Y12

National Security Complex

Managed and Operated by
Consolidated Nuclear Security, LLC

Establishment of a HALEU
Advanced Rx Strategic Reserve (Y/PM-20-042)

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Y-12 History of Transformation

- Construction began in 1943 as part of the Manhattan Project
- During the Cold War, 8,000 people produced weapon secondaries
- Transformation is underway to create a modern facility that will meet future mission needs

Y-12 National Security Complex

- Oak Ridge, TN
- 811 acres spanning 2.5 miles
- 7.3 million ft^2 of laboratory, machining dismantlement, research and development and office areas
- ~5,000 employees
- Average age: 49 / Average years of service: 13

Mission

- Provide the nuclear deterrent
- Fuel the Nuclear Navy
- Reduce the global nuclear threat

Reducing the Global Nuclear Threat

- Provide special materials expertise to government agencies
- Supply high assay low enriched uranium (HALEU)

Recovering Material Across the Globe

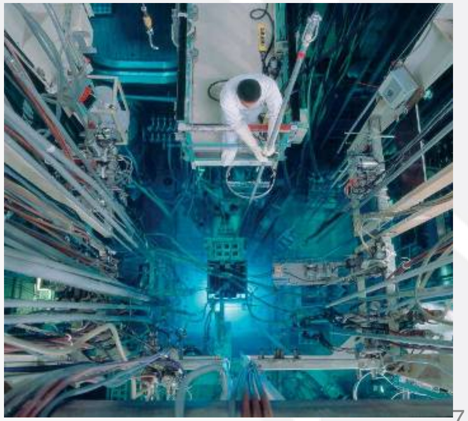
Foreign Research Reactor (FRR) Supply

- Y-12 supplies over 80% of the research reactors around the world (excluding Russia and China designed reactors)

- Provide low enriched uranium (LEU) (19.75% ^{235}U) and small quantities of highly enriched uranium (HEU) (93.15% ^{235}U) to fuel research reactors and produce isotopes for medical and/or industrial use

RA-6 Reactor, Bariloche, Argentina

CEA OSIRIS Reactor, France



Supply - Arrival and Offload

Footprint of Foreign Research Reactor Supply

YGG-14-0200R2

HALEU Fuel is the Critical Path for Advanced Reactors

- Many advanced reactors will require HALEU fuel
- Currently there are **no** existing commercial sources of HALEU in U.S. at production scale
- Private industry will not create such a supply absent of a substantial market for HALEU beyond demonstration quantities
- As documented in numerous white papers, industry presentations/articles, studies, etc., the need by the Adv Rx community for a HALEU Strategic Reserve is **now.**
- Nuclear Energy Institute (NEI) in a July 2018 letter to then Energy Secretary Perry communicated through a survey of advanced reactor developers and fuel designers their predicted annual HALEU needs increase from ~1.5 MTU in 2019 to ~590 MTU in 2030
- Like oil, nuclear fuel is a global marketplace; U.S. utilities purchase 99% of their natural uranium and 100% of enrichment services from foreign owned companies; HALEU for advanced reactors is a commercial commodity and should be traded like LEU

Clear Path / USNIC (2/21/2018 WP): Applicable Policy Recommendations (#1, 3, 6, & 7 of 10)

1. Congress should direct the Secretary of Energy to establish an adequate “strategic reserve” of higher assay LEU at an enrichment of 19.75% in order to serve the needs of the advanced reactor community in the near term. The reserve should contain at least 6 MT by 2020 and at least an additional 30 MT by 2025.

3. Congress should direct the Secretary of Energy to immediately declare a modest amount of its current inventory of highly enriched material, currently assigned to space or Navy propulsion needs, to be surplus in order to serve as the basis for establishing the strategic reserve outlined above.

6. As an alternative to the down-blending strategy included in recommendation 3, Congress could direct the Secretary of Energy to facilitate procurement of HA-LEU in the domestic or <u>international</u> market.

7. Congress should direct the Secretary of Energy to determine if the current capabilities to transport HA-LEU, either in the form of UF6, metal, oxide, or in the form of fuel for advanced reactors, is sufficient to meet the expected need, and if not, shall engage in a program with maximum reliance on the private-sector to design and seek licensing of sufficient transport containers within 5 years.

S.903 - Nuclear Energy Leadership Act (NELA)

- Sec. 960. Advanced Nuclear Fuel Security Program.

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(b) High-Assay, low-Enriched uranium program for advanced reactors.

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(3) QUANTITY.—In carrying out the program under this subsection, the Secretary shall make available—

(A) by December 31, 2022, high-assay, low-enriched uranium containing not less than 2 metric tons of the uranium-235 isotope; and

(B) by December 31, 2025, high-assay, low-enriched uranium containing not less than 10 metric tons of the uranium-235 isotope (as determined including the quantities of the uranium-235 isotope made available before December 31, 2022).

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S.903 - Nuclear Energy Leadership Act (NELA) (cont'd)

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(d) HALEU transportation package research program.—

(1) IN GENERAL.—As soon as practicable after the date of enactment of this section, the Secretary shall establish a research, development, and demonstration program under which the Secretary shall provide grants, on a competitive basis, to establish the capability to transport high-assay, low-enriched uranium.

(2) REQUIREMENT.—The focus of the program under this subsection shall be to establish 1 or more HALEU transportation packages that can be certified by the Nuclear Regulatory Commission to transport high-assay, low-enriched uranium to the various facilities involved in producing or using nuclear fuel containing high-assay, low-enriched uranium, such as—

(A) enrichment facilities;

(B) fuel processing facilities;

(C) fuel fabrication facilities; and

(D) nuclear reactors.

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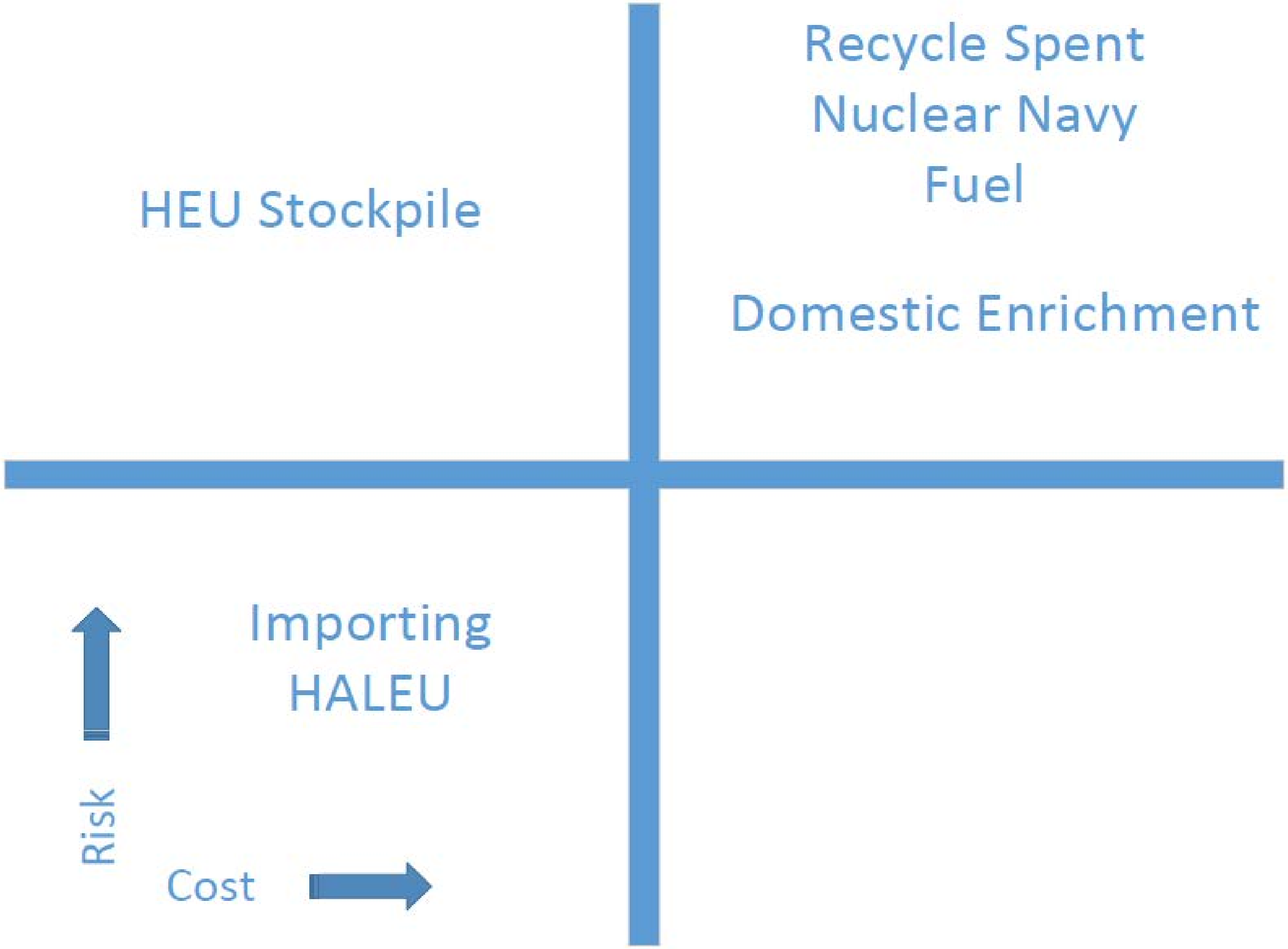
Is There a Solution?

- Y-12 asked routinely, does a Low Risk/Low Cost Solution Exist today for establishing a HALEU strategic reserve? Potentially
- Second routine question, does Y-12 support this type of work and can you help us? As directed or approved by NNSA
- As a result of conversations and a site tour from several key participants attending the 7th annual USNIC Adv. Rx Summit back in February, Y-12's capabilities and resources to help the Adv Rx community continue to be spotlighted.
- Post Adv Rx Summit VII, Y-12 received follow-up inquires to brief on the specifics as to the packages and personnel that exist and could be used for this initiative; thus, today's presentation.

Options and Comparative Risk vs. Cost



Solution

- Y-12 has the capability and initiative to **support** a solution for this issue.
- Y-12 is the Uranium Center of Excellence for the DOE/NNSA complex and also the repository for enriched uranium for the United States.
- We have the resources, capability, and experience to import and store HALEU from international suppliers, **if approved by NNSA**.
- Y-12 manages and maintains the ES-3100 Type B shipping package for DOE/NNSA. This container stands ready to fully support this initiative and the quantity and personnel to execute this program exists **TODAY** at Y-12. No other entity has the needed number of packages, the experienced personnel, or the storage capability for this mission.
- Each ES-3100 can handle ~35 kg metal and ~18 kg oxide.
- Our team has significant international experience in managing and executing this type of material movement/receipt.

Solution (cont’d)

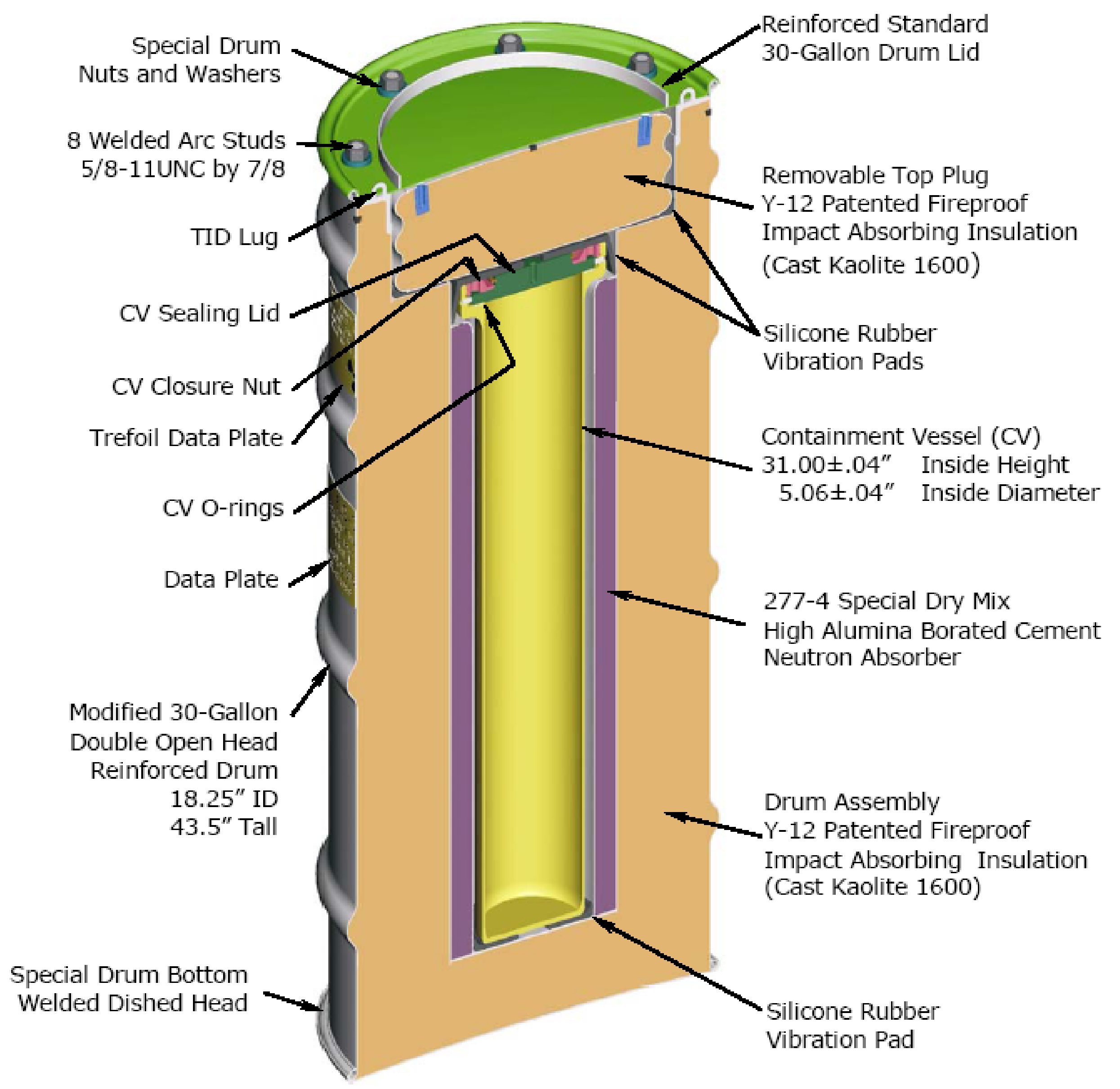
- From experience, we can cycle 100 containers three times per year (total 300).
- Y-12 has verified the storage space exists for receipt of the 50 MT HALEU.
- The mix of metal to oxide can be any ratio desired by DOE/NNSA and the Adv. Rx community.
- It has been communicated to Y-12 that HALEU metal or oxide is available starting this CY.
- For example, if the ratio was 40 MT metal and 10 MT oxide, this would result in ~1,143 and 556 containers worth of material.
  - At 300 containers per year on average, this would equate to ~5.7 years to complete by the deadline of 12/31/2025.
  - Well within the timeframe for needs resulting in fabricated fuel by mid-2020s.

Conclusion

- Industry can support this dilemma for the advance reactor (and medical isotope) community by importing HALEU.
- Establishing this HALEU strategic reserve significantly reduces the pressure on using U.S. origin material to be used only when required and would be a “game changer” for the Adv Rx community while awaiting a complete domestic fuel cycle.

Backup Slides
(ES-3100 Specifics)

ES-3100



Special Drum
Nuts and Washers
8 Welded Arc Studs
5/8-11UNC by 7/8
TID Lug
CV Sealing Lid
CV Closure Nut
Trefoil Data Plate
CV O-rings
Data Plate
Modified 30-Gallon
Double Open Head
Reinforced Drum
18.25" ID
43.5" Tall
Special Drum Bottom
Welded Dished Head
Reinforced Standard
30-Gallon Drum Lid
Removable Top Plug
Y-12 Patented Fireproof
Impact Absorbing Insulation
(Cast Kaolite 1600)
Silicone Rubber
Vibration Pads
Containment Vessel (CV)
31.00±.04" Inside Height
5.06±.04" Inside Diameter
277-4 Special Dry Mix
High Alumina Borated Cement
Neutron Absorber
Drum Assembly
Y-12 Patented Fireproof
Impact Absorbing Insulation
(Cast Kaolite 1600)
Silicone Rubber
Vibration Pad

Approved Content Ground

Certificate Number	Revision No.	Package Identification No.	Page No.	Total No. Pages
9315	16	USA/9315/B(U)F-96 (DOE)	8	15

Table 1.3 –Authorized Content and Fissile Mass Loading Limits for Ground Transportation (cont) [a, b, c]

HEU metal or alloy turnings, fines, or powders [g]	>80%, ≤ 90%	0.0	2.637	Spacers not required
		0.4	5.000	
		0.8	9.166	
		2.0	16.667	
		3.2	21.667	
	>70%, ≤ 80%	0.0	2.967	
		0.4	5.192	
		0.8	8.900	
		2.0	17.059	
		3.2	19.284	
	>60%, ≤ 70%	0.0	3.249	
		0.4	5.848	
		0.8	13.646	
		2.0	21.444	
		3.2	24.692	
	≤ 60%	0.0	5.576 kg U	
		0.4	14.872 kg U	
		0.8	28.814 kg U	
		2.0	35.20 kg U [f]	
		3.2	35.20 kg U [f]	

Approved Content Ground (cont.)

Table 1.3 –Authorized Content and Fissile Mass Loading Limits for Ground Transportation (cont) [a, b,]

Content Description	Enrichment	CSI	No Spacers, ^{235}U (kg)	277-4 can Spacers,[d] ^{235}U (kg)
HEU oxide [h, i] (UO_2, UO_3, U_3O_8, U_3O_8-Al, UO_2-Mg,[j] UO_2-ZrO_2)	≤ 100%	See below	15.13 kg oxide	Spacers not required
bulk density 2.0 – 6.54 g/cm^3		0.0	9.682 kg ^{235}U	
bulk density 2.0 – 6.54 g/cm^3		0.4	12.323 kg ^{235}U	
bulk density ≥1.75, <2.0 g/cm^3		0.0	9.46 kg ^{235}U	
bulk density ≥1.5, <1.75 g/cm^3		0.0	8.36 kg ^{235}U	
bulk density ≥1.25, <1.5 g/cm^3		0.0	7.04 kg ^{235}U	
bulk density ≥1.0, <1.25 g/cm^3		0.0	5.94 kg ^{235}U	
bulk density ≥0.75, <1.0 g/cm^3		0.0	4.84 kg ^{235}U	
bulk density ≥0.5, <0.75 g/cm^3		0.0	3.52 kg ^{235}U	

Approved Content Air

Table 1.3b - Loading Limits for Air Transport [a, b, c]

Content description	Enrichment	CSI	^{235}U (kg)
HEU metal or alloy	≤ 100%	— [d]	7.00
HEU metal or alloy turnings, fines, or powder [e]	≤ 100%	— [d]	7.00
Research reactor fuel elements and components ($UZrH_X$, [f] U-Zr, U-Al, U_3O_8-Al, UO_2, oxides of U-Zr, [g] UO_2-Mg, U_3Si_2-Al)	≤ 20%	— [d]	0.921
	> 20%	— [d]	0.408
HEU oxide [h, i] (UO_2, UO_3, U_3O_8, U_3O_8-Al, UO_2-Mg, [j] UO_2-ZrO_2):	≤ 100%	0.0 (Spacers not required)	see below
bulk density ≥ 1.0, < 1.5 g/cm^3			2.15
bulk density ≥ 1.5, < 2.0 g/cm^3			2.77
bulk density ≥ 2.0, < 3.0 g/cm^3			3.38
bulk density ≥ 3.0, < 4.0 g/cm^3			4.75
bulk density ≥ 4.0, < 5.0 g/cm^3			6.02
bulk density ≥ 5.0, ≤ 6.54 g/cm^3			7.57

ES-3100 CV Loading

Palletized ES-3100’s