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Military Issues Draft EIS on Polluting and Unsafe Gas-Cooled Prototype Mobile Microreactors

The U.S. Department of Defense is proposing to build, within three years, Prototype Mobile Micoreactors that it would transport and use anywhere in the world. Critics say that the nuclear reactors will be targets and that it is unwise to deploy nuclear reactors in theaters of war. [1] The draft environmental impact statement for the proposed gas-cooled high temperature nuclear reactors is available for public comment at https://www.mobilemicroreactoreis.com. [2] Public meetings are to be held October 20 at Fort Hall, Idaho unless cancelled due to COVID.

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[1] Associated Press, *The Idaho Falls Post Register*, "US military eyes prototype mobile nuclear reactor in Idaho," September 26, 2021.

[2] The Department of Defense (DoD), acting through the Strategic Capabilities Office (SCO) and with the Department of Energy (DOE) serving as a cooperating agency, announces the availability of the Draft Construction and Demonstration of a Prototype Mobile Microreactor Environmental Impact Statement. SCO is also announcing a public comment period and public hearings to receive comments on the Draft EIS. SCO prepared the Draft EIS to evaluate the potential environmental impacts of alternatives for constructing and operating a prototype mobile microreactor capable of producing 1 to 5 megawatts of electrical power (MWe). The Draft EIS is available at https://www.mobilemicroreactoreis.com. DoD as the prime agency, acting through the SCO and in cooperation with the DOE, invites Federal agencies, state agencies, local governments, Native American tribes, industry, other organizations, and members of the public to review and submit comments on the Draft EIS. Comments will be accepted during the comment period that will extend for 45 days after the U.S. Environmental Protection Agency publishes the Notice of Availability in the Federal Register on September 24, 2021. The comment period will end on Tuesday, November 9, 2021.

Additional information about the project and the public hearings can be found at this website: https://www.mobilemicroreactoreis.com. All comments, whether oral or written, will be considered by DoD as the EIS is finalized and can be emailed to e-mailed to PELE_NEPA@sco.mil.

SCO will host two public hearings regarding the Draft EIS. Meetings will be held in-person and livestreamed for those who are unable to attend the in-person setting. A toll-free number will be available for commenters not at the in-person meeting. Interested parties are invited to join either or both of the public hearings, each with identical presentation content, planned to be held on Wednesday, October 20, 2021 from 3:00 PM to 5:00 PM Mountain time and from 6:00 PM to 8:00 PM Mountain time at the Shoshone Bannock Hotel and Event Center, 777 Bannock Trail, Fort Hall, Idaho 83203. An American Sign Language (ASL) interpreter will be present. The hearings will begin with a presentation providing an overview of the project, information on the NEPA process, and highlights of the Draft EIS content and analysis. Following the presentation, individuals participating both in-person and remotely will be provided an opportunity to provide comments on the Draft EIS. The hearings will conclude after two hours or until there are no additional commenters. Public comments will be addressed in the Final EIS. A court reporter will be present to transcribe all comments.

These meetings will be livestreamed and recorded for later playback. The recording of the public hearings will be available at https://www.mobilemicroreactoreis.com after the meeting have been held. Those attending the hearings in person at the Shoshone Bannock Hotel and Event Center will be required to wear appropriate face coverings and follow social distancing guidelines. Ongoing health concerns as a result of the evolving COVID-19 restrictions could result in changes or cancellation of these public hearings. Further public notification would be made in the event of postponement or cancellation. In the event of in-person event cancellation, online virtual

The public comment period is scheduled to end November 9. The decision on whether or not to move forward is expected in early 2022.

While the Department of Defense prototype mobile microreactor is to be from 1 to 5 MW electric (MWe), the goal is to develop 10 MWe reactors that will be located anywhere. The design is to be an advanced gas-cooled reactor using high-assay low-enriched uranium (HALEU) tristructural isotopic (TRISO) fuel that is enriched to nearly 20 percent uranium-235.

Touted as safe, the capability of TRISO fuel to release fission products to the skies of southeast Idaho has been proven at the INL's Advanced Test Reactor, which had to terminate the testing or exceed 10 mrem annual doses from INL radiological airborne effluents (read more in last month's Environmental Defense Institute's newsletter). TRISO fuel is designed for normal operating temperatures, but accident conditions may exceed these temperatures allowing fission product release.

The mobile microreactor design, construction and testing is also referred to by the Department of Defense's Strategic Capabilities Office (SCO) as Project Pele although not identified as such in the Federal Register or EIS document title.

The reactor will be fabricated either at BWXT Advanced Technologies, LLC or X-energy, LLC, depending on DOD's selection. The building and the design of the proposed mobile reactors and the fuel fabrication would take place outside Idaho with only the testing of the reactors to be conducted at the Idaho National Laboratory, either close to Idaho Falls at the Materials and Fuels Complex or close to Atomic City, Arco and Blackfoot at the Critical Infrastructure Test Range Complex (CITRC). Demonstration of the reactors would include startup testing, moving the reactor to a second site and re-testing.

No U.S. Nuclear Regulatory Commission licensing will be required for any aspect of the DOD's mobile reactors.

The stated goal to operate the reactors with radiation doses "as low as reasonably achievable" is completely meaningless, especially when the military is involved. For military training, they are already releasing unnecessary radioactive material to the skies of southeast Idaho.

According to the Pele Project draft EIS, "SNF would be managed and stored at the INL Site but pending off-site shipment to a permanent repository. SNF would be managed in accordance with applicable laws and other requirements…."

In other words, the mobile-microreactor Pele Project spent nuclear fuel will be indefinitely stored at the INL because there is no SNF disposal facility on the horizon. The Department of Energy does not have a spent fuel disposal program, nor does it have a program to

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public hearings would still occur on the same dates and times. Written comments can also be submitted through the end of the public comment period. Comments may be mailed to: Mobile Microreactor EIS Comment, c/o Leidos, 2109 Air Park Rd SE, Suite 200, Albuquerque, NM 87106, or e-mailed to PELE_NEPA@sco.mil.

repackage spent nuclear fuel in Idaho or at stranded fuel sites around the country where spent nuclear fuel is stored at operating or closed commercial nuclear reactor sites.

Spent nuclear fuel management, according to a 2019 report by Sandia National Laboratory, [3] will require some combination of three options: 1) repackaging spent fuel in the future, 2) constructing one or more repositories that can accommodate DPCs [dual purpose canisters that are canisters that can be disposed of in the repository], and/or 3) storing spent fuel at surface facilities indefinitely, repackaging as needed. The report admits that current practices "are not optimized for transportation or disposal."

The Sandia report downplays the technical problems we face in designing a safe repository for spent nuclear fuel. The report mentions that for a repository, post-closure criticality continues to be analyzed and the capability of predicting how fast the radionuclides will escape the repository continues to be studied.

Unlike anyone I listened to from the Nuclear Energy Institute during public comment for consolidated spent nuclear fuel storage in New Mexico, the Sandia report admits that "stress corrosion cracking of canisters may be a concern in some parts of the country, and work is ongoing in analysis, detection, and mitigation." Sandia also states that monitoring and aging management practices at storage sites will be important to confirm storage system performance during extended service.

The enrichment of fuel used in earlier commercial nuclear reactors was only about 3 percent uranium-235. With increasing enrichment comes significantly more criticality risk during spent nuclear fuel storage and disposal, should a repository ever become available.

While operating the reactor, fission products build up in the fuel that can be released during routine operation or from an accident. Every phase of Project Pele's Mobile Microreactor — from fuel fabrication, to fuel transport, to reactor transportation prior to operation, to reactor operation, to stranded spent fuel storage, to spent fuel transportation — poses the risk of harming people and contaminating communities. Although the radiological release can be far higher after the reactor has operated, even before operating a nuclear reactor, the uranium in the reactor can be dispersed upon explosion due to sabotage. Uranium is known to cause birth defects and other health problems.

The radionuclides released for routine operations and from accidents cannot be remediated and will continue to sow seeds for birth defects, increased infant mortality, cancer and many other adverse health effects. The nuclear industry focuses primarily on cancer mortality (or death by cancer), choosing to downplay the incidence of cancer, birth defects, genetic effects, increased heart disease especially from cesium-137 and damage to the immune system especially from bone seekers such as strontium-90, plutonium-239, and americium-241.

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[3] Nuclear Energy Fuel Cycle Programs, *Spent Nuclear Fuel Storage R&D at Sandia National Laboratories*, SAND2019-1140PE, February 7, 2019. https://www.osti.gov/servlets/purl/1598436

While the safety characteristics of any particular fuel and reactor design can affect the operating safety of the reactor, and the fuel storage system outside of the reactor can affect the safety of stored spent nuclear fuel. The reactor and the spent fuel will always be vulnerable to terrorism. Even the fission products released from a 1 to 5 Megawatt-electric (MWe or simply MW) nuclear reactor can be devastating for distances of 50 miles or more from the reactor as the radionuclides spread by the wind.

Isolation of the spent nuclear fuel will require currently unfunded repackaging of the spent fuel and unfunded development of the capability to isolate spent nuclear fuel's radioactive toxic mix of plutonium, cesium, strontium, and other radionuclides. **The capability to isolate the radionuclides from water and air for millennia currently does not exist and in reality, does not appear feasible.** The radionuclides in spent fuel remain toxic for millennia and threaten all life on the planet, although this never appears to bother nuclear proponents.

No one will have a choice of living in a community or neighborhood away from the threat of a nuclear power generating reactor catastrophe when these mobile reactors are unleashed. Citizens will have no say over the nuclear reactors moving to their communities.

Understanding some of the misinformation in the Project Pele or Prototype Mobile Microreactor draft EIS

Typical of the disinformation from the Department of Energy is the mischaracterization of the escalating radionuclide releases by the Idaho National Laboratory and the estimated radiation doses from INL airborne radiological releases. The Prototype Mobile Microreactor draft Environmental Impact Statement [4] states the following, which is correct:

"Facilities at the INL Site have the potential to emit radioactive materials and, therefore, are subject to NESHAP, Subpart H, *National Emission Standards for Emissions of Radionuclides Other than Radon from Department of Energy Facilities* (EPA, 2021d). This regulation limits the radionuclide dose to a member of the public to 10 millirem per year from the air pathway. Subpart H also establishes requirements for monitoring emissions from facility operations and analyzing and reporting of radionuclide doses. Airborne radiological effluents are monitored at individual facilities at the INL Site (including MFC) to comply with the requirements of NESHAP and DOE Order 458.1, *Radiation Protection of the Public and the Environment* (DOE, 2020b)."

In reality, there is inadequate monitoring at INL facilities and radionuclide releases are only guesstimated. But then the draft EIS states:

[4] The Department of Defense (DoD), acting through the Strategic Capabilities Office (SCO) and with the Department of Energy (DOE) serving as a cooperating agency, announces the availability of the Draft Construction and Demonstration of a Prototype Mobile Microreactor Environmental Impact Statement. The Draft EIS is available at https://www.mobilemicroreactoreis.com.

"Radionuclide emissions at the INL Site occur from (1) point sources, such as process stacks and vents; and (2) fugitive sources, such as waste ponds, buried waste, contaminated soil areas, and D&D operations. During 2019, an estimated 1,611 curies of radioactivity were released to the atmosphere from all INL Site sources (DOE-ID, 2021c). This level of release is within the range of releases from recent years and is consistent with the general downward trend observed over the past 10 years. For example, reported releases for 2010 and 2015 were 4,320 curies and 1,870 curies, respectively."

There is a general downward trend in the curie amounts of radionuclides over the last ten years; however, **the releases over the last twenty years have generally been higher than the releases during the 1990s**, see Figure 1. The DOE isn't about to discuss the increasing radionuclide releases that commenced in 2001.

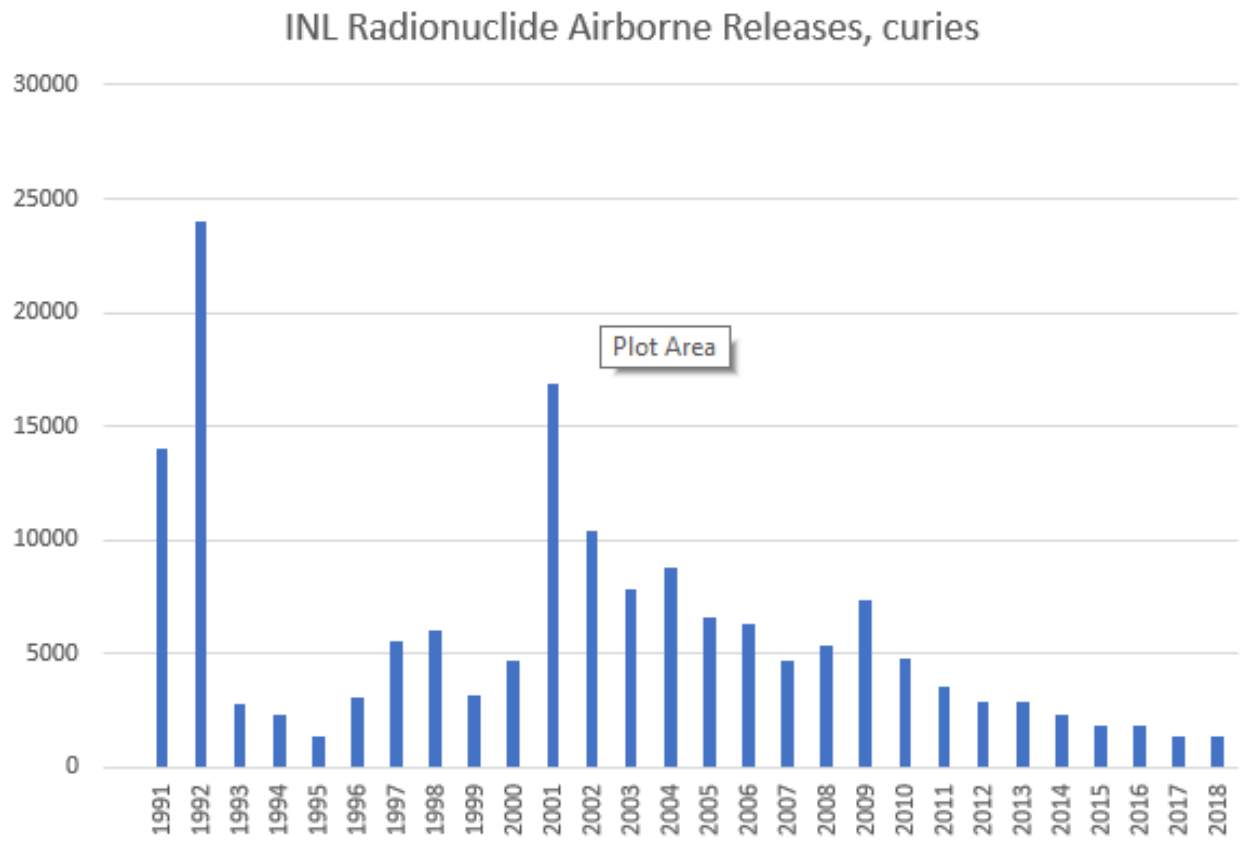

Figure 1. INL Radionuclide Airborne Releases, curies, from 1991 to 2018. Source: Idahoeser.com

The next thing to know is that for some radionuclides like krypton-85, very large curie amounts yield small radiation doses, while **for other radionuclides like iodine-129, plutonium-239 and americium-241, very small curie amount releases yield large contributions to radiation dose.** The trend in annual estimated effective dose is provided in Figure 2.

Year	Effective whole body dose, mrem
1991	0.02
1992	0.004
1993	0.011
1994	0.004
1995	0.018
1996	0.03
1997	0.03
1998	0.007
1999	0.008
2000	0.057
2001	0.035
2002	0.055
2003	0.024
2004	0.044
2005	0.077
2006	0.039
2007	0.093
2008	0.131
2009	0.069
2010	0.058
2011	0.046
2012	0.036
2013	0.03
2014	0.036
2015	0.033
2016	0.014
2017	0.008
2018	0.0102
2019	0.0559

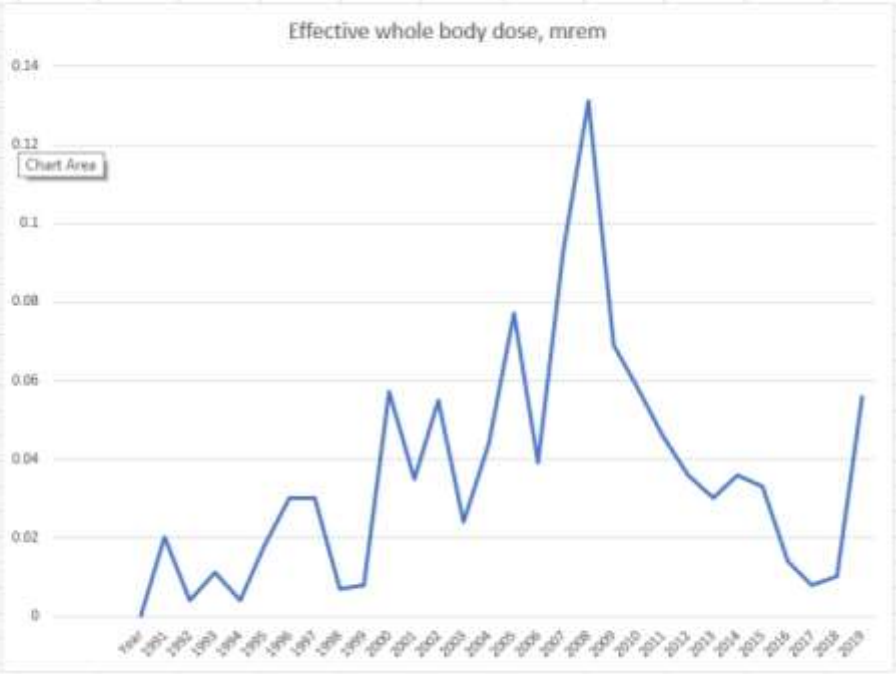

Figure 2. Department of Energy estimated annual effective whole-body dose in millirem from INL airborne releases. Source: Idahoeser.com

As you can see in Figure 2, the radiation doses from the Idaho National Laboratory from 2000 to 2019 are generally higher than for the 1990s. **And the radiation dose trend over the last few years is increasing, not decreasing**. This is without accounting for ingestion of radioactive animal tissue, which the draft EIS does discuss, but I have not included here. The draft EIS asserts that water we drink here, which sporadically includes high levels of radionuclides such as tritium and other man-made radionuclides, don't come from the INL and so they don't add these to the radiation dose. The dose from radioactively contaminated food and water not included in the DOE's dose estimates actually dwarf the annual radiation dose estimates.

The specific radionuclides released from the INL each year vary, as do their curie amounts. The radionuclides that tend to dominate the radiation effective whole-body dose include tritium, argon-41, strontium-90, cesium-137, iodine-129, plutonium-239 and americium-241. **In 2015, 561 curies of argon-41 yielded a 0.0025 mrem dose, while 0.000673 curies of plutonium-239 yielded a comparable dose contribution of 0.0019 mrem.**

In 1998, most of the radiation dose came from iodine-129 (6.3E-3 mrem) and argon-41 (1.8E-3 mrem), while in 2008 most of the dose came from strontium-90 (0.03 mrem), americium-241 (0.011397 mrem) and plutonium-239 (0.011528 mrem).

The effective dose in millirem for 2015 and 2018 are provided in Table 1, to illustrate the variety of radionuclide contributors to dose.

The draft EIS for Project Pele states on page 4-69 that "The highest average individual dose calculated for the MEI (i.e., someone located at the INL Site boundary south of CITRC), regardless of minority or low-income population was 7.0 x 10-3 millirem (i.e., 0.007 millirem). This number is so small that it represents no appreciable change in dose exposure over natural background levels at the INL Site (i.e., 382 millirem) and is well below regulatory limits (i.e., DOE annual public dose limit of 100 millirem or EPA air pathway dose limit of 10 millirem) …"

There are a few things to keep in mind whenever these seemingly negligible doses are discussed. First, they are using the effective whole-body dose which waters down the dose and does not reflect the far higher organ absorbed doses and in no way provides a reliable indicator of health risk, not even fatal cancer risk (more about this in the next article). Second, the organ doses, absorbed doses, need to be presented but are not. The thyroid doses in particular need to be displayed. The thyroid doses are far above natural background levels. And third, the 100 millirem per year that the Department of Energy keeps emphasizing as their allowable and safe level was based on faulty models limited almost exclusively to cancer mortality risk and the incorrect presumption by the ICRP that the risk was 0.0001 fatal cancers per year. This risk was the basis for various regulations selecting 100 mrem per year. But the risk is now admitted to be at least 0.0006 fatal cancers per year (more about this later in this article.)

There are other problems such as the rate of the releases and which direction the wind is blowing during that release has not been accounted for. And the estimates of the curies released from the INL of each radionuclide are un-scrutinized because the estimate methodologies are not made public. And, it is very possible for the estimated releases to omit actual radiological releases, like the radioactive resin beads released for years from the Advanced Test Reactor and not included in stated releases from the evaporation ponds. And, the deposition rate of various radionuclides on the ground and on crops are only guessed at and greatly influence dose estimates. And, some of the radionuclides very important to dose are also very difficult to detect, like iodine-129, which has a 16-million-year half-life. And finally, the radiological monitoring programs are trying very hard not to attribute radiological contamination to the Idaho National Laboratory.

Often forgotten is the fact that the effective whole-body dose is applicable only to late stochastic effects, basically only cancer mortality and not to immediate deterministic effects. This fact was forgotten when the Department of Energy misused effective dose and the cancer mortality rate to state that doses as high as 1000 rem, yes, 1000 rem, caused no harm, despite the long known fact that 50 percent of people exposed to 500 rem would die within weeks. (Read more in the August 2021 Environmental Defense Institute newsletter.)

Table 1. Radionuclides contributing to estimated radiation dose from airborne radionuclide effluents at the Idaho National Laboratory for 2015 and 2019.

Radionuclide (Half Life)	Curies released by INL in 2015	2015 MEI mrem due to INL air effluents	Curies released by INL in 2019	2019 MEI mrem due to INL air effluents
Tritium (H-3) (12.3 year)	532	0.0111	450	0.0011
Carbon-14 (5,700 year)	0.988		0.683	
Chlorine-36 (301,000 year)	-		7.19E-3	0.0035
Argon-41 (1.83 hour)	561	0.0025	884	
Chromium-51 (27.7 day)	-		-	
Cobalt-60 (5.27 year)	1.30E-2		8.22E-3	
Zinc-65 (244 day)	3.26E-5		0.16	0.0019
Krypton-85 (10.7 year)	733		51.1	
Strontium-90 (28.6 year)	3.05E-2	0.0020	2.36E-2	
Antimony-125 (2.73 year)	7.33E-4		-	
Iodine-129 (16,000,000 year)	2.15E-2	0.0037	1.31E-3	
Iodine-131 (8.04 day)	1.1E-2		9.0E-2	
Cesium-137 (30.2 year)	0.0239	0.0010	0.267	0.0314
Plutonium-238 (87.7 year)	1.33E-4		-	
Plutonium-239 (24,000 year)	6.73E-4	0.0019	1.94E-5	
Plutonium-240 (6580 year)	1.90E-4	0.0004	1.88E-6	
Plutonium-241 (14.35 year)	4.19E-3		-	
Americium-241 (458 year)	3.36E-3	0.0093	7.19E-5	
Uranium-234 (246,000 year)	-		5.88E-2	0.0430
Uranium-238 (4.47E9 year)	-		1.29E-1	0.1124

Radionuclide (Half Life)	Curies released by INL in 2015	2015 MEI mrem due to INL air effluents	Curies released by INL in 2019	2019 MEI mrem due to INL air effluents
		Total 0.033 mrem, 2015		Total 0.0588 mrem, 2019

Table notes: MEI is the hypothetical maximally exposed individual located near the Idaho National Laboratory residing south of the INL near the Big Southern Butte. A mrem is the annual radiation dose in units of millirem, or 1.0E-3 rem. The source data for the radionuclide curie releases and the estimated radiation dose is from the Department of Energy's Idahoeser.com website for those years. Note that uranium, plutonium and americium decay half lives are only the beginning of long decay series of radionuclides before ultimately decaying to a stable isotope of lead.

Despite the draft Project Pele EIS stating incorrectly that a rem is defined as "roentgen equivalent man, a measure of radiation" throughout the draft EIS, it isn't.

The roentgen, used before the SI unit system was adopted, corresponds to an absorption of 87.7 ergs per gram of air, or a dose to the air of 0.877 rad. This is sometimes considered similar to the absorbed dose in tissue and would be nearer to a "rad" of absorbed dose, analogous to the SI unit of Gray, where 100 rad equals 1 Gy. However, a roentgen is NOT a rem. The unit of "rem" is analogous to the SI unit of sievert, where 100 rem equals 1 Sv. However, while the "rad" is a physical quantity, the "rem" is adjusted by a series of multipliers that are selected by the ICRP based on the ICRP's opinion of the biologic effect of the radiation, particularly regarding the cancer mortality effect of the absorbed dose. [5]

The rem unit starts off with consideration of the absorbed dose, which is related to the number of ionization events in the target region. The absorbed dose, for external radiation, may correlate with the biological effects. However, the rem waters down the absorbed dose by various multipliers chosen by the ICRP based on selected biologic effects they observed from the biased assessments of the survivors of the atomic bombing of Japan.

Given the more-than-ten years of every county surrounding the INL having about double the incidence of thyroid cancer, you would think by now regulators of radiation health risk would be requiring organ dose assessments, not just a single whole body effective dose estimate. But they aren't. **Thyroid organ doses are not being presented and they would be far higher than the effective whole-body dose.** And the risk of the incidence of thyroid cancer would be far higher than the fatal cancer rate that the draft EIS uses, of 0.0006 fatal cancers per rem. [6] The thyroid organ dose would be far above the levels received from naturally occurring background radiation

[5] One rad of absorbed dose is 100 ergs per gram of tissue and 100 rad is 1 Gray. And 1 Gray is 1 Joule per kilogram. The SI unit of Gray is equivalent to 100 rad. Rad is used for absorbed dose in the U.S. which does not widely use the SI system for radiation workers or EISs, but neither rad nor rem have been defined in terms of roentgens for decades. A roentgen, used before the SI unit system was adopted, corresponds to an absorption of 87.7 ergs per gram of air, or a dose to the air of 0.877 rad.

[6] Project Pele draft EIS, page 4-36 states that a risk factor of 0.0006 LCFs per rem (person-rem) was used in this EIS to estimate risk impacts due to radiation doses from normal operations and accidents.

and this is never presented. (Read more in the July 2020 Environmental Defense Institute newsletter.)

Despite the Department of Energy's insistence and repeated portrayal that a 100 millirem/year dose, continually, every year, would be acceptable, anyone who understands anything about radiation health effects, and especially of the increased harm from internal radionuclides knows that 100 mrem per year for a lifetime would cause a health catastrophe. Even the U.S. Environmental Protection Agency, unless knuckling under nuclear industry pressure, understands that a chronic 100 mrem per year dose should be avoided and the authorized limit should be a fraction of the dose limit.

The 100 mrem per year all pathways radiation dose limit was born based on the International Committee on Radiological Protection (ICRP) assumption back in 1977 that the fatal cancer risk per rem from ionizing radiation was 0.0001 fatal cancers per rem. Then, by 1994, it was recognized that the risk of fatal cancer from ionizing radiation was at least 0.0005 fatal cancers per rem. Current Department of Energy environmental impact statements acknowledge the more recent recommendation (and also underestimate) to be 0.0006 fatal cancers per rem.

Note that the 100 mrem per year radiation health protection standard based on 0.0001 fatal cancers per rem was never changed even when the fatal cancer risk from ionizing radiation was increased 6-fold to 0.0006 fatal cancers per rem!

This is why the EPA was attempting to use 15 mrem per year as the dose limit for various radioactive waste disposal regulations. It wasn't for factors of safety below 100 mrem. It was to try to maintain the same factor of safety presumed in the 1970s that had been wild-assed, hoped for cancer rates by the ICRP! And you can read more about this in a report about TENORM which stands for Technologically Enhanced Naturally Occurring Radioactive Materials. [7]

It gets worse. No really! It gets worse. It has been known now for a few decades that radiation exposure to the developing embryo and fetus "can cause growth retardation; embryonic, neonatal, or fetal death; congenital malformations; and functional impairment such as mental retardation." [8]

In 2007, the International Commission of Radiological Protection (ICRP) lowered its estimate of the risk of genetic harm of congenital malformations by 6-fold, from 1.3E-4/rem to 0.2E-4/rem. Based on the belief that the study of the Japanese bomb survivors did not detect genetic effects, **the ICRP genetic effect estimate for humans is based on studies of external radiation of mice.**

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[7] National Research Council, Committee on Evaluation of EPA Guidelines for Exposure to Naturally Occurring Radioactive Materials. Evaluation of Guidelines to Exposures to Technologically Enhanced Naturally Occurring Radioactive Materials. Washington DC, National Academies Press, 1999. https://www.nap.edu/catalog/6360/evaluation-of-guidelines-for-exposures-to-technologically-enhanced-naturally-occurring-radioactive-materials and chapters at https://www.nap.edu/catalog/6360/evaluation-of-guidelines-for-exposures-to-technologically-enhanced-naturally-occurring-radioactive-materials#toc

[8] Eric J. Hall, *Radiobiology for the Radiologist*, 5th ed., 2000, p. 190.

The ICRP estimate of risk of congenital malformations is a fraction of its predicted cancer risk for cancer mortality (or latent cancer fatality). The ICRP latent cancer fatality risk was 5.0E-4 LCF/rem (1991 estimate), close to the cancer mortality rate used in the Department of Energy's Versatile Test Reactor EIS of 6.0E-4 LCF/rem. [9]

While the studies of genetic injury to the Japan bombing survivors declared that they found no evidence of genetic damage, other researchers have found those studies to have been highly flawed. A report published in 2016 by Schmitz-Feuerhake, Busby and Pfugbeil summarizes numerous human epidemiology studies of congenital malformations due to radiation exposure. [10]

The 2016 report disputes the ICRP genetic risk estimate and finds that diverse human epidemiological evidence supports a far higher genetic risk for congenital malformations. **Nearly all types of hereditary defects were found at doses as low as 100 mrem.** The pregnancies are less viable at higher doses and so the rate of birth defects appears to stay steady or falls off at doses above 1000 mrem or 1 rem. The 2016 report found the excess relative risk for congenital malformations of 0.5 per 100 mrem at 100 mrem falling to 0.1 per 100 mrem at 1000 mrem.

The 2016 report's result for excess relative risk of congenital malformations of 5.0/rem is 250,000-fold higher than the ICRP estimate of 0.2E-4/rem which ICRP appears to assume has a linear dose response. (See the August 2021 Environmental Defense Institute newsletter.)

The bottom line is that the nuclear industry and especially the Department of Energy is grossly underestimating the fatal cancer risk of their radiological releases, and ignoring serious adverse health effects such as cancer incidence, heart disease, reduced immune system function, fertility problems, increased rates of infant death, and reduced life span. And they are also grossly underestimating the risk of genetic effects of ionizing radiation exposure prior to conception that are passed on to their children and grandchildren, by relying on ICRP's industry-biased recommendations.

Understanding the Distortion of "Effective Whole-Body Doses" in millirem presented by the Department of Energy

Although not always delineated as "effective" whole-body radiation doses, the dose estimates in millirem (mrem) that are provided in Department of Energy environmental surveillance annual reports for the Idaho National Laboratory are given only in "effective" whole-body dose.

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[9] U.S. Department of Energy's Versatile Test Reactor Draft Environmental Impact Statement (VTR EIS) (DOE/EIS-0542) (Announced December 21, 2020). A copy of the Draft VTR EIS can be downloaded at https://www.energy.gov/nepa or https://www.energy.gov/ne/nuclear-reactor-technologies/versatile-test-reactor. (See discussion in VTR EIS Appendix C, page C-4).

[10] Inge Schmitz-Feurerhake, Christopher Busby, and Sebastian Pflugbeil, *Environmental Health and Toxicology, Genetic radiation risks: a neglected topic in the low dose debate*, January 20, 2016. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4870760/ The 2016 report found the "excess relative risk for congenital malformations of 0.5 per mSv at 1 mSv falling to 0.1 per mSv at 10 mSv exposure and thereafter remaining roughly constant."

What this means, actually, is that the non-physical concept of "effective" whole body doses does not provide meaningful doses for estimating fatal cancer risk because the organ absorbed doses are unstated. In addition, the basis for assigning importance of various organs or tissues to the contribution to cancer mortality is based primarily on the external gamma dose received by survivors of the 1946 atomic bombing of Japan and it tells nothing about the cancer risks when radionuclides are inhaled or ingested and incorporated into the body. Cesium-137 mimics potassium, strontium-90 mimics calcium, plutonium-239 mimics iron, etc.

Even with accounting for the clearance of the radionuclide from the body and accounting for the tendency for the radionuclide to accumulate in certain organs such as the thyroid or in bone tissue — the harm from internal radiation is greater than from external radiation and is not accounted for by the nuclear industry's International Committee on Radiological Protection (ICRP) models because of their reliance on reviewing the radiation harm from external radiation.

Don't blame the ICRP. They are just nuclear weapons industry-funded folks who don't actually understand human biology. Anyone not sticking to the nuclear industry agenda would be booted out, sooner or later.

An "effective" dose in rem builds into the rem estimate various multipliers that lower the rem value based on nuclear promotor's opinions of the cancer mortality effect of radiation to various parts of your body. And this is in addition to the multipliers regarding the type of radiation, the *equivalent* dose, that increase the dose from alpha radiation and neutron exposure over that of gamma exposure.

The Department of Energy tries to tell people they really don't need a healthy thyroid because people don't often die of thyroid cancer. Never mind how important a healthy thyroid is to the developing fetus/embryo in utero. It reminds me of an old Monte Python comedy, when organ harvesters try to tell the patient that "you really don't need a liver" as they cut out the person's liver to sell the organ for profit.

I have never understood before now just how the "effective" rem dose is lowered before the ICRP's low-balled cancer mortality rate is even applied. I say this because in 1990, John W. Gofman's review of the atomic bomb effects on Japanese survivors predicted 0.0026 fatal cancers per rem, [11] which is over 4 times higher than the current Department of Energy fatal cancers per rem value of 0.0006. But even Gofman's prediction would underestimate the cancer risk from internal radiation, such as the iodine-129, strontium-90, cesium-137, americium-241, plutonium-239, and others, which make up most of the radiation dose from INL radiological releases.

Effective whole-body dose in rem (or millirem which is one thousandth of a rem) starts off with an estimate of absorbed dose but then keeps reducing and further reducing the estimated

[11] John W. Gofman, M.D., Ph.D., Committee for Nuclear Responsibility, Inc., "Radiation-Induced Cancer from Low-Dose Exposure: An Independent Analysis," 1990. See more in the August 2021 Environmental Defense Institute newsletter.

dose on the basis on ICRP opinion of the likelihood of that organ to cause cancer mortality based on external exposure. Then ICRP sums the reduced organ doses, again weights the organs to reduce their importance and thus the black box spits out an "effective" whole body dose.

This method for estimating the effective whole-body dose had actually originally been called **the doubly-weighted organ doses model** or construct, according to a 2017 article by Fisher and Fahey on *Appropriate Use of Effective Dose in Radiation Protection and Risk Assessment*. [12] For additional information about how misleading the "effective dose" is, read *Burdens of Proof* by Tim Connor, Energy Research Foundation, 1997 regarding the multiple failures to attribute Hanford radiological releases to the thyroid cancers in the region.

As far back as 1977, the U.S. Environmental Protection Agency recognized that continued exposure over substantial portions of a lifetime near 100 mrem per year should be avoided, read more in the TENORM report. [13] In 1977, it was assumed by the ICRP that the risk of fatal cancers was 0.0001 per rem (or 1.0E-5 per millisievert in SI units). Various radiation regulations were based on this assumption. It was recognized by 1994 that the fatal cancer risk was higher, at 0.0005 per rem. Even the ICRP currently recognizes that the fatal cancer risk from ionizing radiation is now at least 0.0006 per rem.

The 100 millirem (mrem) per year all pathways radiation dose limit is greatly emphasized by the Department of Energy as the dose they consider allowable. Air permits may be regulated by the U.S. Environmental Protection Agency or by the states, but in either case, the EPA and the state, such as the State of Idaho, will often emphasize that the state cannot regulate Department of Energy radiological emissions. In Idaho, the State of Idaho Department of Environmental Quality will issue an air permit to the Department of Energy based entirely on the DOE's stated radiological release guesses or estimates, the Department of Energy contractors monitoring or lack thereof, and the State will agree to rapid records destruction of radiation monitoring of open-air radioactive waste evaporation ponds that is fully intended to cover up any radiological releases in excess of agreed to quantities. This is precisely the situation at the Idaho National Laboratory's Advanced Test Reactor air permit with the State of Idaho. Even if the Idaho DEQ can, it is typically staffed by people who fall in line and go along with what ever the Department of Energy wants.

In the Department of Energy's environmental monitoring reports, it is greatly emphasized that the DOE's derived concentration standards (DCGs) are safe as they imply a dose of 100

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[12] Darrell R. Fisher and Frederic H. Fahey, *Health Phys*., "Appropriate Use of Effective Dose in Radiation Protection and Risk Assessment," August 2017, PMID: 28658055 and https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5878049/

[13] National Research Council, Committee on Evaluation of EPA Guidelines for Exposure to Naturally Occurring Radioactive Materials. Evaluation of Guidelines to Exposures to Technologically Enhanced Naturally Occurring Radioactive Materials. Washington DC, National Academies Press, 1999. See page 108. https://www.nap.edu/catalog/6360/evaluation-of-guidelines-for-exposures-to-technologically-enhanced-naturally-occurring-radioactive-materials and chapters at https://www.nap.edu/catalog/6360/evaluation-of-guidelines-for-exposures-to-technologically-enhanced-naturally-occurring-radioactive-materials#toc

mrem per year. By now, you may be starting to understand why 100 mrem per year would actually guarantee a health catastrophe to the health of people, especially children.

Before the late 1990s, radiation risks to females was generally treated as roughly equal to the radiation risks to males. But by the late 1990s, studies of the survivors of the atomic bombing of Japan in 1945 by the International Commission on Radiation Protection (ICRP) had higher radiation risk harm to women than men, for the same dose. And the studies showed higher cancer risk to children, especially female children, than to adults for the same dose. The National Research Council BEIR VII report issued in 2006 found even higher risks to women and children. See Institute for Energy and Environmental Research (IEER.org) report, *Science for the Vulnerable*, for additional insight. [14] (Read more in the August 2020 Environmental Defense Newsletter.)

The Department of Energy's DCG from gross alpha radioactivity in air for a 100 mrem per year dose are getting closer to the DCG for gross alpha radioactivity in air and are actually being exceeded from time to time in southeast Idaho. The most restrictive DCG is for americium-241 at 20 E-15 microcuries per milliliter (E-15 uCi/mL). With gross alpha radioactivity air usually below 4 E-15 uCi/mL, it is notable that values such as 7.2 E-15 uCi/mL occur (see Blackfoot monitoring in 2012). The increasing gross alpha radioactivity in air values are within a factor of three or four of the DCG.

There are large fluctuations in the concentrations of gross beta radioactivity in air in southeast Idaho and these fluctuations appear to be due to the INL's airborne radiological releases, despite statements to the contrary by the Department of Energy's environmental surveillance contractor. In 1998, the gross beta radioactivity in air concentrations ranged from 8 to 38 E-15 uCi/mL. In contrast, in 2002, gross beta concentrations ranged from 8 to 129.4 E-15 uCi/mL. The Department of Energy's environmental surveillance contractor continues to assert that no detected radioactivity could be attributed to the INL, stating: "In general, gross alpha and gross beta activities show levels and seasonal variations not attributable to INEEL releases. Seven of the weekly gross beta results showed statistical differences between boundary and distant locations. In all cases the differences were attributed to natural variation or to inversion conditions." And as typical of every INL annual environmental surveillance report no matter what they detect in their monitoring, they state: "In summary, the results of the monitoring programs for 2002 presented in this report indicate that radioactivity from current INEEL operations could not be distinguished from worldwide fallout and natural radioactivity in the region surrounding the INEEL."

The Department of Energy embraces only the effective whole-body dose while ignoring the far higher organ doses, such as the absorbed dose to the thyroid from Idaho National Laboratory releases of iodine-131, iodine-129, americium-241 and other radionuclides.

[14] Arjun Makhijani, Ph.D., Brice Smith, Ph.D., Michael C. Thorne, Ph.D., Institute for Energy and Environmental Research, *Science for the Vulnerable Setting Radiation and Multiple Exposure Environmental Health Standards to Protect Those Most at Risk*, October 19, 2006.

While the International Commission of Radiological Protection (ICRP) continues to say that "Radiation induced heritable disease has not been demonstrated in human populations," Chis Busby writes that evidence of genetic effects *has* been found in humans and at very low radiation doses. [15] [16]

Robin Whyte wrote in the *British Medical Journal* in 1992 about the effect in neonatal (1 month) mortality and stillbirths in the United States and also in the United Kingdom. The rise in strontium-90 from nuclear weapons testing from 1950 to 1964 has been closely correlated, geographically, with excess fetal and infant deaths. The doses from strontium-90 due to atmospheric nuclear weapons testing were less than 50 millirem (or 0.5 millisievert), according the Chris Busby. Radioactive fallout from atmospheric nuclear weapons testing would not only include strontium-90, it would include iodine-131, tritium, cesium-137, and other radionuclides, including plutonium. [17] The extent of the nuclear weapons testing immorality continues to astound me and I applaud the work being done to reduce the risk of human extinction from nuclear weapons. [18]

The ICRP maintains that human evidence of genetic effects due to radiation does not exist. The ICRP then uses the study of external radiation on mice to estimate the heritable risks for humans. One study was conducted using internal radionuclides on mice and the study noted that "detailed research on internal radiation exposure has hardly ever been reported in the past." [19] **This limited study of microcephaly in mice found that far lower doses of internal radiation caused the same effect as higher doses of external radiation.**

[15] Chris Busby, *The Ecologist*, "It's not just cancer! Radiation, genomic instability and heritable genetic damage," March 17, 2016. https://theecologist.org/2016/mar/17/its-not-just-cancer-radiation-genomic-instability-and-heritable-genetic-damage

[16] Chris Busby, Scientific Secretary, European Committee on Radiation Risk, Presentation, *Radioactive discharges from the proposed Forsmark nuclear waste disposal project in Sweden and European Law*, September 8, 2017. Online pdf 646_Nacka_TR_M1333-11_Aktbil_646_Christopher_Busby_presentation_170908

[17] R. K. Whyte, *British Medical Journal*, "First day neonatal mortality since 1935: re-examination of the Cross hypothesis," Volume 304, February 8, 1992. https://www.bmj.com/content/bmj/304/6823/343.full.pdf

[18] Jackie Abramian, ForbesWomen, "After Her Nuclear Disaster Dress Rehearsal, Cynthia Lazaroff Has A Wake-Up Call For Our World As We Sleepwalk Into Nuclear Extinction," September 21, 2021. https://www.forbes.com/sites/jackieabramian/2021/09/21/after-her-own-nuclear-disaster-dress-rehearsal-cynthia-lazaroff-has-a-wake-up-call-as-our-world-sleepwalks-into-nuclear-extinction/?sh=6a22151d62e2 Lazaroff has founded NuclearWakeupCall.Earth due to her concern over nuclear weapons. "There are nearly 13,500 nuclear warheads in current arsenals of nine nuclear-armed states. That the U.S. has more nuclear warheads than hospitals should be a wake-up call," says Lazaroff.

[19] Yukihisa Miyachi, J-STAGE, "Microcephaly Due to Low-dose Intrauterine Radiation Exposure Caused by 33P Beta Administration to Pregnant Mice," 2019 Volume 68 Issue 3 Pages 105-113. https://www.jstage.jst.go.jp/article/radioisotopes/68/3/68_680303/_article/-char/en

What Really Happened in Southeast Idaho in 2002 to 2003? The Search for the Cause of Microcephaly in SE Idaho

What really happened in Idaho Falls in 2002 and 2003. The doses from airborne radiation are often due to food ingestion. Srontium-90, cesium-137, plutonium and americium have long half-lives and would not be reduced by radioactive decay before being consumed.

Significantly elevated levels of gross alpha and gross beta radioactivity in air were detected and higher radiological airborne releases were acknowledged (see Figure 1 earlier in this newsletter.)

The increased effectiveness of dyes used in open-air radioactive waste evaporation ponds to increase the evaporation rate may have caused more rapid release to the environment than has been typical of the past Idaho National Laboratory releases. It appears to me that the Department of Energy's environmental surveillance contractor tries to tamp down the high values by calling them "outliers."

And you know it's bad when the environmental monitoring contractor decides to down-shift the units that gross beta radioactivity is presented in. What they actually did was switch the units that had been used for many years, 1.0E-15 microcuries/milliliter E-15, to 1.0E-14 microcuries/milliliter. So, what previously would have been displayed as 100.0 E-15 microcuries/milliliter became 10.0 E-14 microcuries/milliliter, with that detail in a tiny font in the table notes.

This trickiness and the units downshifting happened in 2002. And the environmental monitoring reports for the second quarter of 2002 are still not available on Idahoeser.com, the Department of Energy's environmental surveillance contractor.

There's another physical reason I can think of that may have increased the radionuclide releases from the INL beyond what is admitted in the published estimates of radionuclide releases. The Department of Energy has long been covering up the extent to which the radioactively-laden resin beads had been escaping from the Advanced Test Reactor's resin bed cleanup system. The radioactively-laden resin beads would escape through a water filter break and be released to the open-air pond, rather than be confined and then buried over the Snake River Plain aquifer. The unintended release of the radioactively-laden resin beads continued over many years but this is not admitted. CERCLA cleanup reports document that the Department of Energy had discovered this radioactive material near a pipe leak in a pipe leading to the ponds and sought to keep it under the radar. The declaration of the unintended release of resin beads occurs only in one DOE Occurrence Report [20] and when I inquired about it, the DOE's INL contractor, Battelle Energy Alliance, refused to answer any questions. The Idaho Department of

[20] A Department of Energy Occurrence Report (OR) was identified in May of 2016. The OR number is NE-ID-BEA-ATR-2016-0014 "Contaminated Soil Outside Warm Waste Evaporation Pond at the ATR Complex." The OR, attached, describes soil contamination being found during non-routine monitoring that was conducted for evaporation pond liner replacement at the ATR Complex at the Idaho National Laboratory.

Environmental Quality CERCLA cleanup expert told me that he had not been told of any massive releases from the INL and so he knew nothing of it and he was not going to pursue it. Never mind that this CERCLA DEQ manager didn't bother to understand that the INL had "remediated" the contamination in ways contrary to CERCLA requirements. (Read more in the November 2017 Environmental Defense Institute newsletter.)

The Idaho DEQ folks involved with air permits for the INL were concerned about the unintended releases of radioactively-laden resin beads to the radioactive waste evaporation ponds, releases occurring perhaps routinely over who knows how many years, but had to defer to the nuclear experts at DEQ who refused to question what was going on.

The U.S. EPA agreed to look into the matter, but basically it was the pretense of an investigation and not in any way a competent investigation. Had a full investigation been conducted, there should have been a report of findings as to how long, for how many years, radioactively-laden resin beads had been flushed to the pond and an estimate of how much radioactivity had been released that had not been reported in accordance with EPA clean air laws.

As I have delved more deeply into the recent decades of Idaho National Laboratory radiological contamination, it explains to me, at least, why I heard of several birth defects occurring in 2003.

Chris Busby reports finding that very low internal radiation doses are linked to heritable effects and especially to barium-140, strontium-90, tritium, radium-226, and uranium, including uranium-234, uranium-235 and uranium-238. [21] The Department of Energy's environmental surveillance program virtually ignores the monitoring of uranium radioisotopes despite large annual releases of uranium and numerous facilities that release uranium, plus the high releases of plutonium which decay through the uranium decay series, as Pu-238 decays to U-234, and Pu-239 decays to U-235.

When I had heard of these birth defects many years ago, I had wondered if it was due to the radiological exposure of the grandparents. I knew that one of the grandparents had worked with the INL. But only recently did I learn that one of the cases involved microcephaly. And this would more likely entail radiation exposure to the mother during the pregnancy. Microcephaly was observed to have occurred to children exposed in utero to the 1945 atomic bombing of Japan. Microcephaly occurs when the brain stops growing at the normal rate and this prevents the cranium from growing at the normal rate. Radiation exposure to the developing child in utero is one cause of microcephaly.

[21] Christopher Busby, *Clinical Pharmacology & Toxicology Journal*, "Radiochemical Genotoxicity Risk and Absorbed Dose," September 14, 2017. https://www.imedpub.com/articles/radiochemical-genotoxicity-risk-and-absorbed-dose.php?aid=20305

The radiation exposures while the child is in utero would need to occur in the cause of microcephaly but this is not the case for other **birth defects which can be caused prior to conception.**

I can't know whether or not INL radiological releases were the cause of the observed cases of birth defects in 2003, but I can say that my investigation of the environmental reporting of that time frame reveals higher than typical radiological releases from the INL and also the attempts to minimize the appearance of anything unusual by the Department of Energy.

Articles by Tami Thatcher for October 2021.