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Navy Issues Final Environmental Impact Statement for $1.6 Billion Facility But Keeps the Old Risky Facility

The final environmental impact statement for the Naval Reactors Facility at the Idaho National Laboratory offered three alternatives: do nothing, repair the old spent nuclear fuel storage pool facility, or build a new facility. The Navy made the case that they needed the new one because it was too expensive and impractical to try to refurbish the 50 year old Expended Core Facility (ECF) pool. But the Navy is setting about repairing the old Extended Core Facility (ECF) storage pool to keep it in service not only for the transition period of 5 to 12 years, but beyond AND building a new pool.

The double-talk isn't just about keeping the old ECF and building a new facility. It is about how the radioactively contaminated water continues to leak from ECF, how much contaminated soil is below the ECF that leakage pushes into the aquifer. And it's about how the solid radioactive waste streams are not adequately disclosed. Not labeling waste as greater-than-class C radioactive waste is different than not actually having it. We know that the NRF creates greater-than-class C waste and buries it over the Snake River Plain aquifer. I have to concede that the Navy's EIS is consistent — almost every aspect of the Navy's EIS is deceptive.

Building the new facility is fine. But putting on this show to pretend to be telling it like it is when they aren't — that's not transparency.

The final EIS summary says that radioactive waste is packaged into waste containers and shipped from the NRF facility. What the summary doesn't say is that this waste is shipped to be buried over the Snake River Plain aquifer at the INL's Radioactive Waste Management Facility (RWMC) or later to its replacement at the INL.

The new replacement for the RWMC is the Remote-Handled Low-Level Waste Disposal Facility. This disposal facility will accept three primary types of RH-LLW: activated metals, ion-exchange resins, and miscellaneous contaminated debris. The activated metals are generated by ATR Complex operations, **Naval Reactors Facility operations**, and from processing waste stored in the **Radioactive Scrap and Waste Facility at the Materials and Fuels Complex**. The activated metals are typically reactor core components replaced during core internal changeouts and are made from stainless steel, inconel, zircaloy, or aluminum. The ion-exchange resins are ceramic beds used to purify reactor cooling water as part of routine operations at the **Naval Reactors Facility** and the ATR Complex. [1]

The leakage of the ECF historically and now wasn't disclosed. Despite claimed reuse of water, the NRF complex uses 37 million gallons per year. Water leaking from the ECF and waste water disposed of in the Industrial Waste Ditch in previous decades contained large amounts of toxic chemicals and radionuclides. The CERCLA cleanup information for NRF is kept separately and is more difficult to find than cleanup information for the INL. While better practices are used now than in the past, tritium, however, isn't filtered and would be continuing to leak into the aquifer. Radioactive contaminants in the soil from NRF operations at INL include cesium, strontium, plutonium, americium, uranium, neptunium, and nickel. ECF water has in the past released tritium, carbon-14, manganese-54, cobalt, nickel, strontium, cesium and yttrium. Many of these contaminants are found in the aquifer downgradient of NRF because of past NRF waste water practices. [2] The NRF EIS glosses over its past, current and future polluting practices.

The upgrade was a stealth operation to build a new facility basically for the new monster casks, the M-290, that the current ECF can't handle.

Another EIS is to be submitted in the future to address building new destructive fuel examination facilities to replace the existing one.

The Navy hides its historical airborne radiation releases from INL's NRF, aggressively minimizes to a fictional extent its radiation worker doses and the harm they have caused, excludes its workers from energy worker illness compensation, and actively hides the extent of historical aquifer contamination. The Navy pretends to wear a halo about its practices yet largely keeps its Superfund/CERCLA cleanup documentation out of the rest of the INL cleanup documentation as well as the EIS. This blatant "bait and switch" final EIS is a very deceptively worded environmental impact statement and the public needs to understand "the rest of the story."

See the Naval Reactor Facility final environmental impact statement at www.ecfrecapitalization.us and the summary at http://www.ecfrecapitalization.us/EIS-0453-FEIS_Summary.pdf See EDI's comments on our website.

[1] Battelle Energy Alliance, Idaho National Laboratory, "Evaluation of Groundwater Impacts to Support the National Environmental Assessment for the INL Remote-Handled Low-Level Waste Disposal Project," INL/EXT-10-19168, August 2010 at https://inldigitallibrary.inl.gov. .

[2] See CERCLA cleanup INL WAG 8 Remedial Investigation and Feasibility Study documentation.

Still No Schedule for INL's Integrated Waste Treatment Unit (IWTU) Operation

The Department of Energy reported the status of the Integrated Waste Treatment Unit at the Idaho National Laboratory at the October INL Citizens Advisory Board meeting. The IWTU is supposed to have treated 900,000 gallons of liquid radioactive waste from fuel reprocessing activities by 2012. The 2012 treatment date is still an Idaho Settlement Agreement milestone that the department has not met. Another schedule for commitments with the State of Idaho to empty tanks holding the waste, renegotiated just last year was missed this fall.

New cleanup contractor Fluor has laid out a four-phase plan to get IWTU up and running but only phase 1 is complete. There is no schedule and they have admitted that they will not be treating the waste any time soon.

The Idaho Falls Post Register reported that Idaho Attorney General Lawrence Wasden pointed out at the meeting that "at some point, those (radioactive waste) tanks will leak. . .that's not an if, that's a when. And we're 60 years closer to that day, because that waste has been in those tanks for about 60 years." [3]

Wasden continues to not sign a waiver to allow spent fuel into the state because the contract with the Department of Energy allowed shipments only if DOE was meeting its milestones in the Idaho Settlement Agreement.

Wasden said that the department has not "proffered a cure" to fix their noncompliance with the settlement agreement. If the tanks begin leaking, the leakage may be detected in the concrete vaults; however, there may be little that can be done to stop the leak or remediate soil. Radionuclides in the soil eventually migrate to the aquifer below.

The tank radionuclide inventory in the liquid sodium-bearing waste to be processed by the IWTU and the anticipated air emissions during processing are provided in Idaho Cleanup Project EDF-6495. [4] The radionuclides include cesium and strontium and long-lived radionuclides including americium, plutonium, uranium, iodine-129, technetium-99, neptunium-237, and carbon-14. Even if and when the liquid waste is treated, much of the plutonium-laden sludge is expected to remain in the tank heels, to be topped off with a concrete grout in hopes of slowing waste migration to the aquifer.

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[3] Reporter Luke Ramseth, *The Idaho Falls Post Register*, "Progress, but no timeline, on IWTU operations," October 28, 2016.

[4] Idaho Cleanup Project, CH2M.WG Idaho, LLC, Engineering Design File, "Mass and Energy Balance for Sodium Bearing Waste Integrated Waste Treatment Unit – Modified to Support Emissions Permitting," EDF-6495, February 18, 2009.

Table 1. Radionuclide inventory of liquid sodium-bearing waste in aging tanks above the aquifer.

Radionuclide (half life)	Inventory (curie)	Maximum contaminant level	Dilution volume (Liter)	Number of aquifers to dilute
Strontium-90 (29.1 year)	128,000	8 pCi/L	1.6 E+16	6.6
Cesium-137 (30.2 year)	196,000	160 pCi/L	1.2 E+15	0.5
Carbon-14 (5730 year)	5.7E-4	2000 pCi/L	2.85 E+5	<<1
Iodine-129 (17,000,000 year)	0.115	1 pCi/L	1.15 E+11	<<1
Technetium-99 (213,000 year)	94.6	900 pCi/L	1.05 E+11	<<1
Neptunium-237 (2,144,000 year)	2.73	15 pCi/L	1.82 E+11	<<1
U-234 (245,500 year)	6.07	15 pCi/L	4.05 E+11	<<1
Americium-241 (432 year to Np-237)	356	15 pCi/L	2.37 E+13	0.01
Plutonium-238 (87.7 year)	4210	15 pCi/L	2.8 E+14	0.115
Plutonium-239 (24,000 year)	456	15 pCi/L	3.04 E+13	0.01246

a. The unit of 1 picoCurie/liter is 1.0E-12 curie/liter. The limit of 15 pCi/L for total alpha (40 CFR 141) excluding uranium. For uranium, total natural uranium limit of 30 microgram/liter is for all combined uranium isotopes.
b. Aquifer volume of 2.44E+15 liters is assumed.
c. The dilution of the volume ignores soil adsorption and migration delay timing; it is provided to give some perspective on the amount of the waste involved. It ignores the fact that the entire aquifer is not going to be involved with dilution, although the waste in the aquifer can fan out and involve a considerable portion of the aquifer downgradient from where the waste enters the aquifer.

Objections to Proposed Aboveground Waste Storage at WIPP

Efforts to re-open the Waste Isolation Pilot Plant (WIPP) in New Mexico after the two accidents in 2014 continue for the deep salt mine facility. Plutonium and other radioactive waste is disposed of at the WIPP facility that is trucked in from Department of Energy facilities around the country. The waste, much of it transuranic, was generated in nuclear weapons production activities. Transuranic waste includes plutonium and americium that remain radioactive for geologic time frames.

The department is asking the State of New Mexico for permission to approve aboveground storage in about 2 acres of land. Special casks are to be used for the aboveground storage and the storage is to be temporary.

Idaho Settlement Agreement milestones for shipping transuranic waste from the Idaho National Laboratory are impacted by the WIPP closure. Shipping progress milestones have been missed and the completion milestone for shipping waste will be missed. Even if WIPP restarts soon, the backlog of waste shipments from various Department of Energy facilities is large and the pace of accepting and processing shipments is expected to be far slower than before the WIPP accidents.

Shipments of INL transuranic waste to WIPP are not expected to resume before next spring. [5] **Note that shipments of aboveground stored Rocky Flats transuranic waste at INL are to be shipped to WIPP but despite an ongoing buried waste retrieval operation at the INL's Radioactive Waste Management Complex, very little of the buried transuranic waste will actually leave Idaho. Most of the buried Rocky Flats TRU and all the other buried radioactive waste will remain buried at the RWMC to trickle into the Snake River Plain Aquifer for millennia.**

Read more at www.wipp.energy.gov and at Albuquerque-based Southwest Research and Information Center which has opposed the aboveground storage and continuing efforts by the department to expand the range of wastes to be disposed of at WIPP.

Russia Suspends Plutonium Deal with US

Russian President Vladimir Putin has suspended a deal with the United States on the disposal of weapons-grade plutonium. The agreement made in 2000 and was expanded in 2006 and 2010, called for Russia and the US to each dispose of 34 metric tons of weapons-grade plutonium. [6] Disposal of the weapons plutonium was to be accomplished by mixing it with uranium to make mixed-oxide (MOX) fuel usable in commercial nuclear reactors.

Continuing cost overruns have led to suggesting disposing of excess weapons plutonium at WIPP because of continuing problems at the South Carolina mixed-oxide (MOX) plant that remains under construction. Putin pointed to the unfinished US MOX plant and said the US had failed to meet its end of the deal. He also said that buried plutonium could be dug up.

Utah Exhibit on Utah Downwinders

The nuclear weapons testing fallout from 1950s and 1960s weapons testing in Nevada that blew over Utah and the US is the subject of an exhibit that opened at the University of Utah. [7] The exhibit's goal is to ensure that future generations remember this period in history. Many people believe that the radioactive fallout caused cancer, leukemia and other health issues among people living downwind from the Nevada Test Site, then run by the Atomic Energy Commission that later became the Department of Energy.

[5] Reporter Luke Ramseth, *The Idaho Falls Post Register*, "Idaho transuranic waste won't leave until spring – WIPP to reopen soon, but nearby waste will be processed first," November 2, 2016.

[6] Reporter V. Isachenkov, *The Idaho Falls Post Register*, "Putin suspends weapons-grade plutonium deal with the US." October 4, 2016.

[7] Associated Press, *The Idaho Falls Post Register*, Utah exhibit shows nuclear testing's downwind effects, October 9, 2016.

The extent of harm to human health from the radiation fallout from the testing remains under study and remains controversial. But is acknowledged that between 10,000 and 75,000 people were exposed to doses of radiation that significantly raised their risk of getting thyroid cancer, according to a 1997 National Cancer Institute study that took 15 years to complete.

Other states, including Idaho, received high amounts of radioactive fallout from Nevada weapons testing. Fallout included iodine-131 that settled on grass, was eaten by cows and thus entered the milk the people, including children, consumed. [8] Many other radionuclides including strontium, cesium and tritium were in the radioactive fallout over the US, but particularly western states. Bomb testing variations and wind and weather patterns varied the total amount and the local concentration of the radioactive fallout.

Rocky Flats Settlement: Too Little, Too Late

Some of the economic harm from loss of property value near the Colorado Rocky Flats weapons production plant is to be compensated, 26 years after the harm. [9] This long legal contest has ended in settlement. Yet, people who lost their health from the polluted air, soil and water have never been compensated. To gain more insight into the harm from past operations at Rocky Flats, I suggest you read Kristen Iversen's ***Full Body Burden***.[10] While workers may be eligible for Energy Employee Occupational Illness Compensation, those living near the plant, especially children living and playing in plutonium-laden soil and water, will never be compensated. State medical professional Carl Johnson studied the harm from Rocky Flats, but his efforts were rewarded by having to seek employment outside of Colorado.

INL's Role in Gateway for Accelerated Innovation in Nuclear (GAIN) Initiative

INL Director Mark Peters says the Idaho National Laboratory is leading the Gateway for Accelerated Innovation in Nuclear (GAIN) Initiative to help sustain the existing fleet of nuclear reactors and develop the next. Peters also said in an October 14 editorial that INL will continue to provide support to NuScale Power as it works to develop the world's first operational small modular reactor.

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[8] Read more about Nevada Test Site fallout in past EDI newsletters including February 2006, May 2005, and April 2005 at www.environmental-defense-institute.org

[9] John Aquilar, The Denver Post, "Payouts to property owners in long-running Rocky Flats suit should start in 2017," August 3, 2016. http://www.denverpost.com/2016/08/08/rocky-flats-payout-property-owners/

[10] Kristen Iversen, *Full Body Burden – Growing Up in the Nuclear Shadow of Rocky Flats*, www.crownpublising.com, ISBN 978-0-307-95563-0, Copyright 2012.

How is the INL supposed to provide support to NuScale if it is to provide expertise to the Nuclear Regulatory Commission in deciding how to regulate the NuScale Small Modular Reactor? No doubt this conflict of interest will have some interesting effects.

INL will keep the economically and environmentally unsustainable fast reactor dreams alive, but their pressing priority is to study how to detect if other countries are pyroprocessing spent nuclear fuel to get weapons material. For this, the INL wants a research quantity of spent nuclear fuel to experiment with in the Materials and Fuels Complex pyroprocessing facility. The INL generously sold their pyroprocessing technology to the South Koreans saying there was no such concern.

INL's Materials and Fuels Complex Radioactive Scrap and Waste Facility Public Comment Period Ends December 16

Material pyroprocessed at the INL and other MFC hot cell operations are typically stored outdoors in vertically buried carbon steel liners buried in tidy rows below ground at the Radioactive Scrap and Waste Facility (RSWF), constructed in 1965. The RSWF is a roughly 4-acre buried waste facility that can hold over 1300 retrievable carbon steel liners of various sizes, from outer-diameter 16-inches to 60-inches, and 10 to 15 feet in length. The waste, much of it plutonium-laden, is usually placed in paint-can-like cans placed inside the liners. The waste includes spent nuclear fuel from the EBR-II sodium-cooled reactor, other irradiated spent nuclear fuel and highly radioactive waste from hot cell operations. The hydrogen build-up and corrosion degradation of containers has happened and continues to be a problem for the RSWF. [11]
The State of Idaho permit modification request regarding some aspects of the Radioactive Scrap and Waste Facility will be discussed at a November 9 meeting in Idaho Falls. The Idaho Department of Environment Quality contact is Garrett Bright. [12]

[11] Battelle Energy Alliance, Idaho National Laboratory, "Safety Analysis Report for the Radioactive Scrap and Waste Facility (MFC-771)," SAR-407, August 23, 2012. p. 3-20, The radioactive inventory of the RSWF is 15 million curies, at time of placement, and may exceed 700 g U-235 and 450 g Pu-239 per liner. https://www.emcbc.doe.gov/SEB/ICPCORE/Documents/Document%20Library/Radioactive%20Scrap%20and%20Waste%20Facility%20(RSWF)%20Safety%20Analysis%20Report%20(SAR).pdf See also a 1994 presentation by Hoskins, 7/11/94, stating that the Radioactive Scrap and Waste Facility had 11.3 metric tons heavy metal (MTHM) of spent nuclear fuel in 1994 (plutonium, uranium and thorium). See ID-10054-81 which states that as of 1981 the RSWF had about 10 million curies of radioactive material.

[12] State of Idaho Permit Modification Request and Public Comment period for the Materials and Fuels Complex Radioactive Scrap and Waste Facility. DEQ contact Garrett Bright (208) 373-0163. See https://inldigitallibrary.inl.gov/PRR/166128.pdf for more information.

Just what they plan to do with cans too corroded to retrieve from the liners? Is the soil and aquifer monitoring at MFC adequate? Has the extent of soil contamination below the liners been independently confirmed? And just what is the time frame for replacing this aging storage facility or moving the material to other INL or off-INL radioactive waste dumps?

Airborne pyroprocessing radioactive emissions historically have not been well characterized, and existing records of past radioactive emissions entries are known to be incomplete and unreliable. Airborne release filtering and air monitoring did evolve over time at the INL and air hold-up tanks were used to delay MFC releases if wind velocity and direction was not deemed favorable. If emissions could be adequately predicted by theoretical estimates, waiver of the Idaho Settlement Agreement to allow shipping research quantities of spent nuclear fuel for testing the emissions would not be needed. Environmental records from the early decades that would be some indication of the highly variable airborne radioactive emissions from the INL historically have been destroyed. More recent monitoring information by the Idaho Department of Environmental Quality, between the late 1980s and 2010, is being withheld from public view and requires permission for in person visitation to the Idaho Falls office.

Another Aquifer Well at the INL Has Mystery PCE

The INL continues to investigate the high concentrations of PCE (perchloroethylene or tetrachloroethylene) in the aquifer at the INL. Now a second deep well was found contaminated with the chemical, PCE, typically used as a degreaser. The Department of Energy, US Geological Survey and cleanup contractor Fluor maintain that the PCE is coming from inside the well shaft itself, which is sealed off from the surrounding aquifer with plastic piping, said a Post Register article. [13]

USGS multi-level deep well MIDDLE-2051 has been sampled numerous times during the last year and found to have levels of the chemical above drinking water standard of 5 micrograms per liter on multiple tests. The MIDDLE-2051 well had 824 micrograms of PCE. Now tests show 830 micrograms of PCE per liter in a well south of the Advanced Test Reactor, USGS well 2050A. These are uniquely designed wells and only used for water sampling. But how are these aquifer monitoring wells actually monitoring the aquifer if water from the aquifer is not what is being sampled?

[13] Report Luke Ramseth, *The Idaho Falls Post Register*, "More water tests show odd chemical at DOE desert site – Additional testing, cleanup of wells slated in coming months," October 27, 2016.

See our July and October 2016 newsletters for previous articles about the PCE problem at the INL in the aquifer.

Understanding Radiation-Induced Breast Cancer Risk from Medical Radiation Including Breast Mammography

I am reminded during October's Breast Cancer Awareness Month with money-raising phone campaigns, pink full page ads, and health insurance company phone calls herding women toward mammography that one thing is certain: breast cancer mammography is big business. I think that the October event might more aptly be called **"Screaming Mammography"** and be accompanied with straight talk about painfully compressed breasts and the radiation breast dose received.

Women need to understand that the breast dose they receive from each mammography exam and how **the number of exams they have in their lifetime adds to their screening mammography radiation-induced cancer risk**.

Women need to understand the fact that their radiation dose from mammography may be significantly higher than the advertised average dose for a variety of reasons: the brand and type of machine, whether the woman has larger breasts or augmented breasts and needs additional x-rays views taken, and whether additional x-rays views are taken to examine anomalies.

Women also should know that other medical radiation exposures other than mammography may add significantly to the cumulative dose from all radiation exposures. Medical radiation to the breast can come from CT scans to the heart, lung or abdomen. Many CT scans can give radiation doses over 400 times higher than a conventional chest x-ray and over 50 times that of mammography. [14] Of particular concern is that often multiple CT scans are given and few doctors or patients actually understand the subsequent lifetime cancer risks from these medical diagnostic exposures.
In one advertisement locally, the radiation dose from mammography is said to be 0.7 milli-seiverts (mSv), or 70 millirem, in the units radiation workers in the US use. [15] The advertisement

[14] Rebecca Smith-Bindman, MD, et al., Arch Intern Med., "Radiation Dose Associated with Common Computed Tomography Examinations and the Associated Lifetime Attributable Risk of Cancer," December 2009; doi:10.1001/archinternmed.2009.427. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4635397/pdf/nihms551373.pdf

[15] Radiation units that may include a biological effectiveness weighting are the milli-seivert (mSv) and the milli-rem. 1 mSv is equal to 100 mrem. (The prefix milli- means one thousandth.) The mSv and mrem may be higher than the absorbed dose if a biological effectiveness multiplier greater than 1.0 has been applied to the absorbed dose. The absorbed dose expresses the energy deposited from the radiation per gram of tissue. Absorbed dose is

states that this is the radiation dose obtained in 7 weeks of exposure to natural background from living on earth. Sounds pretty innocuous.

Let's look at the Health Physics Society fact sheet on background radiation. [16] It shows the average dose from inhaled natural radionuclides as 230 mrem/yr, or about 73 percent of the total dose from background radiation. But most of the radiation is due to radon which causes lung cancer — but not breast cancer.

So, of the roughly 300 mrem/yr of background radiation, let's leave out the 200 mrem/yr from radon. The rest of natural background radiation from terrestrial and cosmic sources, 70 to 100 mrem/yr, result in about 1 track per cell to the whole body including the breast. [17] So about how many tracks per cell does mammography give? For two views with 200 mrem/view, it could be about 0.7 tracks per cell. For 4 views per breast, as may required for some women, this would be over 1 track per cell, as these views do overlap. [18] So actually, despite the advertisements claiming that a mammogram is like 7 weeks to 12 weeks of 300 mrem/yr of natural background radiation, **the breast dose from screening mammography is actually like almost one year or over a year's worth of natural background radiation relevant to the breast when radon is excluded.**

Now factor in the higher dose many women get from screening mammography exams. Or double it to add 3-D digital mammography along with traditional film mammography as they are advising in Idaho Falls, and you are easily getting over 2 years worth of cell tracks to breast cells, not 12 weeks of natural background radiation as advertised.

The average radiation dose from breast mammography isn't awful, especially compared historical medical radiation or to common CT scans. But the risks can add up significantly if women start **annual mammograms at age 40**, especially for the women who receive more than double the average dose from each exam because of large or augmented breasts.

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expressed in milli-Gray (mGy) or milli-rad (mrad). 1 mGy is equal to 100 mrad. The mrem and mrad are still the units commonly used by radiation workers but the mSv and mGy are most commonly used in medical radiology and internationally.

[16] Health Physics Society, Fact Sheet – Background Radiation, updated June 2015 http://hps.org/documents/background_radiation_fact_sheet.pdf *Naturally, the words "cancer" or "harm" do not show up in this fact sheet on natural background and manmade, including medical, radiation.*

[17] Gamma and x-ray radiation cause ionizing radiation tracks. The ionizing radiation transfers its energy to matter in the form of structured tracks of charged particles. Photon radiation (gamma and x-ray) is absorbed by matter mainly through Compton Effect, Photoelectron, and Pair-production. All these cause the creation of tracks of energetic electrons which carry the energy of the original photon. See Chris Busby, INTECH, "Aspects of DNA Damage from Internal Radionuclides,", 2013. http://dx.doi.org/105772/53942

[18] John W. Gofman, M.D., Ph.D., *Radiation-Induced Cancer from Low-Dose Exposure: An Independent Analysis*, Committee for Nuclear Responsibility, Inc., 1990. See page 18-8, Table 21-A, Average Tracks per Nucleus, from Each Exposure to Nine Human Studies.

Women given mammograms back in the 1960s and 1970s received much larger breast radiation doses than today; 10,000 to 35,000 mrem then versus less than 1000 mrem today. Combined with other excessive but always claimed to be safe medical radiation doses given between 1920 and 1970, it's no wonder that US women had more than 5 times the breast cancer than women in Japan not exposed to the atomic bomb and John W. Gofman estimated that perhaps 75 percent of breast cancer in the US was due to medical radiation. And he was excluding radiation for treatment of cancer. [19]

By converting the breast dose to effective whole body dose, the radiology industry has chosen to muddy the water and make it more difficult to ascertain the breast cancer risk from mammography. **Why describe the dose as diluted over the whole body, an "effective" whole body dose, when the actual radiation dose from the mammography cancer screening is concentrated to the breast?** Because it ***sounds*** like less dose, that's why. The radiology industry isn't telling women that the breast is over twice as vulnerable to radiation-induced cancer than other parts of the body, either.

The information the American Cancer Society pointed me to states that "mammography exposes people to 0.4 mSv" [20] or 40 mrem. The radiation absorbed dose to each breast is actually over an average dose of 200 mrem per view and each breast gets two views at least (a vertical and horizontal view of each breast). [21]

Even the American Cancer Society in 2015 backed away from their previous recommendation of annual breast mammograms for every woman over age 40. [22] [23] But

[19] John W. Gofman, M.D., Ph.D., *Preventing Breast Cancer: The Story of a Major, Proven, Preventable Cause of this Disease*, Committee for Nuclear Responsibility, Inc., 1996.

[20] Laird Harrison, *Medscape*, "Public Ignorant About Radiation Dose of Mammography," May 12, 2014. The article states that "mammography exposes people to 0.4 mSv." http://www.medscape.com/viewarticle/824999 Apparently they have converted to dose of the examination of one breast to an effective whole body dose, but they don't bother explaining this in the article. A two-view mammography exam would typically be at least 1.86 mSv per view, so 3.72 mSv breast dose (or 400 mrem). Multiply 4 mSv by 0.12 to yield an effective whole body dose of 0.44 mSv whole body dose.

[21] R. Edward Hendrick et al., *American Roentgen Ray Society*, Comparison of Acquisition Parameters and Breast Dose in Digial Mammography and Screen-Film Mammography in the American College of Radiology Impaging Network Digital Mammographic Imaging Screening Trial, February 2010. Mean glandular dose for the breast per view averaged 2.37 mGy [237 mrem] for screen-film mammography and 1.86 mGy [186 mrem] for digital mammography. Assuming a biological factor of 1, mGy is equivalent to mSv, and 1 mSv equals 100 mrem. Note that 2 views of each breast are taken and from 12 to 20 percent of cases require extra views.

[22] American Cancer Society, contacted October 17, 2016 stated that they currently recommend that women under age 45 have the choice to have mammography, the women age 45 to 54 should get annual mammograms and that women age 55 and older have mammograms every 2 years. ***The American College of Radiology is sticking with the recommendation that all women over 40 get annual mammography because they would never consider accurately assessing radiation harm as it would be bad for business.***

[23] Diana Zuckerman et al., *Cancer Prevention and Treatment Fund*, "2016 Update: When should women start regular mammograms? 40? 50? And how often is "regular"?" http://www.stopcancerfund.org/p-breast-cancer/update-when-should-women-start-regular-mammograms-40-50-and-how-often-is-regular/ Note that this article states that the American Cancer Society changed their policy in 2015 and that the U.S. Preventative

they don't go so far as to say wait until you're 50 and then only get one mammogram every 2 to 3 years. But if you look at the risk versus benefits, that is what some researchers are concluding.[24] [25] The US Preventive Services Task Force recommended in 2009 that generally women wait until age fifty to begin screening mammography and that women ages 50 to 74 get screening every two years. For women over age 74, the Task Force said "the current evidence was insufficient to assess the balance of benefits and harms of screening mammography in women aged 75 and older." [26]

Nowhere do the advertisements mention that the actual breast dose a woman receives may likely, in more than 20 percent of exams, exceed 2, 5 or 10 times the average dose. [27] The estimates of radiation harm usually ignore the prevalence of significantly larger radiation doses for larger breasts, patients with breast augmentation who may need 5 view x-rays instead of the usual 2, or frequent screening situations where additional views are given to clarify an abnormality.

The harm of radiation is estimated in various journal articles based on theory — theory that ignores the mounting epidemiological evidence that the "dose and dose rate reduction factor" known as the DDREF is not supported by human epidemiology. The reduction factor, the DDREF, as we have noted for radiation workers, is simply not substantiated by human epidemiology. The mammography industry's continued use of the assumed DDREF of 2 or 1.5 still divides the theoretical harm by the DDREF, cutting the harm in half. See our October 2016 newsletter for a wide variety of epidemiology studies ranging from radiation workers to medical exposures of low dose and low dose rate exposure that does not support this reduction of harm. The studies show if anything, the DDREF is less than 1.0, indicating that there is more harm from the chronic elevated low dose exposures.

Services Task Force, an expert group that reviews the latest research findings, recommends that mammography screening for most women start at age 50 rather than 40, and that the frequency be every two years (instead of annually) through the age of 74.

[24] Charles Harding et al., *American Medical Association*, "Breast Cancer Screening, Incidence, and Mortality Across US Counties," 2015, http://jamanetwork.com/journals/jamainternalmedicine/fullarticle/2363025 This research states that mammography screening results in 16 percent more breast cancer diagnoses but no significant change in breast cancer mortality.

[25] Mette Kalager et al., *The New England Journal of Medicine*, "Effect of Screening Mammography on Breast-Cancer Mortality in Norway," Vol., 363 No. 13. September 23, 2010. http://www.nejm.org/doi/pdf/10.1056/NEJMoa1000727 This study found 2.4 deaths per 100,000 person-years averted by screening mammography, but acknowledged that 30 percent of women may not have had screening mammography although it was available. It would appear that even this modest benefit from screening mammography may have been overstated.

[26] US Preventive Services Task Force, https://www.uspreventiveservicestaskforce.org/Page/Document/RecommendationStatementFinal/breast-cancer-screening1

[27] Diana L. Miglioretti, PhD et al., Annals of Internal Medicine, "Radiation-Induced Breast Cancer Incidence and Mortality From Digital Mammography Screening – A Modeling Study," vol. 164 no. 4, February 16, 2016. Note: This article states that "Estimates of risk for radiation-induced breast cancer from mammography screening have not considered variation in dose exposure or diagnostic work-up after abnormal screening results."

The estimates of radiation harm from mammography also typically ignore the decades of knowledge that more penetrating gamma rays or high energy x-rays are less harmful than lower energy medical x-rays that cause more radiation harm in tissue. [28] This is where the mrad to express the estimated absorbed energy per gram of tissue should be modified by a biological factor greater than 1.0 to reflect the increase harm and thus a higher estimated mrem dose.

Gofman estimated the harm of medical x-rays as 2-fold higher than higher energy gamma rays. One article put the x-ray harm at 4-fold to 6-fold higher than gamma ray harm. [29] So the mammogram industry underestimates the radiation harm from each mammogram at least three ways: by dividing the dose by an unsupportable DDREF of 2 or 1.5, then by failing to mention that many women get much higher doses because of additional views are taken, and then by ignoring the increased harm of lower energy X-rays (another factor of perhaps 2, 4 or 6).

This means that a study estimating that annual breast exams that would theoretically predict 125 mammography induced cancers per 100,000 women, could easily be more than 1500 mammography induced cancers per 100,000 women for annual screening. (If you multiply 125 radiation-induced cancers by 1.5 to cancel the studies reduction of harm by using a DDREF of 1.5, then multiply the dose by 2 for the higher number of views in many exams, and then multiply the dose by 4 because of the increased harm of X-rays.)

The reduction factor, the DDREF, as we have noted for radiation workers, is simply not substantiated by human epidemiology.

A study of screening mammography benefits that likely overestimates the benefits found only 2.4 breast cancer deaths averted per 100,000 person-years. To some extent, the radiation-induced cancers may be caught by regular mammography which may cancel out some of the harm. But the benefits of regular screening mammography in terms of reduced breast cancer mortality are so far, from the data, either small or non-existent (see footnote 9 above).

[28] Ernest K. J. Pauwels et al., Medical Principles and Practice, "Breast Cancer Induced by X-Ray Mammography Screening? A Review Based on Recent Understanding of Low-Dose Radiobiology, DOI: 1.1159/000442442, January 11, 2015. **Note: these researchers use a DDREF of 1.5, X-ray equivalent to gamma ray, and 2.5 mSv 2-view dose per breast, which may significantly underestimate radiation harm.**

[29] G. J. Heyes et al., Enhanced biological effectiveness of low energy X-rays and implications for the UK breast screening programme. Br J Radiol. 2006 Mar ;79(939):195-200. PMID: 16498030 https://www.ncbi.nlm.nih.gov/pubmed/16498030 These researchers discuss women age 50 to 70 screened on a three yearly basis, the use of DDREF of 1.0, the increased harm of mammography x-rays of 4-fold to 6-fold versus higher energy x-rays, and the higher routine screening dose to women with larger breasts.

New 3-D digital breast tomosynthesis promoters say this may mean less additional imaging for some patients but according to the American College of Radiology it gives an average 1.5 to 2 times the normal dose,.[30] I was assured over the phone, however, that the machine for 3-D imaging in Idaho Falls will yield lower radiation doses that women typically receive. But in the meantime in Idaho Falls, **women would be required to get both the regular 2-view mammographs and the 3-D mammography** so their dose would roughly double.

All this has some women considering breast thermography. Thermography has yet to be endorsed for screening of breast cancer, but it may be an option worth investigating even if health insurance doesn't cover it. [31] [32] [33] But breast mammography will likely be required by your doctor if a lump is found, although many lumps are benign.
While the excessive radiation medical doses of the 1920 to 1960s from fluoroscope exams and numerous now-discarded radiation medical treatment of enlarged thymus, skin ailments, head lice and others are history, people still need to be aware of their cumulative dose from medical radiation. And they need to aware of the cumulative harm of medical radiation especially from frequent radiation sources like annual mammography and from medical radiation that provides excessive radiation doses like certain CT scans.

Women need to know the **breast organ dose** from their mammography exams not just the estimates for an average woman for an average mammography device. Likewise, women need to know the breast dose, not just the effective whole body dose, from CT scans taken near the breast. A typical adult abdominal x-ray gives stomach organ dose of 25 mrem (or 0.25 mSv) while an abdominal CT scan gives 1000 mrem (or 10 mSv). This assumes that the biological effectiveness of the x-ray is 1.0. When looking at CT scan radiation dose, note that it is common for patients to receive several CT scans on the same day. CT scans are now given to millions of adults and children, and the highest risk of subsequent cancer occurs in children because of their increased vulnerability to radiation exposure and remaining years of life. [34]

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[30] See the American College of Radiology website pamphlet at http://www.acr.org/~/media/ACR/Documents/PDF/QualitySafety/Resources/Breast%20Imaging/Patient%20Brochure%20on%20Mammography%20Benefits%20and%20Risks%20HiRez.pdf

[31] M. Kontos et al., Clinical Radiology, "Digital infrared thermal imaging (DITI) of breast lesions: sensitivity and specificity of detection of primary breast cancers." 2011 Jun;66(6):536-9. doi: 10.1016/j.crad.2011.01.009.

[32] *Sarah, The Healthy Home Economist*, "Thermography: A Perfect Alternative to Mammograms?" downloaded October 22, 2016 from http://www.thehealthyhomeeconomist.com/thermography-not-a-perfect-alternative-to-mammograms/ The author, Sarah, writes that thermography is often an out-of-pocket expense because insurance doesn't cover it. And when an abnormality showed up in the thermography, she was required to get a mammogram before she could get an ultrasound. The abnormality, fortunately, was not cancer. But she had been unable to avoid getting a mammogram.

[33] Nimmi Arora et al., *Clinical Radiol.* "Effectiveness of a noninvasive digital infrared thermal imaging system in the detection of breast cancer," March 2011. doi: 10.1016/j.crad.2011.01.009 PMID: 18809055

[34] David J Brenner et al., New England Journal of Medicine, "Computed Tomography — An Increasing Source of Radiation Exposure. November 29, 2007. https://pdfs.semanticscholar.org/87fa/50a4965710d536d5d2f8dd4ede369cb3a911.pdf

Based on the children or teenage females exposed to the atomic bombs dropped on Japan, breast cancer incident risk increases by roughly 2 percent per 1000 mrem of breast radiation dose. The breast cancer risk from radiation exposure to older adult women is about one forth of that. [35] This assumes an x-ray is twice as harmful as a gamma ray. But the dose the adult woman receives from screening mammography may be several times higher than the advertised average dose or the average dose the clinic will tell you if you inquire before an actual exam, about a average 400 mrem breast dose for two views to one breast.

Breast cancer is a serious cancer. But radiation is a known carcinogen. And it has been known for decades that x-rays are more harmful than higher energy gamma rays, and low doses cause at least as much harm as higher doses or dose rates. **Isn't it about time that the medical folks got real about telling women about their medical radiation-induced breast cancer risks?**

In summary:

- Radiation is a proven cause of breast cancer — not the only cause — but a proven cause. And medical radiation since 1920 for various diagnostic and treatments of skin, thymus, and various non-cancerous conditions has likely created a breast cancer epidemic in this country.

- While it may take decades for breast cancer to develop, <u>age of exposure matters</u>. Medical (or atomic bomb exposure) to radiation to female children age 0 to 9 is 10-fold more likely to cause breast cancer than to adult women. Young females exposure to radiation are more likely to have breast cancer at a relatively young age. Elderly women and women with genes that put them at elevated risk of breast cancer are more vulnerable to radiation-induced breast cancer.

- For decades it has been known from human epidemiology that the breast is a very radiosensitive part of the body, about 2.5 times more susceptible to radiation-induced cancer than other glands or organs, according the Gofman's *Preventing Breast Cancer*.

- No matter how low each individual radiation dose, the cancer causing harm adds up — the harm is cumulative. Despite the hope and the hype that the body flawlessly repairs after exposure to low doses, human epidemiology shows that repair isn't flawless at low doses. Radiation-induced cancer risk is not reduced by spreading the doses out over time.

- Expressing medical radiation in terms of <u>effective whole body dose</u> can provide useful perspective, but women need to know their <u>breast dose</u> from each medical radiation exam

[35] John W. Gofman M.D. Ph.D., *Preventing Breast Cancer: The Story of a Major, Proven, Preventable Cause of This Disease*, Committee for Nuclear Responsibility, Inc., 1996. See Chapter 3, p. 12-13. For females exposed before the age of 20, the likelihood that breast cancer occurs before age 35 is 13.6 percent per 1000 mrem. It is from 1.3 to 2.4 percent per 1000 mrem, breast dose, cancer incident risk for females exposed before age 20. See page 275 for adult women's excess cancer risk due to radiation exposure.

in order to understand the cumulative breast cancer risk from their medical radiation and screening mammography exams.

- The radiology industry still underestimates the radiation-induced cancer risk to women from screening mammography in multiple ways despite the fact that they ought to know better. They usually ignore the fact that many women get 2 to 5 times the "average" dose because they have large or augmented breasts, the harm of x-rays is greater than gamma rays in the atomic bomb study of survivors (from a factor of 2 to 6), the brand and operating mode of the particular device may be significantly higher than the average device, the harm of radiation is not less for low dose or low dose rate exposures but is still being divided by the dose reduction factor, DDREF, of 1.5 or 2.0, and the age and gender of the person exposed to radiation, as well as genetic predisposition, may increase cancer risk.

- The popular comparison to natural background radiation is particularly misleading when compared to screening mammography. The mammography breast doses give far more radiation to the breast than the 7 to 12 weeks of natural background radiation that the radiology industry claims. This is partly because about two thirds of average natural background radiation comes from gaseous radon and while it increases lung cancer risk, it does not increase breast cancer risk. Natural background gives one track per cell in one year to the breast but screening mammography can give one or more track per cell, so it is more like one year of natural background radiation exposure than 7 weeks but that may still underestimate the harm.

- There is no consensus on how often women should get screening mammography or what age they should start. Many researchers outside the radiology industry have ceased to support the recommendation of annual mammography starting at age 40 that is still being clung to by the American College of Radiology.

Articles by Tami Thatcher, for November 2016.