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Department of Energy Says It Remains Committed to Consent-based Siting of Nuclear Waste

Nuclear industry champions don't miss a beat to downplay the spent nuclear fuel storage and disposal problem, but strategies that involve changing the subject aren't enough. The litigation that forced the US Nuclear Regulatory Commission to complete its review of the stymied Yucca Mountain repository did not culminate in the hoped for permit to construct the facility because of adamant state opposition and the lack of necessary land and water rights.

So, the US Department of Energy went back to the drawing board, and held meetings around the country this year to obtain public comment on what a consent-based approach [1] for waste storage siting might entail. A consent-based approach was recommended in the 2012 Blue Ribbon Commission report. [2] The DOE's strategy is to build one or several pilot interim storage, consolidated interim storage and permanent disposal facilities for its spent nuclear fuel. [3]

The DOE wants to loosen laws that were intended to curb the tendency to kick the canister down the road. Current laws prohibit building interim storage facilities unless the license to construct a permanent repository has been obtained. [4]

On September 15, the department held a meeting in Washington, DC to briefly summarize the more than 10,000 comments received from the public. [5] They plan to draft a consent-based process for public comment.

The majority of spent nuclear fuel in the United States is from commercial electricity generation at nuclear power plants, enough for two Yucca Mountain repositories. [6] [7]

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[1] See information about the Department of Energy's consent-based siting at www.energy.gov/consentbasedsiting and its Integrated Waste Management and Consent-based Siting booklet at http://energy.gov/ne/downloads/integrated-waste-management-and-consent-based-siting-booklet and http://www.energy.gov/ne/consent-based-approach

[2] Blue Ribbon Commission on America's Nuclear Future, Report to the Secretary of Energy, January 2012. http://energy.gov/sites/prod/files/2013/04/f0/brc_finalreport_jan2012.pdf.

[3] Department of Energy Strategy for the Management and Disposal of Used Nuclear Fuel and High-Level Radioactive Waste, January 2013. p. http://energy.gov/em/downloads/strategy-management-and-disposal-used-nuclear-fuel-and-high-level-radioactive-waste

[4] Nuclear Waste Policy Act currently prohibits construction of an interim storage facility unless the construction license for a permanent repository has been obtained. http://energy.gov/sites/prod/files/2013%201-15%20Nuclear_Waste_Report.pdf

[5] Department of Energy at http://www.energy.gov/ne/downloads/consent-based-siting-summary-public-input-meeting

The rest of the spent nuclear fuel is from DOE research and defense reactors, including Naval spent fuel from nuclear submarines and carriers that is stored in Idaho. The DOE's high-level waste is in various forms ranging from liquid waste at Hanford awaiting vitrification, **highly soluble powder-like calcine at Idaho** [8] [9] [10] [11] and vitrified waste at other sites.

The proposed "pilot" interim storage facility could help the Energy Department cope with its most pressing legal liabilities, [12] but could make it easier for the federal government to weasel out of the 1995 settlement agreement [13] stipulating that Naval spent nuclear fuel stored in Idaho be among the first fuel shipped to an interim facility.

There are many reasons for a viewpoint expressed prevalently at the Boise meeting that there is **a lack of public trust [14] in the Department of Energy**. The department has long assured communities that rigorous monitoring was being conducted and that its practices were not harmful, all the while creating a multitude of Superfund sites around the country including at the Idaho National Laboratory. [15]

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[6] As of 2013, there were 70,000 metric tons www.eia.gov/todayinenergy/detail.cfm?id=24052 of uranium from spent nuclear fuel, enough to fill the stymied Yucca Mountain repository. (see http://www.yuccamountain.org/pdf/final3_eis.pdf) The inventory is expected to roughly double (see http://www.gao.gov/products/GAO-12-797) as the existing fleet of US nuclear reactors operates for its expected life.

[7] See Yucca Mountain Environmental Impact Statement, DOE/EIS-0250F-S1.

[8] See the Leadership in Nuclear Energy Commission reports and the 2013 report at LINE Exec Summary: http://gov.idaho.gov/mediacenter/press/pr2015/pdf/LINE%20Exec%20Summary.pdf The LINE commission report narrative downplays the hazards posed and the lack of a designated repository for permanent disposal of calcine, arguing instead for the State of Idaho to ignore the calcine, delay repackaging and forget about the 1995 Idaho Settlement Agreement. Specifically, the 2013 LINE report states: "Thus, the state should be open to alternative approaches for the calcine; this could include the possibility of keeping the calcine in its current, safe storage configuration so long as any change in plans brought commensurate value to the state of Idaho, such as redirecting the funds saved to other INL [research] projects."

[9] Department of Energy Idaho Operations Office, INEEL/EXT-02-01548, "Structural Integrity Program for the Calcined Solids Storage Facilities at the Idaho Nuclear Technology and Engineering Center," May 2003. Find it at https://inldigitallibrary.inl.gov

[10] Department of Energy Idaho Operations Office, WINCO-1192, "ICPP Tank Farm System Analysis," January 1994. Find it at https://inldigitallibrary.inl.gov

[11] See Environmental Defense Institute's comments regarding the Idaho National Laboratory's calcine at http://www.environmental-defense-institute.org/publications/EDICalcineComments.pdf

[12] 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.

[13] 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.

[14] Environmental Defense Institute, "Submittal of Public Comment on the Department of Energy's Consent-based Approach for Siting Storage for the Nation's Nuclear Waste," July 31, 2016, http://www.environmental-defense-institute.org/publications/EDIXConsentFinal.pdf

[15] 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/

The department also assured workers that they were being protected but shortened many lives with chemical and radiation exposure. [16]

Opening a permanent repository remains more elusive today than when it was first recommended in 1957, despite the Department of Energy's statement [17] that "many locations around the country offer potentially suitable geological conditions for a disposal repository."

Continuing to repackage waste forever will be an enormous burden—and the failure to repackage nuclear waste in new dry-storage containment systems as old ones degrade would unleash a devastating amount of toxic, carcinogenic, and mutagenic material to the environment. Geologic disposal has not been shown to provide isolation of radioactive waste for the time frame that the waste remains toxic. [18]

The DOE has continued to tout deep bedrock boreholes as a potential option for high-level waste disposal, including calcine waste stored in seismically vulnerable bins over our aquifer in Idaho. **Both states slated for borehole research—North and South Dakota—adamantly refused to allow the research to be conducted, fearing it would lead to nuclear waste disposal in their states. [19]**

Epidemiology continues to find elevated cancer risk in radiation workers [20] and medically exposed children and adults and at doses far below 10 rem. The Energy Department and NRC have so far refused to tighten worker radiation protection standards or to admit that public health radiation protection standards are inadequate, especially regarding beginning-of-life exposure. [21]

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[16] 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, EEIOCPA Program Statistics, http://www.dol.gov/owcp/energy/regs/compliance/weeklystats.htm

[17] Department of Energy's consent-based siting booklet at http://energy.gov/ne/downloads/integrated-waste-management-and-consent-based-siting-booklet

[18] The prediction of contaminant migration involves estimating what fraction of the waste will migrate, how quickly the waste would reach watersheds, and what concentration of contaminants people might ingest annually. So far, waste migration predictions haven't been able to correctly predict migration for even relatively short time spans of a few decades. Because the spent nuclear fuel contains radionuclides that will not decay away for thousands of years, predictions involve geologic time frames and are speculative, highly uncertain and not protective of human health or the environment.

[19] Stopping the proposed deep borehole research in 2016 is discussed in many articles, for example: http://www.exchangemonitor.com/publication/exchange-monitor/doe-axes-north-dakota-borehole-project-2/ and http://fukuleaks.org/nonukesSD/2016/04/28/south-dakota-borehole-field-test-c_ould-contaminate-local-water/

[20] Richardson, David B., et al., "Risk of cancer from occupational exposure to ionizing radiation: retrospective cohort study of workers in France, the United Kingdom, and the United States (INWORKS), BMJ, v. 351 (October 15, 2015), at http://www.bmj.com/content/351/bmj.h5359 Richardson et al 2015

[21] "Health Risks from Exposure to Low Levels of Ionizing Radiation BEIR VII – Phase 2, The National Academies Press, 2006, http://www.nap.edu/catalog.php?record_id=11340 The BEIR VII report reaffirmed the conclusion of the prior report that every exposure to radiation produces a corresponding increase in cancer risk. The BEIR VII report found increased sensitivity to radiation in children and women. Cancer risk incidence figures for solid tumors for women are about double those for men. And the same radiation in the first year of life for boys produces three to four times the cancer risk as exposure between the ages of 20 and 50. Female infants have almost double the risk as male infants. Neither the DOE or NRC has acted on this information.

The two most important criteria for establishing the safety of nuclear waste disposal are the prediction of migration of radionuclides from a repository, and human radiation protection standards. But neither of these pillars rests on firm scientific bedrock.

Idaho remains the de facto storage site for roughly 325 metric tons uranium [22] of SNF and high level waste **including seismically vulnerable calcine**. Despite the Idaho Settlement Agreement that has scheduled dates for removal of the SNF and calcine from Idaho, there is no place for this waste to go.

Idaho's leaders, including Gov. Butch Otter, Senator Mike Crapo, and Idaho Falls Mayor Rebecca Casper, giddy over the prospect of creating more nuclear waste in Idaho by building reactors over the aquifer, need to sooner, rather than later, require repackaging the high-level waste calcine to a less vulnerable configuration. These leaders may never admit that these new welfare recipient reactors will come too late to make a dent in climate change.

Idahoans must not be fooled by the illusion of progress that obtaining interim storage may offer, as the problem of finding permanent disposal for the nation's spent nuclear fuel and high-level waste remains unsolved.

A Brief Primer on Epidemiology and Radiation-Induced Cancer Rate

Because of the prevalence of outdated information coming from industry experts who should know better, everyone, especially radiation workers, should read the epidemiology for themselves.

Fact 1: The cancer risk is not reduced when radiation doses are received in small increments, as the nuclear industry has long assumed. [23]

Fact 2: Despite the repeated refrain that the harm from doses below 10 rem cannot be discerned, multiple and diverse studies from human epidemiology continue to find elevated cancer risks below 10 rem and from low-dose-rate exposure. [24]

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[22] US Nuclear Waste Technical Review Board at DOE Nuclear Spent Fuel Fact Sheet, March 2016 http://www.nwtrb.gov/facts/DOE_SNF.pdf

[23] Richardson, David B., et al., "Risk of cancer from occupational exposure to ionizing radiation: retrospective cohort study of workers in France, the United Kingdom, and the United States (INWORKS), BMJ, v. 351 (October 15, 2015), at http://www.bmj.com/content/351/bmj.h5359 Richardson et al 2015 This cohort study included 308,297 workers in the nuclear industry.

[24] US EPA 2015 http://www.regulations.gov/#!documentDetail;D=NRC-2015-0057-0436 . For important low-dose radiation epidemiology see also John W. Goffman M.D., Ph.D. book and online summary of low dose human epidemiology in "Radiation-Induced Cancer from Low-Dose Exposure: An Independent Analysis," Committee for Nuclear Responsibility, Inc., 1990, http://www.ratical.org/radiation/CNR/RIC/chp21.txt And see EDI's April 2016 newsletter for Ian Goddard's summary and listing of important human epidemiology concerning low dose radiation exposure.

Fact 3: The full gamut of radiation risks are often downplayed and might be obscured as one reads studies that focus solely on the risk of solid cancers. The risk of leukemia, other adverse health effects such as heart disease and sterility and transgenerational effects must be kept in mind. [25]

Fact 4: Pretending that doubling natural background radiation levels with man-made radiation from medical and other exposures is benign is not supported by epidemiology. Human epidemiology indicates that elevated levels of background radiation causes an increased risk of cancer, see this study of over 2 million children in Switzerland. [26]

Fact 5: The focus on adults, mostly men, and their cancer rates often leave out the significantly increased risk of harm from the same dose to children or fetus/embryo. Radiation standards allowing even an additional 100 mrem/yr do not protect adults and are even more harmful for children. [27]

Even low-dose-rate exposures are harmful. For more than a decade there has been compelling evidence that chronic low dose radiation exposure is not less harmful than a single acute exposure, [28] [29] yet the radiation worker dose estimates performed in the US continue to ignore the science. The model used by the Department of Energy and the Nuclear Regulatory Commission is the International Commission on Radiological Protection (ICRP) model and it unjustifiably continues to divide the harm of a low-dose rate exposure by 2.

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[25] Munira Kadhim et al., "Non-targeted effects of ionizing radiation – implications for low dose risk," Mutation Research, Volume 752, Issue 2, April-June 2013, p. 84-98, http://www.ncbi.nlm.nih.gov/pmc/articles/PMC4091999/

[26] Ben d. Spycher et al., "Background Ionizing Radiation and the Risk of Childhood Cancer: A Census-Based Nationwide Cohort Study," Environmental Health Perspectives, 2014, http://dx.doi.org/10.1289/ehp.1408549 or http://ehp.niehs.nih.gov/wp-content/uploads/advpub/2015/2/ehp.1408548.acco.pdf Using detailed background radiation level maps that included natural and manmade background, this study of 2,093,660 children found elevated cancer hazard ratios for each added milliSievert (100 mrem) as follows: 1.03 for any cancer; 1.04 for leukemia; 1.04 tumor of the central nervous system. This might seem small, but if exposed to 100 mrem extra each year for 10 years, the 3 percent excess risk would increase 10-fold to 30 percent excess risk. This is an extraordinary finding because we've been told for years by the NRC and the DOE to consider any dose on the order of background levels (300 mrem/yr) as benign. These agencies often posture as if radiation worker limits of 5 rem per year, would be benign.

[27] "Health Risks from Exposure to Low Levels of Ionizing Radiation BEIR VII – Phase 2, The National Academies Press, 2006, http://www.nap.edu/catalog.php?record_id=11340 The BEIR VII report reaffirmed the conclusion of the prior report that every exposure to radiation produces a corresponding increase in cancer risk. The BEIR VII report found increased sensitivity to radiation in children and women. Cancer risk incidence figures for solid tumors for women are about double those for men. And the same radiation in the first year of life for boys produces three to four times the cancer risk as exposure between the ages of 20 and 50. Female infants have almost double the risk as male infants. Neither the DOE or NRC has acted on this information.

[28] Gilbert, Ethel S. "Ionizing Radiation and Cancer Risks: What Have We Learned From Epidemiology?" *International journal of radiation biology* 85.6 (2009): 467–482. *PMC*. Web. 12 Sept. 2016. http://doi.org/10.1080/09553000902883836 While Ethel seems very reluctant to observe adverse health effects at low doses, even she admits that dividing low-dose-rate exposures by 2 isn't justified. This is also an informative article about general epidemiology relative risk and excess risk definitions.

[29] Jacob, P et al., "Is cancer risk of radiation workers larger than expected?" *Occupational Environmental Medicine*, 2009;66:789-796, doi:10.1136/oem.2008.043265 http://oem.bmj.com/content/66/12/789.full.pdf

Dividing the harm by 2 or by 1.5 as assumed in the 2006 Biological Effects of Ionizing Radiation VII, known as the BEIR-VII report, was based on animal and other radiobiological studies but not on human epidemiology. Human epidemiology of low-dose rate and low to moderate total dose continues to provide evidence that the harm is not less than when the radiation dose is received in one acute dose (within 1 hour). Multiple and diverse human epidemiologic studies do not support dividing the harm at all—in fact if anything it would appear to be increased.

So a radiation worker can expect that their dose is twice what their employer tells them. But on top of that, if the worker is a woman, the harm from a given dose is actually about twice as harmful than the same dose to a man—a woman is twice as vulnerable to radiation-induced cancer. [30]

Industry is Ignoring the Epidemiology. Given that the nuclear worker's employers are ignoring the growing body of epidemiological evidence in adults and children, including this 2015 study of thousands of radiation workers, [31] it would behoove people to read up on the epidemiology studies. One of the barriers to reading these studies is the use of international units in these studies, the sievert (Sv) and gray (Gy), while US radiation workers are more familiar with rem and rad. The unit of absorbed dose is gray and rad, while the unit addressing increased biological harm from certain exposures are the sievert and rem.

Sievert and rem can include a multiplication factor to roughly account for increased biological harm of high linear-energy-transfer alpha particles and of neutron exposure. For external radiation exposure from low linear-energy-transfer gamma and x-rays, the multiplier is typically 1.0; therefore seivert equates to gray, and rem equates to rad. I find that having a conversion chart for the units is helpful when reviewing epidemiology studies.

For perspective, typical natural background levels of radiation from the earth, cosmic rays and radon in the US is typically less than 300 mrem (or 3 mSv). A chest x-ray is 10 mrem (01 mSv). A full body CT scan can be 1000 mrem (10 mSv). [32] A 50 rem dose (500 mSv or 0.5 Sv) will cause immediate radiation sickness. Half of the people exposed to a 500 rem whole body dose (or 5000 mSv or 5 Sv) would be expected to die within days.

Radiation doses are often discussed in terms of whole body dose per exposure or on an annual basis. A 100 mrem/yr dose rate is equal to 0.0114 mrem/hour. The dose to organs from a whole body dose is estimated in a rather general way using a weighted fraction for each organ.

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[30] "Health Risks from Exposure to Low Levels of Ionizing Radiation BEIR VII – Phase 2, The National Academies Press, 2006, http://www.nap.edu/catalog.php?record_id=11340

[31] Richardson, David B., et al., "Risk of cancer from occupational exposure to ionizing radiation: retrospective cohort study of workers in France, the United Kingdom, and the United States (INWORKS), BMJ, v. 351 (October 15, 2015), at http://www.bmj.com/content/351/bmj.h5359 Richardson et al 2015 This cohort study included 308,297 workers in the nuclear industry.

[32] The US Nuclear Regulatory Commission assumes that every man, woman and child gets 300 mrem in medical or industrial radiation dose annually – which I think is absurdly high. See http://www.nrc.gov/about-nrc/radiation/around-us/doses-daily-lives.html

Significant uncertainty is present in estimating radiation dose in epidemiology, even in controlled exposures to radiation workers and medical patients. The manner of estimating whole body versus organ dose, skin or colon, is often left unexplained in epidemiology studies. But the increasing statistical power of recent human epidemiological studies with large populations is making it harder for the nuclear industry to continue to dismiss the findings.

A radiation dose unit conversion chart

500 rem =	500,000 mrem =	5 Sv =	5000 mSv	Half of adults exposed to this acute dose would die within 30 days
100 rem =	100,000 mrem =	1 Sv =	1000 mSv	
50 rem =	50,000 mrem =	0.5 Sv =	500 mSv	People exposed to this acute dose would likely have radiation illness symptoms. Increased cancer risk would occur whether acute exposure or fractionated doses
10 rem =	10,000 mrem =	0.1 Sv =	100 mSv	This is typically the threshold for what is considered a "low dose." Adults exposed to this acute dose do not show symptoms but have increased cancer risk even if the exposure is from small fractionated doses
1 rem =	1000 mrem =	0.01 Sv =	10 mSv	**Note that the international radiation worker dose limit is 2 rem/yr but in the US remains 5 rem/yr probably so they can fry workers when it will save money in repairing nuclear plants.**
0.1 rem =	100 mrem =	0.001 Sv =	1 mSv	The public is allowed 100 mrem/yr from the nuclear industry, but epidemiology is finding harm from doses accumulated at this low dose rate

1000 millirem (mrem) = 1 rem; 1000 millisieverts (mSv) = 1 Sv.

A Brief Review of Dry Storage of Spent Nuclear Fuel Risks

The Idaho National Laboratory has various dry storage units for spent nuclear fuel from Peach Bottom gas-cooled reactor, Three Mile Island accident damaged nuclear fuel and others.

The US Nuclear Regulatory Commission inspection of Three Mile Island Unit 2 dry storage units at the Idaho National Laboratory in 2011 yielded this upon inspection of numerous concrete cracks:

"During the March 2011 inspection of the [independent spent fuel storage installation] ISFSI, observations were made of the condition of the concrete on the horizontal storage modules. These modules were originally designed for a 50-year service life when constructed in 1999, but **were showing significant cracking and degradation due to water intrusion into the concrete and the numerous freeze thaw cycles experienced, [after only 12 years !]** Since the March 2011 inspection, the DOE has initiated and completed a concrete repair program to address, mitigate, and stabilize the degradation of the horizontal storage modules (before and after photos are included as Attachment 2). The licensee plans to perform a base line inspection this year and in subsequent years to monitor the condition of the repairs and to analyze any additional degradation that occurs." [33]

Regarding nuclear dry storage units generally, the Electric Power Research Institute has noted that "The credible degradation mechanisms identified by this [failure mode and effects analysis] FMEA are (in order of likelihood) chloride-induced stress corrosion cracking (CISCC), pitting, crevice corrosion, microbiologically induced corrosion, and intergranular attack. Of the degradation mechanisms, CISCC is concluded to be of greatest potential concern for causing penetration of the confinement boundary. The most likely mode of canister confinement failure is the through-wall growth and penetration of a crack. Other less likely modes include a gross corrosion defect and the rupture of a part-depth or through-wall crack. **The consequences of a loss of the canister confinement boundary are considered principally for the integrity of the fuel cladding and for the potential for release of radioactive material.** The most susceptible locations are expected to be the cooler regions of the shell near welds at ISFSIs proximal to marine environments with breaking waves." [34]

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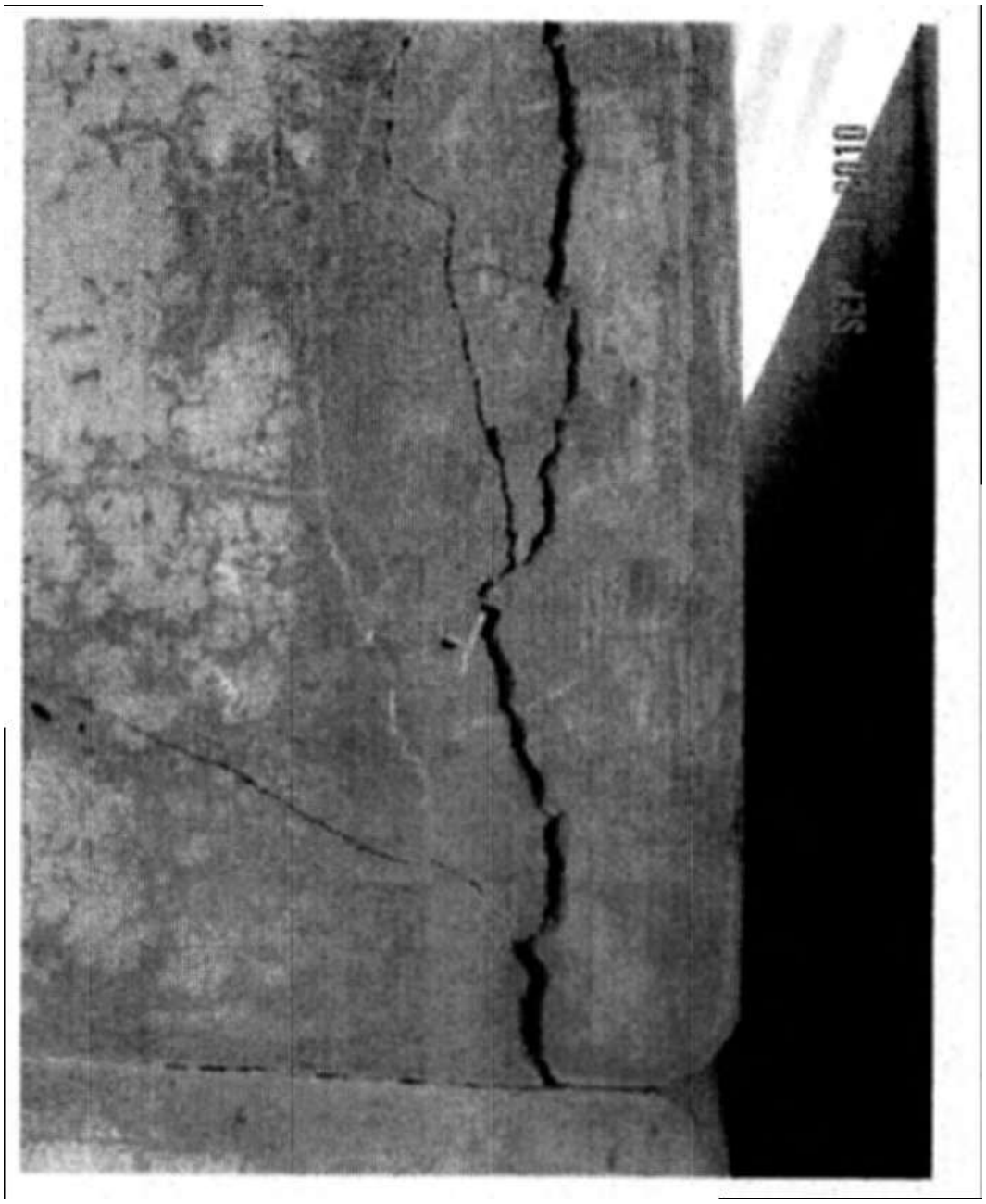
[33] Letter from the US Nuclear Regulatory Commission to Richard Provencher, Department of Energy, Idaho Operations Office, August 14, 2012, "Three Mile Island NRC Inspection of the Independent Spent Fuel Storage Installation – Inspection Report 07200020/2012-001."

[34] **"**Failure Modes and Effects Analysis (FMEA) of Welded Stainless Steel Canisters for Dry Cask Storage Systems**,"** Electric Power Research Institute, Product ID:3002000815, 2013. See http://www.epri.com/abstracts/Pages/ProductAbstract.aspx?ProductId=000000003002000815



This picture is of unexpected cracking of concrete, prior to repair, from the 2012 NRC inspection of the Three Mile Island independent spent nuclear fuel storage installation at the Idaho National Laboratory.

For more information highlighting the risk of canister leakage, see the SanOnofreSafetly.org website and also their comments on the Department of Energy's consent-based siting. [35]

[35] See https://sanonofresafety.org/ and Donna Gilmore, Response to IPC – DOE's CIS Nuclear Waste Plan Risks Major Radioactive Leaks, July 31, 2016 at https://sanonofresafety.files.wordpress.com/2015/10/commentstodoe-ipc-consentsiting2016-07-31.pdf

It will be years before we have more knowledge about the vulnerabilities of the many varieties of dry storage designs, variation of fuel types and fuel burnup and what transportation to interim storage facilities may cause. For those communities wanting to host a "pilot" interim spent fuel storage facility for an unknown length of time and without any capability of repackaging a damaged spent nuclear fuel container—just what do they intend to do with a leaking spent nuclear fuel canister?

Look for the Proposed NuScale Reactors at the Idaho National Laboratory to be an Aquifer User and Polluter

Nuclear power plants use water—lots of water. The Union of Concerned Scientists has studied how much water is used by nuclear reactors and it is more, for the same energy generation, than gas or coal plants.[36] [37] Routine water usage for cooling the feedwater used by the turbine-generator cycle is very high and this water would come from the aquifer. Leakage of piping, pools or ponds contaminates the groundwater and has at every nuclear power plant in the US. Accidents have typically focused on the airborne release of radionuclides but melted fuel in the basement of a nuclear plant, even if continually covered with cooling water, will eventually contaminate the aquifer below.

A 600 megawatt nuclear power plant may use roughly 11 million gallons of water per day, and water rights can be difficult to attain, according to a study done for Washington state. [38] The proposed NuScale reactor cluster would have 12 modules of approximately 60 megawatts each, with a total approaching 600 megawatts.

Nuclear energy accounted for only one-fifth of US electricity generation and as of 2011, electricity generation accounted for one-third of US heat trapping emissions. Power plants also accounted for more than 40 percent of US freshwater withdrawals in 2005. [39] The nuclear boosters who are claiming that NuScale or any other nuclear reactor is a sustainable and timely answer to climate change are not looking at the facts.

And nuclear boosters who claim that the proximity to experts at the Idaho National Laboratory will greatly assist in building the NuScale reactor are counting on the laboratory to

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[36] Union of Concerned Scientists, "How it Works: Water for Nuclear," http://www.ucsusa.org/clean_energy/our-energy-choices/energy-and-water-use/water-energy-electricity-nuclear.html#.V-SQLDWJl49

[37] Harvey Wasserman, "How Nuclear Power Causes Global Warming," September 21, 2016. http://www.progressive.org/news/2016/09/188947/how-nuclear-power-causes-global-warming

[38] Golden Associates for Washington State Energy Facility Site Evaluation Council, "Small Modular Reactors – An Analysis of Factors Related to Siting and Licensing in Washington State," January 2016. http://www.efsec.wa.gov/20160108SMRFinalReport.pdf

[39] A Report of the Energy and Water in a Warming World Initiative, *Water–Smart Power – Strengthening the US Electricity System in a Warming World*," July 2013. http://www.ucsusa.org/sites/default/files/legacy/assets/documents/clean_energy/Water-Smart-Power-Full-Report.pdf

dismiss its mission to provide regulatory assistance to the US Nuclear Regulatory Commission who is chartered to create stringent requirements for construction and operation that protect workers, the public and the environment. The conflict of interest that laboratory scientists would have in providing direct assistance to the NuScale project is clear, even if it hasn't crossed the mind of Idaho Falls Power general manager and board chair of Utah Associated Municipal Power Systems (UAMPS) Jackie Flowers when the benefit of immediate access to INL's experts is touted. [40]

Another issue is how to separate the contamination already in the Snake River Plain aquifer from what NuScale adds and how to separate airborne contamination from other INL facilities or blowing pre-existing contamination from what NuScale emits.

Idaho Cleanup Project Thinks the PCE Chemical Contamination in the Aquifer is from Well Construction

The unique multilevel deep well at the Idaho National Laboratory, well "MIDDLE-2051" has been found to have high levels of PCE (perchloroethylene or tetrachloroethylene) for several months. The cleanup contractor said in email correspondence to me on September 21 that a well having a similar depth, USGS-132, with its deepest port at 1,182 ft below ground surface was sampled once for PCE in 2008, but was not detected below 1 microgram/liter. The federal standard is 5 microgram/liter. The MIDDLE-2051 has tested above the federal standards since last fall.

After repeated groundwater sampling of the unique Westbay well [41] MIDDLE-2051, the US geological survey, the Department of Energy, and Fluor Idaho, LLC have concluded that the source of the PCE is the result of the solvent being inadvertently introduced into the well itself and is not indicative of a contaminated groundwater plume in the aquifer. The contamination will be studied further using the CERCLA cleanup New Site Identification process for Operable Unit 10-08 Record of Decision with further results posted on the Department of Energy's Administrative Record website.[42]

PCE and other chemical dumping at the Idaho National Laboratory commenced in the early 1950s and historical records are typically not adequate to determine the quantity dumped into the aquifer. Spotty monitoring beginning largely after 1987 has found PCE in various wells at the INL. Dumping occurred at Test Area North, the Naval Reactors facility, and burial of PCE-laden

[40] Editorial by Jackie Flowers in the Idaho Falls Post Register, "Building an SMR in eastern Idaho," August 12, 2016. She also claims that the Idaho lab designed and constructed 52 nuclear reactors. Yes 52 nuclear reactors were constructed at the Idaho lab; however, very few of them were designed at the Idaho lab.

[41] See http://westbay.com/groundwater-monitoringtechnology

[42] See https://ar.icp.doe.gov

waste took place at the Radioactive Waste Management Complex. See EDI's July 2016 newsletter for more information.

Idaho National Laboratory CERCLA Cleanup Announces Loosening of Cleanup Standards

Because of changes to federal contaminant levels in water and soil, cleanup standards for cesium-137 in water and soil are being loosened. The changes are described in a new cleanup report available at the Department of Energy's Administrative Record for the INL. [43]

The aquifer maximum contaminant level (MCL) for Cs-137 was 119 pCi/L and based on latest EPA changes it is being raised to 200 pCi/L. Individual radionuclides concentration levels are derived to prevent cancer incidence risk from exceeding 1 in 10,000. The report is acknowledging that all radionuclides need to be considered in a sum of the annual dose rather than only being considered individually.

The maximum contaminant level of Cs-137 in soil was 2.3 pCi/g and is being raised to 6.1 pCi/g.

Amid the loosening of cleanup standards, I have not found evidence of concern over why the large epidemiology study in Sweden found an 11 percent increase in cancer for cesium-137 soil contamination at the 100 kBq/m^2 level. [44] This could be equated to 270 pCi/g if the contamination is assumed to be 1 cm deep and assuming 1 gram of soil is 1 cubic centimeter. Then, by this rather crude estimate, rather than being a 1.0E-4 lifetime risk EPA claims its soil contamination level to be, the risk may actually by increased by 2.50E-3 for each year of exposure to 6.1 pCi/g or a 0.175 lifetime risk. So human epidemiology suggests that the actual lifetime risk from 6.1 pCi/g Cs-137 in soil is not 1.0E-4 but actually 1750 times higher. [45] Of course, there were other radionuclides in the soil in Sweden from the Chernobyl accident—

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[43] Department of Energy, "Explanation of Significant Differences, Resulting from the 2010 to 2014 Five-Year Review, to Implement Changes in Records of Decision at the Idaho National Laboratory Site," DOE/ID-11548. See https://ar.icp.doe.gov/images/pdf/201608/20160810010 54BRU.pdf

[44] Martin Tondel et al, Increase of regional total cancer incidence in north Sweden due to the Chernobyl accident? J. Epidemiol Community Health 2004;58 1011-1016. www.ncbi.nlm.nih.gov/pmc/articles/PMC1732641/pdf/v058p01011.pdf 1 Bq (Becquerel) is 1 disintegration per second. 1 Curie is 3.7E10 Bq.

[45] Convert 100 kiloBq/m^2 to units of picocurie/m^2:
100,000 Bq/ 3.7E10 Bq * (Ci/m^2) (E+12 pCi/Ci) = 0.27E7 pCi/m^2. Then convert from square meter to square centimeter: 0.27E7 pCi/m^2 (1 m^2/(100cm*100 cm) = 0.27E3 pCi/cm^2. Assume 1 cm deep, and 1 cm^3 = 1 gram: 270 pCi/g. Then assume linear proportionality of 11 percent risk increase per year for 270 pCi/g and derive annual risk increase for 6.1 pCi/g: 2.5E-3/yr. Note that the 70 year lifetime risk of 1.0E-4/lifetime would be a 1.0E-4/70 year = 1.429E-6/yr annual risk for 6.1 pCi/g as assumed by the US EPA.

cesium-137 is simply the easiest to measure and can be measured from an airplane or helicopter because of its large gamma ray emission.

What may not be apparent with these contamination levels is that in many places at the Idaho National Laboratory, the contamination is simply too costly or is impossible to clean up. What they are doing instead of meeting these standards is to leave the waste in place where it migrates to the aquifer or if in the aquifer, migrates downgradient. To claim that the "cleanup" is protective of human health, they simply say that their administrative controls for millennia will keep people from accessing the contaminated water and soil.

Because of the unsavory nature of the truth of the **many forever contamination sites** at the Idaho National Laboratory, the information describing this is rather vague and incomplete and it is NOT available on the Department of Energy's Administrative Record for the Idaho lab cleanup. But I did manage to find the list of the many areas at the Idaho lab that will exceed cleanup standards and will be contaminated above these levels for hundreds and sometimes over hundreds of thousands of years at this Environmental Protection Agency website. [46]

Department of Energy Issues Misleading Statement on Cleanup at the Idaho National Laboratory's Radioactive Waste Management Complex and the AP Furthers the Deception

The Associated Press article [47] on buried waste cleanup at the Idaho National Laboratory makes it sound like all of the waste from the Rocky Flats nuclear weapons production plant near Denver, Colorado that was buried in Idaho during the 1950s and 1960s will be exhumed and removed. But the truth is far from it.

The Department of Energy's title could easily mislead readers in an optimistic direction but at least the Department of Energy's statement made clear in the details that only 5.69 of the 97 acre dump would be exhumed. However, the DOE's statement is incorrect when it states that the waste exhumation targets removal of the highest concentrations of solvents and transuranic radionuclides, such as plutonium and americium, buried in the landfill. [48] The fact is that only the most concentrated chemical solvents such as carbon tetrachloride are targeted in the INL CERCLA Record of Decision for the Radioactive Waste Management Complex. [49] Very little of

[46] INL Waste Area Group Institutional Controls Report. Dated March 25, 2016. https://cleanup.icp.doe.gov/ics/ic_report.pdf from the EPA page: https://cleanup.icp.doe.gov/ics/

[47] The Idaho Falls Post Register, AP, "DOE: Idaho radioactive cleanup moving ahead," September 23, 2016. www.postregister.com/.../doe-idaho-radioactive-cleanup-moving-ahead

[48] US Department of Energy, "EM's Idaho Site Crews Complete Buried Waste Cleanup Accomplishment," September 22, 2016. http://energy.gov/em/articles/em-s-idaho-site-crews-complete-buried-waste-cleanup-accomplishment

[49] US DOE, US EPA, Idaho DEQ, *Record of Decision for Radioactive Waste Management Complex Operable Unit 7-13/14*, DOE/ID-11359, September 2008. p. 41 https://ar.inl.gov/images/pdf/200810/2008100100495TUA.pdf

the total plutonium or americium will be exhumed. The amount of plutonium and americium that actually is exhumed won't be known because it is so hard to measure, but it is expected that only a small fraction of what was dumped will be removed. That is the fact of the matter and the DOE's estimates of how much plutonium and americium and other radionuclides will remain buried are documented in the DOE's performance assessment. The DOE long kept its performance assessment out of public view. [50]

Both articles fail to mention that the waste will have to be stored above ground in Idaho because shipments to the defense nuclear waste facility in New Mexico, the Waste Isolation Pilot Plant (WIPP) have ceased because of two accidents in 2014. Shipments are expected to resume later this year but at a slowed pace.

Department of Energy Ends Inquiry into Idaho Radiation Exposure – More Misleading Coverage on DOE Problems

The Boise Associated Press article states that the Department of Energy will not begin a formal investigation of the radiation leak two years ago at the Materials and Fuels Complex at the Idaho National Laboratory. [51] The leakage from a glove box occurred on separate occasions and nine workers had internal uptake from the exposures. The article states that "the low exposure" in late August 2014 **occurred after faulty air monitors failed to detect a release** of radioactive material from a sealed compartment.

Here's the problem: **the process was handling americium-241 but the air monitors were not set up to detect americium-241.** The air monitors performed as they were installed and set up to perform. The contractor had set the monitors up to detect plutonium-239 and had assumed that any release would involve enough Pu-239 to set the monitors off. This assumption was incorrect.

The air monitors were not faulty and did not malfunction. The air monitors gave an alarming indication that stated "poor fit." If the contractor, Battelle Energy Alliance had understood what this meant, they might not have taken over a month to figure out that the air monitors had been sucking up radioactive contamination that didn't fit normal radon levels in air. "Poor fit" actually meant that the radioactivity coming into the monitors didn't match expected background contamination. The "poor fit" alarm was simply ignored, but during filter changeout, the elevated levels of contamination on the filters in the air monitors was detected. But this was not until

[50] 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/

[51] The Idaho Falls Post Register, Boise AP, "Energy Dept. ends inquiry into Idaho radiation exposure," September 2, 2016.

more workers, in separate events weeks apart, were breathing in americium-241 into their lungs when a special process was conducted.

So you have a contractor that does not properly install air monitors for the work to be performed and doesn't adequately respond and comprehend the alarm messages of the air monitor. Then you have to add to that the fact that other measures that are supposed to prevent worker internal contamination also failed: **the hand-held surveys for alpha contamination failed to find contamination in the area or on the workers and the step-in alpha monitors also failed to find contamination on the workers.**

So it is curious that the Department of Energy is so incurious about all of these serious problems that it deems that no investigation is necessary. [52] Well, after all, it's so easy to pencil-whip down the estimated intake doses that the Department of Energy sees no real need to actually prevent these intakes or investigate why the multiple systematic precautions failed.

NIOSH Radiation Advisory Board Presentations and Transcripts Posted Online

The National Institute for Occupational Safety and Health has posted the August Idaho Falls meeting of the Radiation Advisory Board and other meeting on their website. [53] Public comment is included and my comments start on the page 228.

However, information presented in January describes irregularities regarding ability to locate radiation records for some Idaho National Laboratory workers. In March, a compilation of issues for the INL is provided that identifies radiation dose reconstruction issues for INL's Test Area North, Central Facilities Area, Test Reactor Area, Chemical Processing Plant and Burial Grounds. [54] The March 2016 compilation of review issues does not attempt to address Argonne National Laboratory – West issues that are under a separate special exposure cohort petition or the Naval Reactors Facility that excludes radiation workers from energy worker compensation.

One of the problems is "it is not apparent that the lack of internal monitoring data [via bioassay of urine and fecal samples] is indicative of a lack of internal exposure potential."

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[52] See EDI's 2016 May newsletter article "Three events show that the Idaho National Laboratory Still Doesn't Know How to Monitor Airborne Alpha Contamination. See http://www.environmental-defense-institute.org/publications/News.16.May.pdf

[53] National Institute for Occupational Safety and Health, Radiation Advisory Board meetings for 2016 transcripts at https://www.cdc.gov/niosh/ocas/pubmtgs.html See January, March and August months for Idaho National Laboratory presentations and transcripts. See https://www.cdc.gov/niosh/ocas/pdfs/abrwh/2016/tr080916.pdf

[54] Issues for INL Special Exposure Cohort (SEC): Compilation of SC&A Review Issues, Comments, and Recommendation at https://www.cdc.gov/niosh/ocas/pdfs/abrwh/scarpts/sca-inlsec219im-031316.pdf This table highlights many important impediments to accurate radiation dose reconstruction. The resolution of these issues, if the treatment of INL's diverse reactors is any indication, is that the Advisory board will block any meaningful full investigation of the issues in order to reduce costs of investigation, and in my opinion to reduce compensation awards and try to keep the Department of Energy's dirty problems below the radar.

Another problem for the INL is the estimation of airborne radionuclides that were inadequately monitored. Even when monitoring records are available, only an incomplete set of radionuclides was monitored. For that reason, a method used to estimate the missing radionuclides and their proportion of the airborne release has been created and is documented in ORAUT-OTIB-0054. The shortcomings of this method, however, are that it may not properly account for important fission products released because of variations in fuel composition or fuel melt release fraction assumptions affected by fuel design and fuel melt conditions. In addition, the materials testing programs and separations programs involve mixtures not represented by fuel composition.

NIOSH tends to use atypical acronyms to discuss these problems: "mixed fission products" or MFPs and fission and activation products, FAPs. So, if an internal bioassay monitored strontium, NIOSH tries to estimate what the entire suite of airborne radioactive fission products the worker was exposed to was. Activation products, such as cobalt-60, arise from radiation of the metal piping or other materials. Deducing the amount of unmonitored actinides is another issue because the actinides include alpha-emitters such as uranium and plutonium.

The March compilation of review issues identifies serious concerns of radiological protection programs for the INL burial grounds, later named the Radioactive Waste Management Complex. Waste shipments were often inadequately characterized and labeled. There appears to be a lack of radiological controls, oversight and inadequate internal monitoring protocol, historically, for the burial grounds. [55]

This problem of estimating the dose from all of the important-to-dose radionuclides workers may been exposed to is an INL-wide problem. The March compilation of review issues for INL special exposure cohort 0219 highlights include Test Area North where highly diverse activities including many large fuel melt releases took place. At TAN, the lack of applicability of NIOSH default fuel composition estimates from its ORAUT-OTIB-0054 report were identified because of the highly enriched fuels used and extreme temperatures of fuel melt applicable to TAN.

But this problem also applies to the difficulty in estimating offsite public radiation doses from historical INL releases. The March compilation of review issues identifies as relevant to worker radiation dose reconstruction the significant underestimation of airborne emissions found by the CDC's investigation of the Department of Energy's stated releases in its 1991 INEL Historical Dose Evaluation. [56]

Articles by Tami Thatcher, for October 2016.

[55] Issues for INL Special Exposure Cohort (SEC): Compilation of SC&A Review Issues, Comments, and Recommendation at https://www.cdc.gov/niosh/ocas/pdfs/abrwh/scarpts/sca-inlsec219im-031316.pdf See p. 13.

[56] 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