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In this newsletter, a review of environmental monitoring at the Idaho National Laboratory in the 1960s and 1980s highlights the some of the inadequate monitoring amid the large radiological releases. The Department of Energy and contractors have continued to deny that radiological emissions as well as contaminated groundwater have left the perimeter of the 890 square mile site. I provide evidence showing that radiological contamination has spread to communities 50 miles from the INL via airborne emissions. And contaminated waste water injected into the aquifer from 1953 to 1984 has moved far more rapidly to the Magic Valley and Snake River than the Department of Energy has admitted. The years of radiological and chemical releases from the INL appear to explain the elevated cancer rates in communities surrounding the INL. The continued deceptions and inadequacies of the radiological and chemical monitoring at the INL takes on even more importance as radiological releases from the INL are ramping up.

Unsolved Mystery of Iodine-131 in Milk Samples in 1966, Not Attributed to the Idaho National Laboratory or Weapons Testing

I have been vexed by the "mystery milk" in 1966 in the Department of Energy's report, the *INEL Historical Dose Evaluation.*[1] I've always thought it had something to do with the reactor testing conducted at the Idaho National Laboratory's Test Area North of three reactors called SNAPTRAN. This mystery has prompted me to consider the radioactive iodine releases in the 1960s from the Idaho National Laboratory. A review of the environmental monitoring in the 1960s may offer insight into why the levels of cancer are elevated in the counties surrounding the Idaho National Laboratory.

The *INEL Historical Dose Evaluation* report was supposed to state what radionuclides and in what curie amounts were released as well as when the radiological releases occurred. The report would then estimate the health harm to people in local communities. Underestimating the releases causes underestimation of the health harm.

The Department of Energy reactor testing station began reactor operations in 1952 and spent fuel reprocessing in 1953. In addition, many reactor fuel melt tests and accidents occurred. The radiological releases from routine operation and from special experiments and accidents from 1952 to 1989 were examined in the historical dose evaluation (HDE) report. The majority of the

[1] US Department of Energy Idaho Operations Office, "Idaho National Engineering Laboratory Historical Dose Evaluation," DOE-ID-12119, August 1991. Volumes 1 and 2 can be found at https://www.iaea.org/inis/inis-collection/index.html

radiological releases were said to have come from reactor operation and stack emissions from spent fuel reprocessing at the INL's chemical processing plant now called the Idaho Nuclear Technology and Engineering Center (INTEC). Nuclear fuel reprocessing at the Idaho National Laboratory is said to take place between 1952 to 1991 but the final processing run was in 1988. Liquid waste from nuclear fuel reprocessing at the INL is calcined at the Waste Calcining Facility from 1963 to 1981 and at the New Waste Calcining Facility from 1982 to 2003.

In evaluating the results of levels of radioactivity in milk, the study considered the impact of the Nevada Test Site's nuclear weapons tests and global fallout from nuclear weapons testing by the U.S. and other countries conducted outside the continental U.S. The study could not explain why some 16 samples of milk were found to have elevated levels of radioactivity in 1966. There are other years with undetermined causes of elevated levels of iodine-131 in milk samples shown in the table below from the HDE report, between 1965 and 1989.

Iodine-131 is a radionuclide produced abundantly by nuclear weapons testing or by operating a reactor. The radioactive half-life of I-131 is only 8 days which means that it is usually only detectable within about 3 months of when the neutron fissioning in a reactor or weapons test occurred. Idaho received most of its I-131 from the nearby Nevada Test Site, rather than from global fallout from weapons tests conducted outside of the continental US. Iodine-131 can be dispersed to the air from a nuclear weapons test or from dissolving or melting nuclear fuel.

In the 1960s, the Atomic Energy Commission (AEC) (now the Department of Energy) was conducting conducting the nuclear weapons tests at the Nevada Test Site as well as conducting operations at the Idaho National Laboratory, then called the National Reactor Testing Station. The AEC was conducting air and water monitoring. Yet, the game was to not admit what either the INL or the Nevada Test Site were releasing over our country. Whenever plausible, weapons testing by other countries was the excuse given for elevated I-131 in the milk samples.

In the 1966 environmental monitoring report by the AEC, they attribute the highest sample of 63 pCi/L that occurred in early November to fallout from the nuclear test conducted by China on October 27, 1966. But the dose evaluation report identifies elevated concentrations of iodine-131 levels in milk from May 22 to July 24, 1966 in Idaho Falls that they could not attribute to weapons testing or INL operations, see Table 1 below.

In 1966, China and Russia did conduct weapons tests on October 27. And there had been many nuclear weapons tests globally as well as conducted at the Nevada Test Site in 1966. In 1966, there was a very large 365 kiloton test June 30 at the Nevada Test Site and other tests. The Nevada Test Site would continue with multiple tests designated as shaft, tunnel, and crater testing that continued until 1992 despite the 1963 above-ground weapons test ban. [2] It is plausible that global weapons tests or tests at the Nevada Test Site caused the elevated levels of I-131 in 1966, despite the 16 milk samples declared to be from "undetermined causes."

[2] Ferm, R., *SIPRI Yearbook 1999: Armaments, Disarmament and International Security*, "Nuclear Explosions, 1945-98", Oxford University Press, 1999.

Table 1. Milk sampling results for iodine-131 between 1965 and 1989.

			Source of I-131 (Number of Samples)			
Year	**Offsite Samples**	**Samples with Detectable I-131**	**INEL**	**Weapons Test**	**Chernobyl Accident**	**Undetermined Causes**
1964	160	0				
1965	144	10		8		2
1966	**139**	**24**		**8**		**16**
1967	185	6		6		
1968	185	6		6		
1969	185	0				
1970	172	0				
1971	172	3				3
1972	172	0				
1973	153	0				
1974	153	11	1	10		
1975	152	8				8
1976	156	8		8		
1977	156	23		23		
1978	152	3		2		1
1979	146	0				
1980	148	9		5		4
1981	147	2				2
1982	155	2				2
1983	154	8				8
1984	157	0				
1985	172	0				
1986	170	39			37	2
1987	146	0				
1988	142	0				
1989	144	0				

Table notes: Table information from Appendix E of the *INEL Historical Dose Evaluation.* The minimum detectable concentration was lowered from 20 to 1 picocuries/liter (pCi/L) in April 1974. The Chernobyl nuclear accident occurred in April 1986.

The INL also released significant curie levels of iodine-131 from fuel reprocessing conducted from 1953 to 1988. The amount depended on how much fuel was processed and how recently the fuel had been fissioning and producing the fission product I-131. The historical dose evaluation report gives an estimate of the curies of I-131 released each year. In the 1960s, the estimated annual releases of iodine-131 vary from 1.4 curies to 42.8 curies. In 1965, 9.11 curies of I-131 are estimated to be released and in 1966, only 5.35 curies of I-131 are estimated to be released, mainly from fuel reprocessing.

The fuel reprocessing runs, dates and kilograms (kg) of fuel reprocessed are available in a report issued in 2000. [3] [4] After a fuel reprocessing run from December 1965 through January 1966, there is no other fuel reprocessing at the INL in 1966. **So, the mystery is to find the source of the elevated concentration of I-131 in milk from May 22 to July 24, 1966 in Idaho Falls.**

So how much is 10 curies of iodine-131? Drinking milk with 3 picocuries/liter of I-131 if consumed all year, is estimated to give a 4 mrem/yr dose. And a picocurie is 1.0E-12 curie. So, if you took 10 curies of I-131 and added it to water, you would need to mix it with 3.3E12 liters or 3,000,000,000,000 liters of water to dilute it to drinking water standards.

So, the logical conclusion is that it was I-131 from weapons testing. But could it have come from INL operations and experiments?

One of the things about weapons testing and most releases of fission products is that it would be expected that strontium-90 and cesium-137 are carried along with the iodine-131 along with dozens of other fission products. But the AEC 1966 report notes rather low levels of strontium-90 levels in the milk as well. In fact, at a time when milk levels were typically below 10 or 20 pCi/L, in Idaho Falls in 1965 and 1966, the iodine-131 levels in milk are found with maximum levels of 63 pCi/L and average levels of about 21 pCi/L. Yet the strontium-90 levels in 1966 in milk average only 9 pCi/L and 13 pCi/L in 1965. This is in contrast to 1965 when the maximum iodine-131 level in milk is only 20 pCi/L and the strontium-90 maximum and average concentration is 20 pCi/L. In 1966, the level of strontium-90 in the milk samples is low, relative to the iodine-131.

Table 2. Milk sampling results from iodine-131 between 1965 and 1989.

Year	1964	1965	1966
Iodine-131 in milk, pCi/L	Maximum: 20 Average: 20	**Maximum:63** Average: 23	**Maximum: 63** Average: 21
Strontium-90 in milk, pCi/L	Maximum: 44 Average: 21	Maximum: 24 Average: 13	Maximum: 17 Average: 9

Sources: Atomic Energy Commission reports for the National Reactor Testing Station.

It is worth remembering that the Sedan cratering test at the Nevada Test Site test for excavating dirt that caused a huge amount of radioactive fallout conducted on July 6, 1962 and other large weapons tests at the Nevada Test Site during 1962. The limited weapons test ban treaty which did not go into effect until August 5, 1963, caused an increase in international weapons testing and an increase of iodine in milk noted throughout the country in 1962. And importantly, the testing continued at the Nevada Test Site after the 1963 partial test ban.

[3] L.C. Lewis, et al., *Idaho National Engineering and Environmental Laboratory Site Report on the Production and Use of Recycled Uranium*, 2000. Doi:10.2172/768760 available at osti.gov https://www.osti.gov/biblio/768760

[4] Brenda Pace, et al., *Idaho National Laboratory Fuel Reprocessing Complex Historic American Engineering Record Report – ID-3-H*, INL/EXT-06-11969, December 2006. https://inldigitallibrary.inl.gov/sites/sti/sti/4460713.pdf

Now, just for additional background, in 1963, the INL released 25 curies of iodine-131 in four RaLa runs in January and February 1963. The radioactive lanthanum was extracted from fresh Material Test Reactor fuel and it involved releases of I-131 to workers preparing the material as well as to the public. And even with these intentional releases, none of the 199 milk samples in 1963 were above 20 pCi/L. The historical dose evaluation points out that milk sampling results attributable to later weapons testing and to the 1986 Chernobyl nuclear catastrophe varied considerably, with a few samples in the hundreds of pCi/L range, (see Appendix E of the INEL HDE).

There were also tests of fuel samples conducted at the INL's TREAT facility located at the Materials and Fuels Complex, formerly the Argonne National Laboratory – West (ANL-W) facility. But the only I-131 reported from being released from ANL-W occurred in July 1965, 1.4 curies of I-131. [5] It was not typical of ANL-W airborne releases, probably due to the timing of pyroprocessing.

The thyroid absorbs the radioactive iodine and Bonneville County has a high rate of thyroid cancer, exceeding state average rates in Idaho. Bonneville County, where Idaho Falls is located, has double the thyroid cancer rate compared to the rest of Idaho, based on the Cancer Data Registry of Idaho (CDRI) for the year 2017. [6]

Table 3. Bonneville County thyroid cancer incidence rate compared to the rest of Idaho, 2017.

Cancer type	Sex	Rate in Bonneville County	Adjusted Rate in Bonneville County	Rate for remainder of Idaho
Thyroid	Total	28.2	30.7	14.2
	Male	16.0	17.8	7.4
	Female	40.3	43.5	21.0

Table notes: Rates are expressed as the number of cases per 100,000 persons per year (person-years). Rates are expressed as the number of cases per 100,000 persons per year (person-years). Adjusted rates are age and sex-adjusted incidence rates for the county using the remainder of the state as standard. Data from Factsheet for the Cancer Data Registry of Idaho, Idaho Hospital Association. Bonneville County Cancer Profile. Cancer Incidence 2013-2017. https://www.idcancer.org/ContentFiles/special/CountyProfiles/BONNEVILLE.pdf

While this article focuses on abundant but short-lived iodine-131, it is important to understand that the INL also released iodine-129, the long-lived radionuclide with a 16-million-

[5] U.S. Atomic Energy Commission, Idaho Operations Office, Airborne and Liquid Radioactive Waste Management Information for 1962 Through 1970 at the Argonne National Laboratory-West Chemical Processing Plant Naval Reactors Facility Test Reactors Area Located at the National Reactor Testing Station, Idaho, IDO-10056, undated circa 1974.

[6] C. J. Johnson, B. M. Morawski, R. K., Rycroft, Cancer Data Registry of Idaho (CDRI), Boise Idaho, Annual Report of the Cancer Data Registry of Idaho, *Cancer in Idaho – 2017*, December 2019. https://www.idcancer.org/ContentFiles/AnnualReports/Cancer%20in%20Idaho%202017.pdf

year half-life during fuel reprocessing. [7] Once the long-lived I-129 enters the environment, it is a permanent addition. It has been estimated that 12 curies of I-129 were released to the atmosphere from above-ground weapons testing through 1976; 51 curies were released from fuel reprocessing at the Department of Energy Hanford site in Washington from 1944 to 1986, and 4 curies were released from INL fuel reprocessing. [8]

Iodine-129 has a 1 picocurie per liter (pCi/L) federal drinking water standard, but is rarely monitored, now or historically. In 1963, the INL intentionally released an undisclosed amount of iodine-129 as a tracer material. [9] It is discussed in AEC documents for 1963, but not specifically mentioned in the historical dose evaluation. The amount released for tracer testing was a fraction of the overall releases from fuel reprocessing, but the intentional release as a wind tracer shows the disregard for human health any time an interesting research project came along.

Now we look at the Controlled Environmental Radioiodine Test (CERT) releases conducted at the INL. These were intentional, planned releases of radioactive iodine to study the effects in milk and in humans and in the environment. About 1 curie was released at ground level on May 27, 1963 to dose some volunteers to determine uptakes. It was noted in the Human Radiation Experiments review of INL that there has been no evidence of follow-up studies regarding the health of the volunteers. In 1964, about 1 curie was released September 2 and a smaller amount was released December 11, 1964. In 1965, 100 millicurie was released on June 10. **But on September 14, 1965, 2 to 6 curies of methyl iodide (I-131) was released from the INTEC main stack for the CERT program.** Now, why don't they know whether they are releasing 2 curies or 6 curies? The HDE states that "the shipment of 10 curies had leaked in transit" and that "some leakage also occurred at the Central Facilities Area for several days before the test." So, now they releasing I-131 for study and they don't know whether they are releasing 2 or 6 curies or something in between.

Further explanation is given in a 1969 report. There had been a lapse in formally issued environmental monitoring reports from 1964 to 1968. Unlike the formal and long-winded reports for the late 1950s up to 1963, with photographs and rosy depictions of how carefully they are monitoring radiological releases and worker radiation doses, only a series of monthly or semi-annual letter reports were issued for 1964 through 1968. The focus at the AEC increasingly

[7] Federal public drinking water standards for beta emitters are derived from limiting the dose to 4 mrem/yr to total body or critical organ, see Derived Concentrations (pCi/L) of Beta and Photon Emitters in Drinking Water, as defined in NBS Handbook 69.

[8] L. DeWayne Cecil, L. Flint Hall, and Jaromy R. Green, *Reevaluation of Background Iodine-129 Concentrations in Water from the Eastern Snake River Plain Aquifer, Idaho, 2003*. A study by the US Geological Survey, State of Idaho's INEEL Oversight Program, U.S. Department of Energy, and U.S. Environmental Protection Agency.

[9] Human Radiation Experiments Collection for the Idaho National Engineering Laboratory, CERT, U.S. Department of Commerce, Weather Bureau Program from the Environmental and Sanitary Engineering Branch, Division of Reactor Development and Technology, U.S. Atomic Energy Commission, July – December 1964. Section 5. Iodine-129 Technology Studies, "The iodine 129 technology tests, involving both gaseous and aerosol forms of the tracer, were conducted in August [1964]. There was a total of five tests. The launch the tests from Test Area North, apparently, see page 14.

became one of limiting their liability for the harm they were causing to people living near the INL.

The 1969 report [10] states that the portable whole-body counter developed in 1963 was "used to monitor people involved in an incident which occurred when a shipment of methyl iodide released activity in an airplane. Twenty-two people were counted at the Salt Lake City airport with 14 showing positive results. Six individuals were counted at the Idaho Falls airport with two showing positive results." This was, again, for the ***Controlled*** Environmental Radioiodine Tests.

Regarding the unidentified source of elevated levels of I-131 in milk in mid-1966, the CERT program released 0.05 curie I-131 northeast of INTEC on May 31 and June 7, 1966. Then in 1966, on June 14, **5 curies I-131 are released.** And on July 21, **8 curies of I-131 are released.** And another 1 curie was released on July 26. There are several other small 0.1 curie releases of I-131 after that in 1966. The wind can carry these releases straight east to Idaho Falls, although other wind patterns are possible. It should be noted that when the INTEC stack released something on the order of 5 curies of I-131 during fuel reprocessing, it was observed to their surprise that the I-131 was not released all at once from the dissolved fuel and that the release of I-131 was spread out, at least across several days. Each CERTS release was all at one time. The CERT I-131 releases may have gone directly toward dairies located west and northwest of Idaho Falls. The CERTS tests continue on to release various radionuclides through 1977.

The mystery milk issue prompted me to examine tritium levels in wells monitored at the INL that were not receiving nearby reactor pond or INTEC disposal well effluent. In both 1965 and 1966, the levels of tritium were gyrating, yet many samples from wells were sampling at 2000 picocuries/liter (p/Ci/L) or below most of the time. Many wells do spike to 9000 pCi/L in midsummer of 1965. [11] There are very high spikes in tritium levels in the few wells monitored in October 1966 that I'll discuss later and that may be due to weapons tests. But, importantly, the tritium levels in wells around the INL don't seem to spike in the May to July 24, 1966 timeframe.

It is important to understand that airborne contamination is breathed in by the wells, dissolving in the water and affecting the water monitoring sampling results. The groundwater monitoring by the U.S. Geological Survey was and remains irregular in timing of sampling, the selection of wells sampled and the contaminants sampled. Errors in entering the monitoring data also occur. The primary tritium sources to the aquifer from the INL were the Materials Test Reactor and INTEC. Tritium levels had been higher in 1963 from weapons testing but by 1965

[10] U.S. Atomic Energy Commission, Idaho Operations Office, 1969 Annual Report of the Health Services Laboratory, IDO-12073, July 1970. Page 7.

[11] Based on USGS well sampling data, from May through July 1965, the following wells have tritium results at 8000 or 9000 pCi/L (or 8 to 9 pCi/mL): USGS 4, USGS 7, USGS 8, USGS 9, USGS 11, USGS 14, USGS 16, USGS 19, USGS 29, Area 2, Site 9, Atomic City at 11,000 pCi/L, Fackrells and TRA 3. Well monitoring results are scarce for fall of 1966, but the tritium levels are oddly high. EOCR on 10/26/66 is 28,000 pCi/L. USGS 9 and Cerro Grande record impossibly low levels, below the detection level available in 1966 and appear to incorrectly have entered values for actually very high tritium results, greater than 13,000 pCi/L.

and 1966 were typically 2000 pCi/L unless directly impacted by INTEC and the Material Test Reactor. When wells that are not near or downgradient from those INL sources are all showing elevated levels of tritium, it suggests large airborne releases, either from weapons testing or an unusually high airborne release of tritium from other INL activities.

I might be wrong. But, because of the lack of elevated levels of tritium in the May through June timeframe in 1966 and with the all-at-once releases of 5 and then 8 curies of I-131 from the CERT program at the INL, my vote for the source of the iodine-131 in milk, from "undetermined sources" goes to the 1966 releases of iodine-131 by the CERT program at the Idaho National Laboratory. **The CERT program released more than 13 curies of I-131 in the summer of 1966 in two large releases.**

Just by drinking water, milk or simply breathing air in the 1960s in Idaho, was that the reason for the elevated thyroid cancers in Bonneville County? [12]

Radioactive Manganese-54 and why it was in wheat samples near the Idaho National Laboratory in 1963 and 1964

As I was researching the previous article, I noticed the detection of the excessive radioactive manganese-54 found in wheat samples conducted by the Atomic Energy Commission (now the Department of Energy).

In 1963, the AEC added wheat sampling to their environmental monitoring which already included onsite and offsite groundwater monitoring, air and milk monitoring. The analysis of strontium-90 in wheat was determined by chemical processing of the strontium and a 30-minute count in a low background beta counter. The analysis of cesium-137 is by gamma spectrum analysis.

From the AEC's 1963 report: "The cesium-137 activity levels in wheat were determined by gamma spectrum analysis of about 2200 grams of wheat. From the gamma spectra made during the Cs-137 analysis, the presence of a gamma emitter with an energy of 0.84 MeV [mega-electron-volts] was observed. This energy was identified as being emitted by Mn-54 and later substantiated by chemical analysis. Mn-54 values ranged from 0.50 to 100 pCi/g with an average of 0.41 pCi/g."

The gamma spectrometry of the wheat samples had identified the presence of radioactive manganese-54 that they had not expected to find. And the levels of Mn-54 in 1963 and 1964 were high. In 1963 through 1966, wheat samples are analyzed, typically for six counties around the INL site: Bingham, Minidoka, Bonneville, Butte, Jefferson, and Power counties. The wheat in each county sampled had unusually high levels of manganese-54. The level of Mn-54

[12] See the February/March and the April 2020 Environmental Defense Institute Newsletter articles.

(maximums) were 300 to 700 pCi/kg in each of six counties, showing that the Mn-54 was widely spread across southeast Idaho, see Table 4.

Table 4. Average Mn-54, Sr-90 and Cs-137 in wheat sample results in 1963, pCi/kg.

County	Sr-90	Cs-137	Mn-54
Idaho Falls	180	400	700
Blackfoot	160	500	300
American Falls	180	500	700
Minidoka	210 see note	600	500
Arco	160	600	400
Monteview	360 see note	400	400

Source: AEC, Annual Progress Report 1963, Table XIII, using the highest average values among irrigation types of flood, sprinkle or dry land. Table notes: Picocurie/kilogram (pCi/kg). Of the three values typically presented for each radionuclide for each county, for Minidoka and Monteview, only one value is presented, with other results stated as "lost in analysis" and "sample not available." The funny business in Minidoka continues through the subsequent decades, to cover up the excessively high radioactive contamination there, which I suspect largely came from the 1961 SL-1 accident. The results at Monteview are prior to the SNAPTRAN testing that began in 1964 and could be from the 1950s Initial Engine Tests conducted at Test Area North.

The Atomic Energy Commission environmental monitoring reports for 1963 noted that finding detectable levels of manganese-54 in the wheat during a year with relatively little nuclear weapons testing was odd. In 1964, the levels of manganese-54 were even higher, from 500 to 1200 pCi/kg. Yet, in 1964, the level of Cs-137 and Sr-90 in the wheat had decreased, see Table 5. Mangansese-54 was less than detection or less than 100 pCi/L for 1965, 1966 and 1967. Only in 1963 was wheat data for each community provided of the wheat monitoring in the 1960s. It appears that the elevated levels in Minidoka and Monteview needed to be hidden.

Table 5. Manganese-54 in wheat samples from six or seven communities surrounding the Idaho National Laboratory, as reported by the AEC for averaged results.

Year	1963	1964	1965
Strontium-90, pCi/kg	Maximum: 170 Average: 60	Maximum:30 Average: 11	Maximum: 37 Average: 26
Cesium-137, pCi/kg	Maximum: 800 Average: 450	Maximum: 200 Average: 155	Maximum: 118 Average: 88
Manganese-54, pCi/kg	Maximum: 500 Minimum: 100 Average: 410	Maximum: 1200 Minimum: 500 Average: 790	Maximum: < 100 Average: < 100

Sources: Atomic Energy Commission reports for the National Reactor Testing Station. Wheat reported for 6 counties in 1963 had from 300 to 700 pCi/kg in each county. Note also that Manganses-54 was less than detection or less than 100 pCi/L for 1965, 1966 and 1967. Wheat sampling began in 1963.

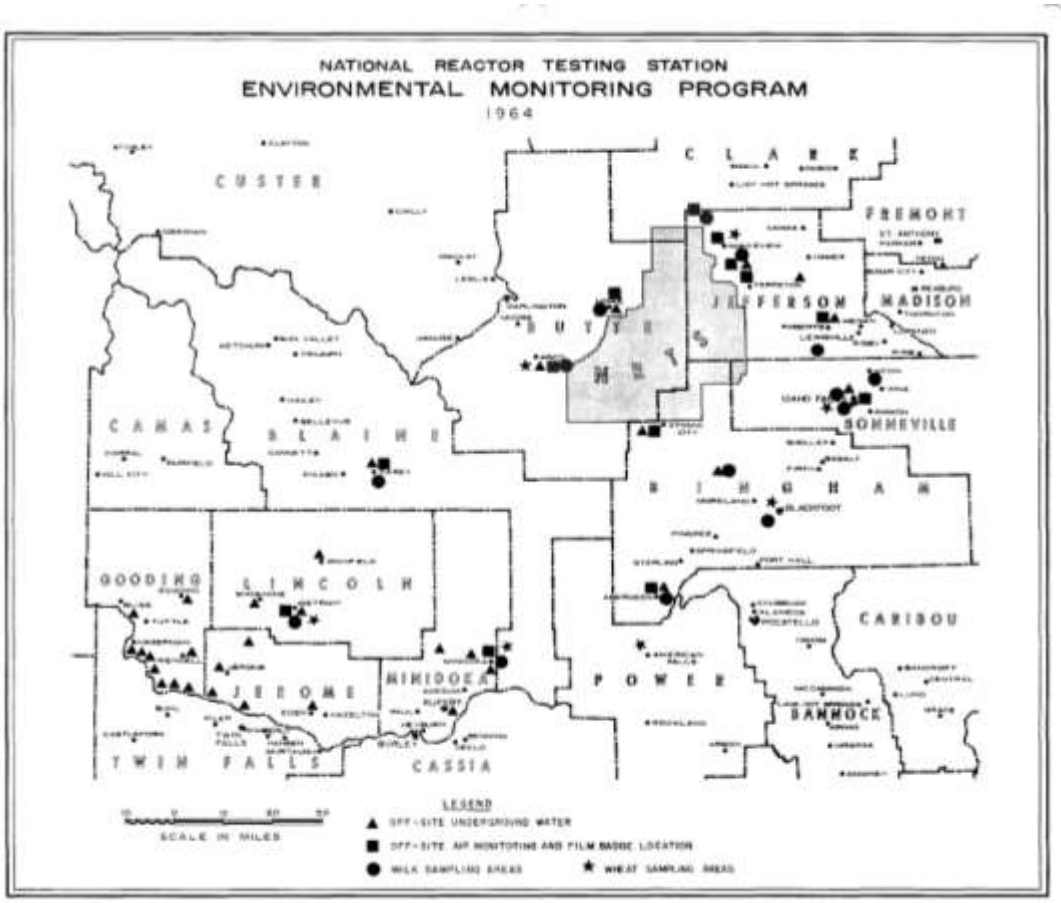

Figure 1. Counties included in the AEC environmental monitoring program, including wheat sampling, near the Idaho National Laboratory, 1964. (Source: Environmental Monitoring Data for the National Reactor Testing Station at https://inldigitallibrary.inl.gov/PRR/112777.pdf)

Manganese-54 can result from weapons fallout, but was typically not be detected back in the 1960s. Manganese-54 has a relatively short half-life of 312 days. Regardless of the health effects of the Mn-54, the data very importantly reflect how wide spread the air emissions from the INL's INTEC were. The Mn-54 came from fuel processing at INTEC.

The Atomic Energy Commission concluded that because there is no Department of Energy limit regarding manganese-54, that "the above data indicates that the wheat is not a significant contributor to the radiation dose of the local population."

In the 1960s, the DOE used "Radioactivity Concentration Guides" which are now called "Derived Concentration Guides." [13] These Department of Energy guides allow 100 mrem/yr to

[13] You can read more about the Department of Energy's Derived Concentration Guides in the Environmental Defense Institute February/March newsletter article "Department of Energy's Derived Concentration Guidelines (DCG) are not protective of health."

the public in contrast to the federal drinking water standard that use 4 mrem/yr, typically. The RCGs which are now called DCGs espoused by the Department of Energy are not protective of human health, particularly of the unborn, of children, of women and the elderly because they are more vulnerable to radiation dose and health will be harmed at levels far below the DCGs. Contamination levels even far below the DCGs will also shorten the life of adult males. Manganese is especially taken up by the pineal gland located in the brain and may be harmful despite low incidence of cancer. In addition, by the failure to monitor the environment, destruction of samples, and other practices to hide the level of contamination in the environment, the DOE can hide the actual levels of contamination in order to argue that the DCGs were not exceeded.

When the AEC discovered high levels of radioactive manganese-54 in wheat it immediately discounted the health hazard and also dismissed the contamination as an odd and unsolvable mystery.

Manganese-54 is released to air and the aquifer from the nuclear fuel reprocessing at INL's INTEC, though it is not usually identified as being in the air emissions or the piping rinse-out water injected into the aquifer. An activation product in cladding, the radioactive Mn-54 decays into stable chromium-54. An activation product in the Department of Energy's research reactors as well as zirconium-clad naval fuel, manganese-54 was released to both air and aquifer from INTEC's fuel reprocessing. The USGS did occasionally report that it monitored managanese-54 in the aquifer and the short half-life makes it a very interesting indicator that is rarely discussed.

Wheat absorbs the airborne radioactive manganese-54 during the growing season. The nuclear fuel reprocessing airborne emissions from the chemical processing plant at INTEC included manganese-54. The proof involves knowing when fuel was being dissolved at INTEC. The reprocessing runs in 1963 and 1964 occur beginning in June with dissolving the fuel cladding and continue over the wheat growing season, with 758.9 kg processed in 1963 and 1228.53 kg processed in 1964. But in 1965, there is only a 44.6 kg reprocessing run from April to June and no other fuel reprocessing until December of 1965. The fuel reprocessing in 1966 occurs in January and only 62.82 kg are processed in 1967. The levels of Mn-54 in wheat are low in 1965.

The elevated levels of manganese-54 documented in 1963 and 1965 were not from weapons testing but were from INL's fuel reprocessing at INTEC. The excessive concentrations of manganese-54 in wheat grown within 50 miles of the INL shows how widely spread airborne emissions from INL's fuel reprocessing were. There are also many other radionuclides and chemicals released from fuel reprocessing.

It is important to note that the Idaho National Laboratory has denied that the stack emissions from fuel reprocessing have ever gone beyond the INL site. And because of this, they have pretended that the nuclear fuel and cladding materials including aluminum, zirconium, beryllium, and many radionuclides emitted from the stack and found in soil from Pocatello to Dubois were

not due to INL airborne releases. There are many signs that point to the source of contaminants in soil miles as being from the INL, but this article is addressing only the manganese-54.

When, in 1996, an effort [14] was made to compile soil sampling reports and to attempt to determine the "background" levels of contaminants in soil, they state many times that they considered all soil sampling off of the INL site to be unaffected by INL activities. They stuck to this erroneous assumption despite plentiful evidence to the contrary. In fact, soil samples detected manganese-54 in Arco, Blackfoot, Howe, Monteview, Mud Lake and St Anthony between 1978 and 1980, not during major nuclear weapons testing but near the time of major fuel reprocessing campaigns at INL's INTEC.

Destructive SNAPTRAN Tests at the INL from 1964 to 1966

Open-air reactor testing at Test Area North for the three small space reactors was conducted for space research for NASA by Phillips Petroleum Company at the INL from 1964 to 1966. The tests involved the SNAP 10A/2 reactor core design. The System for Nuclear Auxiliary Power (SNAP) and associated reactor transient testing, SNAPTRAN, involved severe reactivity insertions. The intent of the testing was to show that the radioactive releases would be acceptable and perhaps to prove that the spherical reactor would not explode like a nuclear weapon.

The cores contained highly enriched 4.75 kg of uranium-235 fuel with zirconium, and the core designs used beryllium neutron reflectors. This does not sound like a lot of nuclear fuel, but less than 1 kg of U-235 fissioned in the World War II atomic weapon used in Hiroshima. The reactors were sodium-potassium (NaK) cooled. The SNAPTRAN-3 core was used to simulate crashing into the ocean and was conducted April 1, 1964. In another test, the SNAPTRAN-2 core was given enough reactivity insertion to release 54 megawatt-seconds of nuclear energy. The test was outdoors and near where people lived and farmed. The destruction SNAPTRAN-2 test was conducted January 11, 1966. The third core, the SNAPTRAN-1 core, was tested in a series of tests between perhaps November 1964 and July 1965, challenging the fuel but without deforming the core. [15]

The AEC claimed that the spread of contamination was limited to a radius of 200 meters from the both destructive tests, on April 1, 1964 and on January 11, 1966. And they claim that they released only "on the order of five percent of all the noble gases formed during the nuclear excursion, which is about 0.5 percent of all the fission products formed." [16] In reality, these two destructive tests released far more fission products that the historical dose evaluation admits. The

[14] S. M. Rood et al., Background Dose Equivalent Rates and Surficial Soil Metal and Radionuclide Concentrations for the Idaho National Engineering Laboratory, INEL-94/0250, August 1996.
[15] Otter, J.M.; Buttrey, K.E.; Johnson, R.P, *Aerospace Safety Program: Summary Report*, July 30, 1978.
[16] Human Radiation Experiments Collection for the Idaho National Engineering Laboratory, CERT, U.S. Department of Commerce, Weather Bureau Program from the Environmental and Sanitary Engineering Branch, Division of Reactor Development and Technology, U.S. Atomic Energy Commission, July – December 1964. P. 15.

1977 Environmental Impact statement states that 600,000 curies of noble gases and 0.1 curie of iodine-131 were released from the January 11, 1966 destructive test of SNAPTRAN-2. [17]

The SNAPTRAN cores were only 4.75 kg uranium-235, basically one-third the size of the 14 kg SL-1 core. The buildup of fission products from reactor operation prior to the final transient is very high in the Stationary Low-Power Reactor, the SL-1. The SL-1 core that released fission products from an accident on January 3, 1961. The HDE also greatly underestimates the release from the SL-1 reactor accident. [18]

Only two cores are mentioned as being reprocessed at INTEC. So perhaps there was nothing left of the core tested on January 11, 1966. **The interesting thing, though, is that the INTEC reprocessing log notes the reprocessing of the SNAPTRAN-3 core in 1964 and reprocessing the SNAPTRAN-2 core in 1969. So, what happened to the SNAPTRAN-1 core?**

To gain some perspective on the potential magnitude of the SNAPTRAN release were it at high levels of burnup from prior operation, and recognizing that the SNAPTRAN cores were about half the size of the SL-1, the SL-1 radionuclide inventory is provided in Table 6. The HDE in its Appendix Table A-41 assumed that the January 11, 1966 SNAPTRAN-2 destructive test released 1.47E-3 curies of cesium-137 and 1.25E-3 curies of strontium-90. **The potential radiological releases from the SNAPTRAN cores may be 200,000 times higher than estimated in the HDE.**

Table 6. SL-1 radiological release estimates for a high burnup 14 kg high-enriched uranium-235 reactor core.

Element	Inventory (Ci)	AEC Release Fraction, percent (Note 1)	INEL HDE Release Estimate (Ci) (Note 2)	More Probable Release Fraction	More Probable Release (Ci)
Iodine-131	18,182 Ci	0.44 percent	80 Ci	30 to 100 percent	5455 to 18,182 Ci
Cesium-137	2,941 Ci	0.017 percent	0.5 Ci	30 percent	882 Ci
Strontium-90	2,778 Ci	0.0036 percent	0.1 Ci	30 percent	833 Ci

Table Notes 1 and 2. See *Idaho National Engineering Laboratory Historical Dose Evaluation*, DOE-ID-12119, August 1991. US Department of Energy Idaho Operations Office, Volumes 1 and 2 (and Table A-41 with SL-1 release estimates) at https://www.iaea.org/inis/inis-collection/index.html or see https://inldigitallibrary.inl.gov

There are interesting spikes in tritium in groundwater monitoring in the summer of 1965 and in the fall of 1966. The spikes have been attributed to weapons testing. These spikes don't coincide with the April 1, 1964 or the January 11, 1966 destructive tests of SNAPTRAN-3 and

[17] US Energy Research and Development Administration, Waste Management Operations, *INEL Final Environmental Impact Statement*, ERDA-1536, September 1977. P. II-249.

[18] Read more about the SL-1 accident in Environmental Defense Institute the December 2019 newsletter article "Interesting Similarities Between the SL-1 and the Chernobyl Nuclear Accidents."

SNAPTRAN-2 cores. But the elevated tritium levels in the summer of 1965 could have come from the high-power level open-air testing of the SNAPTRAN-1 core. The levels of tritium in several wells jump from the usual 2000 pCi/L in 1965 to 9000 pCi/L. And although the aquifer monitoring program is scaled back in 1966, on October 26, 1966, the tritium level at a well called EOCR near the center of the INL spikes to 28,000 pCi/L. On October 24, 1966, a well at Mud Lake is reported to have tritium at 93,000 pCi/L, which the USGS claims is a data entry error and also that the well didn't exist then.

In addition to unusually high levels of tritium detected in October of 1966, unusually high levels of I-131 in milk is also detected. The AEC attributes the elevated iodine-131 levels in milk in the fall of 1966 to a weapons test conducted by China on October 27, 1966. But the unusually high tritium levels in wells occur prior to the October 27 weapons test by China and weapons tests by Russia on the same date. See the timeline below.

Table 7. Timeline for 1964, 1965 and 1966.

Chronology	Radiological Event
April 1, 1964	SNAPTRAN-3 destructive test to simulate core crashing into the ocean from space launch
November 1965 through July 1965	SNAPTRAN-1 core is tested with a series of large reactivity insertions
April through June 1965	INTEC reprocessing limited to 44.6 kg of fuel, a typical run is over 700 kg fuel
May through July 1965	Tritium levels at several wells not downgradient from INTEC or MTR spike near 9000 pCi/L at a time when the wells are typically at 2000 pCi/L or less.
January 11, 1966	SNAPTRAN-2 destructive test
May 22 to July 24, 1966	Elevated concentrations of iodine-131 in milk in Idaho Falls
June 14 and July 21, 1966	CERT program releases iodine-131. On June 14, 5 curies are released and on July 21, 8 curies are released. (CERT also released 2 to 6 curies I-131 September 1965.)
October 25 and October 26	Some USGS wells are sampled and tritium levels are markedly elevated. EOCR well on October 26, 1966 sampled at 28,000 pCi/L and Mud Lake well sample on October 24, 1966 states 93,000 pCi/L but this does not appear to be widespread.
October 27, 1966	Global weapons testing by China and Russia

There are disconnects from the spotty and error prone data, but here's what I suspect: After the first two SNAPTRAN destructive tests, the AEC contractors had not yet had the chance to destructively test a core that had developed high operating burnup. I suspect that they wanted to conduct a test of SNAPTRAN-1 after it had developed a high fission product inventory from the non-destructive testing carried out earlier. A reactor core with high fission product buildup and then a destructive test, vaporizing the fuel would have higher radiological consequences than the prior two destructive SNAPTRAN-2 and SNAPTRAN-3 tests. What I suspect is that a third and final destructive test was conducted in October of 1966 that vaporized the SNAPTRAN-1 core and so there was nothing left to reprocess at INTEC. The reason the test had to remain classified is that it was increasingly known that the fallout was harmful to human life. This test was conducted knowing that the radioactive fallout on the nearby farming community near Test Area North would be too extreme to admit. The actual environmental monitoring records, data sheets and so forth, for the period are inaccessible and were not used in the Department of Energy's historical dose evaluation.

The groundwater monitoring well that the USGS says didn't exist and the NaK and high levels of lead detected in it

The well monitoring data for a well in Mud Lake caught my eye years ago because of the high level of tritium recorded for the well of 93,000 pCi/L in 1966 when levels were typically at or below the detection level, then at 2000 pCi/L. The groundwater sampling entry for the tritium could have been an error; perhaps it was supposed to 9,300 pCi/L. When I asked the U.S. Geological Survey about it, they said that the well didn't exist in 1966 and that it was a data entry error.

The well, labeled with the name "Mud Lake" had several pages of data for various analytes. And I recently noticed three things: various odd jumps in sodium after 1965 and the detection of sodium-potassium (NaK) which was a coolant used in the SNAP core designs that were destructively tested near the Mud Lake well. In addition, although the U.S.G.S. rarely monitored for lead, the data show a very high level of lead. See Table 8. Lead is a decay product of uranium-235 used in the SNAPTRAN tests and fissioning produces thorium decay series that also produce lead.

The Department of Energy avoided monitoring groundwater for radionuclides at the offsite well, except for tritium that the AEC could handily attribute to global or Nevada Test Site weapons testing. And the DOE rarely monitors for lead that the uranium and buildup of actinides in nuclear fuel decay to. Uranium-238, uranium-236, uranium-235, thorium-232, and uranium-233 (or americium-241) all decay to lead. In a reactor, especially a high-enriched uranium-235 reactor, the production of uranium-232 (and uranium-236) and can result in feeding the thorium decay series and rather rapidly decays to lead. The excessive level of lead should have caused further investigation even if the well was not used for drinking water.

The Mud Lake well is north and east of INTEC, near Test Area North and the recipient of airborne releases from open air reactor testing in the 1950s as well as the SNAPTRAN destructive reactor testing conducted from 1964 through 1966. The SNAPTRAN-2 destructive

Table 8. Water monitoring highlights for the Mud Lake well.

Analyte	Analyte Code	Date	Results
Tritium (H-3)	07005	1961 to 5/5/65	< 4000 pCi/L
Tritium	07005	5/31/65 to 8/2/65	10,000 to 18,000 pCi/L
Tritium	07005	9/3/65 to 6/28/66	2 pCi/L
Tritium	07005	10/24/66	93,000 pCi/L ?
Tritium	07005	3/31/67 to 4/12/75	Between 1000 and 2000 pCi/L
Tritium	07005	4/12/75 to 10/3/82	Less than 200 pCi/L
Sodium, percentage, Na Pct	00932	9/15/65	9.3 mg/L
Na Pct	00932	10/11/79	69 mg/L
Sodium, dissolved Na (D)	00930	9/4/63 to 9/15/65	< 8 mg/L
Na (D)	00930	10/11/79	38 mg/L
Sodium plus potassium as Na, dissolved. Na+K (D)	00933	10/11/79	44.00 mg/L
Lead (Dissolved) Pb (D)	01049	10/11/79	120 ug/L

test, in particular, may have spewed airborne beryllium as well as the NaK included in the reactor design. Other destructive reactor testing was conducted at Test Area North in the 1950s, including three Initial Engine Tests, 3, 4 and 10, that released several million curies, according the dose reconstruction reviews that found the Department of Energy's dose reconstruction had underestimated the radionuclide releases. The historical dose evaluation identified 682,000 Ci released at Test Area North and investigators for the Center for Disease Control estimated over

2,000,000 Ci for just one of the releases at Test Area North, IET 10. [19] Dose reconstruction for workers made ill at the INL continues on, decades after the radiological releases, to try to understand the radiological releases from the many reactors and test programs conducted at the INL. [20]

I have found no other well near or at the INL to have included sampling of NaK. The presence of NaK was likely determined by chemical analysis that discovered the presence of NaK.

The concentration of lead in the Mud Lake well is the highest of any of the rarely reported levels, see Table 9. A level of 15 ug/L would be an action level for drinking water. Naturally-occurring levels of uranium in southeast Idaho are not the cause of the elevated level of lead in groundwater in southeast Idaho. The elevated concentration of lead resulted in no follow-up and no explanation.

Table 9. Water monitoring of lead (dissolved) at the INL before 1975.

Well	Location	Date	Lead Results
CFA 2	2 miles downgradient from INTEC	8/20/68	10 ug/L
EBR II 1	Southeast INL	8/20/68	0
Mud Lake	Northeast of TAN	10/11/79	120 ug/L
Site 14	Center of INL	4/9/62	5 ug/L
USGS 17	Northeast of NRF	4/9/62	5 ug/L
USGS 19	Howe	4/9/62	5 ug/L
USGS 87, 88, 89 and 90	Southwest INL near RWMC	1971 to 1973	<6 ug/L

Source: US Geological Survey 84-714.

The USGS can waive off the tritium levels because of the many instances of errors in data entry. But, the NaK detection points to a possible release from the SNAPTRAN tests. And the high concentration of lead points to any of several large open-air radiological releases from Test Area North. The presence of these contaminants and the lack of follow-up and the lack of other monitoring data for radioactive fallout in the vicinity is, unfortunately, all too common for the

[19] SCA Contractor presentation to Advisory Board on Radiation and Worker Health/ABRWH, Center for Disease Control and Prevention, November 10, 2015. https://www.cdc.gov/niosh/ocas/pdfs/abrwh/pres/2015/sca-inltan-111015.pdf

[20] INL SEC-00219 Reactor Prioritization for Evaluation of ORAUT-OTIB-0054 Applicability, June 2016 for the National Institute for Occupational Safety and Health (NIOSH) https://www.cdc.gov/niosh/ocas/pdfs/abrwh/scarpts/sca-inlsec219rsp-r1.pdf

Department of Energy and its partner in covering up the source of the releases, the U.S. Geological Survey.

Tritium trends in the 1980s and efforts to coverup the extent of radioactive waste water flowing beyond the INL

Nuclear weapons testing had not ended in the 1980s but was reduced. The levels of tritium in wells monitored at the Idaho National Laboratory were far lower in the 1980s than the 1960s, for wells not receiving waste water from nuclear fuel reprocessing at INL's INTEC or reactor operation. INTEC's injection well for disposal of radioactive waste water from rinsing out the piping at the fuel reprocessing facility and from nuclear fuel pool storage produced very high levels of tritium in groundwater.

The typical values of tritium in wells distant from INTEC and the Test Reactor Area northwest of INTEC were far less than the 2000 pCi/L average or minimum levels in the 1960s. The detection capability had also improved, so that in the late 1970s and in the 1980s, tritium levels were often reported as less than 200 pCi/L at wells like USGS 83. Even a well south of the Naval Reactors Facility usually sampled at below 200 pCi/L after 1976, with one exception of 400 pCi/L in April 1977.

After the mid-1970s, tritium levels in the aquifer are 200 pCi/L or less. This is far below the 2000 pCi/L typical of the detection level used in the 1960s. Much higher concentrations of tritium, however, are still found in the contamination plume of INTEC and the Test Reactor Area.

That is why, when the report issued by the US Geological Survey in 1990, USGS 90-4090, by L.J. Mann and D. Cecil states that errors in the database caused the failure to recognize elevated levels of tritium in1983 in wells at the southern boundary of the INL, I had to wonder why the USGS forgot about the elevated levels of tritium in these USGS 106 which had elevated levels of tritium in 1980, 1981 and 1982.

While the 1990 report bends over backward to say the tritium was only rarely detected at the INL's southern boundary, USGS tritium monitoring from 1980 and 1981 had already regularly reported tritium levels in USGS 106 between 2700 and 3600 pCi/L. So, the "discovery" of elevated tritium in these INL southern boundary wells in 1983 is long after the tritium had actually reached these wells. Again, the uncontaminated wells were below 200 pCi/L since the mid-1970s, so there was no excuse for the USGS not understanding the elevated results in well USGS 106 by 1980 at over 3000 pCi/L.

Deception about when the radioactive waste water flowed beyond the INL boundaries is nothing new for the Department of Energy. But it is so blatantly false to claim that waste water

only reached the southern INL boundary in 1983. The waste water had reached far south of the INL boundary by the 1970s.

The other very sad thing about what this USGS report does to downplay the levels of tritium in Central Facilities Area drinking water. The report discusses tritium levels at CFA in 1988 without discussing the higher levels that workers had been drinking since 1952. In 1988, the drinking water at Central Facilities was 27,000 pCi/L, above the federal maximum contaminant level (MCL) of 20,000 pCi/L. And note that the federal MCL of 20,000 pCi/L is not protective of health and levels about 400 pCi/L compromise health. Tritium levels in drinking water at Central Facilities peaked at 178,000 pCi/L in 1971, see Table 10 below.

Table 10. Tritium in the aquifer at the INL's Central Facilities Area, CFA-1 well from 1961 to 1982, used for drinking water.

Date	Peak Result, pCi/L	Date	Result, pCi/L
1961	45,000	1973	83,000
1962	66,000	1974	75,000
1963	No data	1975	62,000
1964	133,000	1976	58,000
1965	99,000	1977	54,000
1966	98,000	1978	53,000
1967	96,000	1979	43,000
1968	118,000	1980	43,000
1969	108,000	1981	40,000
1970	106,000	1982	36,700
1971	179,000		
1972	98,000		

Source: U.S. Geological Survey data, 84-714. Note that for results reported in picocurie/milliliter (pCi/mL), multiply by 1000 to obtain pCi/L. Also note that in uncontaminated wells, in the 1960s levels were gyrating but usually below 2000 pCi/L. By the mid-1970s, levels in uncontaminated wells were below 200 pCi/L.

Tritium is not the only radionuclide in the Central Facilities drinking water. But there is no other radionuclide monitoring data for these drinking water wells. The chemical contamination of the water was also extensive and included hexavalent chromium and various chlorinated chemical solvents. The chromium was sampled but not deemed a problem. The other chemical contaminates were completely ignored by the US Geological Survey from 1952 to 1987.

So, what other radionuclides were in the drinking water at Central Facilities?

In the report by the USGS, IDO-22053 by Robertson, some of the radionuclides in the waste water injected into the aquifer are identified from 1952 when reactor operations began until

1970. [21] The injection of waste water via deepwell injection continued through 1984. After that percolation ponds continued to be used or otherwise leaking through 2000. Tritium was only discovered to be in the waste water in 1961 but had been there all along, since 1952. In fact, the levels of tritium from reactor operation of the Materials Test Reactor were disproportionately high because of the lithium-6 in the early fuel design. The IDO-22053 report lists cesium-137, strontium-89 and -90, iodine-131, cerium-144, ruthenium-106 and zirconium-95/niobium-95, along with the category of other or unidentified isotopes and estimates the curie amounts injected into the aquifer. From 1952 to 1970, the total curie amounts disposed of in the Snake River Plain aquifer were estimated in the IDO-22053 report, which are summarized in Table 11.

Table 11. Estimated total curie amounts by radionuclide injected in the aquifer by the INL's INTEC from 1952 to 1970.

Radionuclide (Half-life)	**Federal MCL, pCi/L (DOE's DCG)**	**CPP Effluent > MCL?**	**Average annual, Ci (Range, Ci)**	**Total Ci 1952 to 1970 [liters to dilute peak annual waste water to drinking water standards]**
Tritium (12.3 year)	20,000 (DCG 3,000,000)	Yes, 26-fold.	569 (75 to 1769)	20,000 (1952 to 1960) 5690 (1961 to 1970) [8.8E10 liters to dilute]
Iodine-131 (8.06 day)	3	Yes.	35.5 (0 to 273)	603 [9.1E13 liters to dilute]
Cerium-144 (284.89 day)	30 (DCG:10,000)	Yes, 150-fold.	5.4 (0 to 48)	96 [1.6E12 liters to dilute]
Zr-95/Nb-95 (Zr-95, 64 d and Nb-95, 35 day)	200 (DCG: 60,000)	Yes, 15-fold.	3.6 (0 to 19.4)	62 [9.7E10 liters to dilute]
Sr-90 (29.12 year)	8 (DCG: 300)	Yes, 300-fold.	2.9 (0.3 to 23)	53 [2.9E12 liters to dilute]
Cs-137 (30.2 year)	200 (DCG: 20,000)	Yes, 12-fold.	2.9 (0.5 to 20.5)	52 [1.0E11 liters to dilute]
Rh-106/Ru-106 (368 day)	30 (DCG: 10,000)	Yes, 37-fold.	1.3 (0.2 to 6.1)	23 [2.0E11 liters to dilute]
Sr-89 (50.8 day)	20 (DCG: 3000)	Yes, 20-fold.	0.47 (0 to 2.7)	8 [1.3E11 liters to dilute]

[21] Robertson, J.B. et al, "The Influence of Liquid Waste Disposal on the Geochemistry of Water at the National Reactor Testing Station, Idaho: 1952-1970," US Geological Survey, IDO-22053, UC-70, February 1974. https://pubs.er.usgs.gov/publication/ofr73238

Radionuclide (Half-life)	Federal MCL, pCi/L (DOE's DCG)	CPP Effluent > MCL?	Average annual, Ci (Range, Ci)	Total Ci 1952 to 1970 [liters to dilute peak annual waste water to drinking water standards]
Mn-54 (312.2 day)	300	?	Not estimated but present	
Cobalt-60 (5.3 year)	100	?	Not estimated but sometimes present in excess	
Iodine-129 (16 million years)	1	Yes, as occasionally sampled, 4-fold at CFA. 1974 sampling was 6800-fold above the MCL.	Not estimated but present	In 1974, at wells near INTEC, USGS 42 I-129 at 6800 pCi/L and USGS 57 I-129 was at 1700 pCi/L
Other unidentified isotopes			8.7 (1.1 to 26.8)	156
Total				26,000 Ci tritium and 1199 Ci other isotopes

Table notes: MCL is maximum contaminant level, picocurie/liter is pCi/L, Ci is curies, and the liters to dilute to drinking water standards divides the highest value from the range of annual values by the federal MCL, for each radionuclide.

Tritium was the radionuclide most often measured by the USGS. Various radionuclides that were occasionally monitored included cesium-137 and plutonium-238 and the USGS sometimes with conveniently coarse analytical techniques was satisfied to report "not detected." These radionuclides tend to sorb to soils within the aquifer. The highly mobile and long-lived iodine-129 was monitored at Central Facilities, and has been documented to have exceeded the federal drinking water standard of 1 pCi/L.

The maximum contaminant level for strontium-90 of 8 pCi/L is the most restrictive MCL with the exception of only a few radionuclides, including iodine-131 and iodine-129. If the level of gross beta in water is less than 8 pCi/L, you would remain below the federal MCLs except in the occurrence of I-131 or I-129. Gross beta in groundwater south of the INL have often exceeded 8 pCi/L and are attributed to weapons testing fallout.

Gross beta concentrations in groundwater at the INL have greatly exceeded this beta level but usually are not reported by the USGS. When drinking water programs are developed in the late 1980s, the Department of Energy was granted permission by the State of Idaho to not report radionuclide sampling results to the state of Idaho for inclusion in public drinking water data. Neither is the Department of Energy's drinking water program required to have radionuclide sampling data that is sent to the state. This allows the Department of Energy to not report high

results, to use aggressive averaging and resampling, and to use other contaminant under-reporting strategies.

The radionuclides that contribute to gross alpha concentrations in drinking water include uranium and plutonium isotopes as well as americium-241. The gross alpha level of 15 pCi/L is a federal standard that requires more sampling for drinking water, yet fails to provide a process for identifying the source of the elevated levels when the source is from polluting nuclear facilities.

Many of these radionuclides are rarely presented in US Geological Survey groundwater monitoring data for the INL. Nor are these isotopes typically monitored in public drinking water programs. These radioisotopes occur from reactor operation as well as nuclear weapons tests. The half-lives are each about a year, long enough to affect water, crops and people, but usually not detectable for very long. Are these contaminants a problem?

For every radionuclide contaminant entering the human body, it poses a challenge. Multiple radionuclides in the water and multiple radionuclides in food and air pose a greater challenge. The hexavalent chromium in the water along with chlorine solvents also pose a health challenge. It was negligent for the USGS and DOE to not comprehensively analyze the CFA drinking water.

The current strategy to keep the gross alpha levels below 15 pCi/L is to include large negative values in the averaging and dismiss “outliers” which are any high value detections they wish to deny are accurate.

When in about 1980, the USGS discusses federal drinking water standards, it deliberately avoided revealing just how high the levels of tritium and other radionuclides were at the INL production wells, including the Central Facilities Area, 2 miles downgradient from the INTEC disposal well used for the piping and process rinse outs. The USGS groundwater sampling reports are *sanitized* but not the water workers were drinking.

Here's another thing I noted in the review of the environmental monitoring of the 1960s. The Atomic Energy Commission took credit for expecting low radium-226 and radium-228 levels in its gross beta monitoring in groundwater and air. Therefore, monitoring of these very harmful radioactive contaminants is avoided, by definition. For example, the 1967 AEC Environmental Monitoring Report states: “In choosing applicable RCG’s [Radioactivity Concentration Guides] for drinking water, credit was taken for the fact that significant quantities of radium-226 or radium-228 are not produced by NRTS [National Reactor Test Station] Operations and are therefore not available for release to the environment.” The problem is, elevated levels of radium-226 and radium-228 have occurred and continue to occur from the INL. See Table 12.

The other defining philosophy also stated in the 1967 ACE report [22]is: "No attempt has been made to separate activity contributed by NRTS operations from that contributed by natural sources of radioactivity or by fallout from weapons debris."

This philosophy has continued on, and is part of the continued inadequate environmental monitoring programs regarding the INL. The philosophy is so pervasive that soil and water background levels simply were considered whatever the contamination seemed to be. Only later would samples be taken and averaged to attempt to determine a "background" level, despite that level being the average level of contamination due to years of contamination by the INL.

Table 12. Radium-226 and radium-228 concentrations in groundwater near the INL, expected background concentrations and an example of spiking levels in groundwater encountered.

Total Uranium	Radium-226	Radium-228	Radium-224	Source
Minimum: 0.01 ug/L Maximum: 2.97 ug/L Expected: 0 to 9 ug/L, but this is inflated.	Minimum: 0.03 pCi/L Maximum: 0.096 pCi/L Expected: 0 to 0.1 pCi/L	ND Maximum: 0.618 pCi/L Expected: 0 to 0.3 pCi/L	0.33 pCi/L Maximum: 0.93 pCi/L So rarely monitored, but background levels are not known. Note that uranium-232 contamination would raise the Ra-224 without raising the Ra-228.	Golden Associates compilation of U.S.G.S. data for 5 wells, 1989-1991
Idaho Falls area, spike 1/25/2011 1.22 ug/L	Idaho Falls area, spike 1/25/2011 3.62 pCi/L	Idaho Falls area, spike 1/25/2011 10.26 pCi/L	Not monitored	PDWS, note that gross alpha was 14.17 pCi/L where normally below 3 pCi/L

Table notes: Golden Associates, for EG&G Idaho, "Assessment of Trends in Groundwater Quality at the Idaho National Engineering Laboratory," 933-1151, October 29, 1993.

Zirconium-95/Niobium-95 in the aquifer at the INL throughout the 1970s shows rapid transit times from INTEC's deepwell injection

The nuclear fuel reprocessing at the Idaho National Laboratory included three main types of fuel reprocessing: aluminum-clad fuel, stainless steel-clad fuel, and zirconium-clad fuel. All of the fuels are highly enriched in uranium-235. The stainless steel fuel came largely from the

[22] U.S. Atomic Energy Commission, Idaho Operations Office, National Reactor Testing Station, Environmental Monitoring Report No. 20, First and Second Quarter, 1967.

Experimental Breeder Reactor II (EBR II) which contained the highest proportion of plutonium-239. The Zirconium-clad fuel contained the highest proportion of plutonium-238 and strontium-90. And the Aluminum-clad fuel, from the DOE research reactors including the INL's Material Test Reactor and the Advanced Test Reactor, contained the highest proportion of cerium-144 and zirconium-95 as well as iodine-131 because of the short transit time from the reactor to INTEC for fuel reprocessing.

A useful summary of the radiologically significant radionuclides for the INL's nuclear fuel reprocessing was provided for radiation dose reconstruction, which is provided in Table 13 below. [23]

Table 13. Radiologically significant radionuclides for INTEC fuel reprocessing fuels.

Nuclide	Half-life	Absorption type	Aluminum-clad fuel (decayed 1 year)		Stainless steel-clad fuel (decayed 3 year)		Zirconium-clad fuel (decayed 5 year)	
			Relative activity	Percent inhalation dose	Relative activity	Percent inhalation dose	Relative activity	Percent inhalation dose
Sr-90	28.78 year	F	2.4E-2	13.1	8.6E-2	14.1	2.0E-1	6.3
Y-91	58.51 year	S	2.6E-2	1.1	9.7E-6	0.0	8.0E-10	0.0
Zr-95	63.98 day	S	4.0E-2	1.2	3.3E-5	0.0	5.6E-9	0.0
Ru-106	368.2 day	S	2.3E-2	5.5	3.1E-2	5.7	4.5E-3	0.2
Cs-137	30.07 year	F	2.5E-2	1.2	9.3E-2	3.2	2.1E-1	1.4
Ce-144	284.3 day	M	3.0E-1	47.4	1.6E-1	18.4	2.2E-2	0.5
Pm-147	2.6 year	M	5.6E-2	1.3	1.8E-1	3.2	8.4E-2	0.3
U-234	245500 year	S	2.9E-9	0.0	1.1E-4	4.0	7.2E-8	0.0
Pu-238	87.71 year	M	1.3E-4	26.1	7.6E-6	1.2	3.0E-3	90.0
Pu-239	24100 year	M	4.1E-7	0.1	3.0E-4	50.0	1.6E-6	0.1
Total				97.0		99.0		98.4
Mass fraction U-234 to total U				3.4E-5		5.3E-5		1.4E-4

Source: ORAUT-TKBS-0007-5, January 13, 2006.

So, for example, when soil sampling was finding high levels of plutonium-239 relative to plutonium-238, and it coincides with the time frame of very high amounts of stainless steel EBR-II fuel that is high in plutonium-239 relative to plutonium-238, the source of the contamination may be the reprocessing stack emissions from INTEC.

[23] ORAU TEAM Dose Reconstruction Project for NIOSH [National Institute for Occupational Safety and Health], ORAUT-TKBS-0007-5, January 13, 2006. Table 5-18.

And, for example, when zirconium-95/niobium-95 is detected, and it coincides with the fuel reprocessing of aluminum-clad fuel, the source of the contamination may be the INTEC stack. Similarly, when high levels of strontium-90 along with more plutonium-238 than plutonium-239, and zirconium-clad (naval submarine) fuel was reprocessed, the source of the contamination may be the reprocessing stack emissions from INTEC.

So, with this in mind, the soil sampling results [24] many from the late 1970s and early 1980s make sense to me. And the source of the offsite soil contamination for various radionuclides is the Idaho National Laboratory's fuel reprocessing stack emissions — something that the soil report by Rood does not come to grips with.

There are other materials from the cladding from fuel reprocessing not listed in Table 8, such as beryllium, aluminum, manganese-54 and zirconium and materials used in fuel reprocessing including mercury and iron. When several of the materials are present in elevated concentrations, it provides evidence of effluent from the INL's fuel reprocessing stack. Fuel reprocessing is no longer being conducted. And not all of these materials are toxic or in toxic concentrations. The point is that the Department of Energy was lying about and covering up the extent of the wide-spread releases. The environmental monitoring programs were awful and still are designed to create the illusion of environmental monitoring while actually manipulating the monitoring to argue that they have no idea where the radioactive contamination is coming from. **The DOE argues that the contamination remained below the Department of Energy's "derived concentration guides" and yet we have an epidemic of cancer in southeast Idaho, particularly from radiogenic cancers.**

And now the really big discovery. I found US Geological Survey groundwater data that included manganese-54, zirconium-95, niobium-95 and cerium-144 in groundwater monitoring. Perhaps there was more extensive monitoring data but the data is unavailable for public access.

What I found is ten years of data from three aquifer monitoring wells. And the relatively short half-life of these radionuclides means that this was not from radioactive waste brought to the INL, say from Rocky Flats or other sources. And the concentrations are too high to be from past weapons testing. The source of the data appears to be the INL's INTEC injection well. Very importantly, the peaks in the contaminants coincide with a 10-month lag time from the INTEC fuel reprocessing end date. The data indicate a fast path for 6 to 8 miles from INTEC to travel at roughly 1 mile per month, far faster than average aquifer flow. But when you consider the high volumes of waste water injection into the disposal well and couple that with high volume aquifer usage at Central Facilities, it makes sense that preferential paths were created toward the southwest corner of the INL.

The USGS wells are USGS 87, 88 and 89. These wells are south of both INTEC and Central Facilities and indicate the high levels of radionuclides in drinking water for INTEC, Central

[24] S. M. Rood et al., Background Dose Equivalent Rates and Surficial Soil Metal and Radionuclide Concentrations for the Idaho National Engineering Laboratory, INEL-94/0250, August 1996.

Facilities and the Radioactive Waste Management Complex (RWMC). While it would seem that the wells would be indicative of the burial ground waste, again, the short half-lives of some of these radionuclides rule out the contamination coming from the burial ground. In addition, these wells are located north and west of the burial ground rather that what would be expected to be downgradient from the burial grounds at the RWMC.

The contamination in the wells provided in Table 14 is more indicative of the contamination coming in from the nuclear facilities to the north and not from burial ground contamination. The data, however, for the 1970s do not include chemical contaminant monitoring for the toluene, TCE, PCE and other volatile chemicals prevalent in the groundwater at the INL from fuel and target separations.

Table 14. Radiological concentrations for Ce-144, Mn-54, Zr-95, Nb-95 and Co-60 in three aquifer wells 8 miles south of the INTEC (CPP) disposal well in the 1970.

Radionuclide	USGS 87	USGS 88	USGS 89
Cerium-144 MCL 30 pCi/L	1972 200 pCi/L 1980 320 pCi/L	1972 200 pCi/L 1979 230 pCi/L	1972 200 pCi/L
Manganese-54 MCL 300 pCi/L	1972-73 40 pCi/L	1973-75 30 pCi/L	1972-79 30 pCi/L
Zirconium-95 MCL 200 pCi/L	1972 20 to 70 pCi/L 1974-76 0 to 20 pCi/L	1972-76 0 to 40 pCi/L	1972-76 0 to 30 pCi/L
Niobium-95 MCL 300 pCi/L	1974 10 pCi/L	1972-74 20 pCi/L	1972-76 20 pCi/L
Cobalt-60 MCL 100 pCi/L	1973 100 pCi/L	1973 100 pCi/L	Not sampled

Source: US Geological Survey 84-714. Units of picocurie/liter (pCi/L). A picocurie is 1E-12 curie. Ce-144 and Co-60 are at or about the maximum contaminant level (MCL) for drinking water. INL "production" wells used for drinking water wells were typically not monitored for these radionuclides.

The levels of cerium-144 exceeded the federal MCL near the southwest corner of the INL. The short half-life of Ce-144 means that it will decay away before reaching the Snake River in the Magic Valley. However, the rapid transit from the disposal well to the southwest corner of the INL indicates far more rapid aquifer movement of certain contaminants and points to false and/or incomplete information being provided by the INL environmental monitoring programs and the U.S. Geological Survey. The INL worker drinking water doses were far above federal drinking water standards and this is combined with elevated airborne radionuclides, radionuclides in soil, along with radiological worker exposure and high gamma background levels from the nuclear facilities.

The USGS and DOE had to avoid monitoring these radionuclides because the short half-lives indicate rapid transit times from the INTEC disposal well, with far more rapid movement of contaminants than the DOE or USGS have admitted.

These transit times may not be typical or average. But the excessively slow transit times that the DOE and USGS have tried to argue, are simply to avoid the liability of the chemical and radiological contamination that reached Power, Minidoka, Blaine and Gooding counties years ago.

Articles by Tami Thatcher for May 2020.