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## The Weakest Link Matters in Seismic Assessment

It easier to downplay seismic risks at Department of Energy nuclear facilities with sweeping characterizations of the seismicity of the Idaho National Laboratory site than to provide clarity on seismic risks and seismic design requirements.

First of all, years of study have gone into the DOE's modern analysis and characterization of the INL site seismicity. The precise location and soil and bedrock beneath the INL nuclear facility is taken into account in determining the forces generated by the seismic events applicable to that facility.[1] [2]

The problem has been that the analysis to assure that equipment is adequately designed typically has not been followed through end-to-end.

The more frequent seismic events, say one-in-one-hundred-year events, generate smaller forces for equipment to withstand. Only the essential equipment for assuring safety need meet seismic design criteria. Low hazard facilities need only be designed to withstand these lower intensity earthquakes.

The Advanced Test Reactor is a DOE hazard category I reactor.[3] It is required to withstand a higher intensity earthquake, analogous to a commercial reactor because of its releasable curie inventory.

Equipment essential for safety during or following a seismic event is required to be capable of withstanding a large seismic event, the size of which is determined by the INL's seismic characterization for ATR's precise location and DOE regulations.[4]

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[1] Payne, S.J., et al., 2002, Development of Probabilistic Design Basis Earthquake (DBE) Parameters for Moderate and High Hazard Facilities at INEEL, INEEL/EXT-99-00775, June 2002. (This is one example and not necessarily the most recent document.)

[2] Payne, S.J., "Development of Soil Design Basis Earthquake (DBE) Parameters for Moderate and High Hazard Facilities at TRA" INEEL-EXT03-00942, September 2004.

[3] Hazard category I with a class A reactor is the highest Department of Energy hazard designation. But don't ignore Hazard category II facilities—they span the gamut of releasable hazard but cannot be categorized as higher than category II because they are not nuclear reactors.

[4] The Advanced Test Reactor is Department of Energy regulated and U.S. Nuclear Regulatory regulation and oversight do not apply. The Defense Nuclear Facility Safety Board visits some INL facilities when their mission is deemed to involve defense material. DNFSB currently deems ATR outside its scope.

The ATR has design vulnerabilities beyond those typical to commercial reactors. While it is essential for ATR safety rods to insert, there are other safety functions necessary to prevent an accident. Experiment loops run through the ATR core and their integrity must be assured or the safety rods, even when inserted, may not limit power rises in the reactor. Fuel melt may result in an energetic event: think of the 1961 SL-1 accident which severed piping.

By the way, recently ATR experienced failure of a safety rod to insert which the DOE-ID operations summaries have yet to mention. [5]

Allowing something like an experiment loop or an overhead crane to not be capable of withstanding even a low intensity seismic event, is indeed something to fear. It can mean a severe accident at ATR at a high likelihood, low intensity earthquake. And when vulnerability such as this is unknown, risk assessments blissfully underestimate the risk of an accident.

Typical portrayals of seismic issues in DOE NEPA documents and other documents for public consumption perpetuate a lack of understanding that is at the epicenter of John Snyder's recent editorial downplaying ATR seismic risks.[6]

If as John Snyder says, the seismicity is low, it should be a simple matter to design the equipment to withstand the earthquake intensity applicable to that location and that hazard category.

And now the question is this: when is DOE going to provide verifiable evidence of an end-to-end seismic performance assessment of its moderate and high hazard nuclear facilities at INL?

# The Hidden Truth About INL Drinking Water

The Idaho National Laboratory has disposed of radionuclide and chemical contaminants into the Snake River Plain Aquifer since the early 1950s. Radionuclide and chemical contaminants have exceeded federal maximum contaminant levels at some INL drinking water wells. Much of the history of contaminant levels prior to 1988 remains veiled and with good reason: some wells were well over the federal drinking water MCLs or have been a significant fraction of the MCL even when at or under the MCL.

The history of which wells were used for drinking water, what was sampled, and what the resulting contaminant levels were is largely obscured behind a veil of documents describing "rigorous monitoring" by the US Geological Survey and later by INL contractors.

[5] Department of Energy, "Advanced Test Reactor (ATR) South Safety Rod Failed to Fully Insert During Shutdown," Occurrence Report Number: NE-ID--BEA-ATR-2015-0008, February 23, 2015.
[6] Idaho Falls Post Register editorial by John R. Snyder, Ph.D., "Very little to fear at ATR," May 5, 2015.

In the only USGS report I could find to discuss INL drinking water, identified only one INL drinking well by identifier and provided the tritium data for only one year: 1988.[7] The well was Central Facilities CPP 1. This well, it admitted, for that year, exceeded the federal MCL for tritium. There is no mention of the extremely high levels of tritium at all Central Facilities wells, exceeding five times the MCL, through the 1960s when tritium monitoring began and still reaching the MCL in the early 1990s. [8]

In the early years of sampling, sampling lagged contamination sometimes by years if not decades, very few contaminants of those present were monitored. Detection levels were unable to detect contamination at levels that would now be considered significant levels. Monitoring, when performed, often did not include important contaminants on a regular basis. And people drinking the water were not informed of the toxic brew of chemical and radionuclides they were drinking on a daily basis.

According to a 1990 US Geological Survey report, from 1952 to 1988, the Idaho National Laboratory disposed of approximately 80,900 curies of tritium at INTEC (formerly the Idaho Chemical Processing Plant) and the ATR Complex, formerly the Test Reactor Area. Tritium is also released by above- and below-ground weapons testing and by normally operating nuclear reactors and by reactor fuel melt accidents.

Disposal of radioactive waste water not only contained tritium, it also contained a host of fission products and actinides that were generally not monitored or mentioned. Several unmentioned fission products were mentioned in the closed-access journal article by the US Geological Survey in 1998. This research by Beasley was not placed in a USGS or DOE report, and has not been part of the USGS bibliography until recently at my request. [9]

At INTEC, disposal injection wells were discontinued as percolation ponds were put in use in 1984. But the ponds only slowed the rate some contaminants reached the aquifer. The sorbing characteristics of some radionuclides means that they bind to soils and move much less readily. But non-sorbing radionuclides like tritium, technetium-99, and chlorine-36 move readily through soil into the aquifer. The INTEC plume has contaminated INTEC, Central Facilities, the Rifle Range and is a contamination source at RWMC as well.

[7] USGS Report 90-4090, L.J. Mann and L.D. Cecil, "Tritium in Ground Water at the Idaho National Engineering Laboratory, Idaho," June 1990. p. 34. http://pubs.usgs.gov/wri/1990/4090/report.pdf

[8] US Geological Survey website link: http://id.water.usgs.gov/projects/INL and INL bibliography at http://id.water.usgs.gov/INL/Pubs/INL_Bibliography.pdf . Select individual wells at the USGS mapper at http://maps.waterdata.usgs.gov/mapper/index.html

[9] T. M. Beasley, P. R. Dixon, and L. J. Mann, "$^{99}$Tc, $^{236}$U, and $^{237}$Np in the Snake River Plain Aquifer at the Idaho National Engineering and Environmental Laboratory," *Environmental Science & Technology*, 32:3875-3881, 1998.

At the ATR Complex, the percolation ponds leached water which has become perched over the aquifer. An injection well disposed of hexavalent chromium [10](although the 1960 report does not identify specific chemicals). The contamination levels of this perched water are sometimes not mentioned as aquifer contamination is presented. The only remaining reactor waste water pond at the ATR Complex has been a lined pond since that late 1990s. And the waste water is filtered using resins to retain more radionuclides. The tritium that is now not leaching into the aquifer is emitted directly to the atmosphere AND no attempt is made to even estimate the released amount. [11]

In a peculiar shell game, now rather than the unfiltered waste water percolating to the aquifer in unlined ponds, the filtered waste water sent to lined ponds that release volatile contaminants to the atmosphere. And the resins that filter radionuclides are buried a few feet underground at RWMC and will be buried at the new Replacement facility for RWMC, the Remote-handled low-level waste facility. These buried resins that concentrated various long-lived radionuclides will slowly leach into the aquifer. The ATR Complex and INTEC plumes join together at they flow south of these facilities.

The 1959 annual health and safety report (IDO-12014) discusses contamination found in a production well at INTEC (then called CPP). [12] It doesn't say which production well and it does not specify which production wells were used for drinking water at INTEC. It also does not say what contaminants or what levels of contamination were found. This is what passed for a health and safety environmental monitoring report at INL.

In 1989, INL contractors made errors in reporting how close the tritium contamination at Central Facilities was to the federal MCL. They incorrectly understated the fraction of the MCL by a factor of 100. [13]

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[10] US Atomic Energy Commission Idaho Operations Office, *Annual Report of Health and Safety Division 1960*, IDO-12019, September 1961. p. 123 discusses infiltration capability and disposal well usage. Yet no contaminants or contaminant levels are specified. It describes the USGS work as "directed toward establishing adequate safeguards for waste disposal without imposing economically prohibitive limits on the development of the nuclear industry." If you had any belief that the health and safety reports were concerned with human health, get rid of it: the chief concern was the health of the nuclear industry.

[11] US Department of Energy, *Technical Basis for Environmental Monitoring and Surveillance at the Idaho National Laboratory Site*, DOE/ID-11485, February 2014.

[12] US Atomic Energy Commission Idaho Operations Office, *Annual Report of Health and Safety Division*, 1959, IDO-12014, p. 152, 153.

[13] US DOE Idaho Operations Office, *The Idaho National Engineering Laboratory Site Environmental Report for Calendar Year 1989*, DOE/ID-12082(89), June 1990. See page 20 and Table B-6 on page B-8. Page 20 states: "The highest annual average concentration of tritium in Site drinking water (at CFA) is 1.2% of the derived concentration guide for radiation protection. For Sr-90, the highest annual average concentration (at ICPP) was 0.06% of the derived concentration guide." The problem is that the levels were actually 100 times higher. The tritium concentration of 24,000 pCi/L (or 24 pCi/ml) was at 120 percent of the MCL (or derived concentration guide). And the strontium-90 level of 1.400 pCi/L was 6 percent of the MCL. Stupid like foxes? I don't know how intentional these mistakes were, but they were repeated for several years and remain uncorrected in these reports.

It is important to remember that when more than one radionuclide is present, the fraction of the MCL should be summed. Thus, when tritium was a 20,000 pCi/L, the addition of iodine-129 or strontium-90 would have effectively meant that in fact the total maximum contaminant levels for radionuclides had been exceeded. (See 40 CFR 141)

The challenge to keep the water monitoring from showing that the MCL had been exceeded no doubt led to the pressure to make IDEQ accept the DOE contractor's wish to no longer provide IDEQ radiological data. And simultaneously, the DOE decided not to provide the drinking water data to its independent environmental monitoring organization that provides annual environmental monitoring. The inability to track samples and trend the wells would facilitate keeping the problem under the radar, especially important for health liability issues and for public perception of aquifer contamination. The INL drinking water radiological monitoring data were no longer provided to IDEQ after 1995.

The IDEQ did not break laws by agreeing that INL was not required to provide the radiological data, because INL's wells were not "community" wells. Idaho law does not require Nontransient Noncommunity Systems at INL to report radionuclides prior to its use as a drinking water source. This is consistent with adoption of CFR 141.26 which only requires the reporting of radionuclides for community wells. However CFR 141.35 allows reporting of unregulated contaminants to be requested.

Initially, IDEQ did require INL drinking water systems to provide both radiological and non-radiological water monitoring data. IDEQ should never have granted that request and it can and should now request INL's drinking water radiological monitoring information along with the numerous chemical constituent monitoring data IDEQ continued to require of INL's drinking water systems. IDEQ's laws permits Idaho to request the radiological data from INL and with the historically high levels it should do so. [14]

Contaminants began flowing into the aquifer in the 1950s. USGS started measuring various attributes of the water in 1949, but monitoring of radionuclide or chemical contaminants came years after the contamination occurred. Well sampling by USGS has been at irregular intervals and is available for some of the wells, some of the time. Sampling intervals and data is not consistently available. USGS and DOE reports do not say which wells were used for drinking water and when the wells were used for drinking water or were taken out of service for that purpose.

Historical detection limits have improved over time, but in early decades were insensitive to low levels of the contaminants. Some contaminants reading zero may have been present in health

[14] IDAPA 58.01.08, 2010, "Idaho Rules for Public Drinking Water Systems," Idaho Administative Procedures Act. 009. MONITORING. The Department may, in its discretion, alter the monitoring or sampling requirements for any contaminant otherwise specified in these rules if the Department determines that such alteration is necessary to adequately assess the level of such contamination. (IDAPA 58, page 23)

significant amounts, like Iodine-129. Only a limited set of contaminants were sampled for, now known to be an incomplete set based on increased understanding of the waste waters disposal.

It is important to understand that the radiation protection guidelines are actually known to understate the risks of internal radiation emitters from ingestion by a factor of 100. Thus, a 4 mrem/yr dose acts as a 400 mrem/yr dose. [15] MCLs are treated by regulators as though safe as long at they are not exceeded, but no one drinking the water should assume that.

The National Institute of Occupation Safety and Health that performs radiation dose reconstruction for former INL workers has failed to adequately consider the radiation contribution from drinking water that certainly affected the health of people who worked for years at these facilities.

*Articles by Tami Thatcher, May 2015.*

[15] ECRR – 2010 European Recommendations of the European Committee on Radiation Risk – The Health Effects of Exposure to Low Doses of Ionizing Radiation, Regulators' Edition: Brussels 2010. http://www.euradcom.org/2011/ecrr2010.pdf