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storing, and disposing of a nuclear explosive material**

Robert Alvarez
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Executive Summary

The United States has created a problem called uranium-233, a material suitable for the core of a nuclear weapon and among the most dangerous materials on the planet. If as little as 19 pounds of uranium-233 fell into the wrong hands, it could make an explosion that could destroy all of downtown Washington, D.C. or another city.

Our nuclear facilities may have done a poor job of keeping track of this dangerous material. Now, the Department of Energy has indicated it plans to waive safety requirements to dispose of it. But if the U.S. government makes a mess, they should clean it up. All uranium-233 should be accounted for, stored safely, and disposed of safely.

About two tons of uranium-233, a weapon-useable fissile material, was produced by the United States, mostly in the 1960s and 1970s, as part of its military and civilian nuclear program, at an estimated cost of \$5.5 billion to \$11 billion. About 1.55 tons

of this weapon-useable fissile material was separated, a process making it more suitable for the fission core of a nuclear weapon, before production was abandoned due to radioactive dangers in the production of this type of uranium. About 96 kilograms of uranium-233 may be unaccounted for. Specific estimates of the amount of uranium-233 in storage at certain sites widely vary, suggesting that material control and accountancy of the current U.S. inventory of uranium-233 requires greater attention.

The Energy Department has indicated it plans to waive safeguards and safety requirements to dispose of nearly 2,000 pounds of these concentrated nuclear explosive materials by simply putting them in a landfill. This would be in disregard for international safeguard and security norms as well as the department's own nuclear security and radioactive waste disposal standards. In doing so, instead of setting an example, the U.S. government is establishing a bad precedent for the rest of the world in protecting public safety and security from concentrated fissile materials.

This last remaining stockpile of uranium-233, which the U.S. Congress declared has no further use, should be properly accounted for, safely secured, and diluted for proper disposal, never to fuel nuclear weapons in the future.

The lack of priority given to this problem is underscored by the fact that the Energy Department's "desired timeline" for disposition of this material is set for 2018, some 20 years after significant environmental, safety, and security vulnerabilities were first officially identified by the department's Environment, Safety and Health Division of the Office of Science.

The handling of uranium-233 by the Energy Department is troubling. This report will demonstrate that the Department of Energy has yet to meet the challenges of ensuring that all uranium-233 is accounted for and that it is stored in safe facilities or safely disposed of. If these challenges are not addressed, the American people continue to face unacceptable public safety and security risks with potentially deadly consequences.

Introduction

First discovered in 1940 at the University of California at Berkeley, uranium-233 was soon determined to be a fissionable material capable of fueling nuclear weapons or power reactors, along with plutonium-239 and uranium-235.

Uranium-233 is produced in a nuclear reactor or with an accelerator by bombarding thorium-232, which is about three times more naturally abundant than uranium, with neutrons. Since thorium-232 is not fissile it requires uranium-235 or other fissile materials in nuclear reactors to generate neutrons to produce uranium-233. After a several-year cooling off period, uranium-233 can be recovered from the irradiated thorium through chemical separation in a nuclear reprocessing plant.

Uranium-233 is comparable to plutonium in terms of its weapons-usability. Dilution with uranium-238 to a level of 12 percent produces a similar critical mass to 20% enriched uranium, which defines the internationally accepted boundary between weapon-usable highly-enriched uranium and low enriched uranium.¹

This report begins by providing a brief overview of the history of production of uranium-233 by the United States and the estimates of the current inventory. The second section considers the troubled history of U.S. efforts to develop uranium-233 as a power reactor fuel. The third section assesses the status and concerns about the safeguarding and security of the current uranium-233 inventory. This is followed by a discussion of the problems of managing the uranium-233 legacy and of current plans by the Department of Energy (DOE) to dispose of it as waste.

The Uranium-233 Inventory

From the 1940's until the mid to late 1950's, uranium-233 was produced in small quantities in the United States, initially for weapons research and development. In 1955 the first uranium-233 weapon was exploded at the Nevada Atomic Proving Grounds with a yield of 22 kilotons.^{2,3}

According to a U.S. nuclear weapons laboratory official, "Uranium-233 has been shown to be highly satisfactory as a weapons material."⁴ By 1954, DOE's predecessor agency, the Atomic Energy

Commission (AEC) had conducted a comprehensive study and full-scale production of uranium-233 for weapons did not proceed.⁵ A major factor was the radiation hazards from uranium-232 which is co-produced when irradiating thorium. "The gamma radiation associated with the uranium-232 chain" stated an expert at the AEC's Hanford site "is the major complication in the fabrication and utilization of uranium-233."⁶

In the early 1960's, there was renewed interest in using uranium-233 in nuclear weapons after it was discovered that the plutonium components in strategic warheads in stockpile were susceptible to serious damage when subjected to neutron irradiation induced fissions in space from nuclear-armed interceptor missiles in "near-hit" situations "within a ten mile radius." Because uranium-233 retains its stability at a higher temperature than plutonium, it raised the possibility that uranium-233 nuclear warheads would be more robust.⁷

This prompted the AEC nuclear material production sites to go on a quest to develop techniques to produce "clean" uranium-233, with less than 5 ppm uranium-232 that

would significantly reduce radiation hazards. To achieve this goal, measures were proposed at the Hanford site, in which: (1) thorium obtained from pure monazites ore low in the Th-230 isotope was irradiated; (2) the material would be irradiated in neutron flux relative free of neutrons above 6 Mev, requiring a specially moderated reactor; and (3) Irradiation of the thorium would be halted while it still held protactinium-233 (27-day half-life), which could be separated from uranium-232 before it decayed to uranium-233.⁸

By 1966, although interest in large-scale production of uranium-233 for use in weapons waned, production for weapons research and development continued. A review of the history of the DOE's Rocky Flats Plant, in Colorado, which made fissile material weapons components, found that uranium-233 was being fabricated between 1965 until the early 1980's.⁹ Between 1955 and 1968 several nuclear weapons tests were conducted using uranium-233.¹⁰

Uranium-233 was produced in more substantial amounts from 1965-70 in the expectation that it could serve as a nuclear power reactor fuel. Establishing this

possibility involved the construction and operation of thorium fuel cycle research and development facilities, research reactors, radiochemical separations facilities, hot-cells, fuel fabrication facilities, and the storage of spent commercial reactor thorium fuel by the U.S. Department of Energy (DOE) and its predecessor agencies.

Between 1954 and 1970 uranium-233 was produced in weapons material production reactors at the Savannah River Site in South Carolina, the Hanford site in Washington and in several commercial nuclear power plants (Indian Point I, Dresden I, Peach Bottom I and Fort St. Vrain). A total of approximately 2 tons of uranium-233 was produced, of which 1556 kilograms was separated from 857 tons of thorium at

reprocessing plants (Table 1), at an estimated total cost of \$ 5.5 to \$11 billion (2012 dollars).¹¹ About 655 kilograms of separated uranium-233 was subsequently used as fuel in DOE research reactors and/or lost to waste.^{12,13} About 403 kilograms of uranium-233 was generated in commercial nuclear power and government reactors, but not reprocessed.¹⁴

As of 1999, approximately 805 kilograms of separated uranium-233 was stored at DOE sites.¹⁵ This leaves a discrepancy of approximately 96 kilograms or 6 percent of the total amount recovered from reprocessing plants. By comparison, the DOE's official inventory difference for plutonium published in 2012 is about 2 percent.¹⁶

**Table 1. Summary of Thorium – Uranium 233
Processing in the United States**

Site	Date (Year)	Thorium Processed (tons)	U 233 Recovered (kg)	U 232 Content (ppm U)	Flowsheet Employed
Oak Ridge National Laboratory (a)	1954 - 1958	35	55	10-40	Interim 23 Thorex
Savannah River Plant (b)	1964-1969	240	580	3.9-228	Interim 23 Thorex
Hanford (c)	1965-1970	565	820	6-10	Interim 23 Acid Thorex
Nuclear Fuel Service (Indian Point I Fuel) (d)	1968-69	17	101	125-144	Interim 123
TOTAL		857	1,556		

Sources: (a) R.E. Brooksbank, W.T. McDuffee, R.H. Rainey, *A Review of Thorium Fuel Reprocessing Experience*, Oak Ridge National Laboratory, Conf-780223-3, January 1978; (b) R.L. Wasler, *Purex Process Operation and Performance 1970 Thoria Campaign*, RHO-SA-37, February, 1978 (c) D.A. Orth, *SRP Thorium Processing Experience*, June 1978; (d) Chemical Technology Division Progress Report for the Period April 1983, to March 21, 1985, Oak Ridge National Laboratory, ORNL-6153.

Uranium-233 as Power Reactor Fuel

In the 1960's and early 1970's the DOE's predecessor, the AEC assumed that some 1000 GWe of nuclear capacity would be on line in the United States by the year 2000 with a similar nuclear capacity outside the U.S. As a result, the AEC predicted that world uranium supplies would be rapidly exhausted. These assumptions drove a two-track research and development effort by the AEC to develop a new generation of reactors that would be able to produce more fissile material than they consumed.

(As it turned out, the AEC's prediction of global nuclear capacity was off by an order of magnitude.)

The first track was development of fast-neutron reactors. "Fast" reactors release more neutrons per fission than conventional reactors. Plutonium-fueled fast reactors in particular held the promise of producing electricity and also making 30 percent more fuel than they consumed.

The second was on research and development of the slow-neutron reactors based on the thorium fuel cycle. This led to

the production of significant quantities of uranium-233 for use as a fuel in nuclear reactors. The attractiveness of the thorium fuel cycle was due to the abundant supply of thorium in nature and the potential that uranium-233 has for increasing the efficiency of the production of fissile material in slow-neutron reactors relative to uranium-235 and plutonium. For instance, although current light water reactors generate plutonium-239, about 0.6 atoms are produced per fission of uranium-235 or plutonium-239 (a “conversion ratio” of ~0.6). For thorium the conversion ratio can be greater than one, holding the promise that such a reactor can produce more fissile material than it destroys.

Research and development of several reactor types were launched with the goal of demonstrating that thorium and uranium-233 would be a safe and economical source of electricity. Projects demonstrating the potential viability of slow-neutron “breeder” reactors using uranium-233 were established, most notably the Elk River Reactor in Minnesota, the Molten Salt Reactor at ORNL, and the Light Water Breeder Reactor at Shippingport, Pennsylvania.¹⁷ By 1977,

however, pursuit of the thorium fuel cycle was effectively abandoned in favor of plutonium-fueled fast reactors. All told, the AEC and its successor the DOE spent billions of dollars on the thorium fuel cycle.

Another factor that may have influenced the decision to abandon the thorium fuel cycle is that thorium itself is more radioactive than uranium and thus requires additional precautions. The surface dose rate from a 55-gallon drum of thorium oxide is approximately 60 mR/hr, about 13 times higher than from a similar sized drum of uranium.¹⁸ A worker spending time inside a thorium storage facility could expect to encounter dose rates of 60–100 mR/hr. In a little over six working days, such an employee could reach the maximum annual U.S. occupational exposure limit of 5 rem.

After several failed attempts to establish a thorium fuel cycle, the commercial nuclear industry also walked away from thorium fuels.

- The first commercial nuclear plant to utilize thorium was Indian Point Unit I, a pressurized water reactor that began operation in 1962. However, the cost of recovering uranium-233

from this reactor was described as a “financial disaster.”¹⁹ Less than 1 percent of the irradiated thorium was converted to uranium-233.²⁰ The utility switched to uranium fuel. Shortly after the thorium from the Indian Point reactor was recovered from spent fuel, a 1968 Memo from a Hanford official noted “there is no anticipated use for this material so it will be stored semi-permanently [as a nitrate liquid] in a 5,000-gallon tank...”²¹ Eventually, between 1979 and 1985, it was solidified into an oxide for safety reasons.²²

- The Peach Bottom I Unit, a prototype 40 megawatt high-temperature gas-cooled reactor used thorium fuel. It operated from 1967 to 1974. The reactor was closed after experiencing a high rate of fuel element failures, causing significant down-time.²³ Its spent fuel is currently stored at DOE’s Idaho National Engineering Laboratory at taxpayer expense.²⁴
- The Fort St. Vrain plant was a high-temperature-gas-cooled 330

megawatt reactor using thorium and uranium-235 fuels which operated from 1979 to 1989. Hundreds of events involving equipment failure, gas leaks, fuel failures, cracked piping and graphite, and human error led to its closure.²⁵ DOE is responsible for its spent fuel which is stored in dry casks at the reactor site.²⁶

In June 2000, after lobbying by Oak Ridge National Laboratory, the Secretary of Energy directed the Office of Nuclear Energy to utilize the stockpile of excess uranium-233 to increase the supply of medical isotopes. This would involve a multi-step process in different locations requiring new facilities to extract thorium-229 an 8,000-year half-life decay product of 160,000-year half-life uranium-233, which then decays into actinium-225 (10-day half-life), and subsequently decay, through short-lived intermediates, into bismuth-213 (46-minute half-life), a radioisotope of potential interest for medical therapy.²⁷ In January 2001, the DOE determined that that there is no programmatic use for uranium-233 in storage at ORNL, other than possible use for medical purposes.²⁸ In

2005, the U.S. Congress terminated medical isotope production from the Oak Ridge inventory of uranium-233 and transferred the responsibility for the disposition to the Office of Environmental Management.²⁹ That year, Congress also directed the U.S. Defense Department to dispose of some 3,222 tons of thorium in the U.S. strategic material stockpile.³⁰

Safeguards and Security

Uranium-233 is now classified by the United States government as a Category I special strategic nuclear material, i.e., it is material that “in specified forms and quantities — can be used to construct an improvised nuclear device capable of producing a nuclear explosion.”³¹ The United States and the IAEA require safeguards for uranium-233 in quantities greater than 2 kilograms.³² A Category I quantity of highly enriched uranium (HEU) is 5 kilograms. According to DOE, stringent physical security is required on uranium-233 stocks, in order to prevent “an unauthorized opportunity to initiate or credibly threaten to initiate a nuclear

dispersal or detonation... for onsite assembly of an improvised nuclear device.”³³

The main reasons interest waned in the use of uranium-233 for weapons were its radiological hazards and related costs. Of particular concern is exposure to uranium-232, which is co-produced and is 60 million times more radioactive than uranium-238. This is due to the short half-life of uranium-232 and the high-energy gamma radiation emitted in the decay scheme of uranium-232 daughter products, most notably Tl-208, which emits a 2.6 MeV gamma ray when it decays. This gamma radiation is difficult to shield. If the uranium-232 contaminant is at a level of 1,000 to 4,000 parts per million (ppm), the radiation levels at one foot from a 5-kilogram mass of uranium-233 is greater than 1,000 R/hr.^{34,35}

With a half-life of 72 years, the decay of uranium-232 increases external penetrating (gamma) radiation levels, which peak after 10 years but still makes it dangerous to store and handle (Figure1).

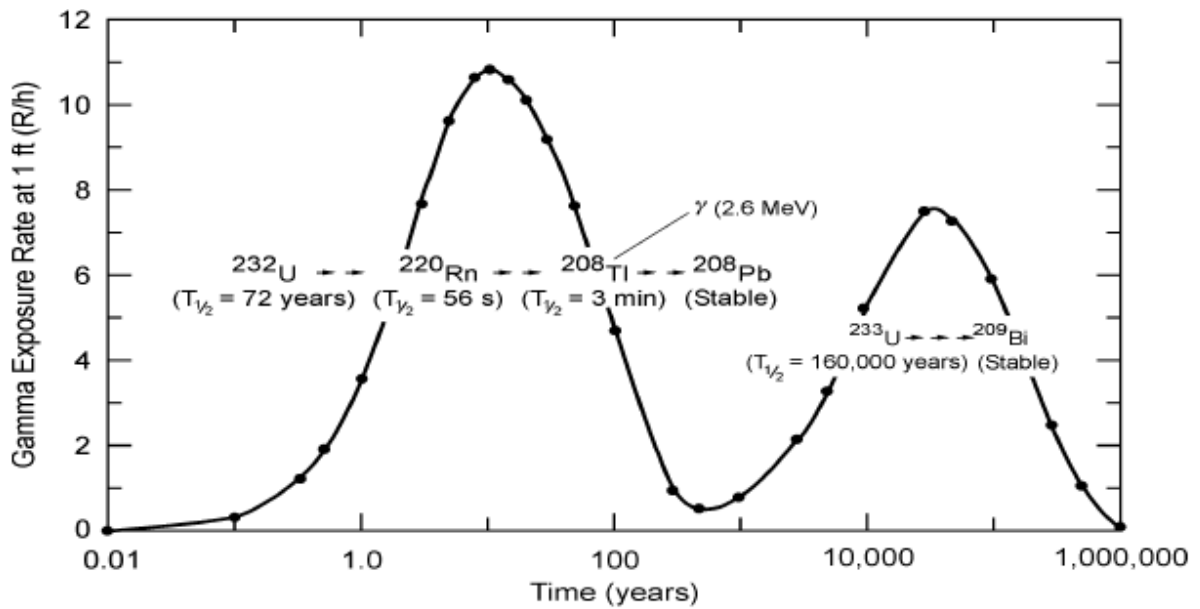


Fig. 1. Gamma exposure for 1 kg ^{233}U with 100 ppm ^{232}U .

Figure 1 Gamma exposure rate for uranium-233. Source: ORNL DWG 98C-157R

The uranium-232 contaminant level, however, is not considered to be an adequate barrier to prevent a terrorist from making an improvised nuclear device. According to researchers at ORNL, "...if a diverter was motivated by foreign nationalistic purposes, personnel exposure would be of no concerns since exposure even that these levels would not result in immediate death."³⁶ Moreover, uranium-233 currently stored at DOE sites typically contains far less quantities of U-232, ranging from 6 to 162 parts per million of U-232 — making it more vulnerable to seizure by terrorists.³⁷ For instance, during the 1960's and 1970's the DOE's Rocky Flats

Plant processed uranium-233 in uranyl nitrate and then fabricated uranium-233 metal components in kilogram quantities. According to a DOE report about handling uranium-233 at Rocky Flats:

"The material also contained approximately 50 parts per million (ppm) contaminant ...A 50 ppm U-232 content equates to approximately 13R/hr at 1 foot and with extrapolation, a 5 to 10 ppm content would emit approximately 5R/hr [at 1 foot]." ^{38,39}

Under this circumstance, it would take a person about one to two weeks of exposure working 12 hours a day before that person would accumulate a potentially lethal dose.

Managing the Uranium-233 Legacy

The lack of an accurate uranium-233 inventory has raised concerns. In 1996, the DOE's Inspector General (IG) issued an audit report that concluded: "management at three sites [Oak Ridge, Rocky Flats, and the Idaho National Laboratory] had not performed all required physical inventories, and one site did not perform measurements, due to safety concerns and operational interruptions... the longer complete physical inventories are delayed, the greater the risk that unauthorized movement of special nuclear materials could occur and go undetected."⁴⁰

In the years following the IG's audit, DOE reports have presented varying inventory estimates at Oak Ridge and Idaho. For instance, published sources for uranium-233 stored in Building 3019 at ORNL range from 359 kilograms⁴¹ to 450 kilograms,⁴² a discrepancy of 91 kilograms. At DOE's Idaho National Laboratory, inventory data of un-irradiated uranium-233 range from 351

kilograms⁴³ to 411 kilograms⁴⁴, a difference of 60 kilograms.

It is possible that more uranium-233 was lost to waste or is in highly diluted forms. Also, the amount that was present at the Los Alamos Laboratory (LANL) in 1997 is classified. According to DOE, prior to 1970, when all uranium-233 was produced, material measurement technologies "were less accurate than today."⁴⁵

There are 1,100 containers bearing uranium-233 stored in Building 3019, a 69-year-old facility at ORNL, which DOE describes as the "oldest operating nuclear facility in the world."⁴⁶ It is also eligible for listing in the National Register of Historic Places.⁴⁷ DOE finds that this facility has "deteriorated beyond cost-effective repair. Significant annual costs would be incurred to satisfy current DOE storage standards, and to provide continued protection against potential nuclear criticality accidents or theft of the material."⁴⁸

Dose rates from the Building 3019 canisters ranged between 1 to 300 R per hour.⁴⁹ About 500 canisters are holding what is considered "high purity" material (about

197 kilograms) that contains less than 50 ppm uranium-232.⁵⁰ Building 3019, which holds approximately 1,000 kilograms of uranium-233 and uranium-235, does not meet current Category I security requirements. (A batch of material that came from the Indian Point I reactor is commingled with 796 kilograms of, or nearly eight times more of, uranium-235, another Category I fissile material.⁵¹) Nor does it meet physical security requirements of the IAEA, which includes intrusion surveillance and motion detection.

After the DOE decided to no longer pursue the thorium nuclear fuel cycle in 1976, efforts were made to stabilize some of the excess uranium-233 at ORNL. Other than that, the U.S. stockpile of excess uranium-233 was subject to decades of neglect. In December 1996, the DOE's Office of Environment, Safety and Health concluded a vulnerability assessment of the storage of highly enriched uranium at its sites.⁵² It found that inventories of separated uranium-233 at several sites were being stored in conditions that increased environmental, safety, and health risks. According to the assessment:

"Some of the significant ES&H vulnerabilities involve U-233... Fourteen vulnerabilities involving U-233 were identified. Four of these are among the most significant found in the assessment. U-233 has been stored in metal containers, outside on pads, buried in drums in earthen mounds, or stored for decades without inspection."⁵³

Of particular concern were the inventories at ORNL Building 3019, constructed in 1943, and holding 1,100 "cans" of uranium-233 (Figure 2). This facility was originally designed as a radiochemical processing facility and not a long-term storage facility for approximately 1,000 kilograms of Category I fissile materials (uranium-233 and uranium-235). In the early 1990's it was designated as DOE's "National Repository for uranium-233" and contains material from the Savannah River Site (SRS), Oak Ridge National Laboratory (ORNL), Rocky Flats (RFTS), Lawrence Livermore National Laboratory (LLNL), and LANL in the form of oxides and metals.

Three years earlier in 1993, a DOE review of Building 3019 found the safety

documentation to be “adequate.”⁵⁴

However, the 1996 DOE vulnerability assessment found that despite the facility’s nuclear safety paperwork, an environmental release of the content from the containers “could be expected to occur within the next five years in that some of the packages are approaching 30 years of age and have not been regularly inspected.”⁵⁵

Concurrently, the DNFSB issued a critical report about the safety of the department’s uranium-233 holdings, which highlighted the problems in Building 3019.⁵⁶ As a result, the Board issued a recommendation in 1997 which urged the DOE to establish an agency-wide project to correct storage vulnerabilities.⁵⁷ Building 3019 at ONRL had among the single largest number of vulnerabilities.

The risks at Building 3019 include natural events (earthquakes, tornados) fires, explosions and nuclear criticalities. Accident consequences from possible fires, explosions and other container failures holding uranium-233 and uranium-235 recovered from Indian Point I reactor fuel, now known as the Consolidated Edison

Uranium Solidification Project (CEUSP) material, are estimated to result in potential offsite doses at a distance at nearly six miles of 45 rems. This is 450 times more than the DOE annual exposure limit for the public.⁵⁸

It took eleven years before the DNFSB closed its recommendation.⁵⁹ During that time, the conditions of the building have continued to deteriorate, while contractor management and costs continue to increase. A major reason why this project receives low priority is that DOE self-regulates the U.S. stockpile of uranium-233 and considers efforts to process and dispose of this material as an “unfunded mandate” not tied to established program activities including environmental compliance agreements. Although the DNFSB can issue recommendations it does not have regulatory authority to establish deadlines or issue fines and penalties.

In November 2005, after several fits and starts, the Office of Environmental Management assumed control of the project to process and dispose of the uranium-233. Nearly five years later, DOE’s IG reported that, “the Department's

uranium-233 disposition project had encountered a number of design delays, may exceed original cost estimates, and will likely not meet completion milestones.” Since the Office of Environmental Management took over this project, it was directed by four different DOE managers in less than two years. The estimated total cost of the project increased from \$384 million to \$473 million.⁶⁰

In 2009, DOE developed a plan for uranium-233 disposition⁶¹ in which:

- The material would be placed directly into the ground without downblending. Materials in 403 canisters generated by the Indian Point I reactor would be directly disposed in a landfill at the Nevada National Security Site to avoid the costs of downblending. This material makes up nearly three-fourths of the fissile materials in Building 3019.⁶²
- The DOE’s National Nuclear Security Agency would assume responsibility for approximately 245 kilograms of uranium-233 oxide contained in welded metal plates and transfer it to the Device Assembly Facility

(DAF) at the Nevada National Security Site.

- Downblending for the remaining balance of materials with uranium-238 oxides using existing hot cells at ORNL or aqueous downblending followed by co-processing with radioactive waste sludges stored at the ORNL site.

In January of this year, the Energy Department announced it had shipped 6 canisters containing Zero Power Reactor plates to the Device Assembly Facility at the Nevada National Nuclear Security Site for use in experiments.⁶³ DOE expects to complete shipment of the remaining 122 plates containing uranium-233 by the end of June of this year.⁶⁴ The “desired timeline” for final removal and disposition of the balance of material in Building 3019 is projected for 2018.⁶⁵

DOE appears to be set on the direct disposal option for the CEUSP material in a landfill, even though it would significantly violate the agency’s safeguard and security requirements⁶⁶ and Nevada National Security Site

Acceptance Criteria⁶⁷ (Figures 3 and 4).
The agency is currently reviewing the

potential of an intruder obtaining this
material after it is disposed.⁶⁸

Figure 2 Landfill disposal of CEUSP material exceeds DOE Safeguard Termination Limits.

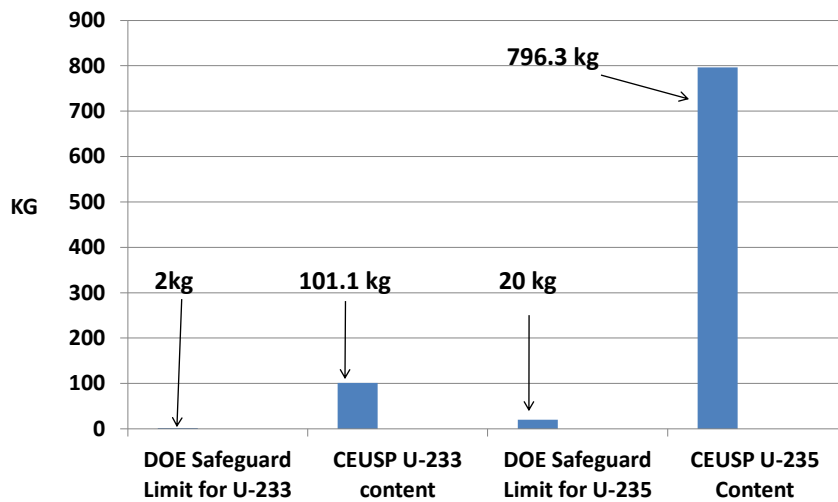
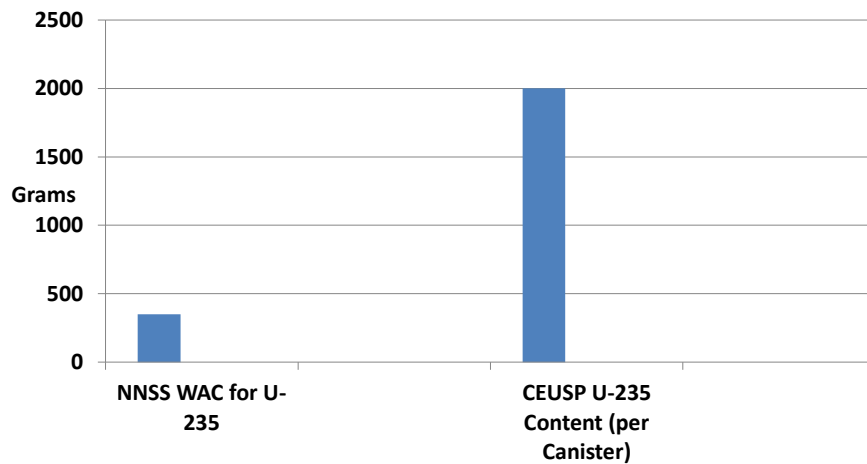


Figure 3 Disposal of CEUSP exceeds DOE's Waste Acceptance Criteria (WAC) for landfill disposal of fissile materials.



The CEUSP material is approximately 86 percent enriched.⁶⁹ It contains 796.3 kilograms of uranium-235 and 101.1 kilograms of uranium-233 in a total uranium content of 1042 kilograms.

The contents in the CEUSP canisters are Category I material and meet the criteria for “high-grade material.” For such material, DOE requires safeguards for quantities of uranium-233 greater than 2 kilograms and quantities of uranium-235 greater than 20 kilograms. In order to dispose of this material the DOE will have to grant an unprecedented termination of safeguard requirements.

The uranium-233 inventory of 323 kilograms, contained in 31 tons of un-irradiated thorium (1 percent dilution), was shipped to the Nevada National Security Site beginning in 2010 where it was disposed as low-level radioactive wastes.^{70,71} In terms of the Nevada National Security Site Waste Acceptance Criteria, uranium-235 disposal is limited to no more than 350 grams per package. The CEUSP material has an average of 2,000 grams of uranium-235 and about 250 grams of uranium-233 per canister. The Nevada

National Security Site Waste Acceptance Criteria is silent about uranium-233 disposal limits, which has critical mass much less than uranium-235.

Meanwhile, over the past fifteen years DOE has spent approximately \$84 million on maintenance of surveillance of the uranium-233 packages at ORNL.⁷² These costs are expected to increase as Building 3019 steadily deteriorates. The CEUSP material was packaged over 25 years ago and contains the highest concentration of fissile material (uranium-233 and uranium-235) in the facility – approximately 86 percent of the total uranium content.

In 1998 the DOE approved termination of safeguards for residues bearing plutonium for disposal at WIPP. It was granted under the condition that the residues would be blended to “below 10 weight percent plutonium and placing the blended residues in the pipe overpack containers prior to removing the residues from the protected area.”⁷³

DOE plans to complete shipment of this material for landfill disposal by August 2014.⁷⁴ If a variance terminating safeguards for the CEUSP material were granted, the

combined fissile material content would be more than eight times greater than allowed for the Rocky Flats material. Moreover, the radiation barrier created by contamination from uranium-232 will diminish by 50 percent in less than 50 years, allowing for

much easier access to the material for use in weapons.

Conclusions

Storage of the U.S. stockpile of uranium-233 is a safeguard, security, and safety risk. The production of the stockpile also has left a disposal burden.

The key concerns are:

1) Inventory for this type of uranium.

There are substantial problems with the keeping of inventory for uranium-233, with possibly 123 kilograms unaccounted for or missing in the DOE complex. It only takes between 20 and 35 pounds to make a multi-kiloton explosion that could destroy all of downtown Washington, D.C. or another city.

2) Storage concerns for this type of

uranium. Inadequate safeguards of this bomb-grade material from terrorists or unwanted parties are present at multiple facilities, such as the 69-year-old historic Oak Ridge National Laboratory. Environmental, safety, and health risks result from inadequate storage of the material. Management, storage, and disposal of spent thorium fuel from several commercial reactors also pose a challenge.

3) Disposal challenges for this type of

uranium. Disposal of large quantities of concentrated uranium-233 bearing waste in a landfill would significantly violate the Department of Energy's safeguard and security requirements and Nevada National Nuclear Security Site Waste Acceptance Criteria. Such disposal would put everyday Americans at risk of nuclear radiation exposure. In order to dispose of this material, the Department of Energy would have to grant an unprecedented termination of safeguard requirements, which would be unwise since it would set a bad precedent for safeguarding and disposal of other wastes containing concentrated fissile materials. The Department of Energy's stated plans to waive important nuclear safeguards are alarming.

To address these concerns, the Department of Energy should ensure that all uranium-233 is accounted for and provide a more accurate inventory. Nuclear material control and accountancy of uranium-233 is a key element in assuring the adequate safeguard and security of this dangerous

material. No waiver of important nuclear safeguards, as is currently being discussed by the Department of Energy, should go forward. All uranium-233 should be

accounted for, stored safely, and diluted for safe disposal so that it can never be used to fuel nuclear weapons.

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