, is to provide DOE feedback on its waste reclassification effort prior to the next CAB meeting. As I stated before, there was no presentation to the CAB and this stealth operation to give the appearance of adequate communication with the public is a sham.

What comes next is likely to be the Department of Energy's efforts to avoid protecting Idaho's aquifer from calcine and other high-level waste. Once the laws requiring geologic disposal of high level waste don't apply any more, solutions are likely to involve the waste

²³ Energy Communities Alliance, "Waste Disposition: A New Approach to DOE's Waste Management Must Be Pursued," September 2017.

<https://static1.squarespace.com/static/55c4c892e4b0d1ec35bc5efb/t/59ce7384cd39c3b12b97f988/1506702214356/ECA+Waste+Disposition+Report.pdf>

staying in Idaho. The solution swallowed by the public will likely involve grout and soil caps which the DOE explains with a straight face will be maintained into perpetuity.

Hanford Waste Could Come to AMWTP

Idaho Cleanup Project Citizens Advisory Board (CAB) chair, Keith Branter was so dissatisfied with the earlier CAB vote in March that did not provide an unconditional endorsement of DOE's efforts to find continuing missions for the Advanced Mixed Waste Treatment Project (AMWTP), Branter brought the issue up again at the June 21 meeting held in Idaho Falls.²⁴ Another vote on another letter to be sent to the Department of Energy was not on the agenda, but the DOE confirmed that the CAB does not have to follow any of the rules regarding prior announcement of meeting agenda items.

I had listened to Branter explain at the Idaho Leadership in Nuclear Energy (LINE) meeting held May 24 in Arco why the CAB had failed to reach a majority vote to strongly endorse the AMWTP — he said the reasons were “political.” He also expressed his distain for any CAB members who had concerns about the Snake River Plain Aquifer.

At the June 21 ICP CAB meeting, seven of eleven members voted in favor of an ambiguous motion to send a letter to the Department of Energy strongly endorsing continuing missions at the AMWTP even though neither the wording of the letter nor a decision about who would write the letter had been decided.

Four CAB members joined in a dissenting opinion, including Blain County Commissioner Larry Schoen, to also be sent to the DOE.²⁵ As reported in the *Idaho Mountain Express*, Schoen expressed three worries: the backlog of processed waste already collecting dust; the lack of stipulations attached to how the waste is transported; and no mention of protections for the Eastern Snake River Plain Aquifer—the main source of water for southern Idaho, which sits directly beneath the lab.

The AMWTP compacts transuranic waste to be shipped to the Waste Isolation Pilot Plant (WIPP) in New Mexico. In March, the CAB had voted in the majority to request more information from the Department of Energy and had withheld unconditional endorsement of DOE's recent departure from previous commitments regarding transuranic waste brought to the Idaho National Laboratory from other DOE sites.

The Department of Energy made it clear that they would not be providing any additional information regarding how it would resolve the issues such as DOE's assertion that the Idaho

²⁴ Idaho Cleanup Project Citizens Advisory Board (formerly the Idaho National Laboratory Citizens Advisory Board) meeting schedules and presentations at <https://energy.gov/em/icpcab/idaho-cleanup-project-citizens-advisory-board-icp-cab> Meeting held June 21, 2018.

²⁵ Mark Dee, *Idaho Mountain Express*, “Citizens board urges taking out-of-state nuclear waste,” June 29, 2018. https://www.mtexpress.com/news/state_regional/citizens-board-urges-taking-out-of-state-nuclear-waste/article_dd040ec4-7b1d-11e8-8934-63236978307b.html

Settlement Agreement stipulation of 6 month in/ 6 month out for waste brought to the facility required “removal or blanket exemption.” The DOE also had stated in March that NRC approved Type B containers for shipping the waste could not be used for much of the waste the DOE wanted to import from Hanford. Also departing from previous National Environmental Protection Act Environmental Impact Statements regarding this activity, the DOE also said that it was considering shipping waste from LANL to Idaho that would have to be dug up. See our Environmental Defense Institute newsletters for March, April and May.

At the June ICP CAB meeting, Fred Hughes of Fluor Idaho, the Department of Energy contractor for the Idaho Cleanup Project that operates the AMWTP and other operations at the Idaho Site stated that he had visited Hanford and hopes to have a plan for shipping some of Hanford’s transuranic waste to the AMWTP by next spring.

Former Republican Idaho governor Phil Batt wrote an editorial in the Idaho Statesman opposing bringing the Hanford waste to Idaho.²⁶

Neutron Exposure During Glovebox Work and Other Handling of Fissile Material at the Idaho National Laboratory and Idaho Cleanup Project

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

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

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

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

Metal jock strap? Lead apron? Sorry. These can lower gamma radiation but they are not effective against densely ionizing high linear-energy transfer (high LET) neutron dose. The

²⁶ Philip E. Batt, Idaho Statesman, “Former Gov. Batt: Don’t bring Washington state nuclear waste to Idaho,” June 15, 2018. <https://www.idahostatesman.com/opinion/readers-opinion/article213245179.html>

double-strand DNA breaks from neutron exposure are more complex and less repairable than from more sparsely ionizing gamma radiation.²⁷

How much do these radiation workers know about the non-cancer health effects of neutron exposure? According to a working group considering neutron exposure, “studies of human exposure to neutron radiation are extremely limited” and the neutron radiation component of the A-bomb dose reconstruction for Hiroshima and Nagasaki was at most 1 percent of the total absorbed radiation dose. Using experimental data, it is assumed that the relative biological effectiveness (RBE) of the A-bomb neutrons is 10 times greater than that of gamma radiation. But other experts think the RBE may be higher, in the range of 20-50.²⁸

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

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

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

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

Metal does not shield neutrons. To illustrate this point, dose reconstructors learned that spent fuel storage casks at the Idaho National Laboratory in the 1980s at Test Area North had dose rates of about 30 mrem/hr gamma and 40 mrem/hr neutron.²⁹ The metal cask attenuates the gamma radiation, but does not appreciably affect the neutron field. According to a NIOSH

²⁷ Agnes Schieler and George Iliakis, *Nucleic Acids Res.*, “DNA double-strand-break complexity levels and their possible contributions to the probability for error-prone processing and repair pathway choice,” Published online 2013 Jun 25. doi: [10.1093/nar/gkt556](https://doi.org/10.1093/nar/gkt556) or <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3763544/>

²⁸ International Agency for Research on Cancer, 2012 <https://www.ncbi.nlm.nih.gov/books/NBK304359/>

²⁹ National Institute for Occupational Safety and Health at cdc.gov, ORAU TEAM Dose Reconstruction Project for NIOSH, “Idaho National Laboratory and Argonne National Laboratory-West Occupational External Dosimetry, ORAUT-TKBS-0007-6, 2011. <https://www.cdc.gov/niosh/ocas/pdfs/tbd/inl-anlw6-r3.pdf> Section 6.3.4.2.3 Test Area North Fuel Storage Casks.

report, neutron radiation levels were discovered in the nearby offices where people were not monitored for neutron dose. Each of three casks were in the area of the offices for two weeks.

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

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

Spontaneous fission neutron yields for various radionuclides are shown in Table 1 based on N. Ensslin's Table 11-1.³⁰ The neutrons are emitted at various energies, not shown. Notice the range of neutron spontaneous fission yield is very for californium-252, curium-242 and -244 and plutonium-238, -240 and -242.

Table 1. Spontaneous fission neutron yields.

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

- Data source: N. Ensslin, Chapter 11, The Origin of Neutron Radiation, Table 11-1. <https://fas.org/sgp/othergov/doe/lanl/lib-www/la-pubs/00326406.pdf>
- Units for fission yield neutron/(second-gram); fission multiplicity Greek letter v, represents the number of neutrons emitted per spontaneous fission.

³⁰ N. Ensslin, Chapter 11. The Origin of Neutron Radiation, <https://fas.org/sgp/othergov/doe/lanl/lib-www/la-pubs/00326406.pdf>

- c. Units for spontaneous fission yield (n/s-g), neutrons/(second – gram).
- d. The average energies are from 4 to 6 MeV (mega electron volts) (see Table 11-3 from N. Ensslin.)

More efforts to expand the Radiation Compensation Act (RECA) to more downwinders

Senator Tom Udall (D-N.M.) testified June 27 on the need to expand the Radiation Exposure Compensation Act (RECA). Currently, many victims of nuclear testing are excluded from compensation, including those living downwind of the Trinity test site in New Mexico and others.³¹

Mike Crapo (R-Idaho) and others have introduced bipartisan legislation, S. 197, to amend RECA to expand compensation to victims of radiation exposure in New Mexico as well as Idaho, Montana, and Colorado.^{32 33} The proposed expansion of RECA would cover all of Arizona, Colorado, Idaho, Montana, New Mexico, Nevada and Utah.³⁴

The Idaho Press reported that “Tona Henderson of Emmett told a U.S. Senate hearing June 27 that she has a list of 1,060 people just in Gem County who have developed cancers connected to fallout from U.S. nuclear tests in Nevada a half-century ago...”³⁵ Gem County, Idaho is north of Boise on the western side of the state. In the 1997 National Cancer Institute study of Iodine-131 fallout from weapons testing, among the top five counties nationally for weapons fallout are four Idaho counties: Blaine, Custer, Gem and Lemhi.³⁶

Compensation would also be expanded for people harmed by uranium mining and milling

Proposed legislation would also increase the compensation cap from \$50,000 to \$150,000. But, if the past is any indication, this legislation is unlikely to be voted on.

³¹ U.S. Senator Tom Udall, NM State KRWG, “Udall Fights for Justice for Victims of Radiation Exposure in Key Senate Hearing,” Jun3 27, 2018. <http://krwg.org/post/udall-fights-justice-victims-radiation-exposure-key-senate-hearing>

³² S. 197 – Radiation Exposure Compensation Act Amendments of 2017, Sponsor: Sen. Mike Crapo (R-ID), introduced January 24, 2017, and Hearings held June 27, 2018. <https://www.congress.gov/bill/115th-congress/senate-bill/197/text?q=%7B%22search%22%3A%5B%22radiation+compensation%22%5D%7D&r=1>

³³ Nathan Brown, *The Idaho Falls Post Register*, “Bill would help Idaho downwinders – Bill would make cancer victims in Lemhi, Custer eligible for government money,” June 27, 2018.

³⁴ Nate Poppino, Idaho Statesman, “They say the government caused their cancer – and they want compensation,” June 27, 2018. <https://www.idahostatesman.com/news/politics-government/state-politics/article213916039.html> “To date, \$2.26 billion has been paid to about 34,600 victims and family members. Of that, \$1.08 billion went to about 21,600 downwinders; \$640 million to 6,400 uranium miners; \$324 million to 4,450 on-site participants; \$175 million to 1,750 uranium millers; and \$36 million to 350 ore transporters.”

³⁵ Betsy Z. Russell, Boise Bureau Chief for Idaho Press, “Idaho downwinders testify at Senate hearing; legislation would compensate them,” June 27, 2018. https://www.idahopress.com/eyeonboise/idaho-downwinders-testify-at-senate-hearing-legislation-would-compensate-them/article_607cbfa5-df91-5d90-8c7f-41ae24789be6.html

³⁶ Christopher J. Johnson, MPH, Epidemiologist and Stacey L. Carson, CTR, Director, *Exposure of the American People to Iodine-131 from Nevada Nuclear Bomb Tests: Review of the National Cancer Institute Report and Public Health Implications*, 1999. <https://www.ncbi.nlm.nih.gov/books/NBK100831/>

**Review of the Mixed Hazardous Radioactive CERCLA Waste
Cleanup Policy at the
Radioactive Waste Management Complex
Subsurface Disposal Area at the
Department of Energy's Idaho National Laboratory
By Chuck Broschious**

Abstract

This report ³⁷ lays out the Department of Energy's Idaho National Laboratory Radioactive Waste Management Complex/Subsurface Disposal Area CERCLA cleanup process and the policy decisions that went into how DOE is compromising Idaho's water future. How did we get to where we are today and why DOE is leaving hazardous nuclear waste buried at the INL and calling it "clean enough"? DOE's decision to leave 90 percent of the buried waste in the dump and violate the 1995 Settlement Agreement and Federal Court Consent Order with the State of Idaho is a crucial threat to our states' safe water future by failing its commitment to cleanup its >70 year nuclear legacy waste. DOE's priority to spent \$1 trillion on building new nuclear bombs rather than spent \$ ~600 million to cleanup the huge environmental disaster from the last bomb legacy represents the value the federal government places on Idaho's water future that is unconscionable by any human rights standards.

This report also reviews both the policy setting Environmental Supplement Analysis for the Treatment of Transuranic Waste and the Record of Decision for the RWMC because they both cover the same policy area and contain the same fundamental flaws related to the DOE's mismanagement of the RWMC. EDI's primary focus is on both the existing waste "Accelerated Waste Retrieval" problems (illegally leaving mixed hazardous/ radioactive waste in-place) at the RWMC/SDA and the importation of additional TRU waste to INL from other DOE nuclear sites. At risk is the underlying Snake River sole source aquifer that most of Idahoans are and will be dependent on for millennia. Radioactive and hazardous waste continues to migrate from this buried waste contaminating the aquifer; so without a comprehensive cleanup required by law DOE is compromising Idaho's future in order to save money for more bombs. Mixed radioactive waste is the most hazardous and biologically dangerous material in the world. When DOE wants to treat it with less environmental protection than garbage, the public must take action to ensure an appropriately adequate cleanup even when current state leadership no longer cares.

³⁷ Chuck Broschious, Environmental Defense Institute, "Review of the Mixed Hazardous Radioactive CERCLA Waste Cleanup Policy at the Radioactive Waste Management Complex Subsurface Disposal Area Department of Energy's Idaho National Laboratory," July 2018. <http://www.environmental-defense-institute.org/publications/RWMCERCLA.pdf> and <http://www.environmental-defense-institute.org/publications/AttachArwmc.pdf>

DOE continues to demonstrate a consistent pattern of violations of environmental laws, hazardous waste regulations and the Federal Court Consent Order's 1995 Settlement Agreement and to include the following examples:

1. Changed the definition of what waste is to be removed from the RWMC from "all TRU and Low-level Apha" (*a*LLW)³⁸ (because of the unilateral change of definition of TRU from >10 to > 100 nCi/g) * to only "stored TRU" and continuing to allow *a*LLW to remain buried at the SDA stipulated in the 1995 Settlement Agreement and Consent Order for removal;
2. Even the *a*LLW "stored" on Pad A originally classified as TRU (0 to > 10 nCi/g) * is left in place;
3. Offers no independent data confirming what waste left in the SDA is not TRU and that the alpha detection methods used in ARPS can accurately detect TRU;
4. Violates Land Disposal Regulations in: IDAPA 58.01.05.009 and 58.01.05.011; 40 CFR 265.13 and 268.7; and NRC under [10 CFR part 61 to include:](#)
 - a. Leaving SDA surface waste pile on Pad A waste in place;
 - b. Leaving 90% of SDA buried mixed hazardous/radioactive waste in place;
 - c. Once a waste dump is remediated, all the contaminated material –including soil – is considered a new waste and thus must be managed according to RCRA/LDR/NRC regulations.
5. Continues SDA burial LLW in a flood zone in violation of Land Disposal Regulations;
6. Use economic leverage as largest employer to capture State leadership, EPA and IDEQ to compromise policy and commitments to former Governors' Andrus, Batt and the public to cleanup buried nuclear waste that continues to contaminate the underling Snake River Aquifer.

Articles are by Tami Thatcher for July 2018 except for the RWMC report abstract by Chuck Broschious

³⁸ Note: Alpha Low-Level Waste [*a*LLW] refers to previously disposed of radioactive wastes having a concentration of transuranic (TRU) radionuclides between 10 and 100 nCi/g. They may include some wastes that contain hazardous constituents regulated under RCRA and Toxic Substances Control Act (TSCA), i.e., mixed waste.