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With Southeast Idaho COVID-19 Hotspots, It's Time to Review the Effect of Radiation on the Immune System

Idaho Falls is the nation's top hotspot, according to The New York Times, reads the headline of an article by The Idaho Falls Post Register. Rexburg was close behind in third place. [1]

Actually, there are five counties in Idaho that are in the "red" zone for COVID-19 cases; Bonneville county where Idaho Falls is located, Madison county where Rexburg is located, and also Jefferson, Fremont and Franklin. [2] Each of these counties, with the exception of Franklin, borders the Idaho National Laboratory.

During the COVID-19 pandemic, suboptimal immune system functioning can mean death.

Could decades of airborne radiological emissions from the INL be related to the higher number of COVID-19 cases?

The Department of Energy and the U.S. nuclear industry tend to focus on the risk of radiation-induced cancer. While *cancer incidence* is considered and basically ignored, the primary focus is on the risk of *cancer mortality*, or death by cancer. The radiation weighting factor assigned by the nuclear promoting industry, for the conversion of absorbed dose (in units of "rad" or "radiation absorbed dose") to an organ in the body, to human health harm in units of "rem," discounts cancer incidence and relies on reported cancer deaths, in the estimating human health harm from ionizing radiation.

So, what do we actually know about radiation exposure and its effect on the immune system?

It has long been known that blood changes can be caused by radiation. Stem cells in bone marrow are the biological beginning of our blood cells. Radiation doses to the bone marrow from either external radiation or internal radiation will affect our blood cells. Our blood cells make up the primary part of our immune system. Bone marrow makes erythrocytes (red blood cells), leukocytes (white blood cells) and platelets. Hemorrhage or anemia are caused by red blood cell or platelet problems. Reduced immunity is caused by leukocyte problems. There are various types of leukocytes, each involved with immunity: monocytes, lymphocytes and granulocytes.

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[1] Kyle Pfannenstiel, *The Idaho Falls Post Register*, "Idaho Falls is nation's top hotspot, says NY Times," March 19, 2021.

[2] Link to Idaho's State Profile Report for the week ending March 12, 2021 at https://bloximages.chicago2.vip.townnews.com/postregister.com/content/tncms/assets/v3/editorial/a/d6/ad62e895-e0b7-5944-9cb0-593ecf18df7a/605380bf334aa.file.pdf

External radiation having gamma radiation above 200 kilo-electron-volts (keV) would be expected to affect the cells in bone marrow. [3] The radiation dose to the bone marrow from internal exposure may vary depending on the particular radionuclide inhaled or ingested. Some radionuclides are known as "bone seekers" and they are quickly taken up into bone tissue.

Some of the long-lived radionuclides that are quickly absorbed into our bones are strongly retained. These radionuclides are basically with us for the rest of our lives. These radionuclides include the "actinides" that include plutonium and americium.

It isn't easy to detect actinides in bone tissue. Especially not while we are alive. That's why I have to talk about animal tissue sampling. Around southeast Idaho, the Department of Energy has an environmental monitoring program because of the Idaho National Laboratory and it sometimes includes sampling animal tissues. Around Chernobyl, the site of the 1986 nuclear reactor explosion, there has also been some limited animal tissue analysis of the radionuclides in the tissues.

In southeast Idaho, the Department of Energy always explains any radionuclide detection as probably due to global fallout from nuclear weapons testing primarily or from the Department of Energy's Nevada Test Site nuclear testing fallout.

But when ducks are analyzed and are known to have had a visit to the Idaho National Laboratory's ATR Complex (formerly Test Reactor Area) warm waste ponds, then the radionuclides known to be in the ponds are usually acknowledged as a possible source of the radionuclides in the animal tissue. [4] As a worker at the INL, I was told that the radiological composition of warm waste sent to the ATR Complex ponds was mostly tritium, but the variety of radionuclides in the warm waste ponds is far more complicated. And it isn't just from the bad-ole-days of the 1950s or 1960s — it continues to this day.

The ponds used to be unlined percolation ponds. In 1993, lined evaporation ponds were installed; however, for several years, the unintended continued retention basis leakage allowed the seepage into perched water above the Snake River Plain aquifer as well as allowed the open-air evaporation of the radionuclide-laden water to the skies.

The radionuclides released in the past and continuing releases are not just from normal nuclear reactor operations. The releases are from isotope separations processes and are highly laden with plutonium and americium and other radionuclides.

These radionuclides, even when laughably not possibly from former global weapons testing or Nevada Test Site nuclear weapons testing, are still attributed by the Department of Energy's

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[3] The keV is a unit of energy corresponding to 1.6E-9 ergs. One erg equals 1.0E-7 Joules. One hundred ergs per gram = 1 rad. One hundred rads equals 1 Gray. A Gray is absorption of 1 Joule per kilogram. Here is one place to look up some of the gamma ray energies emitted by various radionuclides: https://www1.physics.indiana.edu/~courses/p451/examples/Gamma_Energies_table.pdf

[4] Ronald W. Warren et al., Under contract for the Department of Energy, "Waterfowl Uptake of Radionuclides from the TRA Evaporation Ponds and Potential Dose to Humans Consuming Them," Stoller-ESER-01-40, October 2001. http://idahoeser.com/Surveillance/PDFs/TRADuckReport.pdf

environmental monitoring programs, to former weapons testing rather than to the Idaho National Laboratory.

For example, certain rather short-lived radionuclides are abundantly released to the ATR Complex ponds. These radionuclides may have been released during weapons testing, but they have long since decayed away. These radionuclides include cerium-141 or cerium-144, ziroconium-95/niobium-95, manganese-54, cobalt-60, and ruthenium-106. A radionuclide prevalent from the ATR Complex (but not weapons testing) is chromium-51. Its rather short half-life means it isn't from another other source but the INL.

While it may be expected to find these radionuclides in ducks visiting the ATR Complex ponds, why were these radionuclides detected in yellow-bellied marmots living in Pocatello in 2002? [5] The Department of Energy was quick to eradicate all but the cesium-137 and strontiun-90 data in its annual summary report and blame the radionuclides in Pocatello marmots on former weapons testing. But gamma spectrometry showed certain short-lived radionuclides in marmot tissues, like chromium-51 and others that could only have come from recent nuclear reactor operations at the INL.

For americium-241 and plutonium-238, it's a bit more subtle. Yes, these radionuclides are included for global weapons testing and Nevada Test Site fallout. Americium-241 is the decay product of plutonium-241.

But there is strong evidence, including the DOE's own statements of releases, that the INL has continued releasing americium and plutonium in significant amounts. The ratio of americium-241 and plutonium-238 relative to plutonium-239, from the INL is very high compared to global fallout or NTR fallout. [6] [7]

Strontium-90, americium and plutonium are well known bone seekers. Other bone seeking radionuclides include chromium-51, ceium-144, hafnium-181, antimony-124, and manganese-54, which are so generously released by the INL. The long-lived bone seekers like americium-241 and plutonium are retained in the bone, essentially for the rest of your life.

In the summary of studies of victims of the 1986 nuclear disaster at Chernobyl, *Chernobyl: Consequences of the Catastrophe for People and the Environment*, the wide range of health effects from exposure to radiation was explained, including cancer and leukemia but including

[5] Environmental Defense Institute June 2020 newsletter article "What yellow-bellied marmots have to tell us about radiological releases from the Idaho National Laboratory."

[6] T. M. Beasley et al., *Heavy Element Radionuclides (Pu, Np, U) and 137-Cs in Soils Collected From the Idaho National Engineering and Environmental Laboratory and Other Sites in Idaho, Montana, and Wyoming*, Department of Energy Environmental Measurements Laboratory, EML-599, October 1998. (I must refer to this very informative report as the "beastly Beasley report" because it is so challenging to comprehend and because it seems to intentionally or unintentionally conceal a great deal of information.)

[7] Department of Energy's environmental monitoring reports, see idahoeser.com and inldigitallibrary.inl.gov and see the July 2020 Environmental Defense Institute newsletter for a chart of the increasing americium-241 releases from the Idaho National Laboratory.

many other illness. There were observations of the adverse effect of radiation on the immune system.

Allow with many illnesses, the people exposed to higher levels of radiation during and following the Chernobyl nuclear accident had blood changes, intensified infectious and parasitic diseases such as viral hepatitis and respiratory viruses. [8]

In summary, the human immune system depends on the health of bone marrow. Unfortunately, various in-depth studies, many of them published in Russian, have been actively ignored by radiation health communities.

Various radionuclides affect bone marrow, either by strong gamma rays (external or internal radiation) or by internal uptake into bone tissue. Irradiated bone marrow cells mean damaged blood cells that make up the immune system. Increased ionizing radiation means damage to the human immune system; yet, any death not by cancer is not counted as a health harm by ionizing radiation by the nuclear promoting agencies such as the U.S. Department of Energy.

Viral Hepatitis Ignored by Energy Employee Compensation Program Despite Evidence of Increase by Ionizing Radiation Exposure

Let me first admit that I have long ignored the effects of ionizing radiation on the human immune system.

Officially, for liver cancer that involved hepatitis, illness compensation from radiation exposure was excluded from compensation from the Energy Employee Illness Compensation Act. [9] For an employee who had hepatitis and then died of liver cancer, compensation could be granted from chemical exposure but not from radiation exposure. The state of knowledge that is accepted by the U.S. nuclear industry largely seems to dismiss the adverse effects of radiation exposure on the immune system.

When I learned of two cases of viral hepatitis where I worked at the ATR Complex (formerly the Test Reactor Area), in two men who had squeaky-clean life-styles, it made me wonder about the possible chemical and radiation exposures.

The two men in their 40's who had worked for years at the Advanced Test Reactor Complex, were surprised to discover they each had viral hepatitis. Risk factors such as sharing of needles for drug addiction, etc. did not apply to them.

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[8] Alexey V. Yablokov, Vassily B. Nesterenko, and Alexey V. Nesterenko, Annal of the New York Academy of Sciences, "Chernobyl: Consequences of the Catastrophe for People and the Environment," Volume 1181, 2009. http://www.strahlentelex.de/Yablokov_Chernobyl_book.pdf

[9] Federal Register, October 5, 2001, Department of Health and Human Services at https://www.cdc.gov/niosh/pdfs/42cfr81.pdf (specifically excluded liver cancer from radiation compensation if associated with hepatitis.)

One of the men, who was a jogger who frequently jogged around the radioactive waste ponds and then showered in hexavalent-chromium-laden water, died of liver cancer within a year or two of hepatitis diagnosis. The other man is still alive, about 15 years after the diagnosis. Whether or not either man obtained illness compensation is unknown to me.

I didn't know that one study of Japan World War II atomic bombing victims found a strong association between hepatitis C and liver cancer for people exposed to radiation from the bombing. [10]

Studies of health effects of the Chernobyl nuclear accident have also found much information about the effect of living in radiological contaminated areas and consuming radioactively contaminated food. In the summary of studies of victims of Chernobyl, *Chernobyl: Consequences of the Catastrophe for People and the Environment*, the wide range of health effects from exposure to radiation, there is discussion of the immune system effects and it includes discussion of viral hepatitis. **Generally, the people exposed to higher levels of radiation during and following the Chernobyl nuclear accident, had, among many other illnesses, also intensified infectious and parasitic diseases such as viral hepatitis and respiratory viruses.** [11]

For general background, the Chernobyl nuclear accident began on April 26, 1986 in northern Ukraine. The reactor core continued to burn for approximately 10 days, releasing radioactive plumes to the local area and over large areas of Europe and the rest of the northern hemisphere. About 44,000 people who lived within about 3 km of the reactor would be evacuated after more than a day of releases had occurred. Ultimately, over 350,000 people would be evacuated and never return to their homes. About 6 million people in Ukraine, Belarus and Russia have been living in areas considered contaminated, above 37 kBq/m^2 of cesium-137. [12] In the U.S. and throughout the nuclear supporting industry, often the only acknowledged adverse health effect from Chernobyl is of an increased number of thyroid cancers. [13]

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[10] Gerald B. Sharp et al., International Journal Cancer, "Hepatocellular carcinoma among atomic bomb survivors: significant interaction of radiation with hepatitis C virus infections," February 2003. https://pubmed.ncbi.nlm.nih.gov/12478671/

[11] Alexey V. Yablokov, Vassily B. Nesterenko, and Alexey V. Nesterenko, Annal of the New York Academy of Sciences, "Chernobyl: Consequences of the Catastrophe for People and the Environment," Volume 1181, 2009. http://www.strahlentelex.de/Yablokov_Chernobyl_book.pdf

[12] N. A. Beresford et al., *Journal of Environmental Radioactivity*, "Thirty years after the Chernobyl accident: What lessons have we learnt?" Volume 157, June 2016. https://www.sciencedirect.com/science/article/pii/S0265931X16300261 This article gives some basic overall information, yet unfortunately it seems to be bent on minimizing the significance of the catastrophe.

[13] United Nations Chernobyl Forum. Health effects of the Chernobyl accident and special health care programme. In: Bennett B, Repacholi M, Carr Z, et al., editors. World Health Organization Report of the UN Chernobyl Forum Expert Group "Health" (EGH) Geneva: World Health Organization; 2006. https://www.who.int/ionizing_radiation/chernobyl/who_chernobyl_report_2006.pdf "More than 4000 thyroid cancer cases have been reported in Belarus, the Russian Federation and Ukraine in children and adolescents for the period 1990-2002."

Following the Chernobyl accident, even though people were evacuated from the most contaminated areas from Chernobyl fallout, vast regions were radiologically contaminated. Radiation doses were significant during the days and weeks of the reactor accident, and radiation exposure continues decades later from living in contamination and from ingestion of radioactively contaminated food and water.

The region was contaminated with a variety of radionuclides released from the Chernobyl accident. Aerial surveys may be conducted to survey cesium-137 contamination levels and contamination levels may be described in terms of cesium-137 concentrations. But other radionuclides such as strontium-90, plutonium and americium are also present. The strontium-90 and americium-241 tend to bioaccumulate in foods more readily than cesium-137 and the actual bioaccumulation of radionuclides in food is difficult to predict.

For regions of the Ukraine, the rates of Hepatitis B and C were significantly higher in the heavily contaminated territories of the Gomel Province. And, by 1996, the incidence of chronic hepatitis in Chernobyl liquidators was 1.6-fold higher than in 1988-1995. Both adults and teenagers living in the contaminated Vitebsk Province had noticeably higher persistence of infectious hepatitis, from 1993 to 1997. And for children, it was noted that, by 1995, infectious and parasitic diseases were over five times more common in the heavily contaminated territories compared with less contaminated areas.

Increases in Radiation Exposure and Increases in Chromosome Aberrations in Blood Lymphocytes

In regions affected by Chernobyl radioactive fallout, when rates of illness were compared in groups of people living in more highly contaminated areas to people in less contaminated areas, people living in more radiologically contaminated areas had higher rates of many kinds of illnesses. And while it is difficult to estimate radiation doses from the Chernobyl cloud passage and from living in contaminated areas and ingesting contaminated food and water, some studies compared the levels of chromosome breaks in blood lymphocytes, in order to estimate the level of radiation exposure.

The incidence of chromosomal aberrations was significantly higher in territories contaminated by the Chernobyl nuclear fallout. Ionizing radiation causes aberrations in the structure of chromosomes. The stable aberrations are retained for many years after the radiation exposure. Cells with several aberrations can indicate damage from alpha-emitters such as plutonium.

A higher incidence of nonstable chromosomal aberrations (dicentrics and circular rings) was found in children from areas contaminated from Chernobyl fallout with Cs-137 levels from 100 to 1000 kBq/m^2. [14] A study of cancer incidence in Sweden from Chernobyl fallout unexpectedly

[14] Alexey V. Yablokov, Vassily B. Nesterenko, and Alexey V. Nesterenko, Annal of the New York Academy of Sciences, "Chernobyl: Consequences of the Catastrophe for People and the Environment," Volume 1181, 2009. See p.68.

found an 11 percent increase in cancer correlated with aerial estimates of cesium-137 fallout of 100 kBq/m^2, which had been expected to increase the radiation dose by about 100 to 200 mrem in the first year of exposure. [15] Areas of the United States contaminated with global weapons testing and Nevada Test Site weapons testing fallout out in limited monitoring of Idaho, Montana and Wyoming soil were found to have cesium-137 contamination of less than 4.021 kBq/m^2. [16] The health harm from the Chernobyl fallout in Sweden was not expected to be detected for what was considered a low radiation dose of less than 200 mrem per year. The full range of radionuclides in the fallout from Chernobyl on Sweden is not known, nor were there studies of blood changes or the presence of radionuclides in the body.

By whole body counting of cesium-137 in children living near the Chernobyl nuclear accident, children living in contamination in the soil from density of 37 to 555 kBq/m^2 were found to have varying amounts of cesium-137 in their bodies, probably from contaminated milk and food. The cesium-137 activity in their bodies ranged from under 20 Bq/kg to over 200 Bq/kg. As high as 46 percent of children in some regions had over 200 Bq/kg of cesium-137 contamination in their bodies. Levels of cesium-137 known to cause serious illnesses when above 50 Bq/kg.

The whole extent of external radiation and of internal radiation of all the radionuclides, cesium-137, strontium-90, americium-241, plutonium for people living in Chernobyl fallout remains unknown. Comparisons of rates of illness of those people living in more highly contaminated areas or known to have higher numbers of chromosomal aberrations were compared to people with lower levels and the groups with higher radiation levels have higher rates of all kinds of illnesses, not just leukemia or cancer. Birth defects are also higher where radiation exposure is higher.

The level of exposure said to cause noticeable birth defects or teratogenic effects, based on the survivors of the World War II bombing of Japan, is supposedly 10 rem. But the study of decreasing birth rates in countries outside of the Ukraine but affected by modest levels of radioactive contamination, estimated to be around 100 mrem, saw statistically significant spontaneous abortion and resulting lower birth rates 7 to 9 months after Chernobyl. [17]

The frequency of chromosomal aberrations in human cells, obtained by studying blood lymphocytes, reflects the damage of chromosomes throughout the body. Increasing damage is

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[15] Martin Tondel et al., *Increase of regional total cancer incidence in north Sweden due to the Chernobyl accident?*, J Epidemiol Community Health, 2004;58: 1011-1016.

[16] T. M. Beasley et al., *Heavy Element Radionuclides (Pu, Np, U) and 137-Cs in Soils Collected From the Idaho National Engineering and Environmental Laboratory and Other Sites in Idaho, Montana, and Wyoming*, Department of Energy Environmental Measurements Laboratory, EML-599, October 1998. See Table 8.)

[17] Christopher Busby and Alexey V. Yablokov, European Committee on Radiation Risk (ECRR), *ECRR Chernobyl: 20 Years On – Health Effects of the Chernobyl Accident*, ISBN: 1-897761-25-2, 2006. p. 227. https://euradcom.eu/wp-content/uploads/2017/12/ECRR2006MD3.pdf

shown by increasing numbers of abnormalities in the chromosomes, such as dicentric and ring chromosome abnormalities. [18]

The radiation dose that causes chromosomal damage from external radiation has been studied more than alpha-emitting internal radionuclides. The radiation dose of the alpha-emitters to produce increases in chromosomal damage remains somewhat unstudied. The highly retained radionuclides such as americium and plutonium, over the long term, are contributing to health harm but usually are not monitored effectively in the environment or in food. The levels of plutonium (Pu-238, Pu-239 and Pu-240) estimated for territory adjacent to the Chernobyl accident include vast regions with soil above 1 kBq/m^2 and up to 100 kBq/m^2. [19] In contrast, a study in the U.S. published in 1998 found levels of plutonium (Pu-239 plus Pu-240) in Idaho, Wyoming and Montana soils of less than 0.109 kBq/m^2. [20]

Bone marrow, thymus, and other parts of the lymphatic system are affected by ionizing radiation. And as a result, the production of lymphocytes and monocytes, antibodies, immunoglobulins, stem cells, and thrombocytes are adversely affected. **The consequences of radiation exposure, including living in radioactive fallout, includes immunodeficiency.**

Significant changes in all parameters of cellular immunity were found in children born to Chernobyl cleanup radiation workers, called liquidators.

White blood cells (leukocytes) of various types are essential to the human immune system. Lymphocytes, monocytes and granulocytes are types of leukocytes that are essential to the immune system. Red blood cells and white blood cells (leukocytes) are created in bone marrow. Bone marrow stem cells can be damaged from penetrating gamma rays of external radiation or from internal radiation from contaminated air, food or water. Some radionuclides are known as "bone-seekers." Plutonium and americium, as well as strontium are known to be bone seekers. And while plutonium and americium are known from concentrating in the outer surface of bone, they are also rapidly absorbed into bone marrow once in the blood stream. Plutonium and americium are strongly retained in the body, for decades. Plutonium and americium accumulate in the body and contribute to bone marrow radiation dose which in turn, causes chromosomal aberrations in the blood cells and also abnormal levels of blood cells.

The number of T and B lymphocytes and phagocytic activity of neutrophilic leukocytes was significantly reduced in adults from radiologically contaminated areas. **And the number of**

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[18] Alexey V. Yablokov, Vassily B. Nesterenko, and Alexey V. Nesterenko, Annal of the New York Academy of Sciences, "Chernobyl: Consequences of the Catastrophe for People and the Environment," Volume 1181, 2009. See p. 65. http://www.strahlentelex.de/Yablokov_Chernobyl_book.pdf

[19] Christopher Busby and Alexey V. Yablokov, European Committee on Radiation Risk (ECRR), *ECRR Chernobyl: 20 Years On – Health Effects of the Chernobyl Accident*, ISBN: 1-897761-25-2, 2006. p. 172. https://euradcom.eu/wp-content/uploads/2017/12/ECRR2006MD3.pdf

[20] T. M. Beasley et al., *Heavy Element Radionuclides (Pu, Np, U) and 137-Cs in Soils Collected From the Idaho National Engineering and Environmental Laboratory and Other Sites in Idaho, Montana, and Wyoming*, Department of Energy Environmental Measurements Laboratory, EML-599, October 1998. See Table 8.

peripheral blood leukocytes in people who evacuated the Chernobyl exclusion zones remained significantly lower even 7 to 8 years after the 1986 Chernobyl accident.

Immune deficiencies in children were more prevalent in children irradiated *in utero*. Immune status of children correlated with the level of radiological contamination where they lived.

In summary, the review of the real lessons from the Chernobyl accident cannot be learned without reading the review of independent studies in *Chernobyl: Consequences of the Catastrophe for People and the Environment*. [21] It's a frightening report, far more comprehensive than nuclear promotors want you to read. Instead of a few thousand thyroid cancers emphasized by the Idaho National Laboratory and other Chernobyl-minimizing messages from the nuclear promoting community.

The truth is that **the Chernobyl report by Yablokov et al. found animal populations as well as human populations have shown increasing tumor rates, decreasing life expectancy, premature aging, birth defects, changes in blood formation, immunodeficiencies and other compromises to health.**

Fukushima – Twenty Years On

The catastrophe of the nuclear meltdowns in Japan on March 11, 2011 isn't over. The government in Japan has raised the allowable annual limits on exposure, so folks can move back to the radiologically contaminated homes. Don't worry about monetary compensation for the loss of your community, your home, your animals, your livelihood – it's all fine now, and you can move back home to live in the radioactive fallout of the Fukushima Daiichi Nuclear Power Plants — because the radiation health standard was relaxed to allow it.

A recent report by *Greenpeace* has reported that the Japan government relaxed radiation limits from 100 mrem/yr (1 mSv/yr) to 2000 mrem/yr (20 mSv/yr). [22] Even 100 mrem/yr is not safe, especially for children or pregnant women. This higher radiation limit will cause increased illness and birth defects. The Japan government has it covered and has solved the problem: there will be no epidemiology or reporting of adverse health effects.

If you dare to read about what has happened to people's health, particularly children's health, not just highly exposed "liquidators" in the Ukraine and regions with high Chernobyl fallout, [23] you will be very sad for anyone moving back to the areas contaminated by the Fukushima Daiichi nuclear disaster that continues to unfold.

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[21] Alexey V. Yablokov, Vassily B. Nesterenko, and Alexey V. Nesterenko, Annal of the New York Academy of Sciences, "Chernobyl: Consequences of the Catastrophe for People and the Environment," Volume 1181, 2009. http://www.strahlentelex.de/Yablokov_Chernobyl_book.pdf

[22] Greenpeace, *Fukushima Daiichi 2011-2021 – The decontamination myth and a decade of human rights violations*, March 2021. https://www.greenpeace.org/static/planet4-japan-stateless/2021/03/ff71ab0b-finalfukushima2011-2020_web.pdf

[23] Alexey V. Yablokov, Vassily B. Nesterenko, and Alexey V. Nesterenko, Annal of the New York Academy of Sciences, "Chernobyl: Consequences of the Catastrophe for People and the Environment," Volume 1181, 2009. http://www.strahlentelex.de/Yablokov_Chernobyl_book.pdf

A most conventional, and excuse me for calling it this, a serious white-wash of the real health issues from the 2011 Fukushima nuclear disaster can be found in reports like a 2014 report – which was basically saying, without any look at actual health of the exposed people – that everything was fine, no cancers here, look away folks. [24] But even this cited reference discusses that a dose of 10 Gy or 1000 rad (whole body) may result in bone marrow failure, pneumonitis and GI failure – while the U.S. Department of Energy in its Versatile Test Reactor draft Environmental Impact Statement has stated that 1000 rad (acute whole body) is not a harmful dose. [25] [26] Seriously!

I know the Japanese love their children. So, from what I can see, people who love and care about human health are not in charge in Japan. There is no epidemiology being conducted in Japan, by the official bodies. And it is reported that doctors in Japan have been instructed not to associate any illness with the radiation from Fukushima.

There are some folks at the epicenter of living in Japan, affected by the Fukushima nuclear disaster trying to explain the truth, as written about in the March edition of *The Bulletin of the Atomic Scientists*. [27]

The lessons from Chernobyl, written by brilliant and brave scientists, who were not considered part of "officialdom" — have not been learned. No one who teaches at a university or is part of the World Health Organization would dream of reading what Yablokav had to say about the thousands of unofficial studies of the observation of illness, chromosomal aberrations, and genetic effects in the people living in Chernobyl fallout. [28]

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[24] Choi Taylor et al., *Reflections on the Fukushima Daiichi Nuclear Accident*, "Understanding the Health Impacts and Risks of Exposure to Radiation," December 2, 2014. https://link.springer.com/chapter/10.1007/978-3-319-12090-4_13 and https://doi.org/10.1007/978-3-319-12090-4_13 Warning: this cited reference is rich with nuclear booster spin and poor on any actual look at health or ill-health of people subjected to Fukushima fallout.

[25] U.S. Department of Energy's Versatile Test Reactor Draft Environmental Impact Statement (VTR EIS) (DOE/EIS-0542) at https://www.energy.gov/ne/downloads/public-draft-versatile-test-reactor-environmental-impact-statement-doeeis-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. Extended deadline, VTR EIS comments now due: March 2, 2021. Send by email to VTR.EIS@Nuclear.Energy.gov

[26] See Versatile Test Reactor (VTR) draft Environmental Impact Statement comments on our home page at http://www.environmental-defense-institute.org (see http://www.environmental-defense-institute.org/publications/EDI.Com.VTR.6.pdf and http://www.environmental-defense-institute.org/publications/CommentVTRdEIS.pdf and http://www.environmental-defense-institute.org/publications/CommentVTRdEIS2.pdf)

[27] Tatsujiro Suzuki, *Bulletin of the Atomic Scientists*, "Remember Fukushima: The accident is not over," March 11, 2021. https://thebulletin.org/2021/03/remember-fukushima-the-accident-is-not-over/

[28] Alexey V. Yablokov, Vassily B. Nesterenko, and Alexey V. Nesterenko, Annal of the New York Academy of Sciences, "Chernobyl: Consequences of the Catastrophe for People and the Environment," Volume 1181, 2009. http://www.strahlentelex.de/Yablokov_Chernobyl_book.pdf

Understanding Bone-Seeking Radionuclides, like Americium-241, in our Bodies

A study of chromosome aberrations in peripheral blood lymphocytes showed that workers with internal plutonium exposure but no gamma exposure had more symmetrical (double strand) aberrations than workers primarily exposed to external gamma radiation. It was thought that the internally deposited plutonium was irradiating hemopoietic precursor cells and some of those cells with symmetrical aberrations become peripheral lymphocytes. [29]

A 2019 study of workers with americium or plutonium intakes, including autopsy, show americium distribution in bone differs from plutonium. It also showed more uptake to cortical bone for americium than plutonium. [30] More americium was found in the skull which is mainly cortical bone — a new way to be a "hot head." Americium-241 also has a gamma emission, in addition to being an alpha emitter like plutonium, uranium, curium and others. The 2019 study of autopsy results for workers who lived many years after their Am or Pu uptakes, showed that americium is highly retained in the body and very little is excreted as bone remodels or as the liver excretes the americium.

The study found that the urinary excretion of americium 25 years after intake was lower than previously expected. Doses estimated based on urinary excretion long after the intake would now be expected to be higher than the older modeling predicted.

Distribution throughout the bone and the body is used to estimate radiation dose. But blood monitoring, double-strand DNA breaks are basically unmonitored by the Department of Energy. To the Department of Energy, unless death was due to cancer, radiation exposure or intake was not the cause of death. Illness and disease other than cancer are not considered as being caused by radiation, despite growing evidence that radiation exposure and intake contributes to many diseases, including heart disease.

In the analysis of animal tissues, it has been found that americium-241 (and also strontium-90) is more water soluble and moves through food chains more rapidly than previously predicted. [31]

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[29] C.A. Whitehouse et al., Radiation Res., "Chromosome aberrations in radiation workers with internal deposits of plutonium," October 1998, PMID: 9768861. https://pubmed.ncbi.nlm.nih.gov/9768861/

[30] Rich Leggett, Oak Ridge National Laboratory, and Eric Blanchardon, Institute for Radiological Protection and Nuclear Safety (IRSN), Cedex, France, for the U.S. Department of Energy, Updated Biokinetic Model for Systemic Americium, Revision 2, March 4, 2019. https://www.osti.gov/pages/servlets/purl/1557525

[31] Alexey V. Yablokov, Vassily B. Nesterenko, and Alexey V. Nesterenko, Annal of the New York Academy of Sciences, "Chernobyl: Consequences of the Catastrophe for People and the Environment," Volume 1181, 2009. See p. 221. http://www.strahlentelex.de/Yablokov_Chernobyl_book.pdf

Unexpected Americium Behavior in the Environment

Americium uptake from soil into plants (roots, leaves) is 10 to 20 times greater than plutonium. [32] While americium-241 is primarily an alpha emitter, it also emits x-rays and gamma-rays with energies up to 955.7 keV. The most prevalent gamma-ray energy from Am-241 is 59.5 keV (35.9 percent probability). Americium-241 also undergoes a spontaneous fission and has been used as a neutron source. Alpha emitters are a hazard if inhaled or ingested. Americium-241 is among the very highest radiotoxicity of all radionuclides, along with curium, neptunium and plutonium.

Americium-241 is the decay product of plutonium-241. Plutonium-241 is produced in commercial nuclear reactors, in plutonium-production reactors and by nuclear weapons testing. The Department of Energy plutonium production reactors operated at Hanford and at Savannah River, also without any containment like the Chernobyl reactor.

The Chernobyl nuclear reactors in the former Soviet Union, in the Ukraine, produced both electricity and plutonium for weapons. While uranium-235 is the fissile material in most nuclear reactors, uranium-238 in the reactor fuel will absorb a neutron to form U-239 which decays to neptunium-239 which decays to plutonium-239. An operating nuclear reactor is plentiful with neutrons and many neutron absorptions reactions occur in addition to those that cause fission. When plutonium-239 absorbs a neutron, it forms plutonium-240. And when plutonium-240 absorbs a neutron, it forms plutonium-241. When plutonium-241 decays, is forms americium-241.

Nuclear weapons contain plutonium-239 and also a variable amount of plutonium-240 and plutonium-241. The buildup of americium-241 from the plutonium-241 over a few years would require purification of the weapons material. Hence, at the Rocky Flats weapons plant, americium-241 was a waste product and it was one of the waste products brought to the Idaho National Laboratory for burial or for very unsafe above ground storage. And despite burial exhumation, the Department of Energy has estimated that over 90 percent of the americium-241 buried at the INL will remain buried over the Snake River Plain aquifer.

The Department of Energy's nuclear weapons testing at the Nevada Test Site released fission products, and the plutonium-239 that didn't fission, and also plutonium-240 and plutonium-241 were in the radioactive fallout to blow in the wind. The radioactive fallout from Nevada Test Site nuclear explosions had various compositions, depending on the particular recipe used for the weapon being testing. Still, especially the early years of weapons testing used weapons that were designed to minimize the plutonium-240 and plutonium-241. The plutonium-239 was removed from the plutonium production reactors before making more of the neutron addition reactions

[32] M.R. Winberg and R.S. Garcia, Idaho National Engineering Laboratory, for the Department of Energy, "National Low-Level Waste Management Program Radionuclide Program Radionuclide Report Series, Volume 14: Americium-241" DOE/LLW-130, September 1995. https://inis.iaea.org/collection/NCLCollectionStore/_Public/27/032/27032341.pdf?r=1&r=1

that make plutonium-240 and plutonium-241. Later on, longer reactor burnup times were allowed for weapons plutonium production, which allowed higher amounts of Pu-240 and Pu-241. The ratio of plutonium-240 to plutonium-239 varied in Nevada Test Site fallout but was less than a mass ratio of 0.08. Global fallout from nuclear weapons testing outside of the United States by the U.S., the former Soviet Union, England, France, and China, had higher mass ratios of plutonium-240 to plutonium-239, of approximately 0.18. [33]

In an electricity production nuclear reactor, the nuclear fuel remains in a reactor for higher burnup which continues making higher amounts of plutonium-240 and plutonium-241. The higher concentration of plutonium-241 makes a higher concentration of americium-241. The continued decays of plutonium-241 cause the americium-241 to continue to build up in the fuel or in the environment that the plutonium-241 has been released to. The americium-241 builds up to a maximum in about 100 years, and does not decay away for over one thousand years.

In addition to commercial nuclear reactors, nuclear weapons testing, INL nuclear fuels testing, and weapons production wastes, there is an additional source of americium-241 contamination that is due to the isotope production projects at the Idaho National Laboratory. The amount of plutonium-241 and americium-241 releases to the skies of southeast Idaho have ramped up over the last decade. Historical releases did not confess to much of the plutonium or any of the americium (or curium) releases which would have been significant any time the reactor fuel had significant days of reactor operation, such as the Stationary Low Power (SL-1) reactor that went prompt critical and exploded or the INL's isotope production activities.

In summary, americium-241 builds up over 100 years and stays elevated for over a thousand years. Americium-241 is to decay product of plutonium-241. Plutonium-241 decays to americium-241 which decays to neptunium-237, or

Pu-241 → beta decays (T ½ of 14.3 years) to Am-241

Am-241 → alpha decays (T ½ of 431 years) to Np-237

Np-237 → alpha decays (T ½ of 2.2 million years) to a dozen additional radioactive progeny.

These alpha emitters stay rapidly are stored in bone tissue, staying there for the rest of your life and damaging bone cells that damage blood cells, adversely affecting the immune system.

[33] T. M. Beasley et al., *Heavy Element Radionuclides (Pu, Np, U) and 137-Cs in Soils Collected From the Idaho National Engineering and Environmental Laboratory and Other Sites in Idaho, Montana, and Wyoming*, Department of Energy Environmental Measurements Laboratory, EML-599, October 1998. (I must refer to this very informative report as the "beastly Beasley report" because it is so challenging to comprehend and because it seems to intentionally or unintentionally conceal a great deal of information.)

Let's take another gander at the Radionuclides in TRA Ducks

The specific radionuclides in muscle tissue and bone of ducks, in past years in southeast Idaho tell us some very interesting things.

A study of the radionuclides in ducks from 1993 to 1998 found fourteen different radionuclides, all of which were found in the Test Reactor Area (TRA) evaporation ponds. [34] The Test Reactor Area was renamed the ATR Complex in 2005. Some of these fourteen radionuclides have relatively short half-lives and could have only come to southeast Idaho from recent nuclear reactor operations at the Idaho National Laboratory.

I have listed the fourteen radionuclides in Table 1 below, arranged by highest concentration in either muscle or bone. Where the concentration was significantly higher in bone than in muscle, I have commented in the table that the radionuclide appears to act as a bone seeker. Strontium-90, americium and plutonium are well known bone seekers. Other radionuclides were less known to me to be **bone seekers** include chromium-51, ceium-144, hafnium-181, antimony-124, and manganese-54. The long-lived bone seekers like americium-241 and plutonium are retained in the bone, essentially for the rest of your life. And while the curie amounts of the americium and plutonium are lower, these alpha emitters are more adept at making imperfectly repaired DNA damage, compared to gamma radiation.

It is also important to note that even if a radionuclide is not a bone seeker, but is spread out in just muscle or in both muscle and bone rather evenly, or is external to the body, gamma ray energies above 200 keV penetrate bone to the red marrow where blood cells are formed. [35]

White blood cells make up an essential part of the body's immune system. If a person dies of infection, for example, the death will not be attributed to radiation (perhaps unless an acute dose over 300 rad occurred). Regarding bone or red marrow dose, the nuclear industry's fixation on only bone cancer or leukemia and this means that the "effective" dose is a watered-down dose which discounts non-cancerous illnesses including illnesses related to impaired immune system. Deaths other than from cancer or leukemia are not counted as being caused from radiation exposure.

While the study of ducks that landed at the Test Reactor Area ponds and are presumed to have been uniquely contaminated and only present a hazard to human health if consumed and in large number, I believe there is more to be learned. The ducks that were the "control" ducks, and 30 miles or so from TRA also had gamma spectrometry indicating the uniquely TRA radionuclides. The counting statistics, if less than 2 standard deviations were not reported and if less than 3 standard deviations were not considered "real."

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[34] Ronald W. Warren et al., *Waterfowl Uptake of Radionuclides from the TRA Evaporation Ponds and Potential Dose to Humans Consuming Them*, Stoller-ESER-01-40, October 2001. http://idahoeser.com/Surveillance/PDFs/TRADuckReport.pdf They et al but the ducks, after studying the radionuclides in duck muscle and bone from 1994 to 1998…

[35] Department of Energy, External Dose-Rate Conversion Factors for Calculation of Dose to the Public, DOE/EH-0070, July 1988. https://www.osti.gov/servlets/purl/6953527 Released 2004.

Table 1. Radionuclides found in ducks in southeast Idaho from 1994 to 1998 from Stoller-ESER-01-40 report.

Radionuclide	Half-life	Gamma energy, keV (abundance)	Average, pCi/g	Max, pCi/g	Tissue/Bone and notes
Cr-51	27.8 day	320 keV (9%)	16.3	82.8	Bone seeker
Sr-90	29 year	All beta and cannot be detected by gamma spectrometry	2.9	11.5	Bone seeker
Co-60	5.26 year	1173.2 (100%) and 1332.5 (100%)	2.3	10.7	Found in muscle and bone
Ce-144	284 day	134 keV (11%)	0.5	5.2	Bone seeker
Cs-137	30 year	600 keV (from the Ba-137m, 95%)	0.35	1.95	Found in both muscle and bone
Hf-181	42.5 day	133 keV (48%)	0.3	2.1	Bone seeker
Zn-65	245 day	1114 keV (49%)	0.1	0.4	Bone and muscle
Co-58	71.3 day	810 keV (99%)	0.05	1.52	Muscle more than bone
Sb-124	60 day	1692 keV (50%)	(-0.002)	0.04	Bone seeker
Mn-54	303 day	834.8 keV (100%)	0.03	0.1	Bone seeker
Cs-134	2.05 year	605 keV (98%) and 796 keV (99%)	-0.1	0.21	Muscle
Am-241	430 year	59.6 keV (36%)	2.6E-3	7.7E-3	Bone seeker
Pu-238	88 year	1.8 keV	2.6E-4	7.3E-4	Bone seeker
Pu-239/240	24,000 year/ 6500 year	< 1 keV/ 1.7 keV	1.2E-4	4.6E-4	Bone seeker

Table notes: Gamma energy in kilo-electron-volts (keV), and percent abundance which refers to the percent of decays that also release the gamma photon from https://www1.physics.indiana.edu/~courses/p451/examples/Gamma_Energies_table.pdf ; radioactivity in tissue or bone in picocurie per gram, pCi/g where 1 picocurie is 1E-12 curies; when found strongly in bone the figures are for bone rather than muscle; chromium-51 is Cr-51; strontium-90 is Sr-90; cobalt-60 is Co-60, cerium-144 is Ce-144; cesium-137 is Cs-137; hafnium-181 is Hf-181; zinc-65 is zinc-65; cobalt-58 is Co-58; antimony-124 is Sb-124;

manganese-54 is Mn-54; cesium-134 is Cs-134; americium-241 is Am-241; plutonium-238 is Pu-238; and plutonium-239 and/or plutonium-240 is Pu-239/240. See Table 4 of Stoller-ESER-01-40 report for muscle and bone radionuclide concentrations and this table lists either the muscle or bone concentration, which ever was higher. Where the radionuclide concentration in bone was significantly higher than in muscle, I have commented that the radionuclide behaved as a bone seeker in my table.

The problem is that these statistics are intended to prevent false detections. This means that the error of a false negative, or failure to report an actual detection, is as high as 50 percent.

As I compare the radioactivity in duck tissue from the TRA Duck report to the 2002 Marmot tissue report, I also confirm my suspicion that the counting statistics for the Pocatello zoo location marmots was faulty. In the TRA Duck report, chromium-51 maximums were 20 ± 9 pCi/g in bone. In the 2002 marmot report, we have values like chromium-51 of -22.0 ± 450.0 pCi/g; 13.2 ± 460 pCi/g. There is no such thing as negative radioactivity; the overly large uncertainty values indicate serious problems in the analytical techniques.

The thing is, some slipover into negative decay counts is not uncommon in typical environmental monitoring. But these extremely large uncertainty ranges indicate a more sinister problem. Either the counting times should have been lengthened or hot blanks were being used or the gamma spectrometry software was not properly attuned to the unusual INL and surrounding area background radiation levels. The aim of the Department of Energy's environmental surveillance appears to be to deny that the gamma spectrum was real, and deny that the radiological contamination came from the INL, even if there is no plausible explanation for the presence of chromium-51, hafnium-181, zinc-65 and other radionuclides fission or activation products with less than one year half-lives.

Even in the "control" ducks not at TRA, the ratio of plutonium-238 to plutoniuim-239 is too high to be from weapons testing fallout.

The intake of radionuclides from air or bioaccumulation in vegetation is not explored in the 2001 TRA duck report. When this report is viewed in light of the yellow-bellied marmot report from 2002 which found in the gamma spectrometry of marmot tissues, many of these same radionuclides, some of which can only be from the INL, I have to wonder how what human tissue (muscle and bone) include of the ongoing radiological releases from the reactor and isotope operations at the INL.

While strontium-90, cesium-137, and plutonium-239/240 are known to have been spread by the Department of Energy's nuclear weapons testing at the Nevada Test Site, with above ground testing ending in 1963, there are several radionuclides in the table that have rather short half-lives and cannot be from global weapons testing fallout, Nevada Test Site weapons testing falling, or Chernobyl. And in fact all fourteen radionuclides were stated in the 2001 report as being detected in the Test Reactor Area evaporation ponds.

Based on the 2002 report of marmot tissues, there appear to be radionuclides rather arbitrarily omitted that were likely present but not listed as detected in the TRA Duck report. These radionuclides include zirconium-95 (gamma ray 756 keV, 49 percent abundance, 65 day half-life) which decays to niobium-95 (gamma ray 765 keV, 100 percent abundance, 35 day half-life), and ruthenium-106 (gamma ray 511.9 keV, 20.4 percent abundance, and 622 keV, 11 percent abundance, 1.02 year half-life), and cerium-141 (gamma ray 145 keV, 40 percent abundance and 33 day half-life) which were noted in marmot tissues but later excluded from final reporting by the Department of Energy's environmental surveillance with no explanation of the source of the gamma spectrometry identification of the presence of the these radionuclides.

The Department of Energy annual environmental surveillance reports for many years, and including 1993 never included the amount of americium-241 released by the INL. Later reports would include the Am-241 releases. But this means that many decades of americium-241 releases were not included in dose estimates for the offsite public. The Department of Energy environmental surveillance reports also had presented the air effluents and the liquid effluents in a single table. And it appears that the liquid effluents, even after send to open-air lined evaporation ponds, were not included in the dose estimates for the offsite public. Later reports would include, it appears, at least some of the radionuclides sent to the evaporation ponds.

Unique radionuclides that could only come from the Advanced Test Reactor (ATR Complex) or associated operations include chromium-51, cerium-144, hafnium-181, zinc-65, cobalt-58, cobalt-60, manganese-54 and antimony-124. All of these radionuclides have a half-life of less than one year with the exception of cobalt-60, which has a 5.26-year half-life. The elevated evaporation pond and TRA duck levels of cesium-134 and -137, strontium-90, americium-241, plutonium-238 and plutonium-239/240 show these came from the Test Reactor Area although the Department of Energy's environmental surveillance reports frequently deny detected radionuclides came from the INL. Note also the rather short half life of cesium-134, of 2.05 years.

The same ATR Complex radionuclides found in CERCLA cleanup reports, [36] and in ducks are still being found in animal tissue. Some of these radionuclides are found in the "controls" or the animals offsite that are not near the ATR Complex ponds. Could these be found in your tissue?

For a description of the use of gamma spectrometry analysis, see the October 2019 Environmental Protection Agency report. [37] This EPA report includes usual information about gamma energies and includes discussion of low abundance gamma rays that may be used in alpha spectrometry. It also includes a discussion of uncertainty calculations.

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[36] For example, EG&G for the Department of Energy, *Perched Water System Remedial Investigation Feasibility Study for the Test Reactor Area of the Idaho National Engineering Laboratory*, EGG-WM-10002. March 1992.

[37] U.S. Environmental Protection Agency, *High Resolution Gamma-Ray Spectrometry Analyses for Normal Operations and Radiological Incident Response*, EPA 402-B-17-001, October 2019. https://www.epa.gov/sites/production/files/2020-07/documents/guide_for_high_resolution_gamma_spectrometry_analyses_camera_ready.pdf

Articles by Tami Thatcher for April 2021. This newsletter was updated April 5 to explain gamma ray energy a bit more and to provide current links to health effects reports on Chernobyl.