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Inadequately Inspected Mackay Dam is a Disaster Waiting to Happen

The Mackay Dam located 45 miles from the Idaho National Laboratory remains inadequately inspected despite putting Mackay town residents at risk and having the potential for inundating several Idaho National Laboratory nuclear waste burial, waste storage and operating nuclear facilities with several feet of flood water, warn David McCoy and Chuck Broscious, in a letter to Idaho Governor C. L. Butch Otter. [1]

The Mackay Dam was built about a century ago, is located near the Borah earthquake fault that caused a 7.3 earthquake in 1983. In addition to seismic design vulnerability, the dam is vulnerable to heavy spring runoff resulting in overtopping failure of the dam, internal erosion, and other failures. The Mackay Dam has serious levels of underseepage, water leaking out at the base of the dam.

Estimates of 100-year flooding range from about 6200 cubic feet per second (cfs) to 24,870 cfs. The 100-year flooding reaches numerous INL facilities within hours of onset of flooding and reaches several feet above grade. [2] Nuclear facilities that are vulnerable to the flooding include liquid storage tanks and highly soluble calcine at INTEC and an operating reactor at the ATR Complex. The waste waters will accelerate the migration of radionuclides in soil over the Snake River Plain Aquifer at the contaminated INTEC tank farm, the new ponds and burial at the Idaho CERCLA Disposal Facility near INTEC, extensive in soil contamination at INTEC and TRA, and waste above and below ground at the Radioactive Waste Management Complex.

If the storage of powdered calcine at INTEC were compromised by the flood waters, there would be no remediation likely to halt the release of soluble radionuclides over the aquifer.

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[1] Letter to Idaho Governor C. L. Butch Otter, from David B. McCoy, Esq., Board of Directors, Environmental Defense Institute, and Chuck Broscious, President, Environmental Defense Institute, Subject: Mackay Dam: A Preventable Disaster, February 14, 2017. http://www.environmental-defense-institute.org/publications/MackayDam2017.pdf

[2] Letter to Idaho Department of Environmental Quality from David B. McCoy, Esq., Board of Directors, Environmental Defense Institute, Subject: Docket 10HW-0109 including Mackay Dam: A Disaster Waiting to Happen. January 11, 2002. http://www.environmental-defense-institute.org/publications/MackayDam2002.pdf

Radionuclides would migrate through layers of soil and reach the aquifer, then flow downgradient to communities south of the INL.

The consequences of flooding call for using the estimated "probably maximum flood," a less often to occur but more severe flood than the 100-year flood. A PMF was estimated as 66,830 cfs in 1986. The elevations of flood water attained at INL facilities were not well characterized at that time and subsequent studies have found deeper flood waters at INL facilities for much lower flow rates than the 1986 study.

Just how catastrophic the consequences of Mackay dam failure would be to the Radioactive Waste Management Complex will depend on the status of Pad A, the remaining above ground waste, and the performance of the diversion dam. Flooding at RWMC has occurred in the past and at the very least, the flood waters will hasten migration of radionuclides through the soil into the aquifer.

Idaho has experience ignoring disasters waiting to happen. In 1976, the earthen Teton Dam began eroding due to a leak at its base, then burst, resulting in 11 deaths and an estimated 2 billion dollars in property damage. [3]

I'm not holding my breath for Idaho to take action. State officials know they will never be held accountable for ignoring the hazards while pretending to be giving oversight of INL operations.

Citizens Should Be Concerned About the Push to Renegotiate the 1995 Idaho Settlement Agreement

Some Idaho lawmakers like Dell Raybould, R-Rexburg, are pushing for a new agreement because of barriers to obtaining spent nuclear fuel for research. [4] And a report of recommendations to help the Idaho National Laboratory to develop as a world-class national laboratory also is pushing for renegotiation of the 1995 Idaho Settlement Agreement. They are upset by the blocking of a research shipment of spent nuclear fuel to the INL because of continued failure to meet historical Idaho Settlement Agreement milestones to treat liquid waste at the INL.

[3] Reporter Rocky Barker, *Idaho Statesman*, "Dam threat places spotlight on aging Idaho dams, February 15, 2017.
[4] Reporter Bryan Clark, *Idaho Falls Post Register*, "Officials vent about spent fuel setbacks – Raybould: 'Let's start over again,'" February 7, 2017.

The 1995 Idaho Settlement Agreement (ISA) has been modified by various memorandums such as one in 2011 to allow in research quantities of spent nuclear fuel [5] on the condition that DOE keep its milestones. Idaho Attorney General Lawrence Wasden has indicated that he would be flexible about delayed waste shipments to WIPP and that he would not require the treatment of liquid sodium-bearing waste to be completed. But Wasden has pressed for DOE to begin successfully treating the liquid waste before he will sign a waiver. The Department of Energy missed the 2012 milestone to treat the sodium-bearing waste, and also missed more recent commitments to commence treatment last year. Continued problems continue and there is no schedule for getting the facility to treat the sodium-bearing waste, the Integrated Waste Treatment Unit (IWTU), operating.

The ISA is supposed to protect all of Idaho and the aquifer, not just the interests of the Department of Energy or its current contractors. The Department of Energy agreed to meet milestones that they helped to set. And the DOE is at fault for missing these milestones. What is the remedy for DOE's failure to meet milestones in the ISA? So far, the sole remedy of the ISA is cessation of allowing spent nuclear fuel, including research quantities, into the state. Other state cleanup laws are enforcing a fine on DOE for IWTU missing tank closure milestones.

It would appear that DOE is providing funding and a great focus on getting the IWTU running that it might otherwise not be, had the state not had the ISA. So what remedy should DOE offer in return for missing its milestones? If the state were to ask DOE to stop burying waste over the aquifer at RWMC or the future replacement for RWMC, would we then see malicious compliance? Would the waste simply accumulate above ground like the Rocky Flats waste that was stored above ground for the last 40 years?

I would still suggest that a remedy could be for DOE to stop burying its waste at INL over the aquifer and send the newly generated waste to DOE's the operating waste burial facility in Nevada. This is the waste that other low-level radioactive waste disposal facilities won't take. But DOE worries that Nevada will close access to burying more radioactive waste there, so it wants to continue burying long-lived radioactive waste over the Snake River Plain aquifer.

The ISA stated that DOE Idaho was to focus on DOE spent nuclear fuel disposal and the repackaging and shipping needs. The state ignored violation of the ISA when DOE research to support disposal of DOE spent nuclear fuel was defunded. The state is now tangled up in a creative reinterpretation that becoming the nation's premier nuclear laboratory is considered to have replaced the need for DOE to focus on how to repackage, ship and dispose of its DOE SNF.

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[5] See more about Idaho's Settlement Agreement at https://www.deq.idaho.gov/inl-oversight/oversight-agreements/1995-settlement-agreement.aspx Section D(1)(e) stipulates that naval fuel be among the early shipments to the first permanent repository or interim storage facility.

The research to address commercial spent nuclear fuel is a different matter and although this research may also be needed, commercial SNF repackaging and dry storage does not address the research needs for DOE SNF. DOE argues that it doesn't know what the criteria for storage will be, since Yucca Mountain is stalled.

The current fuss is over the pyroprocessing research that INL wants the research shipment for. This research is now deemed necessary in order to detect pyroprocessing to obtain nuclear weapons material. Funny that when INL shared the pyroprocessing technology with the S. Koreans, INL insisted there was no weapons material proliferation issue.

There will likely be no repository for SNF by 2030, 2048 or . . . pick any date you like. Should the ISA be renegotiated to acknowledge that DOE may never successfully site a permanent repository for DOE defense SNF or for commercial SNF?

The 1995 Idaho Settlement Agreement is highly flawed. In 2008, after winning the "all means all" determination that both the buried and the above ground stored transuranics, much of it from Rocky Flats, were to be removed from Idaho, Idaho agreed to a very limited buried waste retrieval that focused on chemical waste and removes only a portion of the waste, limited to the "targeted waste," from less than 6 arces of the 97-acre radioactive burial ground. Most of the buried transuranics from Rocky Flats and decades of radioactive waste buried there will in fact remain buried at RWMC.

Two major flaws of the ISA are that it focused on transuranic waste while ignoring the real threat of other long-lived radionuclides buried over the aquifer and then it allowed most of the buried transuranic waste to remain buried.

The public and law makers have been given incomplete information about the CERCLA cleanup at the Idaho laboratory. Essential documentation concerning the extent of the waste and the hazard escalation after the EPA 1000 year timeframe was withheld from public view regarding the buried waste at RWMC. The 2008 decision to leave the buried waste in place and lowered the ingestion dose using numerous inappropriate assumptions such as perfect soil cap performance for millennia is a failure of epic proportion. People downgradient will suffer from contamination for millennia. [6] [7] [8]

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[6] INL Waste Area Group Institutional Controls Report. Dated February 16, 2016. https://cleanup.icp.doe.gov/ics/ic_report.pdf from the EPA page: https://cleanup.icp.doe.gov/ics/

[7] 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/

Idaho accepted the DOE's historical dose evaluation of the airborne radiological releases from its operations from 1949 to 1989. [9] The doses were shown to be low and therefore no epidemiology was needed in the communities surrounding the Idaho National Laboratory, originally called the National Reactor Testing Station. But the health problems of citizens in communities surrounding the INL site are elevated and there are studies that point to the issue. The adverse health effects, including elevated cancers, were largely not recognized by the authors of the ISA.

Two-thirds of Energy employee illness compensation claims are denied was also not factored in to the 1995 agreement. The Energy Employee Occupational Illness Compensation Act was not passed until 2000. And that fact that epidemiology since 1995 has shown repeatedly that the health harm from radiation is greater than officially modeled by the nuclear industry in the US.

Regarding spent nuclear fuel, if Department of Energy actually succeeds in citing a "pilot" interim storage facility to help DOE cope with its most pressing legal liabilities, [10] this could make it easier for the federal government to weasel out of the 1995 settlement agreement stipulating that Naval spent nuclear fuel stored in Idaho be among the first fuel shipped to an interim facility.

Yes, there are problems with the Idaho Settlement Agreement, but most of the folks calling for it to be renegotiated are extremely short-sighted and they don't begin to understand the problems.

Report Suggests Changes to Boost INL's Profile

A report of recommendations to help the Idaho National Laboratory to develop as a world-class national laboratory was issued last year. The report by the Nuclear Energy Advisory Committee, (NEAC), by a 12-member committee, gave advice to the Department of Energy's Office of

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[8] 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 CleanupProject. 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/201411/2014110300960BRU.pdf

[9] US Department of Energy Idaho Operations Office, "Idaho National Engineering Laboratory Historical Dose Evaluation," DOE-ID-12119, August 1991. Volumes 1 and 2 can be found at https://www.iaea.org/inis/inis-collection/index.html

[10] Utilities have won more than $5 billion http://www.cnbc.com/2016/07/05/how-the-department-of-energy-became-a-major-taxpayer-liability.html in compensation from the Energy Department because of its failure to provide a disposal facility as required by the Nuclear Waste Policy Act of 1982.

Nuclear Energy and was issued last October. [11] The report makes for interesting if not depressing reading. Basically the Idaho lab continues to struggle to be relevant and so need to focus on advertising to get the pro-nuclear message to the public. It should do this in all ways possible including via the university consortium CAES which it said needed to try to appear to be an honest broker while sending its pronuclear message. No need to actually be an honest broker of science or selection of the best and most economical technology: just fix the message so that the public sees nuclear as relevant — despite the safety and low costs for renewables.

Among various rather predictable recommendations for the INL to become more prominent internationally and collaborate more with other national labs, the report recommends improving communication with outside groups including watchdogs about research conducted at the lab. It even suggests that lab officials should keep these groups informed and "seek where appropriate their input regarding lab objectives and operations."

This is certainly in stark contrast to existing communications where DOE-NE programs have been concerned. Discussion of DOE-NE research programs have been strictly off-limits for discussion at environmental management focused INL Citizens Advisory Board meetings. The reasoning appeared to be that the public had no right to hear about the messes being made by current research—only the legacy messes being cleaned up.

The Citizens Advisory Board is made up of volunteers who attend several meetings a year to listen to cleanup status presentations. The presentations do help shed light on INL cleanup operations and the CAB members are to be thanked for their efforts.

If the CAB chooses to and reaches a consensus, the CAB can document its approval or disapproval of cleanup decisions. But many of the unpaid board members have limited technical background to understand what is presented. Even when their questions are spot on, they tend to be pressed into accepting partial answers from the "experts" from the Department of Energy or supporting contractors. CAB members typically have too little time or technical background to independently assess what is not being accurately portrayed during the brief presentations.

In my view, the logical step for more communication to the public about INL research would be to add these presentations to the INL CAB meetings which the public can attend.

DOE-NE programs traditionally were focused on defense, from naval submarines to nuclear weapons production. As the INL increasingly is involved with trying to make itself relevant in

[11] Nuclear Energy Advisory Committee, "Recommendations for the Idaho National Laboratory to Develop as a World-Class National Laboratory," October 1, 2016. https://www.energy.gov/sites/prod/files/2016/12/f34/INLFinalReport.pdf

the commercial nuclear power plant market place, these missions can't hide behind national security needs as much.

Not only is INL and CAES unlikely to be a fair broker for assessing the relevancy of nuclear energy, the pressure on INL help support commercial deployment of light-water small modular reactors (SMRs) creates a potential conflict of interest that arises if the INL also helps to support Nuclear Regulatory Commission safety evaluations and licensing.

The Post Register provided a summary of some important elements of the report by NEAC in "Report suggests changes to boost INL profile." [12]

Officials Deny Aquifer Contamination, Continue Groundwater Sampling for PCE

Tetrachloroethylene, known as PCE, was unexpectedly detected in the aquifer north of the Radioactive Waste Management Complex (RWMC) at the Idaho National Laboratory in 2015. Detections of PCE and other volatile organic chemicals at RWMC are common and include carbon tetrachloride, chloroform also known as trichloromethane), and trichloroethylene. But the aquifer flows downgradient in generally a southerly direction. So the detections in deep multilevel wells, north of RWMC and even north of INTEC came as a surprise.

Cleanup contractor Fluor Idaho is planning to sample 11 groundwater wells at INL for tetrachloroethylene, known as PCE. The Idaho Falls Post Register [13] reported that officials don't think that the Snake River Plain Aquifer is contaminated with PCE, but that the contamination is isolated inside sealed shafts of the Westbay wells. The Westbay wells installed about a decade ago were filled with an outside water source when they were installed and that water has remained separate from the surrounding aquifer. PCE was found in the aquifer in what is being called "preliminary tests" last year.

The US Geological Survey has been monitoring the groundwater at the INL since 1949. The Westbay wells were installed about a decade ago and monitoring results from the Westbay wells have been published since 2010 for a partial set of selected radionuclides and chemicals. But now it would appear that taking water samples and analyzing them and repeating this several times each finding contamination is now being referred to as a "preliminary test." If the USGS installed sampling wells that are isolated from the aquifer water, exactly how do they monitor the

[12] Reporter Luke Ramseth, *Idaho Falls Post Register*, "Report suggests changes to boost INL profile – The lab is still not established among many international researchers, companies," February 22, 2017.

[13] Reporter Luke Ramseth, *Idaho Falls Post Register*, "Fluor to test 11 wells for hazardous chemical – Field sampling effort to get underway in spring," February 17, 2017.

aquifer from them? Even if a degreaser as adding to the contamination in the Westbay wells, one would have expected the mystery PCE to be explained by now, a year and a half since the elevated levels of PCE were detected.

Absent are discussions of the historical disposal of PCE at INL, which has been monitored spottily at INL since 1987. Chemical contamination in groundwater at the INL was largely ignored by the US Geological Survey until 1987. This makes trending difficult and the amount of chemicals disposed of is typically not known. In 1987, many wells were found to exceed federal drinking water standards for various chemicals and workers were given bottled water at TAN and RWMC. But the drinking water was probably contaminated for decades prior to 1987.

PCE and other volatile organic chemicals are recognized as probable carcinogens or as carcinogens. PCE can degrade to TCE and then to vinyl chloride. The aquifer at INL is typically contaminated with many chemicals. So workers bodies had to cope with drinking water laden with a toxic soup of both chemicals and radionuclides and cope with radionuclides in the air and soil at INL facilities, and cope with elevated gamma radiation fields at these facilities.

Numerous wells have exceeded the federal maximum contaminant level for PCE, as noted by a 1999 to 20001 study issued in 2006 by the USGS. [14] A well no longer sampled was found in 1996 to have 46 ug/L of PCE. [15] This now long ignored well is USGS 24 located at TAN. In 1988, USGS 24 had 120 ug/L of PCE. [16] TAN is roughly 30 miles upgradient to the northwest of where the contamination is being found. The disposal at TAN commencing as early as the 1950s that was not monitored until about 1987 could have migrated to the southwest to the wells now being found contaminated in the vicinity of INTEC. A rough estimate of bulk aquifer movement of 10 ft/day gives 0.69 miles per year; in 62 years, the movement would be over 42 miles. Indeed. The source of contamination could be Test Area North, despite shallow plume monitoring that gives the impression that contamination in the aquifer at TAN somehow defies the known downgradient flow water in the aquifer.

The levels of PCE found since November 2015 are significantly above the federal drinking water standard of 5 microgram/liter. The levels have been 830 ug/L at well 2050A and 824 ug/L at

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[14] US Geological Survey, “Selected Radiochemical and Chemical Constituents and Physical Properties of Water in the Snake River Plain Aquifer, 1999 – 2001,” Report 2006-5088, https://pubs.usgs.gov/sir/2006/5088/section6.html

[15] US Geological Survey, “Hydrologic Conditions and Distribution of Selected Constituents in Water, Snake River Plain Aquifer, Idaho National Engineering and Environmental Laboratory, Idaho, 1996 Through 1998,” Report 00-4192, DOE/ID-22167, 2000. https://pubs.usgs.gov/wri/2000/4192/report.pdf

[16] US Geological Survey, Mapper, USGS 24, well identifier 435053112420801, 326 ft deep, water quality data collection cease in 1996. The peak of PCE contamination may be been many years before first measured in 1988.

Middle-2051. [17] The extent to which these levels may have been affected by Westbay well construction is unknown.

Citizens concerned about the aquifer should not have to wait another year for answers about the source of PCE contamination in the aquifer.

A Monument of Uranium: Pad A at RWMC

The cleanup at the INL's Radioactive Waste Management Complex has been expensive. What receives little attention is that the vast amount of buried radioactive waste is not being removed. The vast majority of the shallowly buried waste is staying above the Idaho's Snake River Plain Aquifer.

But a unique monument to the waste problem at INL is a mound of uranium and nitrate laden waste called Pad A. It is not shallowly buried waste—it is above ground buried waste.

After DOE agreed it would no longer bury waste from Rocky Flats, here's what DOE did: DOE stacked about 18,000 barrels and about 2000 4 ft by 4 ft by 7 ft wooden boxes of depleted uranium and nitrate waste on an asphalt pad called Pad A. [18] They sprinkled it with top soil and repeatedly tried unsuccessfully to get something to grow.

This roughly 20 ft high pile of radioactive trash is supposedly going to be protected by the soil cap for millennia as the waste grows ever more radioactive by decay progeny. The soil cap is yet to be designed. Yet the INL CAB is fed sweet statements about soil caps being adequate because they could last about 1000 years. Soil caps require annual maintenance and this one is needed for millennia—talk about a welfare queen.

The only thing scarier than leaving Pad A there to blow in the wind or be unearthed by flooding is the prospect of actually having to exhume the waste. The RWMC where the Pad A monument is placed flooded twice in its early history and is vulnerable to the aging Mackay dam built in 1919. Idaho's track record for inspection and maintenance of dams is scant comfort. [19] The Mackay dam is vulnerable to overtopping by high spring runoff and by a seismic event. The flooding would head directly to the INL and RWMC. The containers at Pad A likely have long since degraded and the combination of explosive nitrates with uranium likely make remediation extremely hazardous.

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[17] See our November 2016 newsletter at http://www.environmental-defense-institute.org/publications/News.16.Nov.pdf

[18] EPA/ROD/R10-94/073 "EPA Superfund Record of Decision: Radioactive Waste Management Complex, Idaho Falls, ID 1/27/1994" January 1994.

[19] Reporter Rocky Barker, *Idaho Statesman*, "Dam threat places spotlight on aging Idaho dams, February 15, 2017.

February 2017 Cleanup Status at the INL

Retrieval of Above Ground Stored Rocky Flats Waste

Retrieval of barrels of waste stored above ground at the Advanced Mixed Waste Treatment Project is now finished with the process that began in 2003. There were 28 boxes left to retrieve reported the Idaho Falls Post Register [20] in early February but the INL Citizens Advisory Board DOE presentation held February 23 reported that all boxes were retrieved two days earlier. This is a huge achievement for this above ground stored Rocky Flats waste that had been stacked for temporary storage since the 1970s. Rocky Flats transuranic waste prior to this time was shallowly buried at RWMC.

Treatment work is required prior to shipping the waste out of Idaho to the deep salt mine defense waste repository in New Mexico, the Waste Isolation Pilot Plant, WIPP. About 61 shipments of radioactive waste will be sent to WIPP over the next year, the Idaho Falls Post Register reported. [21] (In addition to the AMWTP TRU waste and the exhumed targeted waste buried at RWMC, additional TRU waste from the Materials and Fuels Complex Radioactive Scrap and Waste Facility and other INL locations must also be shipped to WIPP for compliance with the Idaho Settlement Agreement.)

A decision on the future mission of the AMWTP is expected later this year. Officials want to keep the recently upgraded machinery used to remotely move and repackage waste in use after its current mission is complete. They envision bringing more waste to Idaho from Hanford in Washington or the Los Alamos National Laboratory in New Mexico. The risks associated with continuing operations at AMWTP are waived away now, despite past arguments for reduced cleanup in Idaho because more than 10 years of exposures to unmonitored workers yielded high radiation exposures; this is was argued was reason not to conduct a 30 year cleanup. About 25 to 30 jobs would be eliminated if the facility closes.

Milestones for continued shipping of transuranic waste to the Waste Isolation Pilot Plant (WIPP) in New Mexico have not been met. The settlement agreement requires shipping 2000 cubic meters out of the state annually and sending out the last shipment in 2018. With over 900 shipments ready to ship but WIPP accepting perhaps five per week initially, completion of these shipments by 2018 is not expected and the Idaho Settlement Agreement milestones will be missed. [22] WIPP has recently reopened following two accidents there.

[20] Luke Ramseth, *The Idaho Falls Post Register*, "Radioactive waste retrieval nearly complete – Process has lasted 15 years, but treatment work remains, February 1, 2017.

[21] Luke Ramseth, *The Idaho Falls Post Register*, "Idaho to send 61 waste shipments to WIPP in N.M.," February 15, 2017.

[22] Luke Ramseth, *The Idaho Falls Post Register*, "DOE may miss 2018 nuclear waste deadline – Idaho has 900 shipments ready for New Mexico repository," January 18, 2017.

Contamination of the underground salt mine, WIPP, will continue to slow its ability to receive transuranic waste shipments. Previously, mining to create new holes for remotely-handled waste as well as ceiling bolting could be conducted as waste was brought down into the mine.

Now waste cannot be brought into the mine during excavations for RH-handled waste and bolting of the ceiling. This makes mine ventilation issues more important during this and routine bolting of the ceiling to cope with salt creep.

The potential for chronic exposure of workers to elevated levels of americium-241 and plutonium exists now following the February 2012 accident that contaminated the underground mine.

Exhumation of Targeted Buried Rocky Flats Waste

Near to the AMWTP is the buried waste at the Radioactive Waste Management Complex. Of the 97 acres of buried waste, 5.69 acres were targeted for buried waste exhumation. About 4.5 acres to the targeted waste has been exhumed, sorted and either returned to the ground or shipped to WIPP. The targeted waste is the most chemically laden waste from Rocky Flats weapons production. The chemical contamination of the Snake River Plain aquifer under RWMC exceeds federal drinking water standards and the contamination of carbon tetrachloride has continued to increase despite the exhumation and the operation of vapor extraction.

The buried waste exhumations take place in temporary buildings called Accelerated Retrieval Projects. Exhumation of the eighth enclosure called ARP-8 continues. Construction of he ninth and final enclosure, ARP-9 — covering nearly three-quarters of an acre — is expected to be finished by early summer. [23] Over 90 acres of the landfill's low-level radioactive and toxic waste are left in place and much of the radioactive material from the exhumed 5.69 acres will ultimately be left in the ground or returned to the ground because it isn't laden with carbon tetrachloride, the chemical that was already exceeding federal drinking water standards in the aquifer at RWMC.

The decision to leave most of the radionuclides in place has been based on the EPA practice at the time of ignoring timeframes beyond 1000 years. The radioactive waste at RWMC has many long-lived radionuclides, creating a source of radioactive contamination to the aquifer for millennia. The Department of Energy's analysis of this migration of contaminants was kept from

[23] Luke Ramseth, *The Idaho Falls Post Register*, "Buried radioactive waste removal 80 percent done," February 2, 2017.

public view during CERCLA public meetings. The DOE's analysis assumes perfect soil cap performance for millennia, something that soil cap designers appear to be unaware of.

The RWMC is located near what is called the "spreading area" at the mouth of the Big Lost River. This is a region known for flooding and it is vulnerable to a Mackay dam break from overtopping or a seismic event. See our Earth Day report about "forever contamination" and a report about long-lived contaminants at RWMC that are not being remediated on our website. [24]

Continued IWTU Testing With No End In Sight

The Integrated Waste Treatment Unit (IWTU) is the problem plagued project slated to treat the sodium bearing liquid waste at the INL, missing its 2012 deadline. The Department of Energy contractor Fluor is now performing additional small scale testing at the Hazen Research facility near Denver. [25] Past testing by the previous DOE cleanup contractor had cleverly concluded that the testing did not show that the facility could not run. The resumed testing, now years after trying unsuccessfully to get the IWTU operating, may decide the fate of the Integrated Waste Treatment Unit (IWTU).

Fluor has given no schedule for commencing treatment of liquid sodium-bearing waste. [26] The waste was to have been treated by the previous contractor by 2012 in order to meet the Idaho Settlement Agreement.

Previous testing of a non-radioactive material to test the IWTU has resulted in extensive damage to equipment including the auger-grinder and the ring header. The operation of the denitration mineralization reformer (DMR) resulted in temperature excursions. Instead of the desired spheres of calcine, there was insufficient particle size control that resulted in "sand castles," a formation of solid scale resembling "tree bark," and a concrete-like buildup in the auger-grinder. Experimental redesign of the components continues. A manway into the DMR, a high pressure tank, is also being made. [27]

Calcine Retrieval Project

DOE officials reported at the INL CAB meeting February 23 that they plan to start to process of transferring the 220 cubic meters of calcine from the oldest bin set to a newer bin set. The

[24] See http://www.environmental-defense-institute.org/publications/EarthDayINLreport.pdf and http://www.environmental-defense-institute.org/publications/RWMCunrem.pdf

[25] Keith Ridler, AP, *The Idaho Falls Post Register*, "Tests planned on IWTU waste treatment component," December 30, 2016.

[26] Luke Ramseth, *The Idaho Falls Post Register*, "Fluor to be paid $6.9 M for 2016 work," January 14, 2017.

[27] See the Idaho National Laboratory Citizens Advisory Board meeting presentation February 23, 2007, for the Idaho Cleanup Project at inlcab.energy.gov

calcining of radioactive liquid waste at INL was conducted from 1963 to 2000, creating 4,400 cubic meters of calcine stored over the aquifer. [28] The liquid waste resulted from government spent nuclear fuel reprocessing to obtain enriched uranium to be used in government reactors for weapons production. The dry beads of calcine resemble laundry detergent and are stored in "bin sets" of various designs.

While there is no place to ship the calcine, the Idaho Settlement Agreement requires it to be road ready for shipment. The calcine, while less vulnerable to leakage from corrosion than liquid waste, is stored over the Snake River Plain aquifer and is vulnerable to seismic events and flooding. The bin sets have various levels of seismic vulnerability, depending on the particular design. The calcine is a highly soluble material containing an enormous inventory of radioactive material and the loss of confinement of this material would be an environmental disaster for Idaho and the aquifer. [29]

This repackaging of calcine is being held up by the tardiness of the IWTU project because its facility is to be repurposed for calcine repackaging. The currently proposed project would investigate how to transfer the calcine from bin set 1 into bin set 6 which is currently only about half full.

Then bin set 1 could be closed. The research would help the make progress in understanding what it must do to transfer bin set material and close an empty bin set. The work to repackage the calcine for transport out of Idaho would still remain to be completed.

How DOE Underestimates the Harm of Plutonium Inhalation

The inhalation of plutonium and americium-241 is often difficult to detect. Radiation workers at the Idaho National Laboratory, at the defense waste repository in New Mexico, WIPP or at other DOE nuclear facilities who have a suspected inhalation need to understand the risk of their inhalation dose being underestimated.

The worker suspected of an inhalation of plutonium may undergo a lung count to attempt to detect radioactivity in their lungs. This requires very special equipment and even so, plutonium cannot be detected. The amount of plutonium can only be inferred from the weak gamma from the americium-241 and the fraction of the material that is due to the americium.

[28] Reporter Luke Ramseth, Idaho Falls Post Register, "$50 M calcine retrieval project to start – Radioactive waste is stored in six concrete silos," February 24, 2017.

[29] See EDI's calcine storage vulnerability report from July 2016 at http://www.environmental-defense-institute.org/publications/EDICalcineComments.pdf

Three detectors are placed over the workers lungs and the number of counts of radioactive decays is made along with profiling the energy spectrum of the decays. One of the problems is that for a person with a large chest wall thickness, the shielding by their chest wall may reduce the number of detected counts by one third or one half, in comparison to a smaller sized person. [30]

Another problem is that when a mixture of radionuclides is inhaled, it is not known if the solubility of each radioisotope is the same. Americium-241 has been known to be more soluble than plutonium. If the americium-241 is more soluble and the plutonium stays in the lungs, the plutonium will not be detectable via a lung count.

Bioassay is the analysis of urine and fecal samples. Plutonium retained in the lungs may show up less in the urine. And while larger particles of plutonium may be cleared from the lungs up to the throat and into the digestive tract, small particles will move deeper into the lung.

So the composition of the radioactive material inhaled, the solubility of each radionuclide, and the particle sizes inhaled all play an important role in assessing the amount of material inhaled, the amount retained in the lung and the amount transported by blood and lymph to be stored in the liver, bone and various organs of the body, or excreted via urine or feces.

The accepted method of estimating a radiation worker's dose is to use the International Commission on Radiological Protection (ICRP) model. The idea was that if you knew the rate of urine excretion and material solubility, you could estimate the intake of radioactive material. Likewise, if you knew the rate of fecal excretion of the radioactive material, you could estimate the intake of radioactive material. The problem is that based on experience, the ICRP model does not properly predict the intake from either one. The analyst has practically infinite discretion as to how to use the ICRP model to estimate the dose. The analyst can produce any answer desired and still claim to be following the accepted ICRP model.

A French study points this out based on its study of two separate worker accidental intakes of plutonium. [31] These analysts concluded that the biokinetic behavior of plutonium chemical forms they witnessed was different than assumed by the ICRP model for solubility types S and M. They found that the ICRP model results could range from 10 millirem to 30,000 millirem in a specific case analyzed of a worker with an inhalation of plutonium. This means that the dose could be an insignificant dose of 10 mrem. Or it could be a very health significant dose, six times above the 5,000 mrem (or 5 rem) annual dose limit in the US for radiation workers. They found that the dose estimated by the accepted ICRP method could over 3000 times too low.

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[30] See PNNL-MA-574 Section 4.0 Figure 4.4 Efficiency Curve as a Function of CWT. 2010 version.

[31] Blanchin, N. et al., *Radioprotection*, "Assessing internal exposure in the absence of an appropriate model: two cases involving an incidental inhalation of transuranic elements," December 2008. DOI: https://doi.org/10.1051/radiopro:2008014 and see at http://www.iaea.org/inis/collection/NCLCollectionStore/_Public/43/004/43004048.pdf

The enormous uncertainty of the internal radiation dose estimates by officials at Department of Energy facilities cannot be overstated. For this reason, other methods of medical monitoring of workers exposed to plutonium intakes should be continued for many days or weeks following the intake. Blood monitoring of monocyte depletion and other characteristics of white and red blood cells need to be documented and tracked.

The contractors for the Department of Energy who may face stiff penalties for the worker's accidental inhalation of plutonium are also tasked with estimating the dose to the worker from the inhalation. This conflict of interest puts workers health in jeopardy. The subsequently low-balled radiation dose may also result in a denial of worker illness claims.

If the estimation of the lifetime radiation dose from the material inhaled and incorporated into the body were performed consistently and conservatively, the statement of estimated dose could be of some relative information. However, in the US, the contractor estimating the dose may make many non-conservative assumptions that lower the estimated dose.

At the INL, highly insoluble particles are not recognized even though it has been known for many years that highly insoluble particles, called Super S class, stay in the lungs far longer than S class. The ICRP model does not have Super S class, and therefore underestimates lung retention and lung dose.

At the INL, particle size may be assumed to be 5 um-AMAD. [32] But it is widely known that the actual particle size may be 1 um-AMAD oxide fuels at DOE facilities. [33] A higher dose results for the smaller particle size if the material is insoluble and the basis for INL's use of the particle size that lowers the estimated radiation dose needs to be supported by particle size analysis.

Table 1 gives a rough idea of the variation of the committed dose coefficients for an intake of a plutonium mixture at a weapons lab. The dose coefficient is used to estimate the total dose. The dose coefficient is highest for an intake directly into the blood. For dose to the bone, the dose from a moderately soluble mixture is about 5 times higher than the dose from a Class S solubility which more slowly enters the blood stream. The dose to the bone from a moderately soluble mixture is 16 times the dose of Super S solubility class. So, an assumption of moderate solubility would be conservative for all cases except those involving a very rapid intake such as a wound.

An assumed moderate solubility with 5 um particles in appropriately conservative unless the behavior is that of an instant uptake. But what INL has done is to assume the least conservative intake based on 5 um Class S while the material is very likely 1 um and may be Super Class S.

[32] 5 micro-meter activity median aerodynamic diameter, indicated here as 5-um-AMAD.

[33] John W. Gofman, MD, Radiation and Human Health, Sierra Club Books, 1981. p. 490 Gofman writes that when plutonium oxide is prepared for the purpose of making fuel rods, the particle sizes are in the 1-mircron range, perfectly suited for respiratory toxicity.

Table 1. Committed Dose Coefficients for Acute Intake of 20-Year Aged Weapons-grade mixture (rem/nanoCuries).

Source: PNNL-MA-860, Issued January 2003.[34]							
	Instant Uptake	Class M Inhalation		Class S Inhalation		Super S Class inhalation	
Organ or Tissue		1-um	5-um	1-um	5-um	1-um	5-um
Effective	3.8E+00	4.7E-01	4.8E-01	3.3E-01	1.4E-01	5.9E-01	2.2E-01
Bone	7.1E+01	8.5E+00	9.3E+00	3.3E+00	1.7E+00	9.6E-01	5.7E-01
Red Marrow	5.5E+00	6.6E-01	6.1E-01	2.6E-01	1.3E-01	7.4E-02	4.4E-02
Liver	1.3E+01	1.5E+00	1.6E+00	6.0E-01	3.0E-01	1.9E-01	1.1E-01
Lung	insig.	6.3E-02	2.3E-02	1.2E+00	4.2E-01	4.4E+00	1.6E+00
Gonads	1.0E+00	1.3E-01	1.4E-01	4.8E-02	2.9E-02	1.3E-02	8.5E-03

a. Dose coefficient in rem/nanoCuries. 1 nano Curie is 1.0E-9 curie. 1 Seivert is 100 rem. 1 becquerel is 1 disintegration per second. 3.7E10 bq = 1 curie.
b. Particle size of 1-um or 5-um where um is micro-meter activity median aerodynamic diameter.
c. Class M has previously been named Class W; Class S has previously been named Class Y.
d. The CDC recognizes Super Class S for energy worker illness compensation calculations. See cdc.gov.

High levels of insoluble uranium often accompany plutonium intakes. While official estimates of cancer risk for the uranium dismiss the cancer risk of the uranium intake, the heavy metal stress and ionizing radiation from the multiple uranium decays causes serious stress on the body. A final suggestion to radiation workers, especially those who may be exposed to plutonium or uranium inhalation: have your children before you become a radiation worker. The elevated risk of serious birth defects from ionizing radiation including internal alpha emitters is ignored by the Department of Energy but should not be ignored by workers, of either gender, who plan to become parents. The birth defects of children of people with depleted uranium intakes has been documented in Gulf War veterans and in regions contaminated with artillery-use depleted uranium. [35] [36]

[34] H. Carbaugh et al., Pacific Northwest National Laboratory, "Methods and Models of the Hanford Internal Dosimetry Program, PNNL-MA-860, PNNL-15614, 2003. http://www.pnl.gov/main/publications/external/technical_reports/PNNL-15614.pdf Table 8.14.

[35] Depleted Uranium Education Project, "Metal of Dishonor Depleted Uranium –How the Pentagon Radiates Soldiers and Civilians with DU Weapons," 1997.

[36] R. Bertell, *International Journal of Health Services*, "Depleted Uranium: All the Questions About DU and Gulf War Syndrome Are Not Yet Answered," 2006. https://ntp.niehs.nih.gov/ntp/roc/nominations/2012/publiccomm/bertellattachmentohw.pdf

Iodine-131 Calculator Back Online

The National Cancer Institute's nuclear weapons testing fallout Iodine-131 dose and risk calculator is up and running and available to the public after a several month absense. [37]

It does not include the historical iodine-131 releases from the Idaho National Laboratory. But in addition to radioactive fallout from the Nevada Test Site, the calculator now includes global weapons fallout from US weapons testing outside the continental US including the Marshall Islands, Johnston Island and other Pacific sites, and weapons testing by foreign countries including the former USSR, including Semipalatinsk, Kazakhstan and Novaya Zemlya, Russia, and other worldwide sites such as China.

According to the National Cancer Institute website, "between 1945 and 1980, the U.S., the U.S.S.R., the U.K., France and China carried out more than 500 atmospheric tests of nuclear weapons totaling the explosive equivalent of 440 megatons of TNT. These tests injected radioactive material into the atmosphere, much of which became widely dispersed before being deposited as fallout. Cancer investigators have been studying the health effects of radiation for decades, including radioactive fallout, making radiation one of the best-understood agents of environmental injury. The legacy of open-air nuclear weapons testing includes a small but significant increase in thyroid cancer, leukemia and certain solid tumors."

"The Nevada Test Site (NTS) in the U.S. was used for surface and above-ground nuclear testing from early 1951 through mid-1962. More than 100 tests were conducted at or above ground level and hundreds underground, with only about 14 of the latter resulting in significant releases of radioactive material into the atmosphere. Radioactive debris from the NTS tests subsequently was deposited, to varying degrees, over most of the continental U.S."

"Global fallout originated from high-yield weapons that derived much of their yield from fusion reactions. These tests, of what were called H-bombs or hydrogen bombs, were conducted by the U.S. in the mid-Pacific and by the Soviet Union at northern latitudes. Fallout from these large tests was distributed over the northern hemisphere."

"Fallout from the NTS and from global sources contributed exposures to persons living in the U.S. through ingestion of contaminated food products, primarily fresh milk, but also from external dose and from inhalation. The internal thyroid dose received by any individual depends largely on the individual's age at the time of each test, geographic location, and the types and amounts of fresh milk consumed. The principal radionuclide of concern for internal dose to the thyroid gland is Iodine-131 (I-131). There are many other radionuclides deposited in fallout though they primarily contribute to the thyroid dose from external exposure."

[37] National Cancer Institute, Division of Cancer Epidemiological and Genetics, Thyroid Dose and Risk Calculator for Nuclear Weapons Fallout for the US Population. February 2017. https://dceg.cancer.gov/about/organization/programs-ebp/reb/tools-iodine-131 or https://radiationcalculators.cancer.gov/fallout

"The NCI Fallout Calculator is a software tool to estimate the internal and external dose to thyroid gland from exposure to radioactive fallout and the subsequent risk of developing thyroid cancer for persons resident in the U.S. between 1951 and 1980." [38]

According to NCI's 1997 dose calculations, 3 Idaho counties (Custer, Gem, Blaine and Lemhi received the highest dose of 12 to 16 rads; Idaho county received 9 to 12 rads.]

One disappointment I have with the new I-131 calculator is that the name of the weapons test is no longer provided for the contribution to the dose in a particular county at a particular time. And there is no assistance for the use of international units for dose.

Articles unless otherwise noted are by Tami Thatcher, for March 2017.

[38] National Cancer Institute, About the I-131 Calculator: https://radiationcalculators.cancer.gov/fallout/about/