Environmental Defense Institute

News on Environmental Health and Safety Issues

June 2017 **Volume 28** **Number 6**

Method of Repackaging INL's Vulnerable Calcine was Selected as Hot Isostatic Pressing, But Independent Panel Prefers Vitrification

Most of the radioactive liquid High Level Waste at the Idaho National Laboratory was calcined into a fine powder said to resemble laundry detergent between 1963 and 1998. The calcine is stored in a variety of partially underground "bin sets" of various designs. The bin sets are vulnerable to seismic and flooding events but are less vulnerable to corrosion and leakage than liquid storage in tanks.

The Department of Energy had formally announced in 2009 the decision to use Hot Isostatic Pressing (HIP) as the method of repackaging the calcine for shipping and disposal. [1] The 2009 decision was actually amending previous decisions. Now it appears that the 2009 decision may be changed again because the Department of Energy recently issued a report by an independent review panel describing the possible treatment options for the calcine. [2]

The report expressed the view that HIP was a technical challenge and a better option might be some form of vitrification to create a stable waste form for shipment and disposal. Leaving the calcine in place was recognized as an environmental devastation over the Snake River Plain Aquifer although it was downplayed in the report as simply being "unacceptable to stakeholders."

Construction of the HIP process has not begun as efforts remain focused on attempting to get the Integrated Waste Treatment Unit (IWTU) operating to treat liquid sodium bearing waste. Once treated, the sodium bearing waste would be in a dry form that will require another special treatment for its packaging and disposal. The 1995 Idaho Settlement Agreement requires that the calcine be road ready by December 31, 2035.

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[1] Department of Energy Press Release, Amended Record of Decision: Idaho high-Level Waste Facilities Disposition Final Environmental Impact Statement REVISED BY STATE 12/21/09. http://www.id.doe.gov/NEWS/PressReleases/PR100104-HIP/Calcine%20ROD%20final_SIGNED_PDF.pdf In 2009 DOE had decided to select hot isostatic pressing (HIP) to treat the calcine.

[2] US DOE-EM, "Independent Analysis of Alternatives for Disposition of the Idaho Calcined High-Level Waste Inventory, Volume 1 – Summary Report," April 2016. https://energy.gov/sites/prod/files/2016/05/f31/Volume%201%20Calcine%20AoA%20Final%2004-19-16%20w_signatures.pdf

With the Yucca Mountain repository now designated for spent nuclear fuel from commercial power plants rather than DOE waste and with Yucca Mountain facing decades of court challenges, the repository for the calcine and dry sodium bearing waste has yet to be named. The Energy Department has expressed interest in disposing of INL and Hanford high level waste at the New Mexico Waste Isolation Pilot Plant (WIPP) even though currently these wastes are not accepted at WIPP.

Environmental Defense Institute submitted comments to the Idaho Department of Environmental Quality about the calcine. [3] [4] More background on the calcine can be found in other reports listed here. [5] Pressure continues to get Idaho to back down on treating the calcine — because there is no place to ship it. [6]

The INL's cleanup is leaving over 90 percent of the buried waste right where it is — over the Snake River Plain aquifer. The vacuum extraction of volatile organic compounds has reduced but not solved the aquifer chemical waste contamination problem.[7] There remains the continued failure to treat the liquid sodium bearing waste. Then a billion dollar HIP or vit calcine treatment facility needs to be built to make calcine road ready. And there is also the needed construction of a spent nuclear fuel repackaging facility to make the non-Navy SNF at INL road ready. Then there is the matter of "institutional controls" forever to prevent humans from entering the forever contamination sites at the INL that the cleanup is leaving behind.

Nuclear Lives in its own private Idaho amid questions about whether AP1000 nuclear plants will be scraped as INL pushing "JUMP" and "GAIN"

The Idaho National Laboratory continues to push for nuclear reactor research although President Trump's proposed nuclear research budget reduces nuclear energy research funding. Recently proposed cuts would slash Idaho National Laboratory workforce, reported *The Post*

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[3] Chuck Broscious and David B. McCoy, "Preliminary Comments on Calcined Solids Storage Facility," Submitted to Idaho Department of Environmental Quality, May 9, 2017. http://www.environmental-defense-institute.org/publications/EDI-CSSF-Permit-S.pdf and pictures at http://www.environmental-defense-institute.org/publications/EDI-CSSF-Attach.pdf

[4] Calcined Solids Storage Comment Submittal (Docket No. 10W-1604), by Chuck Broscious and Tami Thatcher, July 11, 2016. http://www.environmental-defense-institute.org/publications/EDICalcineComments.pdf

[5] J. V. Crum and J. D. Vienna, Pacific Northwest National Laboratory and D. K. Peeler and I. A. Reamer, Savannah River Technology Center, for the US Department of Energy, "Formulation Effects for Direct Vitrification of INEEL Blend Calcine Waste Simulate: Fiscal year 2000. http://www.pnl.gov/main/publications/external/technical_reports/PNNL-13483.pdf

[6] Bryan Clark, reporter, *The Idaho Falls Post Register*, "Another look at '95 Settlement Agreement – Grossenbacher: Second look could improve environmental protection," April 25, 2017.

[7] Department of Energy Idaho Operations Office, Five-Year Review of CERCLA Response Actions at the Idaho National Laboratory Site, Fiscal Years 2010-2014, DOE/ID-11513, December 2015.

Register May 24. [8] If the Office of Nuclear Energy budget is reduced, research and development on reactor concepts may be cut by $41 million (30 percent), and research on the nuclear fuel cycle by $161 million (65 percent). Other cuts would include $25 million for smart grid research (71 percent), $12 million for energy storage (60 percent) and $26 million for clear energy transmission (67 percent). The budget also proposes zeroing out small modular reactor licensing support. And it would cut bioenergy and renewable energy research at INL.

Research on the Trump's proposed budget also cuts clean renewable energy research funding from other laboratories. [9] Trump is also considering pulling out of the Paris climate accord and the US pledge to cap or reduce emissions of heat-trapping greenhouse gases. [10]

Meanwhile the Westinghouse bankruptcy has put the completion of four AP-1000 nuclear plants in the US in question because the plants are only about half finished. [11] How can the plants be completed if contractors doubt whether they will be paid?

And there are existing nuclear plants around the country, like Davis Besse in Ohio, seeking money from states to prop up these money losing nuclear plants.

INL's own initiative — the Joint Use Modular Plant, or JUMP is a joint proposal by INL, NuScale and Utah Associated Municipal Power Systems— hopes to make NuScale's small modular light water reactor more marketable. [12]

The INL also is pursuing advanced nuclear energy systems by delivering the Gateway for Accelerated Innovation in Nuclear (GAIN) initiative. [13] This is despite learning that the INL's material testing reactor, the Advanced Test Reactor, cannot provide a strong enough fast neutron spectrum to adequately irradiate test materials in a reasonable timeframe to support fast neutron reactor research.

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[8] Bryan Clark and Kevin Trevellyan, reporters, *The Idaho Falls Post Register*, "DOE cuts would slash INL workforce – If passed as is, INL could lose hundreds of jobs," May 24, 2017.

[9] Bryan Clark, reporter, *The Idaho Falls Post Register*, "Report: Trump proposes steep cuts for nuclear [energy research]," May 19, 2017.

[10] Josh Lederman and Catherine Lucey, AP, *The Idaho Falls Post Register*, "Trump weighs climate accord pullout – Under the Paris deal, the U.S. committed to cut emissions 26 to 28 percent by 2025," May 6, 2017.

[11] New York Times, May 2, 2017 https://www.nytimes.com/reuters/2017/05/02/world/asia/02reuters-toshiba-accounting-westinghouse-nuclear-insight.html?_r=0

[12] Kevin Trevellyan, reporter, *The Idaho Falls Post Register*, "Expanding possibilities – Small modular hybrid energy, additional reactors possible," April 25, 2017. The Nuclear Regulatory Commission accepted for a 40-month review in March 2017. It is slated to begin operation in 2026 at the INL..Each of up to 12 modules would produce roughly 50 megawatts.

[13] Post Register, *The Idaho Falls Post Register*, "ATR Complex named nuclear historic landmark," May 19, 2017.

Excavator slides into waste pit at INL days after tunnel collapses at Hanford

Incidents happened at both INL and Hanford last May but neither incident was reported to have exposed workers to excessive radiation levels. At INL, an excavator inside an Accelerated Retrieval Project (ARP) closure partially slid into a pit. The enclosure was ARP-8 located at the 97-acre subsurface disposal burial ground at the Radioactive Waste Management Complex at the INL. Fluor officials aren't sure yet what caused the pit face to slough.

Over a few years, the ground inside the enclosure would have dried out. My guess is the drier soil became less stable than soil with normal rain and snow fall.

The waste in the pit includes plutonium-laced sludges, graphite materials and filters. Not mentioned was the vast amounts of Americium-241, concentrated from purifying Rocky Flats plutonium that is also buried there.

As with the inability to know the amount of plutonium or americium in a barrel of waste at the February 2014 accident at WIPP, it is not feasible to know the amount of these wastes present in the pit or after retrieval because estimates of quantity are based on spot sampling yet the material is not evenly distributed in the waste. Records of the buried waste are known to be highly inaccurate.

Minute amounts of these alpha emitting wastes are a serious internal radiation hazard once inhaled or ingested. Even with modern equipment and controlled laboratory environment, an amercium-241 release at INL's Materials and Fuels Complex in 2014 that caused significant internal contamination events went undetected for over a month. Read our May 2016 newsletter article: "Three events show that the Idaho National Laboratory still doesn't know how to monitor airborne alpha contamination." [14]

The tunnel collapse at Hanford caused the soil to sink 2 to 4 feet over a 400-square-foot area. Hanford, located in Washington state 200 miles east of Seattle, is a highly contaminated 580-square-mile federal site where leaking tanks of liquid High Level Waste remain to be treated. The HLW resulted from from decades of plutonium production and fuel separations for producing nuclear weapons. Robert Alvarez, a former DOE official told *the Post* that "the tunnels now store contaminated train cars and a considerable amount of highly radioactive, ignitable wastes including possible organic vapors." [15] There are many opportunities for more serious radiological events at Hanford and at INL in addition to these recent events. And there remains the slow moving environmental catastrophe of the waste that will remain at these sites

[14] Environmental Defense Institute May 2016 newsletter: http://www.environmental-defense-institute.org/publications/News.16.May.pdf

[15] Harvey Wasserman, Progressive.org, "Tunnel Collapse at Hanford Nuclear Dump — Harbinger of the Collapse of the Entire Industry?" May 18, 2017. http://progressive.org/dispatches/tunnel-collapse-at-hanford-nuclear-dump-accelerates-the-coll/#.WRPOcPO7XXA.email

even if decades more of cleanup plans are completed. The amount of long-lived radioisotopes in the soil at Hanford rendered it ineligible for consideration of becoming a greater-than-class-C disposal area for the nation's nuclear GTCC wastes [16] because there's already more contamination poised to migrate than will meet drinking water standards in the future.

At INL's RWMC, of the 97 acres of subsurface disposal area that began accepting waste in 1952 and continues to accept waste, only about 6 acres of "targeted waste" will be retrieved. An estimated initial inventory is provided in Table 1. [17] The most mobile contaminants, such as technetium-99, iodine-129, and chlorine-36 are from INL wastes and remain poised to contaminate the aquifer because "targeted waste" includes only a portion of Rocky Flats waste and not INL wastes. These contaminants will exceed federal drinking water standards even though their curie inventory seems small. Other rather low curie amounts of radionuclides like uranium, plutonium and americium will cause seriously unhealthy drinking water for hundreds of thousands of years.

Downgradient of INL, the migrating buried waste will reach 100 mrem/yr unless the soil cap performance is perfect for millennia. But that is based on contrived modeling of soil "sorbing" factors that slow the migration of the waste into the aquifer and contrived mixing that maximizes dilution. [18] [19] "Fast paths" that can move relatively concentrated contamination to

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[16] Department of Energy, "Draft Environmental Impact Statement for the Disposal of Greater - Than-Class C GTCC) Low-Level Radioactive Waste and GTCC-like Waste," DOE/EIS-0375-D), February 2011. http://www.gtcceis.anl.gov/guide/gtccllw/index.cfm

[17] Tami Thatcher, "Important Long-Lived Contaminants at INL's RWMC Not Remediated," at http://www.environmental-defense-institute.org/publications/RWMCunrem.pdf

[18] Idaho National Laboratory, "Explanation of Significant Differences Between Models Used to Assess Groundwater Impacts for the Disposal of Greater-Than-Class C Low-Level Radioactive Waste and Greater-Than-Class-C-Like Waste Environmental Impact Statement (DOE/EIS-0375D) and the Environmental Assessment for the INL Remote-Handled Low-Level Waste Disposal Project (INL/EXT-10-19168)," INL/EXT-11-23102, August 2011. http://www.inl.gov/technicalpublications/documents/5144355.pdf and a report prepared for the US Department of Energy, DOE Idaho Operations Office, "Preliminary Review of Models, Assumptions, and Key Data Used in Performance Assessments and Composite Analysis at the Idaho National Laboratory," INL/EXT-09-16417, July 2009. See p. 11, Tables 3 and 4 for sorption coefficients.

[19] See that the publically available administrative record for RWMC cleanup does not contain the assessment of radionuclide migration and radioactive doses after 10,000 years. The pre-10,000 year contaminant migration is artificially suppressed for the first 10,000 years and then rapidly escalates and stays elevated for hundreds of thousands of years. See the Administrative Record at Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) documents for documents associated with this cleanup action, including "Record of Decision" documents and EPA mandated Five-year Reviews at http://ar.inel.gov or http://ar.icp.doe.gov

Table 1. Radionuclide and chemical contaminants at RWMC for 1000 year and 10,000 year groundwater ingestion peak risk estimates and groundwater concentrations, unremediated.

Radionuclide (half life)	Inventory	Source[a]	Peak Risk	Calendar Year	Peak Aquifer Concentration (Percent of MCL)	Maximum Contaminant Level
Am-241 (432 yr)	243,000 Ci	RFP	3E-3[b]	3010	6.8E-8 (< 1 percent)	15 pCi/L
C-14 (5,730 yr)	731 Ci	INL	1E-5	2133	186 **9.3 percent**	2000 pCi/L
Cl-36 (301,000 yr)	1.66 Ci	INL	2E-6	2395	21.2 3 percent	700 pCi/L
I-129 (17,000,000 yr)	0.188 Ci	INL	4E-5	2111	13.1 **1310 percent**	1 pCi/L
Tc-99 (2213,000 yr)	42.3 Ci	INL	3E-4	2111	2710 **301 percent**	900 pCi/L
Np-237 (2,144,000 yr)	0.141 Ci	INL	1E-4	12000	86.8 **579 percent**	15 pCi/L[c]
U-238 (4,470,000,000 yr)	148 Ci	RFP[f]	9E-5	12000	47.1 **472 percent**	1.01E1 pCi/L[d]
Total Uranium[c]			NA	12000	1.44E-1mg/L **480 percent**	3.00E-2 mg/L[e]
Carbon Tetrachloride	7.9E8 g	RFP	5E-4	2133	3.07E-1 mg/L **6140 percent**	5.0E-3 mg/L
1,4-Dioxane	1.87E6 g 4.24E4 g	RFP INL	2E-5	2111	1.69E-01 mg/L **5633 percent**	3E-3 mg/L
Methylene chloride	1.41E7 g	RFP	5E6	2245	5.85E-2 mg/L **1170 percent**	5E-3 mg/L
Nitrate	4.06E8 g 4.97E7 g	RFP INL	(Hazard index 1)	2094	66.7 mg/L **667 percent**	10 mg/L
Tetrachloroethylene	9.87E7 g	RFP	7E-7	2145	6.64E-2 mg/L **1328 percent**	5.0E-3 mg/L
Trichloroethylene	8.92E7 g	RFP	9E-4	2130	3.8E-2 mg/L **760 percent**	5.0E-3 mg/L

Sources: DOE/ID-11241 sections 4 and 7.
a. Rocky Flats Plant (RFP); Idaho National Laboratory (INL)
b. The peak risk for Americium-241 is due to external exposure, soil ingestion, inhalation and crop ingestion. The risk for the other contaminants is primarily groundwater pathways.
c. The limit is 15 pCi/L for total alpha (40 CFR 141).
d. The limit is 3.0E-2 mg/L (30 microgram/L) for total uranium. To compare concentrations of uranium isotopes, 3E-2 mg/L is converted to the equivalent activity for each isotope.
e. Total uranium is presented for comparison to the maximum contaminant limit.
f. Table 4-4 of the RI/BRA shows that most of the U-238 waste is from Rocky Flats. Of this, 24.9 curies of U-238 was placed on pad A which is not currently planned to be removed.

downgradient wells are ignored. [20] And more long-lived radioactive waste is being buried at the INL. [21]

The DOE's report summarizing the "forever contamination" at RWMC was never disclosed to the public prior to EDI's freedom of information act request. [22] A figure from the DOE's report showing the rising radiation doses largely from migration of contaminants to the aquifer is shown figure below depicting the 100 mrem/yr case without credit for the soil cap slowing migration of contaminants to the aquifer.

In the short term, less than 1000 years, the ingestion dose from drinking water near RWMC due to migration of radionuclides buried at RWMC to the aquifer is primary due to carbon-14, chlorine-36, iodine-129, and technetium-99. In the longer term, americium-241 is the predominant contributor to dose as well as various uranium and plutonium isotopes. The figure does not show the chemical contamination at RWMC which already exceeds federal MCL drinking water standards.

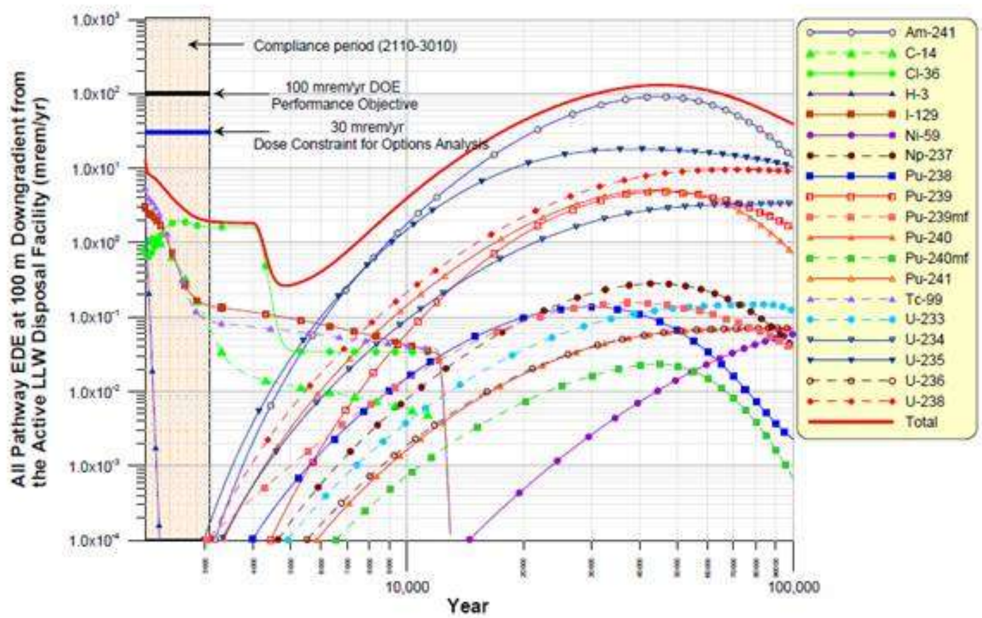

Figure 4-2. All-pathways effective dose equivalent 100 m downgradient from the Radioactive Waste Management Complex boundary from year 2110 to year 100,000 with cover infiltration rate equal to 1 cm/year.

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[20] Johnson TM et al., Geology, "Groundwater "fast paths" in the Snake River Plain aquifer: Radiogenic isotope ratios as natural groundwater tracers," v. 28; no. 10; p. 871-874, October 2000.

[21] US Department of Energy, "Environmental Assessment for the Replacement Capability for Disposal of Remote-Handled Low-Level Radioactive Waste Generated at the Department of Energy's Idaho Site," Final, DOE/EA-1793, December 2011. http://energy.gov/sites/prod/files/EA-1793-FEA-2011.pdf

[22] 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. See https://www.inl.gov/about-inl/general-information/doe-public-reading-room/

NIOSH Contractor Reviews Historical Burial Grounds Worker Radiation Monitoring — Why So Wrong For So Long?

A recent review was conducted that found that the NIOSH presumption that radiation monitoring was adequate at the INL's burial grounds prior to about 1970 found the opposite: radiation monitoring of workers at the burial grounds was inadequate and radiation dose reconstruction cannot be adequately conducted. Under the Energy workers compensation act of 2000, radiation dose reconstruction is used to determine eligibility for compensation if the worker has been diagnosed with one of twenty-two cancers. [23]

Decades after many workers were exposed to radiation, most — about two-thirds — of Idaho National Laboratory worker compensation claims have been denied for either radiation or chemical exposure claims. [24] Only in recent years has NIOSH determined that alpha monitoring was inadequate at some INL facilities. This has led to designating a few INL special exposure cohorts (SECs) that provide compensation without requiring a radiation dose estimate to determine eligibility. The recently added special exposure cohorts are described in the April 2017 EDI newsletter. [25] The radiation dose estimation process largely relies on the adequacy of radiation records and bioassay (urine and fecal monitoring) that is found for the employee. Record destruction and falsification is frequently discussed in public testimony at NIOSH meetings. The destruction of 602 boxes of documents identified by the Center for Disease Control's National Center for Environmental Health (NCEH) was admitted by INEEL/Lockheed Martin in December 1998.

Another petition has qualified for review involving INTEC, formerly "the chemical plant" between 1975 and 1980. [26]

Details regarding the May 1, 2017 SC&A contractor review of the INL's burial ground can be found on the NIOSH website. [27]

The CDC's NIOSH said dose reconstruction could be done (see 6th page) because "NIOSH's ER basis for deeming dose reconstruction feasible for Burial Ground workers is the availability of "procedural information" and the "data on-hand," from which NIOSH finds that it has "adequate monitoring data" to estimate dose, with sufficient accuracy, from exposure to both

[23] 42 USC 7384, The Act--Energy Employees Occupational Illness Compensation Program Act of 2000 (EEOICPA), as Amended and see the website for the Center for Disease Control, National Institute of Occupational Safety and Health, Division of Compensation Analysis and Support at http://www.cdc.gov/niosh/ocas/ and U.S. Department of Labor, Office of Workers' Compensation Programs, EEIOCPA Program Statistics, http://www.dol.gov/owcp/energy/regs/compliance/weeklystats.htm

[24] See the NIOSH Radiation Dose Reconstruction Program at http://www.cdc.gov/niosh/ocas. See the Idaho National Laboratory status at http://www.cdc.gov/niosh/ocas/ineel.html and see the portion of INL formerly ANL-W at http://www.cdc.gov/niosh/ocas/anlw.html

[25] Environmental Defense Institute April 2017 newsletter: http://www.environmental-defense-institute.org/publications/News.17.April.pdf

[26] https://www.cdc.gov/niosh/ocas/pdfs/sec/inl/fr041317-238.pdf

[27] See 2017 SC&A burial ground review at https://www.cdc.gov/niosh/ocas/pdfs/abrwh/scarpts/inlburgnd-r0.pdf

internal fission product and “other radionuclides” (most notably, plutonium). In conjunction with these findings, the ER emphasizes the programmatic strength of the prevailing radiological control program at the Burial Ground in 1952–1970 (NIOSH 2017)”

But, regarding radiation dose reconstruction at the burial grounds now called the Radioactive Waste Management Complex the review by SC&A found that radiation dose reconstruction would not be feasible.

“. . . SC&A finds that the Burial Ground (1) was considered a low priority by INL Management and was so underfunded that needed health physics smear instrumentation was lacking; (2) apparently lacked a management culture that supported disciplined operations and a formality of radiological controls to minimize unnecessary contamination; (3) dealt with high-exposure MFPs and transuranics that were often unidentified as to specific isotopic content, activity levels, and physical form and quantity ; (4) lacked adequate alpha monitoring capability; and (5) lacked adequate bioassay and occupational air sampling responsive to Burial Ground contamination. From worker interviews, radiological incidents, and photographs of dumping operations, it is clear that an exposure potential existed for waste handlers, and that personal contamination was experienced during both waste handling and cleanup.”

“It is also clear that airborne contamination may not have been detected and necessary bioassay followup would not have occurred given the lack of alpha monitoring, lack of both routine and special bioassay monitoring, limited workplace air monitoring, and the apparent lack of smear counting instrumentation during certain time periods.”

“From a sampling review of NOCTS claimants, there does not likewise appear to be any clear means or evidence that even places an individual worker at the Burial Ground for specific periods of time—it was typically a collateral task among many such assignments for workers at CFA.”

Just a few years ago, NIOSH was visiting Idaho Falls emphasizing how well the radiation programs at INL were controlled and how doses for workers were carefully monitored and recorded. All the issues raised about INL radiation exposures had been high glossed away.

Then a petition was submitted asking NIOSH to take a closer look at alpha monitoring, particularly before about 1970. The result has been revelations that have produced a slow trickle of the creation of Special Exposure Cohorts for some years and facilities at the INL (including ANL-W)

Now, finally NOISH have added several Special Cohort Petitions (SECs) for the early years at INL (and ANL-W). And contractor reviews are continuing. But many more years and many facilities at INL (and ANL-W) should be found to need SECs. The CDC has already found that releases at Test Area North have been found larger than DOE estimated. Alpha monitoring at Test Area North, Test Reactor Area, the Burial Ground, and the reactor areas near SL-1 and Power Burst facility should also find inadequate alpha monitoring in addition to the Chemical Processing Plant now called INTEC.

Someone should be asking NIOSH why they got it so wrong for so long? And more importantly, how long is it going to take to find the truth of inadequate radiation protection at other INL facilities?

Advanced Test Reactor Anniversary of 50 Years of Operation — And A Look At Recent Occurrence Reports

The Advanced Test Reactor began operation in 1967 and was recently named a nuclear historic landmark. [28] Photos were taken and there is reason to take pride in the achievements of running this reactor for materials testing for the US Navy, commercial users and other nations.

However, few people know of the problems that are not shared in the local newspaper. The safety systems like the firewater coolant injection system that was deliberately not adequately tested for decades; the firewater system lawn irrigation interconnections that were lied about and not depicted on plant drawings so that safety systems could ignore more non-safety loads; the building confinement leakrate tests that were altered by incidentally wiring a fan to keep running which reduced the apparent leak rate; the Department of Energy's steadfast insistence to avoid seismic upgrades—the list could go on and on.

For safety, this reactor needs to be able to shutdown by inserting control rods and safety cool down, which in an emergency would require deep well pumps and the emergency firewater system. Fuel storage canal water level must also be maintained. Safety requires power supplies, and in an emergency, battery-backed power supplies. [29]

So, the numerous occurrence reports of failure of scram actuation systems, failure of control rods to insert, failure of emergency firewater injection systems, failure of deepwell pumps, and failures, numerous battery backup system failures should be a concern.

A recent battery upgrade was completed without the design process having properly accounting for important safety equipment that needed to be kept running. Recent occurrence reports detail in three separate event reports the inability to properly maintain battery liquid levels needed for batteries to operate. [30]

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[28] Post Register, *The Idaho Falls Post Register*, "ATR Complex named nuclear historic landmark," May 19, 2017.

[29] Department of Energy Occurrence Reports for the Advanced Test Reactor: Plant Protection Systems NE-ID—BEA-ATR-2016-0001, -0009 and NE-ID—BEA-ATR-2017-0005; safety rod scram NE-ID—BEA-ATR-2016-0015 and NE-ID—BEA-ATR-2017-0004; Canal level NE-ID—BEA-ATR-2016-0039, diesel generators NE-ID—BEA-ATR-2016-0020 and NE-ID—BEA-ATR-2017-0018, firewater pumps NE-ID—BEA-ATR-2016-0002 and -0011, -0028, -0033 and NE-ID—BEA-ATR-2017-0016 and -0020; deepwell pumps NE-ID—BEA-ATR-2016-0003.

[30] Department of Energy Occurrence Reports for the Advanced Test Reactor relating to battery backed power equipment degradation issues NE-ID—BEA-ATR-2017-0001, 0002, 0005, 0013, 0015, and NE-ID—BEA-2016-0009.

And in a very interesting radiological contamination occurrence not due to "legacy" issues but due to recent actions, years after a highly touted improvement to use a lined evaporation pond instead of percolation ponds, air borne contamination levels from the pond were found so elevated that the contractor had to admit that radionuclides were being sent to the open air pond that the pond was not designed for. [31]

This is after years ago the Advanced Test Reactor stopped reporting the tritium levels released by the facility, requiring some estimates to be made by those "making up" the air emissions reports.

Let's hope and pray that our luck does not run out. This reactor could release about one billion curies into the Idaho skies and/or aquifer should a severe accident happen.

DOE-ID Operational Summaries are posted online, albeit late and the final Occurrence Reports can be found in a database in the Department of Energy's Dashboard. [32] [33]

Pyroprocessing of EBR-II Spent Nuclear Fuel – Decades to Process One-fifth of EBR-II Fuel

The electrorefining or pyroprocessing of spent[34] Experimental Breeder Reactor II (EBR-II) blanket and driver fuel is still underway at the Materials and Fuels Complex.

Jungmin Kang and Frank von Hippel has written about South Korea's sodium-cooled fast neutron reactor and pyroprocessing plans. Their view is that S. Korea's estimated reductions in spent nuclear fuel repository volume and toxicity will not be realized. And their view is that the costs of the program will be many billions of dollars higher than current estimates state.

A description of pyroprocessing from 1995 [35] points to no significant known advantages compared to chemical SNF reprocessing with PUREX in terms of volume of wastes produced and costs. Pyroprocessing is done on a small scale and cost savings are not expected when numerous facilities are built. The complexity of the materials and processes do not point the way to larger batch processing.

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[31] Department of Energy Occurrence Report NE-ID—BEA-ATR-2016-0014.

[32] DOE-ID Operations Summaries, http://www.id.doe.gov/NEWS/OperationsSummarys.htm retrieved May 25, 2017, with no report of events since August 2016.

[33] Department of Energy Final Public Occurrence Reports as of May 2017. See https://energy.gov/ehss/policy-guidance-reports/dashboards

[34] Jungmin Kang and Frank von Hippel, *Bulletin of the Atomic Scientists*, "Reprocessing policy and South Korea's new government," May 15, 2017.

[35] National Research Council, *An Assessment of continued R&D into an Electrometallurgical Approach for Treating DOE Spent Nuclear Fuel*, 1995. DOI:https://doi.org/10.17226/9272. https://www.nap.edu/catalog/9272/an-assessment-of-continued-r-d-into-an-electrometallurgical-approach-for-treating-doe-spent-nuclear-fuel

Pyroprocessing treatment of EBR-II fuel and FFTF fuel from the Hanford Fast Flux Test Facility is described in an undated conference paper. [36] According to a 2013 paper, (since 1995) 4.7 metric tons of EBR-II fuel have been treated of the original 25.75 MT inventory. [37] Fuel from Hanford's Fast Flux Test Facility, about 213 kg, has been processed. [38]

Articles are by Tami Thatcher, for June 2017.

[36] R.W. Benedict, H.F. McFarlane, K.M. Goff, *Electrometallurgical Treatment of Sodium-Bonded Spent Nuclear Fuel*, (cerca 2000). http://www.iaea.org/inis/collection/NCLCollectionStore/_Public/33/048/33048049.pdf

[37] M.F. Simpson et al., *Global 2013 Salt Lake City, Utah*, "Management of Salt Waste from Electrochemical Processing of Used Nuclear Fuel," 2013. https://inldigitallibrary.inl.gov/sites/STI/STI/5871986.pdf

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