Environmental Defense Institute

News on Environmental Health and Safety Issues

August 2018 **Volume 29 Number 8**

Potential Unreviewed Safety Question Affecting Department of Energy Complex Concerning Hydrogen Generation in TRU Waste Drums

After searching for the reasons why four transuranic waste drums ruptured in April 2018, just hours after being repackaged, [1] I came across a report published in 2002 that seemed to provide important clues for the rapid drum overpressurization. [2] The four waste drums had been repackaged by Fluor Idaho, the operating contractor for the Idaho Cleanup Project, under the Department of Energy at the Idaho National Laboratory site.

The information in the 2002 report suggests that the Department of Energy needs to conduct a thorough review of the safety issues pertaining to transuranic (TRU) waste drums not only in Idaho but also at other sites around the DOE Complex including the Waste Isolation Pilot Plant (WIPP) and at the Los Alamos National Laboratory, both in in New Mexico. The emergency response at any location that the waste is transported through may also need to be reviewed.

Cause of the Four Drum Rupture has been a Mystery

So far, the Department of Energy has not offered any explanation for the rapid gas buildup, within hours, from repackaging the waste into new drums. I don't know how far along Fluor

---

[1] Keith Ridler, *The Idaho Statesman*, "Officials say radioactive sludge barrel ruptures now total 4," April 25, 2018. http://www.idahostatesman.com/latest-news/article209827149.html

[2] David B. Barber and Kevin P. Carney, Argonne National Laboratory, "Observations of Excessive Hydrogen from Transuranic Waste Type IV Solidified Organics," January 2002. Funded by the DOE's Transuranic and Mixed Waste Focus Area. https://www.researchgate.net/publication/238614280_Observations_of_excessive_hydrogen_from_transuranic_waste_type_IV_solidified_organics The paper describes unexpectedly high levels of hydrogen generation in tests conducted of transuranic Type IV solidified organics. There is a variety of materials present in the sludge (oil, inert and volatile organic compounds) and variation in the localized and drum-total ionizing radiation doses, variation in storage conditions, and variation in radiolysis, recombination and matrix depletion effects. "It has certainly proven difficult to isolate mechanisms for hydrogen production and release from these organic systems. The three mechanisms discussed previously, i.e., storage-and-release, cracking of radiation-produced organic compounds and radiocatalysis, as well as other causes may be at play. Several research paths including inerted sampling remain to be pursued to resolve these questions." The Department of Energy's funding for this research was terminated.

Idaho, the Idaho Cleanup contractor, is in determining the cause of the rupture of the four TRU waste drums. I only know that they have not released any information pertaining to analysis of drum contents and that they have communicated to the Idaho Department of Environmental Quality that they do not plan to issue a report until November, several months from now. But in the meantime, shipments to WIPP are continuing.

The Unreviewed Safety Question process is a formal process used by the Department of Energy to document the issues that arise that could mean that their documented safety analysis for their nuclear operations may have understated the likelihood or the consequence of an accident.

I hope to prompt the Department of Energy and its contractors to make sure that they assess the report published in 2002 that observed unexpected and excessive hydrogen generation on a transuranic waste sample at ambient temperature.

Currently, there appears to have been the assumption that as long as no incompatible materials were added to the waste and the waste was not subjected to excessive temperatures, there would not be excessive hydrogen generation.

But for the four drums that ruptured, no materials had been added and the drums were being stored at normal temperatures.

Excessive Hydrogen Generation Noted in TRU Sludge Waste in 2002 Report

In the research described in the 2002 report, the transuranic organic waste sludge sample that unexpectedly generated excessive hydrogen apparently had not had material added to the sample or been stirred. The intent of the experiment was to heat the samples and measure hydrogen gas generation. But the hydrogen level was already elevated in one sample when the experiment started. Simply upon unsealing the sample of transuranic sludge waste material, an excessive amount of hydrogen generation was observed. The DOE defunded the research. And it is not clear that the observations were ever followed up on.

In my limited review of the technical bases for concluding that the chemically-laden transuranic sludge waste would not overpressurize drum waste containers, it appears that the technical bases may be awfully thin. It appears that analyses by a single author, John Dick, who tested chemical combinations that had not been exposed to radioactivity, which is normally present in transuranic waste, concluded that as long as the waste materials were not subject to excessively high temperatures and did not have reactive materials added to the waste, that the waste would not overpressurize. [3] [4]

[3] John R. Dick and Brent N. Burton, INEEL, "Evaluation of Chemical Compatibilities of the OU 7-10 Glovebox Excavator Method Project," INEEL/EXT-01-01587, June 2002. https://ar.icp.doe.gov/images/pdf/200304/2003041100126KAH.pdf See also John R. Dick, INEEL/EXT-01-00265 and INEEL/EXT-03-00471 cited in ICP/EXT-04-00248.

Therefore, there appears to be an Unreviewed Safety Question concerning TRU waste within the Department of Energy Complex involving inadequate technical bases for concluding there would be no excessive hydrogen buildup when TRU waste containers are opened, intentionally or accidentally, and allowed to take in oxygen.

DOE Must Avoid Focusing Too Narrowly on Drum Repackaging in Idaho

It might be narrowly decided that the cause of the April four-drum rupture is limited to the specific chemical constituents present in that waste — or that repackaging the waste into new drums was a necessary condition for the excessive hydrogen generation. But, additional configuration and factors beyond those need to also be considered.

I suggest that the Department of Energy not restrain itself too narrowly during the investigation of the four-drum rupture event. I am concerned about the tendency to continue to rely on an incomplete and now proven to be grossly inadequate technical bases for assuming there would not be significant overpressurization events as long as the waste was stored as normal ambient temperatures and as long as no addition materials such as organic kitty litter or other reactive waste had not been recently added to the waste.

In light of the TRU waste overpressurization at WIPP in 2014 and now in light of four TRU waste drums that overpressurized at the Idaho National Laboratory site at the Idaho Cleanup Project in April 2018, the 2002 report that identified excessive hydrogen buildup in TRU waste samples is particularly important. Because of the WIPP event being thought to be due to the addition of organic absorbent, a wheat-based kitty litter, initial responses to the Idaho four-drum rupture event in April were to point out that no organic materials had been added to the drum when it was repackaged.

The particle size of the TRU radionuclides as well as the amount of ionizing radiation and neutron radiation and possible reasons for inadequate radioactive material assay also need to be examined. Even for so-called “homogeneous” sludge waste from Rocky Flats, the original waste in the drum would not necessarily have been well mixed which could result in radiation assay underestimation of the TRU material present in the drum. The way that Portland cement and other materials were added to the original TRU waste drums from Rocky Flats (or a supplier to Rocky Flats) might not be well mixed and could result in underestimating the radioactive material present. It would appear that the incorrect assay of the amount of TRU radioactive material present may have been a significant factor in the 2014 WIPP drum explosion.

Poorly Characterized Waste Stream

The transuranic waste involved in the rupture of four drums at the Idaho Cleanup project appears to have involved a waste stream that was particularly poorly understood. This

[4] North Wind Inc. for U.S. Department of Energy, Environmental Management, “Historical Background Report for Rocky Flats Plant Waste Shipped to the INEEL and Buried in the SDA from 1954 to 1971,” ICP/EXT-04-00248, Revision 1, February 2005. https://ar.icp.doe.gov/images/pdf/200504/2005040400022KAH.pdf

characteristic seems to be the only reason they have offered for deeming it acceptable to continue other shipments to WIPP.

A long listing of chemicals that might be in the waste that was in the four drums that ruptured had been assigned but there was no physical sampling to determine which of the chemicals were in the waste prior to its repackaging. Nonetheless, the contractor, the DOE, and the Idaho Department of Environmental Quality deemed the process safe enough based on their very limited knowledge of what was in these drums of "homogenous" sludge.

Awfully Thin Technical Bases for Current Assumptions

The bases for concluding that hydrogen generation in the TRU drums should not be a problem appears to stem from analyses largely by the same analyst, John Dick, who concluded that the TRU waste would not overpressurize when ambient temperatures for storing the waste would maintained. It appears that his research regarding mixing of chemicals did not include actual TRU waste and thus would not reflect the possible increased susceptibility to hydrogen generation of chemicals long exposed to radiation.

The four drums that ruptured had been repackaged in Idaho did not add new material. The contents of the drums were mixed around in a trough and then repackaged into new drums. These drums were stored in areas of the facility where no worker respiratory protection would have normally been provided. There was no expectation that these drums were vulnerable to over-pressurization and rupture. If not for the good luck of the timing of the drum ruptures being during the off hours when no workers were in the facility, many workers would have had significant inhalation of radioactive material. And these drums could have been moved from this facility to other locations that also would have put workers and/or the environment at risk.

Possible Reasons for Excessive Hydrogen Buildup

The question of why there was excessive hydrogen buildup might be explained by research conducted at ANL-W and reported in 2002. The report by David B. Barber and Kevin P. Carney and Jack C. Demirgian is "Observation of Excessive Hydrogen from Transuranic Waste Type IV Solidified Organics." This work was funded by DOE's Transuranic and Mixed Waste Focus Area under contract W-31-109-ENG-38.

However, upon finding unexplained excessive hydrogen buildup in actual TRU waste samples, the research was defunded.

While this research did not make final conclusions of the cause of excessive hydrogen buildup in some TRU samples, they did offer possible reasons.

The reasons can include variation in chemical contents of the TRU waste, variation in the amount of ionizing radiation in the sample, increased susceptibility of the compounds to release gases at lower temperatures because of long term exposure to ionizing radiation resulting in "thermal cracking," and the presence of free radicals formed by the ongoing ionizing radiation.

In the 2002 report by Barber et al., simply opening the container of the TRU sample which allowed in oxygen (and no mention of stirring or mixing the waste) was enough to, in a noted case, result in unexpected and excessive hydrogen gas generation.

Had this finding been further and adequately researched, additional precautions might have been put in place to monitor hydrogen off-gassing (and temperature). So, some of the precautions that have been put in place at least temporarily at the ARP V now, after the four-drum accident, could have been identified years earlier.

The historical bases for the assumption that opening drums, stirring drum material, and repackaging drums and/or storing the drums would not develop pressures that would overpressurize the drums and release large amount of TRU waste material appear to be inadequate.

Other research has noted increased hydrogen generation levels, characterized by G-value, for mixed chemicals. [5]

TRU Drum Handling Risks Beyond Repackaging, Include Transportation

The safety analyses must also address safety issues concerning unintended opening TRU waste packages, allowing oxygen entry to the previous oxygen deprived drum.

The wrong conclusion which was that the TRU waste, now opened after a long oxygen limited environment, would not have excessive hydrogen buildup that would result in container drum rupture, has been a very dangerous error made by the Department of Energy.

I implore the Department of Energy to perform adequate analysis review of the bases for concluding that there was no or minimal risk from the newly opened and repackaged drums. This issue pertains not only to the repackaging of transuranic waste drums, it also pertains to the necessary precautions and emergency response regarding an accidental drum breach. Forklift tines puncturing a drum, could, for instance, allow oxygen into the drum and put the drum at more risk of an overpressurization within a few hours of the initial breach. The possible build up of excessive temperature (300 F) in the waste and possible drum lid popping pressures need to be understood and mitigated in drum handling and transportation incidents.

Summary

A thorough review of the inadequacy of the technical bases for assuming that there was little risk of drum overpressurization needs to be conducted. The old assumptions — that unless new

[5] B. L. Anderson et al., Hydrogen Generation in TRU Waste Transportation Packages, NUREG/CR-6673, UCRL-ID-13852, Lawrence Livermore National Laboratory, February 2000, https://www.nrc.gov/docs/ML0037/ML003723404.pdf p. 77 "Aromatic hydrocarbons, such as benzene, toluene, and cyclohexene protect TBP from radiolysis, while saturated hydrocarbons such as hexane, cyclohexane, and dodecane sensitize TBP to radiolytic degradation (Barney and Bouse 1977). Carbon tetrachloride has also been found to sensitize TBP radiolysis."

materials were added to the drum, the drum would not overpressurize at ambient temperatures — are flawed.

Additional vulnerability of TRU drums at lower than previously assumed temperatures also needs to be revisited. Many assumptions made in the documented safety analysis for handling of TRU waste appear to be without sound technical bases. Without sound technical bases, the necessary mitigations and controls had not been put in place.

The multitude of drum storage and handling configurations and incidents such as puncturing a waste drum also appear to potentially pose a higher likelihood and consequence from potential rapid overpressurization such as would cause additional drum rupture or lids to pop off the drums, during the response to a drum incident that had allowed oxygen to enter to drum.

Radiation Workers at the Idaho National Laboratory and Around the DOE Complex Need to Understand Blood Count Changes That Can Indicate a Significant Radiation Exposure

A large external or internal radiation exposure can damage bone marrow and the damage is reflected by changes in complete blood count (CBC) results. A CBC is the determination of the number of red and white blood cells per cubic millimeter of blood. The following discussion would be relevant to a radiation worker with an above normal ionizing radiation external exposure or an internal exposure from intake of radioactive material.

After a significant radiation exposure, there is a sharp drop in lymphocytes which may remain depressed for several months. There is also a brief increase in granulocytes followed within a day by a decrease which reaches a minimum several weeks after exposure, and then returns to normal after several weeks or months. The depression in blood counts are due to destruction of the blood-forming stem cells in the bone marrow rather than to the destruction of the blood cells themselves. The red blood cell count does not reflect an overexposure until about a week after exposure. Then, depression in the red blood cell count continues until a minimum is reached between 1 and 2 months after exposure, followed by a slow recovery over a period of weeks.

Radiation workers with an internal exposure should be cautioned that much of the information available that describes radiation-induced blood changes is based on external exposure from penetrating gamma radiation. A disproportionately higher bone marrow dose may be received by internal exposure to bone seeking radionuclides such as plutonium taken into the body via inhalation, ingestion, or wound entry. The bone seeking radionuclides include americium-241, plutonium-238, plutonium-239, thorium-228, radium-226, radium-228, and strontium-90. When a radionuclide such as plutonium-239 is stored in bone, near the stem cells that produce white blood cells, these radionuclides deliver a chronic dose of radiation that can interfere with normal blood-cell production.

The hematopoietic system is made of the bone marrow and other organs and tissues involved in the formation and functioning of blood elements. Human blood consists of (1) red blood cells (also called erythrocytes), (2) white blood cells (also called leukocytes), (3) platelets (also called thrombocytes), and (4) plasma.

There are five types of white blood cells: the lymphocytes and monocytes (which are agranulocytes) and the neutrophils, basophils, and eosinophils (which are granulocytes). The lymphocytes are produced in the lymph nodes and spleen and remain alive in the blood for about 24 hours. The granulocytes are produced in the bone marrow and remain alive in the blood for about 3 days. Neutrophils account for 50 to 75 percent and lymphocytes account for 20 to 40 percent of the cells in blood. The red blood cells are formed in the bone marrow and survive in the blood for about 90-120 days. The platelets are also made in the bone marrow and live about 8-12 days. The drop in the number of leukocytes can lower the resistance to infection. The drop in the number of platelets may lead to hemorrhage or profuse bleeding. Average concentrations of formed elements in human blood are shown in Table 1.

Table 1. Average concentrations of formed elements in human blood.

Formed elements	Concentration (per cubic millimeter) (Source: Mosby's Dictionary, 8th ed.)
Erythrocytes (red blood cells)	4,700,000 to 6,100,000 (adult males) 4,200,000 to 5,400,000 (adult females)
Leukocytes (white blood cells)	5,000 to 10,000
Lymphocytes	2,710 *
Neutrophils	4,300 *
Monocytes	500 *
Platelets	200,000 to 300,000

* Monocyte depletion is discussed and an estimate of the normal number of neutrophils, lymphocytes and monocytes per "microlitre" of blood is provided, and appears to actually correspond to milliliter. http://www.ccnr.org/bertell_book.html

Rosalie Bertell wrote that in addition of observing lymphocyte and neutrophil depletion that is typically described for assessing radiation exposure, [6] it is also important to observe monocyte depletion. The low number of monocytes and the lower variation in what may be considered normal levels allows the monocyte depletion to be a sensitive indicator of radiation exposure. Monocytes recycle 37 to 40 percent of the iron in the red blood cells when they die, so monocyte

[6] Radiation Emergency Assistance Center/Training Site (REACT/TS) Managed by Oak Ridge Institute (ORAU) for the Department of Energy, *The Medical Aspects of Radiation Incidents*, 4th Edition. https://orise.orau.gov/reacts/documents/medical-aspects-of-radiation-incidents.pdf and see more about REACT/TS at https://orise.orau.gov/reacts/index.html

depletion is important to iron deficient anemia. Monocytes also secret the substance that activates the lymphocyte immune system and so monocyte depletion is important to depressed cellular immune system. [7]

Red blood cells can be deformed and are associated with chronic fatigue syndrome. This chronic fatigue syndrome has been observed both a Hiroshima and Nagasaki and at Chernobyl.

An elevated serum amylase provides a supplementary piece of information that may also be an early sign of serious radiation exposure involving the head and neck. The results of this test are nonspecific, however, and may also reflect alcohol intake, a stress response, trauma to the face or abdomen, or other factors. [8]

According to the Oak Ridge Associated Universities website, chelation with diethylene triamine pentaacetic acid (DTPA) accelerates renal elimination of radioactive materials from the body from plutonium, americium or curium. **The use of DTPA is indicated when individuals have been internally contaminated with a significant amount of radioactive plutonium, americium, and/or curium.** It should be noted that these radionuclides are also neutron emitters. [9] DTPA treatment may actually increase the deposition of uranium and neptunium into bone and thus is not recommended treatment for contamination with these radionuclides. [10] There are calcium or zinc forms of DTPA: Ca-DTPA and Zn-DTPA. Ca-DTPA is considered more effective in the first 24 hours but carries a higher risk of mineral depletion from the body. Zn-DTPA is considered as effective as Ca-DTPA 24 hours after exposure but carries less risk of mineral depletion if given over a long duration.

---

[7] Dr. Rosalie Bertell, Gulf War Syndrome, Depleted Uranium and the Dangers of Low-Level Radiation, http://www.ccnr.org/bertell_book.html which references Bertell, R. "Internal Bone Seeking Radionuclides and Monocyte Counts", International Perspectives in Public Health, Vol. 9, pp 21-26, 1993.

[8] Anthony B. Wolbarst et al., Radiology, "Medical Response to a Major Radiologic Emergency: A Primer for Medical and Public Health Practitioners, February 8, 2010. https://pubs.rsna.org/doi/full/10.1148/radiol.09090330

[9] Environmental Defense Institute, July 2018 newsletter article "Neutron Exposure During Glovebox Work and Other Handling of Fissile Material at the Idaho National Laboratory and Idaho Cleanup Project. Note that Pu-239, which is fissile, is bred from U-238 by single neutron capture. Other transuranic radionuclides, which may or may not be fissile, result from repeated neutron absorption, usually in a nuclear reactor. Uranium and transuranic radionuclides such as plutonium, americium and curium may undergo spontaneous fission and emit neutrons. Some transuranic materials are created in spent nuclear fuel, while some transuranic radionuclides are created from target material exposed to high neutron flux in a nuclear reactor. Radiation workers who work around uranium and transuranic radionuclides such as plutonium are exposed to neutron radiation which is not stopped by metal shielding or lead aprons and which causes densely ionizing damage to the human body. The neutron dose from an intake is usually ignored; however, the radiation workers most likely to have a plutonium, americium or curium intake may be chronically exposed to neutron radiation in their jobs. I suspect that the detrimental health effects of chronic neutron exposure such as infertility may be underappreciated in these radiation workers.

[10] Medical Countermeasures for Radiation Exposure and Contamination webpages at https://www.orau.gov/rsb/countermeasuretraining/#DTPA

Chelation following plutonium intake is recommended to commence within one hour of the intake or wound entry. Actinides such as plutonium are rapidly taken up by bone within two hours. [11]

A blood sample can be analyzed for chromosome aberrations to estimate radiation dose. However, there are only two laboratories that perform dicentric chromosomal analysis, at REAC/TS and at the Armed Forces Radiobiology Research Institute. [12] Neither lab would appear free of bias and might wish to protect the reputation of the Department of Energy. Using this method to determine whether the number of chromosome aberrations in lymphocytes was elevated along with continued blood counts would provide important information about the radiation dose the worker received. So far, the Department of Energy contractors have avoided using counting chromosome aberrations in lymphocytes, as they seem to prefer paying in-house dose analysts to argue that the dose was low.

Also, see this report on our website at the Radiation Health Effects page for Radiation Workers at http://environmental-defense-institute.org/publications/RadCBC.pdf

Ill-Conceived Consolidated Interim Storage of Spent Nuclear Fuel in New Mexico Proposed by Holtec

The Environmental Defense Institute submitted comment to the U.S. Nuclear Regulatory Commission regarding scoping Environmental Assessment of a proposed spent nuclear fuel consolidated interim storage facility in New Mexico by Holtec. [13]

The Holtec draft Environmental Impact Statement is lacking basic information necessary in order for protection of human health and the environment. An adequate Environmental Impact Statement for the proposed Holtec consolidated storage facility in New Mexico must include the following:

---

[11] Nicholas Dainiak, MD, FACP et al., Radiation Emergency Assistance Center/Training Site, Oak Ridge Associated Universities, "REAC/TS Approach to Rapid Dose Estimation and Decontamination of Plutonium Following a Puncture Wound," Presentation May 10, 2017. https://radiation-medicine.de/fileadmin/user_upload/Praesentationen/Dainiak-ConRad2017.pdf Actinides (plutonium, americium and others) are absorbed through wounds rapidly, within 2 hours. The actinides are taken up strongly by bone and liver. "Early decorporation therapy (1-2 hours) with DTPA is required to reduce rapid translocation of actinides to tissues." In 2018, at a DOE site where a worker had a puncture wound involving 300 disintegrations/minute on an alpha meter, the wound was flushed and treatment with Ca-DTPA was initiated within 1 hour.

[12] Anthony B. Wolbarst et al., Radiology, "Medical Response to a Major Radiologic Emergency: A Primer for Medical and Public Health Practitioners, February 8, 2010. https://pubs.rsna.org/doi/full/10.1148/radiol.09090330

[13] Public Comment Regarding Application to the U.S. Nuclear Regulatory Commission on the "Holtec International HI-STORE Consolidated Interim Storage Facility Project," Docket NRC-2018-0052-0058. See Docket NRC-2018-0052 at https://www.regulations.gov/document?D=NRC-2018-0052-0058

- Include valid and conservative characterization of the **radiological consequences** of through-wall cracked canisters. The spent nuclear fuel is stored in canisters are described as "below ground" but in reality, are open to the environment to allow air circulation to cool the spent fuel in the canisters. Radionuclides released from a canister stored in the Holtec facility will be released directly to the environment.
- Include valid estimates of the number of through-wall cracked canisters likely to occur at the Holtec facility for the up-to-10,000 canister (or 100,000 metric tons heavy metal) facility
- Avoid reliance on optimistic conjecture stating that previously unsolved problems will be solved, such as the rather intractable problem of how to develop effective methods for canister inspections, especially in the face of years of failure to do so
- Include valid estimates of the increased risk of canister and other failures resulting from inadequate quality assurance practices that are already apparent
- Include conservative estimates of the number of rejected canisters that will not be accepted by the Holtec facility, that must stay behind at the stranded spent fuel sites (and therefore prevent the stated goal of these returning to green-field status)
- Acknowledge the impacts of high burn-up spent nuclear fuel and the complications of transportation and storage this may cause, both at the proposed Holtec facility and the implications for stranded fuel sites
- Acknowledge infrastructure costs as well as accident risks of spent fuel transportation to New Mexico in the light of recent years of increased rail accidents, especially involving more severe fires than previously thought likely, cask and canister quality problems and deteriorating roads and bridges.
- Acknowledge the scientifically supported human health radiological impacts to workers and the public that are higher than the currently accepted industry radiological health impacts
- Acknowledge that the service life of the proposed facility is perhaps forty years and that the radiotoxicity of the spent nuclear fuel is more than a million years and that there is a very high likelihood that no permanent spent nuclear fuel storage facility will be opened and remain open before the service life of the Holtec facility has elapsed, making its operation intractable. And the risk that even if a permanent repository is opened, that it may not be able to accept all the spent nuclear fuel that has accumulated. Shipments to a repository can also be halted should a major transportation incident or problem with the repository arise. The EIS must explain what will happen to canisters stranded in New Mexico will mean regarding spread of radionuclides to the environment in New Mexico as canisters fail.
- An honest EIS must include the creation of a repository in New Mexico for the spent fuel rather than pretend that the spent fuel shipped to New Mexico will soon leave for a repository in another state.
- Acknowledge the imperative need to phase out nuclear energy in light of the peril facing communities near stranded fuel sites and Holtec's proposed facility in New Mexico. Citizens in other countries have the sanity to phase out nuclear power plants.

Background about the Proposed Holtec Facility for Dry Storage of Spent Nuclear Fuel in New Mexico

Holtec proposes an up-to-10,000 canister storage facility (or 100,000 metric tons heavy metal) for spent nuclear fuel and greater-than-class C nuclear waste in New Mexico, [14] some 38 miles from where another facility is proposed to be operated by Waste Control Specialists, in Andrews, Texas.

The dry storage of spent nuclear fuel will be in canisters placed vertically somewhat below grade and must maintain open vents to allow the air flow necessary to cool the canisters. It is important to understand that when the storage is described as "below ground" that the stored canisters are and must be in contact with circulating air. Any breach of a canister in the Holtec facility will result in a direct release of radionuclides to the environment to blow in the wind and that is a permanent release to the environment. Inadequacy of the monitoring to identify the magnitude of the releases from canister failure coupled with failure to conduct epidemiology may hide the truth but it does not reduce the actual harm to people living nearby.

The desire to move spent nuclear fuel away from now closed nuclear reactor sites is understandable; but none of the safety problems with dry fuel storage are solved by moving spent fuel canisters, some already compromised, to consolidated storage in New Mexico in conjunction with leaving the rejected canisters at the stranded fuel sites. The vulnerability of canisters stored near saltwater is not solved by moving the canisters after years of exposure to chloride.

The concept of filling a consolidated storage site when there is no licensed and operating spent fuel repository has long been known to be fool hardy. The nuclear waste, once in New Mexico, is likely to never leave the state. It may force New Mexico to open a repository.

Vague promises to develop meaningful inspection techniques for canisters sometime in the future is unacceptable. The NRC must create and enforce regulations that protect communities by requiring the design, inspection and contingency methods to keep canisters from leaking and to ensure the containment of any that do.

Canister Leakage is Certain, But Radiological Consequences Not Yet Characterized

The Holtec study of dry storage risks omitted accidents involving canister leakage from chloride-induced stress corrosion cracking. [15] Furthermore, the NRC has not published analyses

[14] See Docket NRC-2018-0052 at https://www.regulations.gov/document?D=NRC-2018-0052-0058

[15] This "Pilot" analysis left out aging and sabotage and wrongly assumed there was no corrosion mechanism to break a canister. A. Malliakos, NRC Project Manager, "A Pilot Probabilistic Risk Assessment of a Dry Cask Storage System at a Nuclear Power Plant," NUREG-1864, Published March 2007. https://www.nrc.gov/docs/ML0713/ML071340012.pdf But that's OK – it was only a Pilot study…

characterizing the **radiological consequences** of a through-wall crack in a canister or other degradation accident scenarios. A 2017 EPRI report stated that "The potential consequences associated with unmitigated [chloride-induced stress corrosion cracking] CISCC of canisters have not been specifically analyzed. The CISCC degradation scenario could include through-wall cracking, followed by loss of inert backfill overpressure, air ingress, and reduced heat removal capacity." [16]

The NRC has yet to complete a study of the radiological consequences of a through-wall crack in a canister. Still unknown are what the rate of leakage of radionuclides will be, which radionuclides will be released (gaseous and volatiles initially and the rest as the fuel fails?), what will the total radionuclide release be, what role the condition of the spent fuel initially will play, what will happen to the fuel condition following the leak, and the vulnerability of hydrogen explosion.

How Many Canisters Will Leak at the Holtec Facility?

There has been acknowledgement by the NRC that canisters will leak. There just has not been an estimate of how many canisters will leak. How can a valid EIS be prepared without estimating the number of canisters expected to leak over the facility life?

At the June 13 meeting of the U.S. Nuclear Waste Technical Review Board held in Idaho Falls, NRC's Darrel Dun stated that only a limited number of canisters would have problems. [17] He also stated that the canisters can be inspected, but he admitted that the canisters in dry storage less than 20 years and prior to re-licensing had not been inspected at San Onofre, but that the NRC *was now studying ways that inspections could be performed*. It is supposed to be reassuring that the NRC is now trying to find ways to inspect the spent fuel dry storage canisters for cracks.

Inability to Perform Adequate Inspection of Canisters Assures Canister Failure

An adequate Environmental Impact Statement for interim spent nuclear fuel storage at a proposed Holtec facility in New Mexico must not ignore the realities of imminent — perhaps within two decades — fuel storage canister failure due to chloride-induced stress corrosion cracking or other canister vulnerabilities.

The proposed new Holtec facility in New Mexico is not providing any means for replacing a faulty canister. In fact, they don't even have the technology in place to detect crack development. Despite the claim that they are trying to develop canister inspection methods, the reality is that

[16] Electric Power Research Institute (EPRI), *Dry Cask Storage Welded Stainless Steel Canister Breach Consequence Analysis Scoping Study*, November 2017, 3002008192 on www.epri.com, Publicly Available. It states that the amount of radioactive gas that may escape a spent fuel canister with a though wall crack has been previously guessed to be from less than 1 percent per year to 60 percent per year.

[17] Darrell Dunn, U.S. Nuclear Regulatory Commission presentation to the Nuclear Waste Technical Review Board (NWTRB) meeting held in Idaho Falls on June 13, 2018. "NRC Perspective on a National Program to Transport Spent Nuclear Fuel and Radioactive Materials,"

we may only learn of a through-wall cracked canister because it is leaking radionuclides into the atmosphere. Despite this, the trend in the U.S. nuclear industry is to reduce air monitoring around canisters to only once a quarter and only at the air inlet and not the air outlet of the dry storage units.

The Nuclear Regulatory Commission has licensed dry storage facilities without adequate technical basis for design of the spent fuel canisters. The NRC expected that the canisters would be shipped to a repository by 1998. The industry has been, belatedly, studying the susceptibility of the spent nuclear fuel dry storage canisters to chloride-induced stress corrosion cracking. [18] [19] [20] [21] Neither the Holtec facility planned for New Mexico nor dry storage of spent nuclear fuel around the country have the capability to conduct effective inspections to detect canister cracking. They do not have the capability to repair a partially or fully cracked canister, and the NRC does not require or endorse any method of isolating a canister. [22]

For spent nuclear fuel storage near the ocean coast, all three criteria are met for localized corrosion to create a through-wall crack, and through-wall cracking may fail the canister with sixteen years of crack initiation. [23] I worked at a Department of Energy nuclear facility that unexpectedly discovered stress corrosion cracking indoors and nowhere near an ocean in safety class stainless steel piping that occurred simply because of check valves allowing in some groundwater that had not been demineralized.

In order for stress corrosion cracking to occur, three conditions must be met: (1) a sufficiently aggressive chemical environment, (2) the metal is susceptible to SCC, and (3) sufficient tensile

---

[18] Nuclear Regulatory Commission, Darrell S. Dunn, August 5, 2014 "Chloride-Induced Stress Corrosion Cracking Tests and Example Aging Management Program," August 5, 2014 https://www.nrc.gov/docs/ML1425/ML14258A082.pdf

[19] Electric Power Research Institute (EPRI), *Aging Management Guidance to Address Potential Chloride-Induced Stress Corrosion Cracking of Welded Stainless Steel Canisters*, March 2017, 3002008193 on www.epri.com, Publicly Available.

[20] Electric Power Research Institute (EPRI), *Welding and Repair Technology Center: Friction Stir Welding of Degraded Dry Cask Storage System Canisters*, August 2017, 3002010734 on www.epri.com, Publicly Available.

[21] J. Renshaw and S. Chu, Electric Power Research Institute (EPRI), Presentation: "Monitoring and Aging Management of Spent Fuel," 33rd INMM Spent Fuel Management Seminar, January 24, 2018. https://www.inmm.org/INMM/media/Documents/Presenations/Spent%20Fuel%20Seminar/2018%20Spent%20Fuel%20Seminar/1-24-18_0950-2-Renshaw-Monitoring-and-Aging-Management-of-Spent-Fuel.pdf

[22] Myron M. Kaczmarsky, Holtec, presentation to the Nuclear Waste Technical Review Board meeting in Idaho Falls on June 13, 2018, "Integrated Planning for Packaging, Transportation, and Storage of Commercial SNF at an Interim Storage Facility." They were planning on a version of H.R. 3053 to expand Yucca Mountain from 70,000 to 110,000 metric tons, give DOE full control of public land, authorize the DOE to store SNF at an NRC-licensed interim storage facility owned by a nonfederal entity.

[23] Kristina L. Banovac, NRC to Anthony Hsia, NRC, Memorandum: Summary of August 5, 2014, Public Meeting with the Nuclear Energy Institute on Chloride Induced Stress Corrosion Cracking Regulatory Issue Resolution Protocol, September 9, 2014. https://sanonofresafety.files.wordpress.com/2013/06/ml14258a081-8-5-14meetingsummary.pdf or https://www.nrc.gov/docs/ML1425/ML14258A081.pdf "Based on estimated crack growth rates as a function of temperature and assuming the conditions necessary for stress corrosion cracking continue to be present, the shortest time that a crack could propagate and go through-wall was determined to be 16 years after crack initiation."

stress must be present. A published in 2016 found that all three conditions are present for at least some of the spent nuclear fuel dry storage sites. [24]

While other countries (Germany, France, Japan and others) had decided to use thick walled cast iron canisters that can be repaired if cracks develop, the U.S. NRC licensed thin walled stainless steel dry storage canisters knowing that there was no approved method for repairing the canister or replacing the canister. Even if a fuel pool were required to be available (and there is no requirement for a pool to remain available), it may not be known whether fuel could be safely extracted from the canister. [25] [26] [27] [28]

At dry fuel storage sites around the U.S. as well as at the facility proposed by Holtec, so far there is no way for canisters to be effectively inspected for cracking. [29] [30] Holtec has pointed to NUREG-1864 as the probabilistic risk assessment for dry cask storage despite the fact that it omits consideration of aging effects, stress corrosion cracking, sabotage, etc. Holtec has no approved provision for isolating a canister leaking radionuclides. They have no way to transport a compromised canister. The NRC also assures people that the number of compromised canisters *will be limited and the corrective actions necessary to return to normal operations will be taken*. [31] NRC has no specific estimates of the risk (likelihood or consequence) of canister cracking and has no specific plans to address isolating or repairing a cracked canister.

The risk of canister failure is not just about failure will occur following long-term neglect. The airborne release of radionuclides from the canisters within a decade or two should be expected. And the opening of a consolidated storage facility that slowly accepts some selected canisters while rejecting others that then remain a stranded fuel sites still leaves the U.S. with the wide-spread problem of spent fuel canister failure from aging mechanisms such as chloride-induced stress corrosion cracking. It is not a matter of if a canister will leak (and the NRC has

---

[24] D. G. Enos and C. R. Bryan, Sandia National Laboratories, "Final Report: Characterization of Canister Mockup Weld Residual Stresses," SAND2016-12375R, November 22, 2016. http://prod.sandia.gov/techlib/access-control.cgi/2016/1612375r.pdf

[25] See the petition Ray Lutz, Citizens' Oversight, PRM-72-8, Position White Paper by Citizens' Oversight, "A New Strategy: Storing Spent Nuclear Fuel Waste," January 2, 2018.

[26] See this power point presentation by Erica Gray: https://www.nrc.gov/public-involve/conference-symposia/dsfm/2015/dsfm-2015-erica-gray.pdf

[27] See Donna Gilmore on thin walled canister versus thick walled canisters used in other countries at https://sanonofresafety.org/

[28] More nuclear "qwap" about canisters near the coastline https://documents.coastal.ca.gov/reports/2017/10/w9a/w9a-10-2017-corresp.pdf

[29] See SanOnofreSafety.org

[30] Krishna P. Singh, Ph.D. and John Zhai, Ph.D., Holtec, "The Multipurpose Canister: A Bulwark of Safety in the Post-9/11 Age," 2003. (begins on 8th page of the link which is compiled by Dr. Fred Bidrawn, Ph.D., Revision 1 March 28, 2018.) https://publicwatchdogs.org/wp-content/uploads/2018/06/holtec-response-to-queries-on-shim.pdf

[31] Darrell Dunn, U.S. Nuclear Regulatory Commission presentation to the Nuclear Waste Technical Review Board (NWTRB) meeting held in Idaho Falls on June 13, 2018. "NRC Perspective on a National Program to Transport Spent Nuclear Fuel and Radioactive Materials,"

acknowledged this [32]). It is a matter of how many canisters and what amount of the radionuclides in the spent fuel will be released.

Poor Quality Assurance on Casks and Canisters

Holtec's track record on cask and canister quality assurance certainly appears questionable and the NRC has enabled shoddy construction practices. [33] Where is the NRC's risk assessment of the risk of various weld and other defectives in canister and cask manufacture?

Recently, after loose pins were found in canisters by Edison at San Onofre, it was discovered that Holtec had modified the canister design without getting NRC approval for the modification that failed. Holtec did not discover the failed pins and had approved the defective canisters for use. [34] Basically, citizens cannot expect that the approved design will be used or that even simple inspections to find canister flaws will be performed. The loose pin problem indicates not just the short-cut decision that the shim design change was "like-for-like," it also indicates extremely poor fabrication and quality control in the manufacture of canisters for storage of spent fuel.

Rejected Canisters Must Stay at Stranded Fuel Sites

Holtec proposes to accept only uncompromised loaded canisters at the new facility. Yet, the canisters that have been stored above ground may already have been exposed to factors that induce canister failure such as chloride-induced stress corrosion cracking. Other canisters that will be left behind at stranded fuel sites include pressurized water reactor (PWR) canisters that pose a criticality risk if water enters the canister. [35] The stated goal of returning stranded nuclear sites back to green field status will not be met when flawed canisters are not accepted at the Holtec facility. The number of rejected canisters must be estimated and the reality that there may be a large number of compromised canisters that remain stranded at former nuclear reactor sites must be acknowledged.

Complications from Increasing Spent Fuel Burnup Must be Described

---

[32] Darrell Dunn, U.S. Nuclear Regulatory Commission presentation to the Nuclear Waste Technical Review Board (NWTRB) meeting held in Idaho Falls on June 13, 2018. "NRC Perspective on a National Program to Transport Spent Nuclear Fuel and Radioactive Materials,"

[33] Nuclear Information and Resource Service, Summary of Oscar Shirani's Allegations of Quality Assurance Violations Against Holtec Storage/Transport Cask, July 22, 2004. https://www.nirs.org/summary-oscar-shiranis-allegations-quality-assurance-violations-holtec-storagetransport-casks/

[34] Teri Sforza, Orange County Register, The Press-Enterprise, Why the redesigned San Onofre nuclear waste containers weren't approved by the feds, April 3, 2018 and updated June 4, 2018. https://www.pe.com/2018/04/03/why-the-redesigned-san-onofre-nuclear-waste-containers-werent-approved-by-the-feds/ Holtec decided that a design change that affected heat flow and reliability of the shims inside the canister was a "like-for-like" change that didn't require NRC approval. Holtec didn't tell Edison of the change. And Holtec didn't detect that the pins had failed and were loose in the canister. Holtec also is noted in the article as having to pay fines to TVA for an issue involving bribery.

[35] See HOLTEC Draft EA at https://www.nrc.gov/waste/spent-fuel-storage/cis/hi/hi-app-docs.html
And see HI-STORE [Consolidated Interim Storage] CIS Facility Environmental Report, Attachment 4 to Holtec Letter 5025021 at https://www.nrc.gov/docs/ML1802/ML18023A904.pdf

The complications from the increasing levels of fuel burnup must be acknowledged. Higher burnup fuels may be more brittle and more susceptible to cladding failure, as well as having more fission product and transuranic radionuclide content in the fuel. The conditions that must be met in order for transportation, storage and contingency methods to apply must be clearly stated in regard to fuel burnup status and the lack of knowledge of how the increased fuel burnup is going to adversely affect the safety of storage, transportation, and any proposed contingency planning and must be clearly stated in the EIS.

The consequences of canister failure must adequately address how much of the radionuclide inventory in a canister is released (see Table 1).

Table 1. Spent fuel canister radionuclide inventory. (Source: NUREG-1864, 50,008 MWD/MTIHM (10-yr-cooled))

Nuclide	Bq	Ci	Nuclide	Bq	Ci
Co-60	1.61E14	3133	Pu-238	3.98E15	107440
Kr-85	2.77E15	74800	Pu-239	1.87E14	5060
Y-90	3.40E16	918000	Pu-240	3.47E14	9384
Sr-90	3.40E16	918000	Pu-241	5.23E16	1414400
Ru-106	2.72E14	7888	Am-241	1.20E15	32504
Cs-134	5.13E15	138720	Am-242m	1.97E13	532
Cs-137	5.54E16	1496000	Am-243	3.07E13	816
Ce-144	5.08E13	1374	Cm-243	3.02E13	816
Pm-147	3.37E15	91120	Cm-244	5.66E15	153000
Eu-154	4.15E15	112200			

Table notes: MWD is MegaWatt Days of reactor operation; MTIHM is metric tons initial heavy metal (uranium-238 and uranium-235); Bq is becquerel and is disintegration per second; Ci is curie; 1 curie is 3.7E10 bq. This is only a partial list of radionuclides in the spent fuel.

Chloride-induced stress corrosion cracking has been studied for many decades and there is no technical reason for the U.S. NRC to have ignored it. [36] And it is a fact that the proposed Holtec CIS is near the world's purest potash deposit is in Lea County, New Mexico. Potash includes potassium chloride. The proposed consolidated interim storage facility is very near the Waste Isolation Pilot Plant (WIPP) that is underground salt mine that is the Department of Energy disposal facility for defense wastes and it is the DOE's wish to expand the use of WIPP for spent nuclear fuel.

[36] INCO, The International Nickel Company, Inc., "Corrosion Resistance of the Austenitic Chromium-Nickel Stainless Steels in Chemical Environments," Copyright 1963. http://www.parrinst.com/wp-content/uploads/downloads/2011/07/Parr_Stainless-Steels-Corrosion-Info.pdf This report from 1963 shows that Types 304 and 316 stainless steels are susceptible to stress-corrosion cracking from exposure to potassium chloride. Corrosion and pitting occurred from exposure to many of the halogen salts including magnesium chloride, see Table IX p. 13 of the report.

The Holtec documents have very misleading statements about criticality. [37] Various Holtec documents do not let the reader know just how unsafe, from a criticality perspective, the PWR fuel and in particular, the high burn-up PWR fuel is.

It actually helps to have a sense of humor if you understand what they are actually saying. Because the facts of the situation are diametrically opposed to the impression they are straining to create. They try to say that three unlikely failures must occur for criticality to occur in a canister. But actually, for this significant number of PWR canisters, not even two unlikely failures have to occur.

Often it is difficult to locate information about criticality risks in the web of Holtec documents. But PWR fuel that had to be loaded using borated water in the canister is vulnerable to criticality if water enters the canister. PWR fuel and in particular the high burnup PWR fuel that must be loaded with borated water in order to prevent a criticality during loading of spent fuel into the canister does not meet the double contingency criteria for preventing criticality. And the assurance that they won't transport a fuel canister that is obviously leaking — is no assurance whatsoever!

The available canister inspection techniques do not allow detection of stress corrosion cracking. This means that a flooding event that occurs when a canister has through-wall cracking, which is far more probable than the U.S. Nuclear Regulatory Commission and Holtec want to admit is far more probable than an *unlikely* event.

---

[37] Holtec safety analysis Proposed Rev. OA has the most information about criticality issues at https://www.nrc.gov/docs/ML1731/ML17310A222.pdf It is on the page listing Holtec safety and environmental report documents for the proposed consolidated interim storage of spent nuclear fuel in New Mexico at https://www.nrc.gov/waste/spent-fuel-storage/cis/hi/hi-app-docs.html See p. 3-8, 180 of 581 [8th page of 409] where Holtec talks about rejecting canisters: "Only canisters that have been determined to have no credible leakage shall be stored at the HI-STORE CIS facility. [Note that they use the word credible and with an event is not credible it should mean a 1-in-one-million-year likelihood or less. Yet canister through-wall cracking is a greater likelihood than "unlikely" or 1-in-100-year likelihood. The determination that the canister's confinement boundary is intact and effective to prevent intrusion of any fluids including water is performed at both the plant of origin and upon its arrival at HI-STORE." The problem is that Holtec admits they have no effective method for determining whether stress corrosion cracking is occurring. "Thus, while the canister is qualified to remain subcritical even in the presence of water by virtue of its fixed basket geometry and fixed neutron absorbers installed in the canister's Fuel Basket, the guaranteed absence of water inside the canister at the HI-STORE CIS facility makes any loss of criticality safety non-credible. Therefore, no additional criticality prevention measures are needed." But Holtec forgot about the PWR canisters when they made this statement. See Chapter 8, beginning at p. 8-1 that PWR high burnup requirements for transport won't stay subcritical if the canister is flooded. They just say that the acceptance tests for loading for transport will be enough – and basically all that will ensure is that the canister is not already leaking when they transport it. Failure 1: Flooding; Failure 2: Canister leaks (and Holtec does not have an effective inspection technique to determine whether stress corrosion cracking is in progress AND IT MORE THAN LIKELY IS; Failure 3: Canister transportation requirement requires that fuel remain subcritical even if canister full of water [but this is no protection because the NRC said for PWRs not to worry about meeting this important safety requirement). So, Holtec does not meet the double contingency requirement except for BWR fuel and perhaps some low burnup PWR fuel.

Those leaking canisters subjected to water infiltration associated with a transportation accident or with flooding during storage at the proposed storage facility will result in a criticality event that sustains more fissions and can have greater radiological release consequences than a canister with simply with through-wall cracking. However, when a canister has through-wall cracking that allows oxygen to enter the canister, the likelihood and consequence of hydrogen explosion remains undocumented. [38]

Transportation Risks

High temperature fires burning longer than 30-minutes are more severe than spent fuel transportation casks were designed to withstand. There is currently no way to avoid sending spent fuel casks along with any number of oil tankers connected in route.

An EIS is Must Describe Scientifically Valid Radiation Health Harm

It is important to know that the public and the misinformed radiation workers will be receiving life shortening radiation doses even at when below allowable radiation protection standards. The U.S. NRC fails to acknowledge compelling and diverse studies of human epidemiology that show more harm than accepted radiation protection standards predict. The radiation exposure from transportation of the spent fuel to Holtec poses a risk to the public.

Science requires the constant review of new evidence. But the U.S. NRC has not only ignored valid evidence from epidemiology in other countries and in multi-country studies, the NRC has refused to conduct epidemiology near U.S. nuclear facilities that would reveal increased childhood cancer and leukemia. The NRC ignores extensive and diverse evidence that there is more harm from radiation exposure to people than the U.S. nuclear industry has assumed.

The NRC continues to use radiation health models that underestimate the actual health harm to humans from radiation exposure. [39]

Radiation workers receiving an average 400 mrem/yr had greater cancer risk, yet the annual limit is 5000 mrem/yr for a worker. [40] The reproductive health effects are larger than workers realize,

---

[38] Transmittal by Susan Corbett, Sierra Club, "Docket NRC-2015-0070 Advanced Notice of Proposed Rulemaking (ANPR): Regulatory Improvements for Decommissioning Power Reactors Comments," March 21, 2016. See comments at http://www.nrc.gov/docs/ML1608/ML16082A004.pdf

[39] "Health Risks from Exposure to Low Levels of Ionizing Radiation BEIR VII – Phase 2, The National Academies Press, 2006, http://www.nap.edu/catalog.php?record_id=11340 The BEIR VII report reaffirmed the conclusion of the prior report that every exposure to radiation produces a corresponding increase in cancer risk. The BEIR VII report found increased sensitivity to radiation in children and women. Cancer risk incidence figures for solid tumors for women are about double those for men. And the same radiation in the first year of life for boys produces three to four times the cancer risk as exposure between the ages of 20 and 50. Female infants have almost double the risk as male infants.

[40] Richardson, David B., et al., "Risk of cancer from occupational exposure to ionizing radiation: retrospective cohort study of workers in France, the United Kingdom, and the United States (INWORKS), BMJ, v. 351 (October 15, 2015), at http://www.bmj.com/content/351/bmj.h5359 Richardson et al 2015 . This epidemiology study that included a cohort of over 300,000 nuclear industry workers has found clear evidence of solid cancer

in terms of sterility and in terms of increased risk of birth defects. And reproductive effects may be worse for workers whose work requires being near spent fuel canisters because of the potential for neutron exposure from the fissile material. The neutron exposure is not measured by typical radiation detectors.

The NRC marches on as though its emergency planning and environmental monitoring of radionuclide emissions are adequate, despite evidence to the contrary. The truth about the lives shortened by the Three Mile Island Unit 2 accident matters. [41]

The US Nuclear Regulatory Commission refuses to fund epidemiology studies near US nuclear power plants. The framework for the study was reported in "Analysis of Cancer Risks in Populations Near Nuclear Facilities; Phase I (2012). [42] After 5 years in planning for the study, the NRC decided it would take too long and cost too much. I think the NRC knows that a credible study would be the end of licensing new nuclear plants.

Epidemiology conducted in Europe includes the study known by its German acronym KiKK (Kinderkrebs in der Umgebung von Kernkraftwerken). The KiKK study on Childhood Cancer in the Vicinity of Nuclear Power Plants, completed in 2007 is scientifically rigorous and statistically sound and its peer reviewed results show significantly elevated cancer risk for children under five years of age living within 5 km of a nuclear power plant. The study looked at childhood leukemia and cancer near nuclear plants from 1980 to 2003.

The NRC issued a statement [43] explaining their decision which included this excuse: "For example, the German study initially found an association of increased childhood leukemia risk within 5 kilometers of the facilities. However, upon examination of the offsite exposures, the authors concluded the increased risk could not be explained by the releases from the facilities." In other words, it couldn't happen, so it didn't.

In Illinois, near the Braidwood and Dresden nuclear power plants, one family learned that many children in the area had cancer, brain cancer, and leukemia, after their daughter Sarah was diagnosed with brain cancer when she was seven. [44] Cindy and Joe Sauer lived in the area of these reactors from 1998-2004. Joe Sauer, a medical doctor, conducted his own epidemiology

---

risk increases despite the average exposure to workers being about 2 rem and the median exposure was just 410 millirem. Also see December 2015 EDI newsletter.

[41] Steve Wing, David Richardson, Donna Armstrong, and Douglas Crawford-Brown, A Reevaluation of Cancer Incidence Near the Three Mile Island Nuclear Plant: The Collision of Evidence and Assumptions, Volume 105, Number 1, January 1997, Environmental Health Perspective

[42] See cancer risk study at nap.edu.

[43] NRC Policy Issue Information SECY-15-0104, August 21, 2015 "Analysis of Cancer Risks in populations Near Nuclear Facilities Study," http://pbadupws.nrc.gov/docs/ml1514/ML15141A404.pdf

[44] Read about Cindy and Joe Sauer and what they learned about childhood cancer near nuclear power plants: http://ieer.org/resource/commentary/on-life-near-two-nuclear-power-plants-in-illinois/ and read Joe Sauer, MD, presentation on elevated cancer rates near the Dresden and Braidwood nuclear plants at http://ieer.org/wp/wp-content/uploads/2013/06/Health-Concerns-and-Data-Around-Illinois-Nuclear-Plants-slides-for-SDA-2013.pdf

study which showed clear increases in childhood cancers near the plants. Read his findings of elevated brain and other cancers near these plants and other studies. [45] [46]

An EIS for an "Interim" Storage Facility Must Acknowledge That A Permanent Disposal Facility May Not Open

For the proposed consolidated interim storage facility in New Mexico (or any other state), there is magical thinking that a disposal facility, i.e. Yucca Mountain, will be opening soon. Promoters of the Holtec facility don't mention that they are actually dooming New Mexico to have to dispose of the spent nuclear fuel in their state because its going to be that or have it blowing in the wind. An EIS that is not honest about the reality that a spent fuel repository will not open is simply not honest about the dire reality of hosting an "interim" consolidated storage facility.

The short service life of the Holtec facility, of perhaps 40 years, will be determined by the degradation of the concrete and spent fuel canisters and other equipment. The EIS must acknowledge what will happen as structures and equipment ages and what sort of provisions it has for that event. The radionuclides in the spent nuclear fuel that are radio-toxic for over a million years. The lack of provision for replacing aging structures such as the concrete the canisters are stored in and transported over or replacing the spent fuel canisters must be acknowledged.

By the way, the canisters used by Holtec are not likely to be accepted for disposal at Yucca Mountain even if the canisters are transportable decades from now. [47]

There is considerable lack of understanding by the public about the longevity and toxicity of long-lived radiative waste. It is not like natural uranium and thorium bound up in rock. The longevity and toxicity of radionuclides that dominant repository contamination migration studies include, for example, chlorine-36 (301,000 year), iodine-129 (17,000,000 year), technetium-99 (213,000 year), uranium-234 (245,500 year), neptunium-237 (2,144,000 year), americium-241 (432 year but decays to Np-237), plutonium-238 (87.7 year but decays to U-234), plutonium-239 (24,000 year but decays to U-235). We are not talking about a mere 150,000 years of radiotoxic material. The 10,000-year timeframe once proposed for Yucca Mountain was never adequate. And, even the one-million-year analysis timeframe for the waste migration may not be sufficient.

---

[45] Dr. Paul Dorman, "Why UK nuclear power plants may cause childhood cancer and leukaemia," May 16, 2011, **https://www.escosubs.co.uk/theecologist/promotion.asp?code=RF2011ROW**

[46] Steve Wing, David B. Richardson, Wolfgang Hoffman, "Cancer Risks Near Nuclear Facilities," Environ Health Perspect. 2011;119(4):417-421.

[47] Robert Howard and Bret van den Akker, Oak Ridge National Laboratory, *Symposium on Recycling of Metals arising from Operation and Decommissioning of Nuclear Facilities, Nykopiong Sweden, April 8-10, 2014*, "Considerations for Disposition of Dry Cask Storage System Materials at End of Storage System Life," 2014. http://www.iaea.org/inis/collection/NCLCollectionStore/_Public/46/062/46062901.pdf Includes overview of U.S. dry storage systems for spent nuclear fuel. Notes that current canisters are not approved for disposal in a repository.

The stable end product for uranium, thorium and plutonium is lead which is not good to have in your water either.

The Yucca Mountain repository is destined to fail because the geology of the porous mountain located above groundwater does not isolate the spent nuclear fuel which is not protected from corrosion. The low radiation doses from ingestion of contaminants from the proposed Yucca Mountain repository rely on titanium drip shields which have not been designed nor has the method for their installation been developed. It may be impossible to robotically install the relied upon titanium drip shields in the dusty, collapsing tunnels after a few centuries of cooling the SNF. Any realistic assessment of the likelihood of failure to install the titanium drip shields or failure of their adequate performance has not been included by the NRC's optimistic study of contaminant migration from Yucca Mountain. The NRC was supposed to review the Department of Energy's Yucca Mountain submittal but ended up preparing the cornerstone estimate of the repository's estimated radionuclide releases. [48]

The geology of Yucca Mountain does not prevent corrosion of the SNF or its containers and does not prevent the migration of radionuclides into nearby watersheds. The technology to monitor or retrieve the spent fuel does not exist. [49]

Arguments that migration of the contaminants from the repository will be acceptably low hinge on the assumed protection of 1,500 5-ton titanium drip shields to be robotically installed after the waste is in place. [50] [51]

---

[48] U.S. NRC, "Supplement to the U.S. Department of Energy's Environmental Impact Statement for a Geologic Repository for the Disposal of Spent Nuclear Fuel and High-Level Radioactive Waste at Yucca Mountain, Nye County, Nevada," NUREG-2184, May 2016. https://www.nrc.gov/docs/ML1612/ML16125A032.pdf

[49] U.S. Nuclear Waste Technical Review Board, "Geologic Repositories: Performance Monitoring and Retrievability of Emplaced High-Level Radioactive Waste and Spent Nuclear Fuel," May 2018.

[50] State of Nevada, Office of the Governor, Agency for Nuclear Projects, "Report and Recommendations of the Nevada Commission on Nuclear Projects." December 10, 2010. https://www.leg.state.nv.us/Division/Research/Library/Documents/ReportsToLeg/2010/61-10.pdf

Excerpt: "For example, the current license application includes covering all the waste canisters with 11,500 titanium drip shields to protect them from rock fall and highly corrosive groundwater. But the drip shields themselves (estimate to cost $12 billion or more) are only proposed to be installed 80 to 100 years after the waste is put into the mountain, using yet-to-be developed robotics due to the extreme thermal and radiological environment that would exist within the emplacement tunnels. Despite this, potentially disqualifying conditions were reveal ed at the site (i.e., fast groundwater pathways, unacceptably high level potential for escaping radioactive gasses, recent volcanism, high levels of seismicity, etc.). To get around this, DOE petitioned Congress to exempt the site from health and safety regulations and then scrapped its own site evaluation guidelines altogether."

Another excerpt: "It posits the existence of titanium alloy 'drip shields', one 5-ton drip shield over each of the 11,500 waste packages, to ward off the corrosion-promoting water. However, these extremely expensive drip shields are not part of the current waste installation plan but are intended to be installed by a yet-to-be-designed, remote-controlled robotic mechanism about one hundred years after the wastes have been emplaced."

[51] The Department of Energy was planning to use a consent-based approach for siting spent nuclear fuel and high-level waste storage and disposal facilities including: (1) a pilot interim storage facility, (2) consolidated interim storage facilities, and (3) permanent geologic disposal facilities, one for commercial spent nuclear fuel and the other for defense spent nuclear fuel and high-level waste.

A consent-based approach was recommended in the 2012 Blue Ribbon Commission report on the nation's problem of spent nuclear fuel disposal, but no one knows what a consent-based approach entails. What we do know that

(Footnotes continued) [52] [53] [54] [55] [56] [57]

Despite any appearance of progress toward a repository, there are numerous ways that removal of spent nuclear fuel from either stranded fuel sites or consolidated interim storage may continue to be delayed: failure to grant a license for permanent storage, delayed licensing, construction delays, lack of funding, delays in licensing or procuring transportation overpacks, or an accident that causes an interruption in shipping. Needed roads and railways don't necessarily connect the utility to the highway or railway or may be inadequate for the heavy loads.

The EIS must acknowledge that once the spent nuclear fuel is at a consolidated interim storage site, it will likely force that state to open a permanent repository. New Mexico, while accepting the burial of transuranic defense waste at WIPP, has opposed burial of spent nuclear fuel. But once the airborne radionuclides are blowing in the wind from leaking canisters, and there is no way to transport damaged canisters or the aging fuel in the canisters, New Mexico may be forced to allow burial of spent fuel in underground salt.

The amount of spent nuclear fuel considered in the environmental analysis has assumed the amount of spent fuel that has already been created and that would be created by existing plants prior to their end of life. An environmental analysis must also evaluate the consequences of not phasing out new construction of nuclear power plants.

---

even with local support, state opposition effectively stymied efforts to obtain authorization to construct the geologic waste disposal at Yucca Mountain at Nevada and prevented a proposed interim storage site at Skull Valley, Utah. The DOE held meetings in 2016 around the country seeking public input on the consent-based process, including one in Boise, Idaho. The Department of Energy successfully disposed of the consent-based approach and the public comments collected following the appointment of Rick Perry as the Secretary of Energy in 2017.

The majority of the spent nuclear fuel is from commercial electricity generation from US nuclear power plants. As of 2013, there was 70,000 metric tons heavy metal, enough for the stymied Yucca Mountain repository. The inventory is expected to roughly double as the existing fleet of US nuclear reactors operates for its expected life. Utilities are winning billions in compensation from the DOE over the continuing costs of storing the spent nuclear fuel because of the DOE's failure to provide a disposal facility.

The rest of the spent nuclear fuel is from DOE research and defense reactors, including nuclear submarines and carriers. The DOE's high-level waste is in various forms ranging from liquid waste at Hanford awaiting vitrification, highly soluble powder-like calcine at Idaho and vitrified waste as other sites.

[52] Before ending the consent-based siting effort, information found about the Department of Energy's consent-based siting at www.energy.gov/consentbasedsiting and its Integrated Waste Management and Consent-based Siting booklet at http://energy.gov/ne/downloads/integrated-waste-management-and-consent-based-siting-booklet

[53] State of Nevada's website reflecting its opposition to Yucca Mountain, see http://www.state.nv.us/nucwaste/

[54] Utah Department of Environmental Quality reflects state leaders' views and offers this information on its opposition to storage of spent nuclear fuel at the facility proposed on the Skull Valley Goshute Indian Reservation at http://www.deq.utah.gov/Pollutants/H/highlevelnw/opposition/concerns/concerns.htm

[55] See Yucca Mountain Environmental Impact Statement, DOE/EIS-0250F-S1.

[56] Department of Energy Strategy for the Management and Disposal of Used Nuclear Fuel and High-Level Radioactive Waste, January 2013. p. http://energy.gov/em/downloads/strategy-management-and-disposal-used-nuclear-fuel-and-high-level-radioactive-waste

[57] Blue Ribbon Commission on America's Nuclear Future, Report to the Secretary of Energy, January 2012. http://energy.gov/sites/prod/files/2013/04/f0/brc_finalreport_jan2012.pdf.

No Funding Passed to Re-Open the Licensing Process for Yucca Mountain…But Stay Tuned

Despite the eagerness of the House to ramrod the licensing for the Yucca Mountain repository by stripping Nevada of its rights and reversing federal laws, [58] so far, the Senate has blocked funding to revive the YM licensing process for 2019.

Despite $15 billion spent to study Yucca Mountain and words from the faithful that the science is settled — no — the so-called "science" behind Yucca Mountain is not settled in the view of citizens of Nevada or anyone who takes a peek at the so-called "science" of predicting the migration of radionuclides from the repository over one million years. The House also passed its version of funding to increase the storage capacity of Yucca Mountain from 70,000 to 110,000 metric tons.

The bill passed by the House is vastly different from the bill passed by the Senate, [59] and a compromise bill to authorize Pentagon spending for fiscal 2019 is still needed. Hearings could resume in the next Congress, after the midterm elections in November. [60]

Various versions of several bills have thrown States rights, radiation protections standards, and the National Environmental Protection Act (NEPA) under the bus whether "minibus" or "omnibus" bills. See our July 2018 EDI newsletter for more information.

Articles are by Tami Thatcher for August 2018.

[58] H. R. 3053 – Nuclear Waste Policy Amendments Act of 2018, 115th Congress (2017-2018). The proposed bill would take rights away from the State of Nevada. It would also allow Monitored Retrieval Storage to be allowed without having a permanent repository. https://www.congress.gov/bill/115th-congress/house-bill/3053?q=%7B%22search%22%3A%5B%22yucca+mountain%22%5D%7D&r=6

[59] S. 2975 – Energy and Water Development and Related Agencies Appropriations Act, 2019, 115th Congress (2017-2018) https://www.congress.gov/bill/115th-congress/senate-bill/2975/text The proposed bill allows the Department of Energy to open Consolidated Interim Storage for spent nuclear fuel, calling it a "Pilot Program."

[60] Gary Martin, *Pahrump Valley Times*, "Yucca Mountain revival efforts appear dead – for now," July 27, 2018. https://pvtimes.com/news/yucca-mountain-revival-efforts-appear-dead-for-now/