Title: Uranium Disposition Efforts at Los Alamos National Laboratory

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Uranium Disposition Efforts at Los Alamos National Laboratory

Plutonium Science and Engineering Lecture

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Los Alamos NATIONAL LABORATORY EST. 1943

NNSA National Nuclear Security Administration

Managed by Triad National Security, LLC for the U.S. Department of Energy's NNSA

Some Uranium Facts

- Occurs naturally in the earth's crust
- Is dense, radioactive and has a long half life
- U-233 and U-235 are fissile
- Used for
  - Nuclear weapons
  - Nuclear reactor fuel
  - Kinetic energy penetrators
- Uranium is less toxic and less fissile than plutonium

Uranium Isotope Abundance and Half-Life

Isotope	Abundance	Half Life
U-233	Trace	1.592×10^{5} y
U-234	0.005%	2.455×10^{5} y
U-235	0.720%	7.04×10^{8} y
U-236	Trace	2.342×10^{7} y
U-238	99.274%	4.468×10^{9} y

Uranium Bare Critical Mass = 52 kg
Plutonium Bare Critical Mass = 10 kg

Pu-239 Half life = 2.41X10 * 4

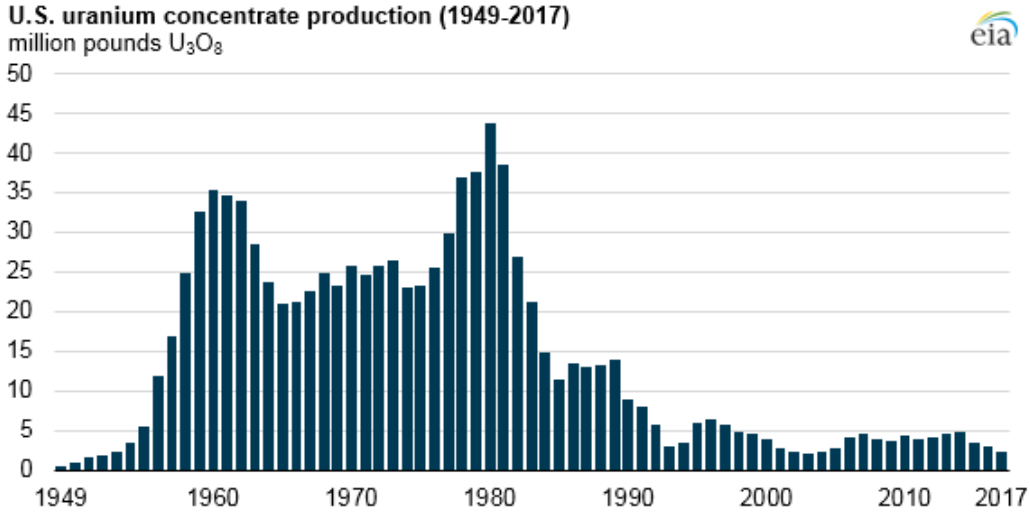
Major U.S. Uranium Reserves

Sources: Based on U.S. Department of Energy, Grand Junction Project Office (GJPO), National Uranium Resources Evaluation, Interim Report (June 1979) Figure 3.2; and GJPO data files.

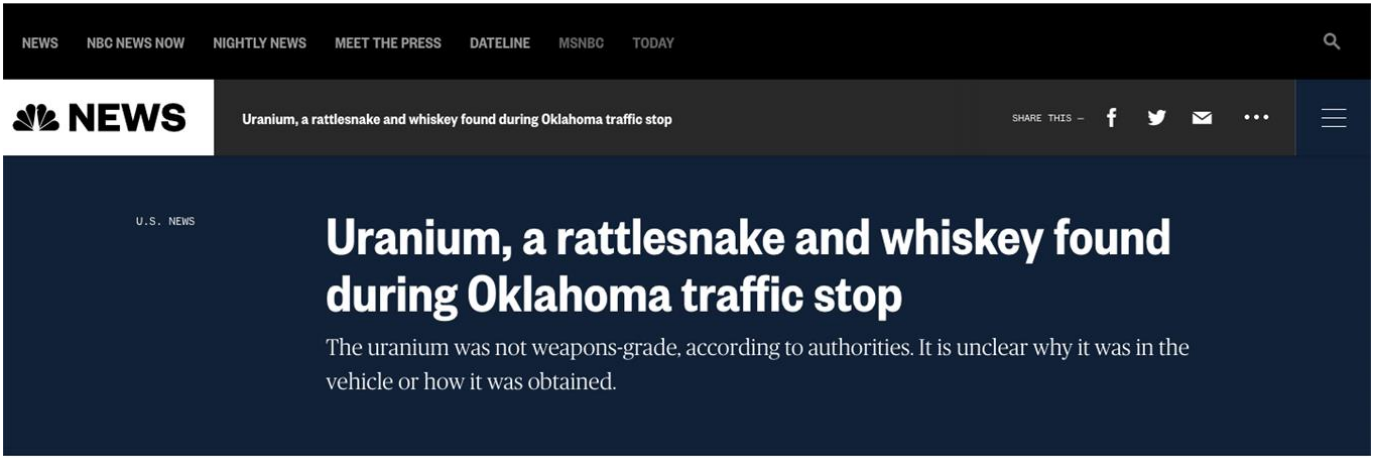
Uranium Fever Hit America in the 1950's….

https://www.youtube.com/watch?v=2ANI6oj8p2M

20 Million pounds is about 10,000 Tons



…And, Uranium is Still Popular Today!



July 11, 2019

July 11, 2019, 1:56 PM MDT

By Janelle Griffith

Police in Oklahoma say they found an open container of Kentucky Deluxe whiskey, a rattlesnake, a gun and a canister of radioactive powdered uranium during a traffic stop of a vehicle that had been reported stolen.

Depleted, Natural, and Enriched Uranium*

Nuclear Material Type Code	% U-235	Safeguard Category	Reporting Unit
12-18	>0.21 - <0.71	Depleted Uranium	Kg
19?	0.720	Natural Uranium	Kg
21-33	<0.712 - <20.0	Low Enriched Uranium	Gram
38	92-94	Highly Enriched U	Gram
39	94 and higher	Highly Enriched U	Gram

Three popular ways to enrich uranium are:

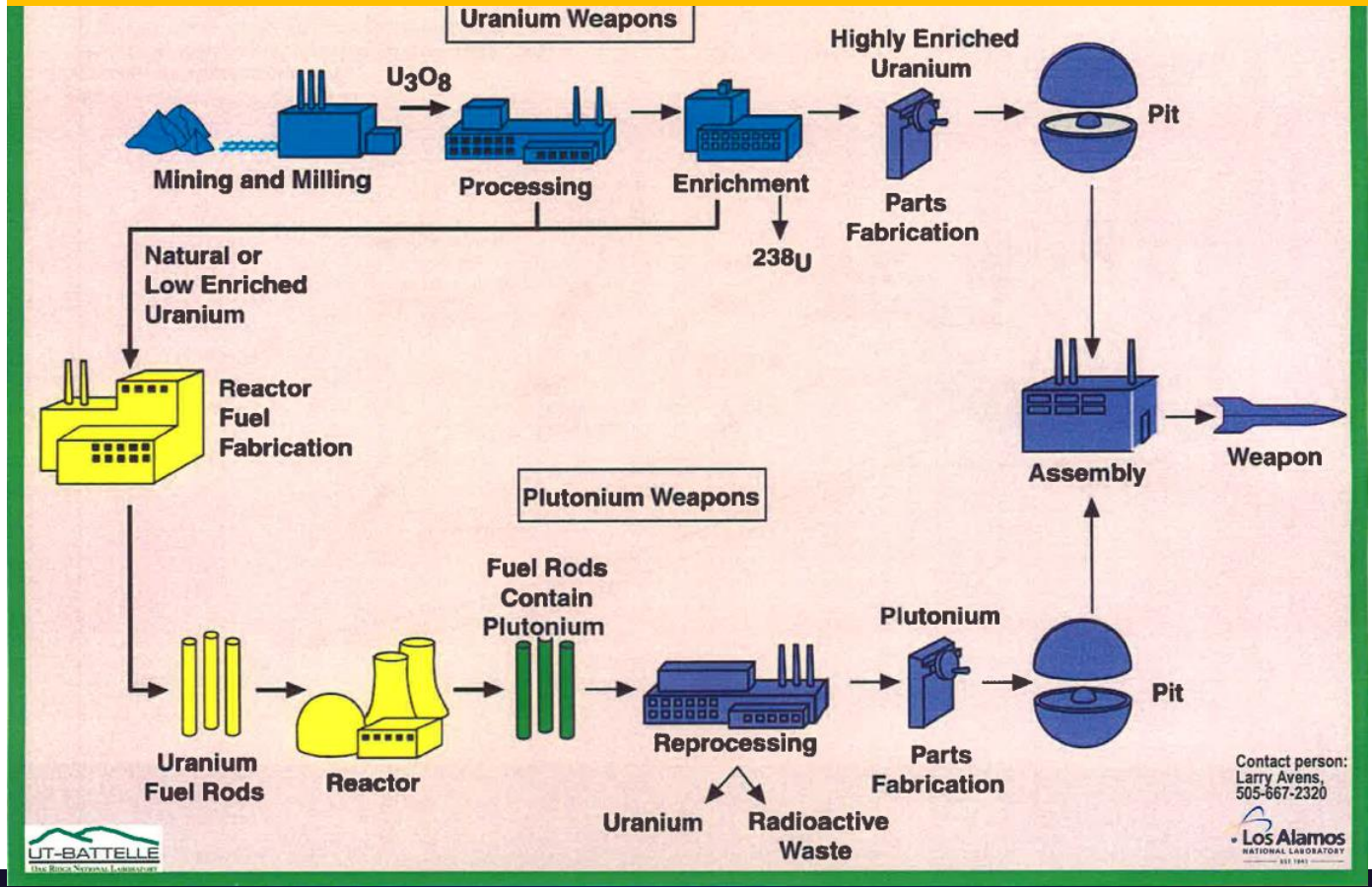
1) Electromagnetic Separation (Y-12 / ORNL, and Iraq)

2) Gaseous Diffusion using UF_6 gas (K-25 / ORNL, Paducah KY, Piketon, OH)

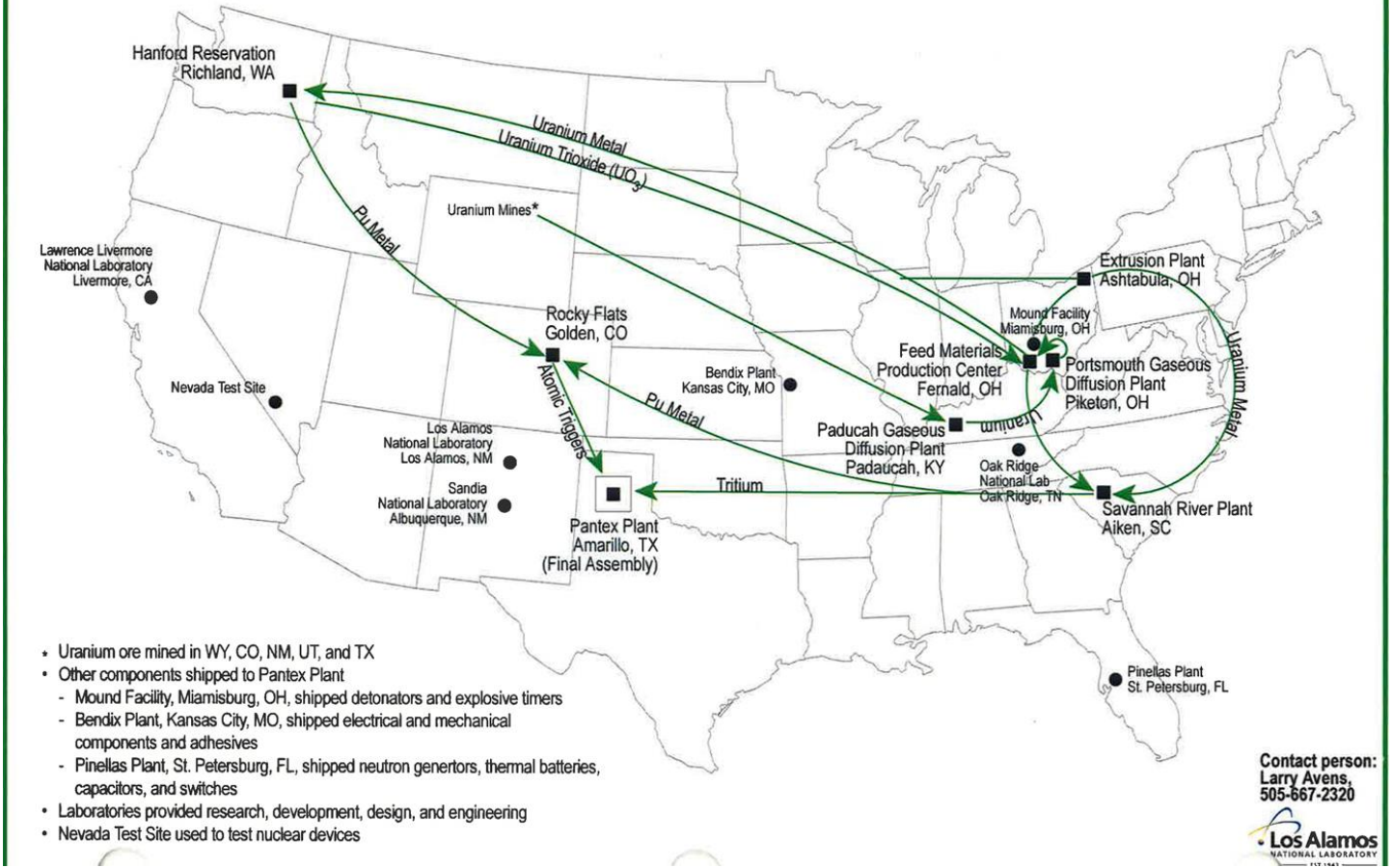
3) Gas Centrifuge using UF_6 gas (K-25, Piketon, OH)

* From DOE P 470 // Safeguards and Security Program

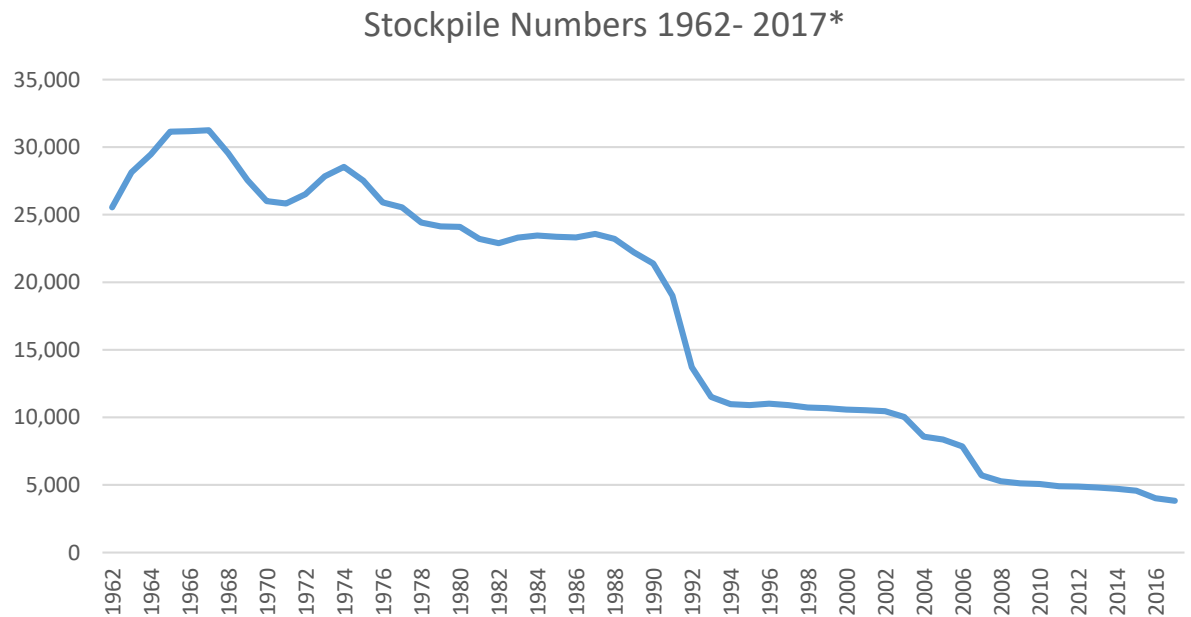
Generic Overview of a Mature Nuclear Weapons Program



US Department of Energy
Weapons Complex Facilities *circa 1985*



Size of the US Nuclear Weapon Stockpile Over Time

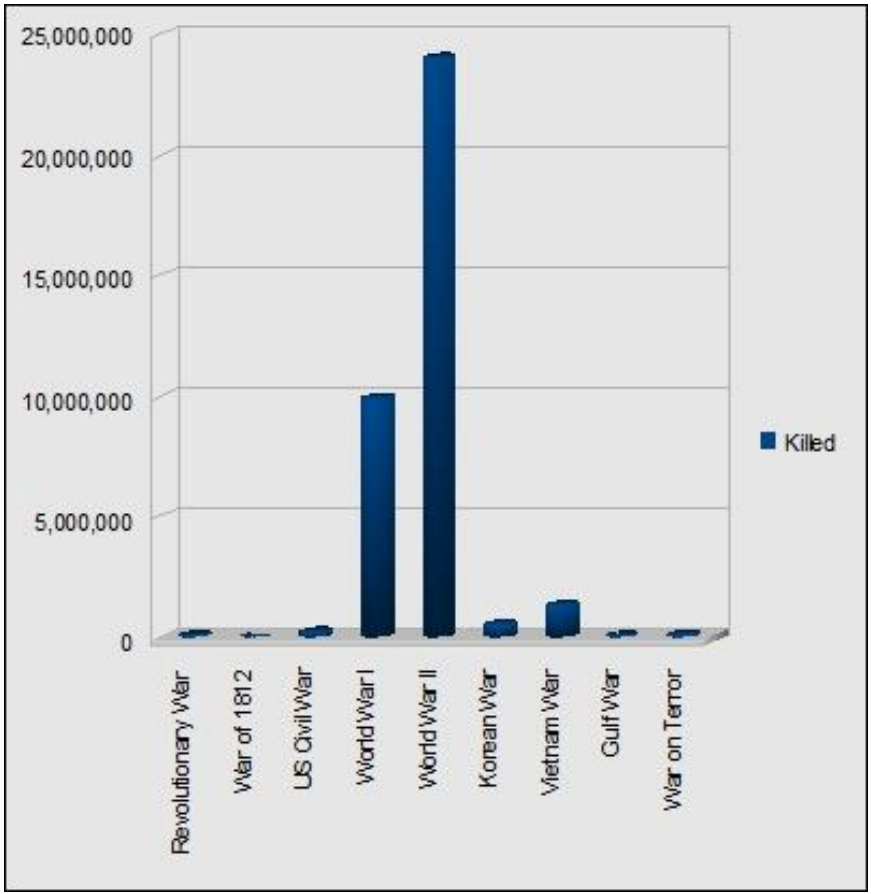


- *"Classification Bulletin WNP-183; FY 2017 Stockpile Quantities and Dismantlements" March 20, 2018*
- *U.S. Nuclear Weapons Complex, Overview of DOE Sites, Congressional Research Service, Feb.3, 2020*

The Enduring Legacy of Nuclear Weapons

Over hundreds of years death rates from wars escalated as lethal force multiplied. U.S. fatalities at Iwo Jima, for example, totaled almost 7,000.

This cycle ended with the introduction of nuclear weapons in 1945. The scale of destruction makes war between State combatants prohibitive.



Very Brief HEU and Pu Disposition Background

- The “Cold War” was pronounced dead shortly after the Soviet Union collapsed. The huge nuclear weapon draw down began in the first Bush administration (about 10,000 warheads in 10 years)
- Plutonium and Enriched Uranium disposition flowed from the nuclear weapon draw down.
- The Nuclear Weapons Council “December 1994 Excess Fissile Materials Declaration” and the March 1, 1995 announcement on this topic by President Clinton declared 174.3 metric tons of HEU excess to national security needs. The NNSA is charged with disposition of this material. [1, 2]

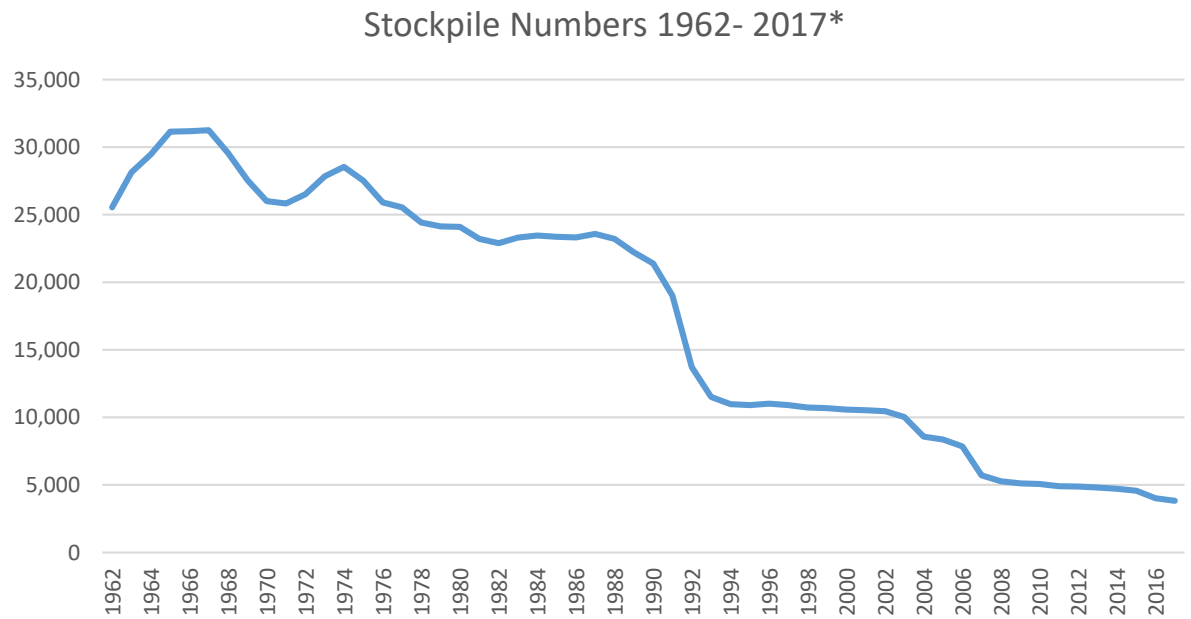
Internet search terms you can use to learn more about nuclear material disposition and this era:

- Natural Resources Defense Council, Inc.
- Nuclear Threat Initiative
- Center for Strategic and International Studies

[1] Highly Enriched Uranium: Striking a Balance, US DOE / NNSA, Jan. 2001. (https://fas.org/sgp/othergov/doe/heu/striking.pdf)

[2] Excess Uranium Inventory Management Plan, July 2013. (https://www.energy.gov/sites/prod/files/2013/07/f2/Excess%20Uranium%20Inventory%20Management%20Plan.pdf)

Size of the US Nuclear Weapon Stockpile Over Time



** "Classification Bulletin WNP-183; FY 2017 Stockpile Quantities and Dismantlements" March 20, 2018*

“Excess Uranium Inventory Management Plan, July 2013”

DOE Uranium Inventories as of December 31, 2012

The scope of this Plan covers DOE uranium currently held as excess in various forms and qualities, including HEU, LEU, NU, and high-assay DUF_6 (defined for purposes of this Plan as DUF_6 with an assay greater than 0.34% ^{235}U but less than 0.711% ^{235}U[5]) that have the potential to enter the commercial uranium market. (For purposes of this report, the term “uranium inventory” means that uranium currently held by DOE as excess and not dedicated to national security missions.) Table 1 summarizes the Department’s uranium inventory as of December 31, 2012.

Table 1. Overview of Uranium Inventories Included in the 2013 Plan, as of December 31, 2012

Inventory	Enrichment Level	MTU	NU Equivalent Million lbs. U_3O_8	NU Equivalent MTU
Unallocated Uranium Derived from U.S. HEU Inventory	HEU/LEU	18.0	8.8	3,394†
Allocated Uranium Derived from U.S. HEU Inventory	HEU/LEU	11.4	5.4	2,077†
LEU	LEU	47.6	1.1	409
U.S.-Origin NU as UF_6	NU	5,234	13.6	5,234
Russian-Origin NU as UF_6	NU	7,705	20.0	7,705
Off-spec LEU as UF_6	LEU	1,106	4.9	1,876
Off-spec Non-UF_6	NU/LEU	221	1.6	600
DUF_6*	DU	114,000	65-90	25,000-35,000

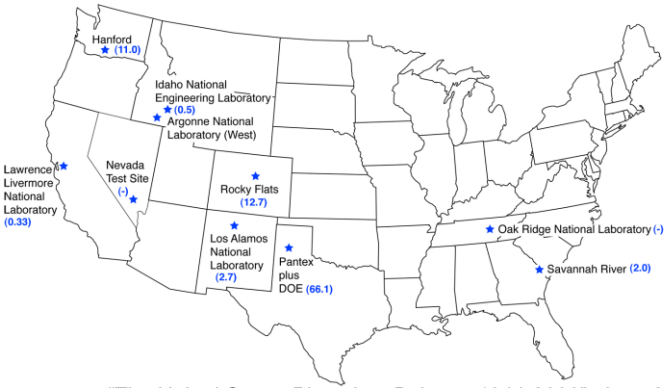
† The NU equivalent shown for HEU is the equivalent NU within the LEU derived from this HEU, most of which will be retained by DOE in the timeframe under consideration herein. This table includes LEU down-blended from HEU and HEU that is to be down-blended or that is in the process of being down-blended.
* DUF_6 quantity is based on uranium inventories with assays greater than 0.34% ^{235}U but less than 0.711% ^{235}U. The amount of NU equivalent is subject to many variables, and a large range has been shown to reflect this uncertainty. DOE has additional DUF_6 inventory that is equal to or less than 0.34% ^{235}U that is not reported in this Table.

Changes from 2008 Plan

Table 2 represents annual snapshots of the Department’s uranium inventory, as published in the 2008 Plan (through Fiscal Year [FY] 2008), and at the end of CYs 2009, 2010, and 2011. The

[5] Additional DUF_6 inventory below 0.34% ^{235}U that may be considered for entry into the commercial uranium market.

“Highly Enriched Uranium: Striking a Balance, US DOE / NNSA, Jan. 2001”*



“The United States Plutonium Balance 1944-2009”, June 2012

(An update of “Plutonium: The first 50 years” U.S. DOE, Feb. 1996, DOE/DP-0137.)

U.S. HEU Inventory
(as of September 30, 1996)

Location	MTU
Y-12 Plant, Pantex Plant and Department of Defense	651.6
Idaho National Engineering & Environmental Laboratory	27.4
Savannah River Site	22.2
Portsmouth Gaseous Diffusion Plant	21.7
Rocky Flats Environmental Technology Site	6.0
Los Alamos National Laboratory	3.5
Other	8.3
Total	740.7

*(https://fas.org/sgp/othergov/doe/heu/striking.pdf)

Uranium Electrolytic Decontamination (UED) History at TA-55 1998-2013…

- TA-55 Uranium Disposition grew out of the ARIES Pit Disassembly efforts
- Composite pits make up a significant quantity of the excess pit inventory
- A composite pit has plutonium and uranium hemishells nested
- After decades in the stockpile, a nested HEU shell carries significant plutonium contamination
- This HEU must be decontaminated to disposition this material
- Electropolishing or “electrodecon” is used to achieve this goal

UED History at TA-55 (continued)

- UED operated continuously from 1998-2013
- Crit Safety issues paused UED in 2013
- Hundreds of successful evolutions were completed from 1998-2013

UED History at TA-55 (continued)

Because UED was not operated for a period exceeding 12 months, the DOE Readiness order required that the full spectrum of Readiness Reviews: MSA, CRA, FRA be conducted to restart UED.

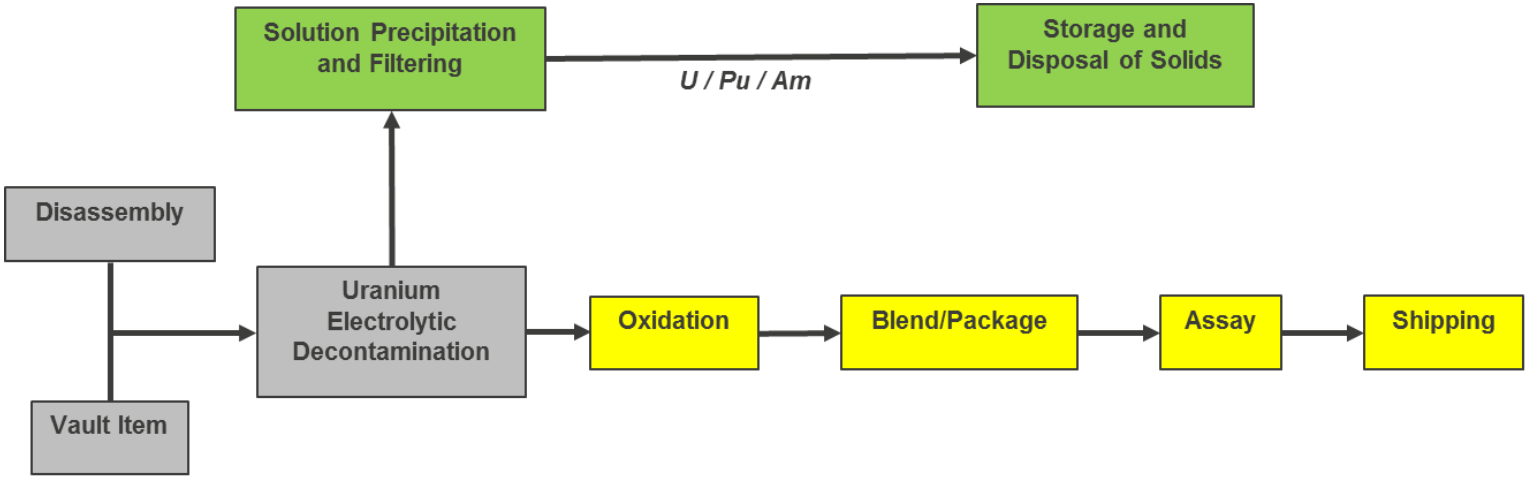
Management Self Assessment	*September 10-14 2018*
Contractor Readiness Assessment	*November 5-15, 2018*
Federal Readiness Assessment	*January 28-31, 2019*
Management Observation	*July 2019*
Normal Order	Restored in FY2019

Hundreds of Pu contaminated HEU shells remain to be cleaned in the TA-55 inventory

Early Research on Uranium Electropolishing

- B. W. Mott and H. R. Haines, Atomic Energy Research Establishment (Harwell, U. K) Metallurgia, **43**, 255 (1951) // J. Inst. Metals, **80,** 621 (1952).
- H. A. Saller, and F. A. Rough, Trans. Amer. Inst. Min. Met. Eng. **197**, 545 (1953). (at Battelle)
- F. A. Metz, Ames Laboratory Dissertation “Electropolishing of Metals”, (1960)
- UED was conducted at Rocky Flats Plant for many years to return HEU hemishells to Y-12

Enriched Uranium operations at TA-55



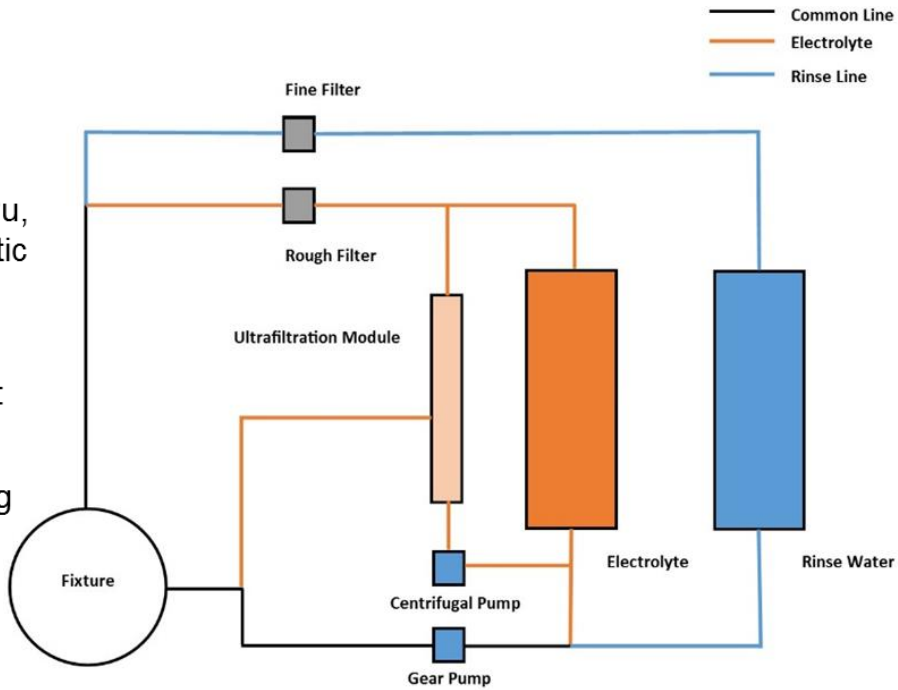
Contaminated Uranium Parts → Clean Uranium Metal → Clean Uranium Oxide

Uranium Electrolytic Decontamination (UED) Drawing

The Uranium Electrolytic Decontamination operation removes surface contamination (Pu, Am) from uranium parts through an electrolytic process.

The operation consists of two main activities:

- Uranium decontamination
- Solution precipitation, filtering and drying to separate U, Pu, Am from the solvent



Clean hemishells are converted to uranium oxide, assayed and shipped to Tennessee

- The decontaminated hemishell is converted to HEU oxide by furnace calcination.
- Analysis is performed to determine plutonium content (< 820ppb).
- The uranium oxide is packaged and shipped to Y-12 or NFS

UED Operations –

Unclassified Image of the UED Fixture

- Decontaminated Uranium Hemishells are passed out of line through the “Intro” Hood to the left of the UED fixture.

"Uranium Disposition Efforts at Los Alamos National Laboratory"

In Summary

- Doing uranium work in a plutonium facility has challenges: NDA is geared to plutonium, Pu contamination, DU discards

- The future volume of the feed stream to UED is dependent on pit disassembly. The dilute and dispose Pu disposition option will cause the HEU stream to grow significantly

- Shipping HEU metal directly to Y-12 is a long term goal.