# Environmental Defense Institute

**News on Environmental Health and Safety Issues**

**July 2021** **Volume 32** **Number 7**

## Department of Energy Ousts Fluor Idaho, Selects New Idaho Cleanup Project Contractor called the "Idaho Environmental Coalition"

The new Idaho Cleanup Project contract has been awarded by the Department of Energy to the newly formed Idaho Environmental Coalition, a joint venture between Jacobs Technology Inc. and North Wind Portage. [1] This means that Fluor Idaho, the cleanup contractor since June 2016, is out.

Idaho Environmental Coalition was to take over the contract in October. Only about five senior Fluor staff members won't be coming back, as about 1,900 cleanup employees will continue to work. The cleanup project and staffing will continue to shrink as the cleanup project winds down. But now the Department of Energy has signaled that it may keep Fluor Idaho on for up to an additional 90 days, through December of this year. [2]

The decision by the Department of Energy to let other groups compete for the cleanup contract signaled that Fluor Idaho had little chance of being selected to continue as the cleanup contractor.

Despite its leadership's strong background in Idaho transuranic waste issues, Fluor Idaho mismanaged the Radioactive Waste Management Complex, causing the explosion of four transuranic waste drums in 2018. That accident could have been far worse, had the explosions occurred just a few hours earlier. Fluor Idaho's Fred Hughes was very familiar with the RWMC's operations and allowed poor practices to continue including longstanding mischaracterization of the contents of waste drums, inadequate sampling of drum contents and ignoring many signs that the waste the exploded which contained high amounts of unoxidized uranium was unsafe and was not in compliance with its state hazardous waste permit because of its pyrophoric behavior.

After exposure to air during repackaging, the uranium started oxidizing and methane was formed by the beryllium carbide in the waste, which was not identified as being in the waste. Both Fred Hughes of Fluor Idaho and then Department of Energy head, Rick Provencher had signed the hazardous waste documentation saying that they were knowledgeable and competent

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[1] John Roark, *The Idaho Falls Post Register*, "Jacobs group Idaho Environmental Coalition wins Idaho Cleanup Project bid," June 20, 2021.

[2] John Roark, *The Idaho Falls Post Register*, "Bechtel-led team protests Idaho Cleanup Project contract," June 25, 2021.

and that the operation would be safe. Neither man faced any repercussions for actively ignoring experts warning of problems with the waste which could have caused far more serious injuries, fatalities and environmental contamination.

The other high profile project that has kept Fluor Idaho busy is the INL's Integrated Waste Treatment Unit (IWTU), which Fluor has not managed to get running to treat the liquid sodium bearing waste left over from spent nuclear fuel reprocessing at the INL's Idaho Nuclear Technology and Engineering Center (INTEC). Fluor Idaho has continued to find problems and redesign the ill-conceived IWTU, but has not treated any of the sodium bearing waste stored in tanks over the Snake River Plain aquifer. Before Fluor took over the contract in 2016, the previous contractor was supposed to have completed treatment of the liquid sodium bearing waste in 2012. [3] The price tag for treating the sodium bearing waste is now over 1 billion dollars, double the original estimate and it is now expected to take several years to treat the waste, even if all goes well.

The new team for the Idaho Cleanup Project, the "Idaho Environmental Coalition" does not appear to add any particular competence to the cleanup. These small contractor ventures are generally weak and tend to disappear after their contracts fade. The accountability over time is nil, by design, in the contractor musical chairs at Department of Energy laboratories.

While *The Post Register* reported that Fluor Idaho does not plan to protest the decision, in late June, a losing team, the Bechtel group called the Idaho Remediation Company, has protested the Department of Energy's decision to award the contract to Jacobs Technology Inc. group, the Idaho Environmental Coalition. [4]

## Idaho Cleanup Project Status for June 2021

Under the existing cleanup contractor, Fluor Idaho, the removal of above-ground stored transuranic waste is continuing, as drums of transuranic waste brought to Idaho were unsafely stored above ground. Limited past buried drums retrievals were also stored above ground since the 1970s.

Additional exhumation of buried waste, called "accelerated retrieval projects" have sought to remove only the most chemically-laden Rocky Flats weapons plant buried waste. The completion of the "targeted exhumations" will leave buried over 90 percent of the americium and plutonium still buried over the aquifer and will leave all of the other radioactive and chemical waste buried over the Snake River Plain aquifer since inception of the INL in 1949.

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[3] See the latest Integrated Waste Treatment Unit design changes in the Hazardous Waste Management Act /Resource Conservation and Recovery Act Storage and Treatment Permit for the Idaho Nuclear Technology and Engineering Center, EPA ID No. ID4890008952, June 2021 at https://inldigitallibrary.inl.gov/PRR/IWTU Class 3 PMR_June 2021.pdf

[4] John Roark, *The Idaho Falls Post Register*, "Bechtel-led team protests Idaho Cleanup Project contract," June 25, 2021.

The "targeted" waste being exhumed from the burial ground is on the ninth and final phase, Accelerated Retrieval Project (ARP) IX. The deterioration of the buried drums in this ARP is making the work even more difficult than the past ARPs and this ARP has also had structural foundations from past ARP enclosures in the way of this exhumation.

**But unfortunately, removing all of the targeted waste will leave over 90 percent of the buried transuranic waste remaining buried.**

The remaining americium-241 dominates the estimated threat to the aquifer. The important metric is how much of the americium-241 that was buried (after a few initial or early retrievals) and how much will remain buried after the "targeted waste" is exhumed.

In fact, over 90 percent of the americium-241 is remaining buried. An estimated 215,000 curies will remain buried after targeted waste is removed according to composite analysis calculations of 230,000 curies of americium-241 having been buried. [5] [6] [7]

The buried americium-241 is not the only radionuclide that contributes to contaminant migration, but it was the dominant contributor according to the buried waste performance assessment. For simplicity and due to the significance of the americium-241 to the estimated migration of radionuclides from the burial ground, the amount of americium-241 that is not being exhumed from the burial ground is explained but the lion's share of other transuranic radionuclides, like plutonium-239, are also remaining buried.

In addition to addressing the continued shipments of above-ground stored (never buried) transuranic waste and the very limited exhumed from burial transuranic waste, the cleanup contractor has to continue to manage spent nuclear fuel storage at the INL. Progress has been made in moving the spent fuel from wet pools into dry storage.

But the Idaho Settlement Agreement milestones of removing the spent nuclear fuel from Idaho cannot be met. There is currently no place for the spent nuclear fuel to go because the Department of Energy doesn't even have the pretense of a disposal program.

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[5] See the July 2017 EDI newsletter for a timeline for the burial ground at the Radioactive Waste Management Complex and other cleanup information at http://www.environmental-defense-institute.org/publications/News.17.July.pdf

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

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

The soil cap slated for the RWMC, like other U.S. Environmental Protection Agency approved waste dump cap designs is likely to become a smoldering dump. The heat load of the underground waste, has admittedly, not even been considered in the State of Idaho approved design.

An article in the Idaho Falls Post Register states that the "plutonium-contaminated waste contained large amounts of chemicals that could potentially leak into the Snake River Plain aquifer." [8] But the reality is that the carbon tetrachloride and other chemicals had already been leaking into the aquifer by 2008. Contaminants detected in the Snake River Plain aquifer were detected, including levels above federal drinking water limits.

The article also points out that the INL injected contaminated wastewater directly into the aquifer leading "to contamination of the groundwater below some areas of the INL with heavy metals, chemicals and radioactive elements," a DOE statement read. But the reality is that not only are some areas below some areas of the INL contaminated, once contaminants are in the aquifer (and not just soil or perched water above the aquifer) these contaminants take a ride downgradient in the aquifer, to places like Shoshone Falls, Rupert, Dietrick, Shoshone, and Thousand Springs. The contaminants not pumped and used for irrigation or drinking water continue to flow until they reach the Snake River.

Once a contaminant reaches the aquifer, the trip for a contaminant begins toward the Magic Valley. Contaminates can be rapidly detected if sampling from "fast paths" and the timing of when the bulk of the contamination reaches a particular location is probably only a decade or two. Knowing that the public would not like this, the reporting of the contaminants, downgradient from the INL became more and more deceptive. The U.S. Geological Survey is first and foremost, the Department of Energy handmaiden that had originally advised the DOE that aquifer injection and other terrible practices were economical and acceptable.

## Integrated Waste Treatment Unit (IWTU) Redesign Continues

The Department of Energy is continuing to pay fines to the State of Idaho over the failure to treat the liquid radioactive sodium bearing waste in the Integrated Waste Treatment Unit (IWTU). Fluor Idaho has continued testing and redesigning the facility that DOE had expected to begin operating early in 2021, before the COVID pandemic, which has slowed progress.

The DOE prefers to not call the liquid waste that resulted from spent nuclear fuel reprocessing "high level waste" but the DOE has not officially reclassified the waste. By not formally reclassifying the sodium bearing waste, no legal action is "ripe" to contest the reclassification. The Department of Energy has procured containers to ship the treated sodium

[8] John Roark, *The Idaho Falls Post Register*, "Jacobs group Idaho Environmental Coalition wins Idaho Cleanup Project bid," June 20, 2021.

bearing waste to the Waste Isolation Pilot Plant (WIPP) in New Mexico, despite laws preventing WIPP from accepting high-level waste or tank waste from spent nuclear fuel reprocessing. [9]

What's in the sodium bearing waste that DOE denies is high level waste? The radionuclides that Department of Energy contractors have listed vary. The radionuclides listed in the sodium bearing waste based on estimated concentrations of radionuclides from the recent hazardous waste permit [10] are provided in Table 1 below. About 900,000 gallons (or 3.4 million liters) of sodium bearing waste have been stated as being the total amount of liquid in the tanks.

**Table 1.** Radionuclide concentrations in the sodium bearing waste tanks decayed to January 2021, in picocuries per liter in the liquid supernate and in picocuries per gram for the solids.

| Radionuclide (half-life) | WM-187 Supernate | WM-187 Solids | WM-188 Supernate | WM-189 Supernate | Max Curie for 900,000 gallons |
|---|---|---|---|---|---|
| Cesium-134 (2.1 year) | 2.61E4 | 3.12E2 | **1.33E5** | 0 | 0.45 curies |
| Cesium-137 (30.2 year to Ba-137m) | 1.97E10 | 6.11E7 | **6.06E10** | 4.56E10 | 206,456 curies |
| Barium-137m (2.55 minutes) | 1.86E10 | 5.78E7 | **5.73E10** | 4.31E10 | 195,214 curies |
| Strontium-90 29.1 year to Y-90) | 1.29E10 | 3.11E7 | **4.03E10** | 3.01E10 | 137,297 curies |
| Yttrium-90 (64.6 hour) | 1.29E10 | 3.11E7 | 4.03E10 | **3.01E10** | 102,546.8 curies |
| Antimony-125 (Sb-125, 2.7 year) | | **1.07E4** | | | (grams of solid unknown) |
| Cobalt-60 (5.3 years) | 5.43E5 | 3.76E3 | **5.14E6** | 0 | 17.5 curies |
| Europium-154 (8.59 year) | 1.18E7 | 3.92E4 | **6.41E7** | 0 | 218.4 curies |
| Niobium-94 (20,300 year) | | **1.42E5** | | | (grams of solid unknown) |
| Americium-241 (432 year to Np-237) | 7.81E7 | 5.21E5 | 6.91E7 | **8.28E7** | 282 curies |

[9] Government Accountability Office, NUCLEAR WASTE CLEANUP – DOE Faces Project Management and Disposal Challenges with High-Level Waste at Idaho National Laboratory, GAO-19-494, September 2019. https://www.gao.gov/assets/gao-19-494.pdf p. 25 states "New Mexico amended its permit for WIPP in 2004 to prohibit waste that has ever been managed as HLW, including the SBW at INL, from being disposed at WIPP unless the disposal of such waste is specifically approved through a permit modification."

[10] See the latest Integrated Waste Treatment Unit design changes in the Hazardous Waste Management Act /Resource Conservation and Recovery Act Storage and Treatment Permit for the Idaho Nuclear Technology and Engineering Center, EPA ID No. ID4890008952, June 2021 at https://inldigitallibrary.inl.gov/PRR/IWTU Class 3 PMR June 2021.pdf

| Radionuclide (half-life) | WM-187 Supernate | WM-187 Solids | WM-188 Supernate | WM-189 Supernate | Max Curie for 900,000 gallons |
|---|---|---|---|---|---|
| Neptunium-237 (2,144,000 year) | **6.74E5** | 2.76E3 | 6.14E5 | 1.20E2 | 2.3 curies |
| Plutonium-238 (87.7 year) | 3.50E8 | 1.49E7 | 6.31E8 | **6.70E8** | 2282.6 curies |
| Plutonium-239 (24,000 year) | 4.75E7 | 1.69E6 | **7.69E7** | 6.59E7 | 262 curies |
| Plutonium-240 (6560 years) | **2.87E7** | 5.56E5 | 2.63E7 | 2.42E7 | 97.8 curies |
| Uranium-233 (160,000 year) | **4.01E1** | 3.0E2 | 3.88E1 | 1.1E-3 | 0.000137 curies |
| Uranium-234 (245,500 year) | 1.11E6 | 3.66E3 | 1.58E6 | **1.87E6** | 6.37 curies |
| Uranium-235 (703,800,000 year) | 2.34E4 | 8.23E1 | 3.87E4 | **4.59E4** | 0.156 curies |
| Uranium-236 (23,420,000 year) | **1.16E1** | 2.24E-1 | 1.12E1 | 3.18 | 0.000039 curies |
| Uranium-238 (4,500,000,000 y) | 2.40E4 | 6.78E1 | 4.03E4 | **4.29E4** | 0.146 curies |
| Carbon-14 (5730 year) | | | | | (94.6 curies) (EDF-6495) |
| Technetium-99 (213,000 year) | | | | | (94.6 curies) (EDF-6495) |
| Total | 6.46E10 pCi/L | 1.99E8 pCi/g | **1.99E11 pCi/l** | 1.50E11 pCi/L | Est 645,000 curies |

Table 1 (continued) Table 1 Source: EDF-11067, Table 8, with predicted decayed values calculated for January 2021 from Integrated Waste Treatment Unit design changes in the Hazardous Waste Management Act /Resource Conservation and Recovery Act Storage and Treatment Permit for the Idaho Nuclear Technology and Engineering Center, EPA ID No. ID4890008952, June 2021 at https://inldigitallibrary.inl.gov/PRR/IWTU Class 3 PMR June 2021.pdf (Compare to EDI newsletter from November 2016, Table 1.) The highest value in a row is noted in **Bold**. Picocurie per liter is pCi/L; picocurie per gram is pCi/g. Assuming maximum concentration and 900,000 gallons, equivalent to 3,406,870.6 liters. The latest document leaves out the long-lived carbon-14 and technetium-99 from the sodium bearing waste without explanation as well as iodine-129 of 0.115 curies which are included in EDF-6496. See also ICP/EXT-05-01116, 2005 for estimated annual dose from IWTU treatment emissions of 0.0746 mrem/yr.

The fission products of cesium and strontium contribute the most radioactivity in curies, yet will decay away within 10 radioactive decay half-lifes, about 300 years. Note that cesium-137 (or about 94.6 percent of it) decays to radioactive barium-137m, and it is the barium-137m gamma ray that is used to estimate the amount of cesium-137. Strontium-90 decays to radioactive yttrium-90. Long-lived fission products include niobium-94 and technetium-99. The cobalt-60 and antimony-125 are mainly cladding activation products.

The americium, plutonium, neptunium and uranium isotopes are known as actinides. Most are alpha emitters and they decay through a long decay series of other radionuclides before

finally ending as an isotope of lead. The lower curie amounts are deceptive, the actinides are still deadly when inhaled or ingested and the problem persists for longer than hundreds of thousands of years.

Several uranium isotopes in Table 1 are not naturally occurring. Natural uranium ore includes uranium-238, uranium-234 and uranium-235. The uranium-234 often isn't mentioned in the composition of natural uranium because of its low weight percent, but the U-234 in natural uranium provides significant radioactivity. The concentration of uranium-234 as well as the concentration of uranium-235 is elevated in enriched uranium fuel. And, recycled (or reprocessed) spent nuclear fuel concentrates the uranium-234 to even higher amounts.

Because new nuclear reactor fuel typically includes natural uranium-238 and naturally-occurring but higher concentrations of fissile uranium-235, you might wonder how the spent fuel contains uranium-236, uranium-232 and uranium-233.

The U.S. Government Accountability Office (GAO) states: "Natural uranium is comprised of approximately 99.3 percent of the uranium-238 isotope and 0.7 percent of the uranium-235 isotope – which undergoes fission to release energy. Uranium enrichment is the process of increasing the concentration of uranium-235 in a quantity of natural uranium to make LEU [low enriched uranium] to fuel nuclear power plants or to make HEU [high enriched uranium] which is used in nuclear weapons and as fuel by the U.S. Navy." [11]

Naturally-occurring uranium is 99.28 percent uranium-238, 0.72 percent uranium-235 and 0.0055 percent uranium-234, by weight. [12] But the activity of the uranium-234 is nearly equal to the activity of the uranium-238.

**Uranium-235 enrichment processes cannot separate out the uranium-234 and so nuclear fuel enriched in uranium-235 also has higher levels of uranium-234 than would occur in natural uranium ore.**

Uranium-236 is made in a nuclear reactor and is a marker for INL spent fuel reprocessing waste. Uranium-235 in a nuclear reactor may, instead of fissioning, absorb a neutron, becoming uranium-236. Uranium-236 alpha decays to thorium-232. The thorium-232 may absorb a neutron to produce thorium-231, which decays to protactinium-231, which may absorb a neutron to become protactinium-232 which decays (half-life of 1.3 days) to uranium-232. [13]

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[11] U. S. Government Accountability Office, *Nuclear Weapons – NNSA Should Clarify Long-Term Uranium Enrichment Mission Needs and Improve Technology Cost Estimates*, GAO-18-120, February 2018. https://www.gao.gov/assets/gao-18-126.pdf This report notes that the location where aluminum-clad Advanced Test Reactor fuel was to be reprocessed at the Savannah River Site's, H-Canyon would have high costs and is not currently accepting materials for processing. The Department of Energy's H-Canyon (fuel processing plant) is over 50 years old and may have safety issues should an earthquake occur, according to the GAO report.

[12] Oak Ridge Associated Universities, ORAU TEA Dose Reconstruction Project for NIOSH, Y-12 National Security Complex – Site Description, ORAUT-TKBS-0014-2, Rev. 1, November 8, 2007. https://www.cdc.gov/niosh/ocas/pdfs/tbd/y12-2-r2.pdf

[13] Governmentattic.org's two DNFSB reports from 1996 and 1997 at https://www.governmentattic.org/20docs/2DNFSBtechReptsStorRadioMatls_1996_1997.pdf (p. 35) Uranium-

Uranium-233 can be created by using natural thorium-232 in a reactor. Some of the fuel from the Fort Saint Vrain reactor, Peach Bottom and Shippingport Light Water Breeder reactor programs stored at the Idaho National Laboratory include uranium-233 produced from natural thoriuim-232.

But uranium-233 is also created in a conventional reactor that fissions uranium-235. A uranium-235 atom, by two successive neutron captures becomes uranium-237, which decays to neptunium-237. The neptunium-237 decays to uranium-233. The neptunium-237 can also undergo a (n,2n) reaction to form Np-236 which decays (half-life of 22 hours) to plutonium-236, which then decays to uranium-232. **Uranium-232, although not listed in the sodium bearing waste, is also a contaminant from reprocessing spent nuclear fuel and it decays to thallium-208.**

Naval spent fuel that was reprocessed at INTEC was high in uranium-235 and due to its robust cladding could be operated for a long time, thus could be called "high burnup." The U-235 in a reactor creates a high amount of Np-237 and plutonium-238, whereas the U-238, by absorbing a neutron, creates more plutonium-239, and plutonium-240, -241, and other plutonium and curium radioisotopes with successive neutron absorptions. Americium-241, the decay product of plutonium-241, is roughly as harmful as plutonium in the human body. [14]

**The plutonium-240, uranium-236 decay into very toxic radium-228 and these, in addition to uranium-232 decay into the high gamma emitting thallium-208.** [15] The source of elevated levels of radium-228 found in drinking water in Idaho is not identified and it is typically implied that the radium-228 is from naturally-occurring thorium-232. The Department of Energy environmental monitoring programs largely avoid monitoring the specific isotopes of uranium or any of the many decay products of uranium, plutonium or americium.

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and Thorium Storage Safety at Major Department of Energy Facilities, Defense Nuclear Facilities Safety Board, DNFSB/TECH-8, and Review of the Safety of Storing Plutonium- Pits at the Pantex Plant, DNFSB/TECH-18.

[14] Modeling assumptions continue to vary the estimated harm and relative harm from various radionuclides. Radionuclide dosimetry (clearance times), whether to include decay progeny, and the averaging of age and gender of the person exposed, can vary. Typical drinking water monitoring programs are not protective of health especially for the unborn and for children. Drinking water programs may determine the level of gross alpha contamination and may determine the contribution from uranium, but do not determine the concentration of alpha emitting americium-241 (or other neptunium or plutonium or curium) radioisotopes. The federal limit for the maximum contaminant level (MCL) for gross alpha concentration is of 15 pCi/L in drinking water. Yet, depending on assumptions used, americium-241 with only 1.5 pCi/L in drinking water would achieve the federal MCL of 4 mrem/liter, see the ANL Factsheets at https://www.remm.nlm.gov/ANL-ContaminantFactSheets_All_070418.pdf

[15] See how the uranium and plutonium decays series in the ANL Factsheets at https://www.remm.nlm.gov/ANL-ContaminantFactSheets_All_070418.pdf or in Tables 5 through 8 of my public comment submittal on the U.S. Department of Energy's Versatile Test Reactor Draft Environmental Impact Statement (DOE/EIS-0542) at at http://www.environmental-defense-institute.org/publications/CommentVTRdEIS.pdf

# Department of Energy's Billion Dollars' Worth of Recycled Uranium From INTEC

At great expense and with tremendous polluting of the air, soil and aquifer, and often high radiation exposure to workers and the public, the Department of Energy reprocessed high-enriched spent nuclear fuel at the Idaho Nuclear Technology and Engineering Center (INTEC), formerly called the Idaho Chemical Processing Plant (ICPP). Much of the fuel was from the Naval submarines and carriers but fuels from the Materials Test Reactor, Experimental Breeder Reactor II, and other research reactors was also reprocessed.

The Department of Energy claims that the INTEC recycled over one billion dollars' worth of uranium. [16] But, the environmental cleanup costs of the spent nuclear fuel recycling, just to attempt to turn the remaining radioactive liquid sodium bearing waste into a solid material, far exceed the high-enriched uranium cost. The so-called "cleanups" all too often leave much of the contamination in the environment and only claim to be protective of human health and the environment by assuming that humans will not live in the contaminated areas or drink the contaminated water. The restrictions on access to the vast areas that are contaminated at the INL are assumed to last beyond hundreds of thousands of years — basically forever.

In 1952, INTEC started reprocessing spent nuclear fuel. A variety of fuels were processed, but to a large extent, naval submarine and Department of Energy research reactor fuel, highly enriched in uranium-235, were processed. The zirconium-clad high burnup (HB) spent naval fuel, aluminum-clad research reactor fuel, and stainless steel-clad Experimental Breeder Reactor II (EBR II) fuels were prominent.

Fuel reprocessing had ceased by 1991. The reprocessing was conducted to recover uranium-235. But reprocessing introduced various radionuclide contaminants that make the recovered uranium-235 difficult to fabricate nuclear fuel with. Most of the uranium-235 recovered from spent fuel in Idaho was sent to the Oak Ridge Y-12 plant. **Due to radioactive impurities such as uranium-232 that make fuel fabrication difficult**, most of the uranium-235 recovered at the INL was used only by the Department of Energy for driver fuel for the weapons production reactors at Savannah River. [17]

According to a DOE Idaho Operations Office report prepared in 2000 by the Idaho National Laboratory (then called the Idaho National Engineering and Environmental Laboratory), INTEC (then called the Idaho Chemical Processing Plant) produced over 32 metric tons of uranium product from processing spent nuclear fuel. Most of the uranium product (high in uranium-235), about 25.7 metric tons, was shipped to the Y-12 plant at Oak Ridge to be used as driver fuel for

[16] John Roark, *The Idaho Falls Post Register*, "Jacobs group Idaho Environmental Coalition wins Idaho Cleanup Project bid," June 20, 2021.

[17] Brenda Pace et al., Idaho National Laboratory operated by Battelle Energy Alliance, *Idaho National Laboratory Fuel Reprocessing Complex Historic American Engineering Record Report – ID-3-H*, INL/EXT-06-11969, US Department of Energy Idaho Operations Office, December 2006. https://inldigitallibrary.inl.gov/sites/sti/sti/4460713.pdf See page 31.

the Savannah River plutonium production reactors and about 4 metric tons was sent to Portsmouth gaseous diffusion plant. Some product was shipped to various DOE labs. About 1.77 metric tons of recycled uranium product from spent fuel reprocessing was acknowledged to be stored at the INL. [18]

Recycled uranium from the INL was sent to the Oak Ridge Y-12 plant as either uranium oxide or **liquid uranyl nitrate**. From 1953 until the late 1980s, INL's ICPP processed spent Navy, research and experimental reactor fuel. The shipments were of uranyl nitrate solution until a denitrator was installed at ICPP in 1970 so the later shipments to Y-12 were of uranium oxide ($UO_3$). [19]

The Department of Energy reprocessed spent nuclear fuel at both INL and at the Savannah River Site. The recycled uranium, from either INL or Savannah River was sent to Y-12 to make highly enriched uranium (HEU) metal and was then sent to the Savannah River Site to make driver fuel for Savannah River's plutonium production reactors. Savannah River Site shipped 125 metric tons of recycled HEU to Y-12 whereas the INL sent 25.6 metric tons to Y-12. [20]

The fuel for the SRS plutonium production reactors included not only used uranium recovered from processing of naval reactor fuel and research reactor fuel at INTEC, additional sources of high-enriched uranium for the Savannah River production reactors included HEU recovered at the Savannah River Site from reactor research fuel and from the SR production reactors and HEU from weapons-grade oralloy from Y-12. The Savannah River production reactors used a uranium-aluminum alloy fabricated at Savannah River and the reactors used about 6 to 7 metric tons of HEU annually but less than 3 MT annually (often less than 1 MT annually), came from INTEC fuel reprocessing. [21]

There is over 7 metric tons of spent fuel from the Savannah River Production Reactors which were shut down in the early 1990s but the rest had been reprocessed. [22]

A 2008 U.S. Government Accountability Report (GAO-08-084) states that approximately 7.5 metric tons of various HEU materials are currently stored at five DOE facilities across the nuclear weapons complex. [23]

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

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[18] 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

[19] BWXT Y-12, LLC, for the Department of Energy, *Recycled Uranium Mass Balance Project Y-12 National Security Complex Site Report*, Y/LB-16,036, Rev. 1, December 2000. https://www.osti.gov/servlets/purl/775048

[20] BWXT Y-12, LLC, for the Department of Energy, *Recycled Uranium Mass Balance Project Y-12 National Security Complex Site Report*, Y/LB-16,036, Rev. 1, December 2000. https://www.osti.gov/servlets/purl/775048

[21] See Nuclear Weapons Databook, Volume II, https://fas.org/nuke/norris/nuc_87010103b_65c.pdf

[22] U.S. HEU Spent Nuclear Fuel Inventory, Table C3, as of 1996 https://fas.org/sgp/othergov/doe/heu/appc.pdf

[23] U.S. Government Accountability Office (GAO), *Nuclear Material: DOE Needs To Take Action to Reduce Risks Before Processing Additional Nuclear Material at the Savannah River Site's H-Canyon*, July 25, 2008. https://www.gao.gov/assets/a278582.html

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 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. Naval zirconium-clad high-enriched fuels had higher neptunium; stainless steel Experimental Breeder Reactor II (EBR-II) fuel had higher plutonium and all of the fuels included technetium-99 contamination.

**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." [24]**

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. Workers may not have been adequately protected.

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.

According to a 2015 U.S. Department of Energy Report to Congress, *Tritium and Enriched Uranium Management Plan Through 2060*, [25] 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 naval spent fuel 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 increases the complexity and cost of fuel fabrication and reactor operations.

[24] 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

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

**Table 2.** 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

The Idaho National Laboratory did not monitor how much technetium or neptunium was in the uranium product, nor how much plutonium or uranium-236 was in the recycled uranium product. There was no monitoring of technetium nor any reporting of it. There was also an excessive amount of uranium-234, not only from the use of enriched uranium in the fuel that was reprocessed but also because of the reactor operations with fuels highly enriched in uranium-235 which created even more uranium-234 which decays much faster than uranium-238.

The INL monitoring programs largely avoid monitoring he specific uranium isotopes that would implicate INL as the source of radioactive contamination. Likewise, the rather short-lived fission products from reactor operation, when detected by gamma spectrometry, are not attributed to INL operations.

The recovery of uranium-235 at the INL's INTEC facility created a very contaminated recycled uranium product generally considered unsuitable for nuclear fuel fabrication for use in conventional nuclear reactors. The uranium-236 and the uranium-232 in the recovered high enriched uranium (HEU) makes for additional radiation shielding problems for the fuel that must be manually fabricated.

# Department of Energy Publishes Final Environmental Assessment for MARVEL Microreactor

The Department of Energy has made available its Final Environmental Assessment for the Microreactor Applications Research Validation and Evaluation (MARVEL) project microreactor to be placed inside the INL's Transient Reactor Test Facility (TREAT). [26] An *Environmental Assessment* is a short-sheeted version of an Environmental Impact Statement and this one is laden with an unacceptably high quantity of unsubstantiated claims.

On June 7, the DOE announced that they will be accepting comment on its proposed Finding of No Significant Impact until July 8, which can be emailed to marvel@id.doe.gov.

I oppose the Department of Energy's MARVEL microreactor project and recommend that the No Action Alternative which is that the MARVEL microreactor project not be implemented. The MARVEL microreactor project should not be implemented because of the cost, nuclear accident risk and nuclear waste issues posed by the project.

According to the Department of Energy, MARVEL is a sodium-potassium (NaK) cooled, thermal microreactor with a power level of less than 100 kilowatts of electricity, although the EA states it is expected to provide only 20 kilowatts of electricity. It is important to know, however, that the Department of Energy considers anything up to 20 megawatts-thermal (or 20,000 kilowatts-thermal) to be included in the category of "microreactor" and sweeping statements are made in the EA about any "microreactor."

The program will use 150 kilograms of about 20 percent uranium-235 enrichment, with about 30 kg of uranium in 36 fuel pins. The design of the fuel and where the fuel will be made have not been determined. MARVEL's 30 kilograms (kg) or about 66 lbs of uranium-235 fuel in the reactor is significant — the rather inefficient atomic bomb dropped on Hiroshima contained only 64 kg of uranium-235.

The fuel material is to be a uranium-zirconium-hydride in stainless-steel cladding. Each fuel pin is about 38-in. long and will be sodium-bonded. MARVEL will be using High-Assay Low-Enriched Uranium (HALEU) and use heat exchangers known as Stirling engines which are to be closed-cycle lead-bismuth heat exchangers, heated by the circulating NaK that cools the reactor.

The Department of Energy has stated they plan to have MARVEL operating by late 2022 or early 2023. [27] The costs of this boondoggle are going to be extraordinary.

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[26] Department of Energy, Final Environmental Assessment for the Microreactor Applications Research, Validation, and Evaluation (MARVEL) Project at Idaho National Laboratory, DOE/EA-2146, June 2021. https://www.id.energy.gov/insideNEID/PDF/DOE%20EA-2146%20Final%20Environmental%20Assessment%20for%20the%20MARVEL%20Project%20at%20INL.pdf and https://www.id.energy.gov/insideNEID/PDF/CLN211013%20signed%20final.pdf

[27] Jess C. Gehin, Battelle Energy Alliance, Microreactor Research Development and Demonstrations at Idaho National Laboratory, INL/CON-21-61799-Revision-0, March 2021. https://inldigitallibrary.inl.gov/sites/STI/STI/Sort_33173.pdf#search=MARVEL

The EA names two options for obtaining MARVEL microreactor unique and untested fuel: INL production or supply from TRIGA International. TRIGA International, a General Atomics (GA) and Compagnie pour l'Etude et la Realisation de Combustibles Atomiques joint venture, have re-established the TRIGA fuel manufacturing capability in France that was previously performed by General Atomics in San Diego, California.

The MARVEL microreactor fuel is supposed to use a new, undesigned fuel similar to TRIGA fuel, which according to a 2020 report, which may not perform well in accident conditions with elevated temperatures. [28] The INL even states that "Despite its use in previous experiments, its integrity over time under irradiation, thermal aging, and exposure to sodium need to be evaluated against MARVEL's expected operating conditions and lifetime expectations" and "Because of the fission gas pressure, the likelihood of stress rupture needs to be evaluated." [29]

Yet, the Department of Energy's unspecified design, unspecified quality controls, and new and unique fuel for MARVEL, the Department of Energy's Final EA makes the broad and unsubstantiated claim that: "Microreactors are inherently safe because they are self-regulating and do not rely on engineered systems to ensure safe shut down and removal of decay heat."

The Department of Energy's assertions about the MARVEL reactor and any microreactor being "inherently safe" are hubris and bordering on fraudulent.

Apparently, the Department of Energy has learned nothing from its past reactor accidents, particularly the Stationary Low Power Reactor 1 (SL-1) reactor accident in 1961.

A 1950s vintage documentary film by the AEC presenting the Boiling Water Reactor Experiments (BORAX) tests [30] states "The [BORAX] experimental reactor was built for the purpose of testing this self regulation [reactor power reduction due to steam formation] and its most important consequence—the inherent safety of the reactor. The reactor is inherently safe against the accidental addition of any amount of excess reactivity ***which can be removed by the formation of steam before the power rises to a dangerous level***. [Emphasis added]" The need to pay particular attention to the last caveat would be demonstrated again by the SL-1 accident that occurred at the Idaho National Laboratory due to extremely poor safety management by the Atomic Energy Commission which is now the Department of Energy.

Interestingly, many of the BORAX tests increased reactivity by dropping the water temperature in the reactor tank. Investigators of the SL-1 accident would later comment that the

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[28] Dennis D. Keiser, Jr. et al., Battelle Energy Alliance, LLC for the Department of Energy, *An Investigation of Liquefaction in Irradiated TRIGA Fuel Exposed to Relatively High Temperatures*, November 2020. https://www.osti.gov/biblio/1737565-investigation-liquefaction-irradiated-triga-fuel-exposed-relatively-high-temperatures "The specimen tested at 1000°C still had over 75% of the cladding that was unreacted."

[29] Adrian R. Wagner et al., Battelle Energy Alliance, LLC for the Department of Energy, *MARVEL Fuel System*, INL/EXT-21-61273, Rev. 1, January 2021. https://inldigitallibrary.inl.gov/sites/sti/sti/Sort_27532.pdf

[30] Borax – Safety experiment on a Boiling Water Reactor. Film produced by the Argonne National Laboratory. Operated for the U.S. Atomic Energy Commission by the University of Chicago. circa late 1950s. The destructive BORAX-1 experiment was conducted in 1954 at the Idaho site.

SL-1 accident, with water initial temperature of 90 to 100 degree F increased the peak power by a factor of 10 what it would have been had the water been at saturation temperature. [31] [32]

The narrator in the BORAX film states: "Extension of experimental data to such a condition was considered important **even though the accidental addition of so much excess reactivity to an operating reactor has almost negligible probability**. **Addition of so much reactivity is not easy, for unless the ejected control rod is very large and is moved rapidly**, **the reactor will shut itself down** by steam formation before the desired amount of reactivity has been added. [Emphasis added]"

The safety analysis for the SL-1 did not include consideration of any accident involving melting of fuel and release of fission products, let alone destruction of the reactor from a prompt criticality achieving a total energy release of 133 MW-sec. [33] [34]The fuel cladding of the SL-1 reactor was twice as thick as the BORAX design—and other aspects of the fuel design had made it more susceptible to reaching a prompt critical condition than the BORAX reactor. It would be determined that the SL-1 reactor needed only 2.4 percent delta-K compared with the 3.3 percent delta-K reactivity insertion for the BORAX-1 destructive test. [35]

It was known with the BORAX experiments that movement of a rod of sufficient reactivity worth, in a few tenths of a second, could result in increasing the reactor power so rapidly that neutron population doubling occurred in milliseconds. Such rapid power increase in the fuel from fission heated the fuel plates in the SL-1 reactor "to a point near or above melting, depending upon location in the core. In the center regions of maximum neutron flux, the fuel within the plates experienced vaporization temperatures and burst the plate cladding. Thus the spewing of hot vaporized fuel rapidly produced steam in the surrounding water. The steam was generated at a rate far faster than could be dissipated. . ."

This is the Department of Energy's experience with claiming their reactors were ***inherently safe*** and then causing a reactor accident due to gross safety mismanagement of the poorly designed, poorly fabricated and poorly managed SL-1 reactor. The remedy for the problem was to blame the SL-1 accident was due to the deliberate act by one of the crewmen. This lie is repeated in many college-level nuclear textbooks. The stuck control rod was overlifted during an outage and anyone who has worked over a reactor top making manual lifts knows that the overlift of a stuck control rod was basically unavoidable. That reactor's design put so much reactivity worth into one rod and had no prevention for such an accidental overlift to occur.

The stated accident dose from a MARVEL accident at the site boundary 6000 meters from the facility is stated to be 0.131 rem in Table 10 and stated to be 2.65 rem in Table 11, with no

[31] ibid. IDO-19313, p. 151.
[32] ibid. IDO-19300. p. 132 in contrast to IDO-19313, says the temperature in the reactor vessel was 73 F based on log entries, an even worse situation for providing heat transfer to reactor fuel plates.
[33] ibid. IDO-19300, p. 170.
[34] ibid. IDO-19311. Table III-I.
[35] ibid. IDO-19311. p. IV-25.

explanation of the difference and each described as "the highest postulated accident consequences." The radiation dose to the public from a radiological release from a MARVEL accident is unacceptable.

With the 2.65 rem dose to the offsite public from a MARVEL accident, it should be understood that recommended limits on radiation exposure to an embryo or fetus should not exceed 200 mrem to the abdomen surface (ICRP) and not exceed 50 mrem/month (NCRP). [36]

The radiological release from a severe accident involving the MARVEL microreactor would depend on the fuel burnup at the time of the accident as well as the type of accident. The Final EA does admit that there are numerous ways that a MARVEL reactor may have an accident and release fission products and actinides. The ways a MARVEL microreactor can have an accident that would pose a risk to southeast Idaho include a natural phenomena hazard (seismic event), a failure of the control drives to insert, and intentional sabotage. A loss of adequate cooling has been deemed not to able to cause an accident.

The Department of Energy's Final EA does not list the radionuclides that would be released due to a MARVEL severe accident, but it would be the usual large array of fission products including strontium-90 and cesium-137 and the plutonium-238, plutonium-239, plutonium-240, plutonium-241, curium-244, neptunium-237 and americium-241. The radiological release would yield not only plume passage doses, but also chronic radiation doses from breathing and ingesting these long-lived radionuclides, which become incorporated into the body.

The 2.65 rem at the site boundary from Table 11 does not fully explain the damage to radioactively contaminated farms and vehicles, which are not financially insured for radioactive contamination. This is in no way within acceptable levels of radioactivity to the public. The EA falsely portrays the accident dose as being a one-time dose, while omitting the chronic doses from inhalation and ingestion of radionuclides that will persist in the air, soil and water after an accident.

**The EA claims that the accident release consequences are only a few rem, yet fails to acknowledge only short-term dose and ignores the long term ingestion consequences, the crop interdiction, the uncompensated and uninsurable car, home, business, livelihood and health costs of an accident radiological release. The EA must explain the curie amount of each radionuclide that would be released in an accident and must explain the full economic impacts of such a release.**

The EA incorrectly states that "INL maintains the necessary apparatus, equipment, and a state of the art Emergency Operations Center in Idaho Falls to respond to emergencies, not only at from the MARVEL microreactor and other INL Site operations, but also throughout local communities." **The EA fails to acknowledge decades of repeated inadequate emergency preparation for site emergencies in terms of training, decontamination, radiological**

[36] Eric J. Hall, *Radiobiology for the Radiologis*t, Fifth Edition, Lippincott Williams & Wilkins, 2000. Table 15.4 Summary of Recommended Dose Limits.

**medical treatment, inadequate emergency radiological monitoring during and after the emergency.**

The EA discusses reactivity control for MARVEL using rotation of control drums but inadequate information is provided to determine the safety adequacy of this design.

In another document, it was stated that "Its reactor control systems will consist of four independent vertical control drums and a central shutdown rod." [37] Nothing in the EA provides confidence in the reactivity control system safety of MARVEL.

The seismic design requirements for MARVEL remain unstated.

Seismic design category 2 of the TREAT building means that the building is vulnerable to large seismic events which would be unacceptable for a hazard category I reactor. MARVEL is stated to be less than a hazard category I reactor; however, it is erroneous to conclude that the facility is not vulnerable to seismic events.

The EA states: "No environmental impacts are assessed from the MARVEL microreactor in TREAT as a result of potential future earthquakes. The TREAT Reactor building is classified as a seismic design category (SDC), SDC-2. Per DOE Order 420.1C, *Facility Safety* (2019), implemented through DOE Standard, DOE-STD-1020, *Natural Phenomena Hazards Design and Evaluation Criteria* (2016), seismic design criteria for TREAT are obtained from the International Building Code (IBC). The MARVEL microreactor and its installation in TREAT will be designed to withstand vibratory ground motions (or ground shaking) as specified by IBC. Ground shaking levels are obtained from the U.S. National Seismic Hazard maps available online from the U.S. Geological Survey (https://www.sciencebase.gov/catalog/item/5d5597d0e4b01d82ce8e3ff1) for the specific rock conditions and geographical location of TREAT. Because no impacts from the MARVEL microreactor would occur as a result of earthquakes, cumulative impacts are not expected."

This statement in the EA shows that the INL has not provided adequate seismic design criteria in place to protect Idaho from an accident. The truth of the matter is that at a likelihood greater than 1 in 100 years, a seismic event would cause failure of the building and any containers of spent nuclear fuel or the reactor. Using 150 years of seismic experience is inadequate to conclude that no impacts due to seismic events would occur.

The final EA states: "To protect workers from impacts from radiological exposure, 10 CFR Part 835 imposes an individual dose limit of 5,000 mrem (5 rem) per year."

The final EA provides an estimate of the latent cancer fatality for receiving a total lifetime dose of 1 rem, stating: "The consequence of a dose to an individual is expressed as the probability that the individual would incur fatal cancer from the exposure. Based on a dose-to-

[37] Andrew Foss et al., Battelle Energy Alliance for the Department of Energy (NE), *NRIC Integrated Energy Systems Demonstration Pre-Conceptual Designs*, INL-EXT-21-61413, Rev. 1, April 2021. https://inldigitallibrary.inl.gov/sites/sti/sti/Sort_27617.pdf See p. 8.

risk conversion factor of 0.0006 latent cancer fatality (LCF) per person-rem, and assuming the linear no-threshold model, an exposed worker receiving a dose of 1 rem would have an estimated lifetime probability of radiation-induced fatal cancer of 0.0006 or 1 chance in 1,700."

It would be far more useful to discuss the dose of the Department of Energy's allowed 5 rem per year to an adult worker. If the worker's career was to span 30 years, and the allowed dose were received each year, then the total radiation dose would be 5 rem times 30, or 150 rem. Then according to their accepted model, the lifetime probability of radiation-induced fatal cancer would be 0.0006 LCF/rem times 150, or 0.09 or 1 chance in about 1 chance in 11. The chance of severe heredity effects would be 20 percent of that, or 0.018 or about 1 chance in 56. And the increased health risk for non-cancer illnesses is simply not evaluated by the "effective dose" which uses tissue/organ weighting factors largely selected only based on the expected cancer mortality. So, the shortened life span is really not accounted for by the EA's computations, and the Department of Energy apparently assumes that the people of Idaho don't care about hereditary effects.

If the example uses it non-binding, discretionary 2 rem per year guidance value, that it does not enforce as a legal limit, for a worker receiving 2 rem/yr for 30 years, the radiation-induced fatal cancer would be 0.0006 LCF/rem time 2 rem times 30 years, or 0.036, or about 1 chance in 28.

I think the obvious pattern of deception in the Department of Energy's final EA, is exemplified by the final EA's use as an example, of 1 rem total lifetime dose causing 1 chance in 1,700 of a fatal cancer.

The Department of Energy's repeated use antiquated terminology "Roentgen-equivalent-man" for rem leaves open for interpretation what level of absorbed dose forms the bases for the Department of Energy's dose. A roentgen corresponds to 87.7 ergs per gram of air absorbed dose, whereas a rad corresponds to 100 ergs/gram. The EA leaves unstated whether it is still using Roentgens or whether it nows defines rem in terms of the definition of a sievert.

The latent cancer fatality risk used is a population average and the cancer fatality risk to women, children, embryos and fetuses is significantly higher than to adult men. Although not labeled as using the assumption of a low dose and low dose rate reduction factor, this assumption has not scientific basis. The latent cancer fatality uses the dose reduction factor based on the assumption that the consequences at lower doses are half of the consequences observed at higher doses, yet diverse studies have found that the dose reduction factor is not valid.

Finally, there is the issue of unsolved radioactive waste problems.

The radioactive waste management issues are unavoidable and the Department of Energy's assertions about the radioactive waste are misleading and irresponsible. The Department of Energy asserts that it breaks no laws by creating a threat to human health and all life on Earth by continuing to make more radioactive waste and ignoring how much the problem is going to cost

to solve, if the waste can actually be isolated from the biosphere for the time frame that the waste is hazardous, more than hundreds of thousands of years.

The EA allows the careless disposal of spent nuclear fuel over the Snake River Plain aquifer if DOE deems the spent nuclear fuel to be related to research. This artificial definition defies science and is simply to shortcut proper disposal to isolate the material from soil, air and groundwater.

Treatment of the MARVEL fuel requires using dilapidated and aging facilities at the Materials and Fuels Complex, which is already far behind in treatment of sodium bonded fuels.

The MARVEL EA relies on the existence of Yucca Mountain which has not been funded since 2010 and was never granted a license-to-construct. The Department of Energy is no closer to finding a solution to isolate spent nuclear fuel from the biosphere now than it was over 60 years ago.

*Articles by Tami Thatcher for July 2021.*