National Security Complex

Managed and Operated by
Consolidated Nuclear Security, LLC

NCSP 2021 Virtual TPR

Y-12 NSC Status of Metallic Fuel Projects & Capabilities

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Global Security & Strategic Partnerships

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Y-12 History of Transformation

- Construction began in 1943 as part of Manhattan Project
- During the Cold War, some 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 Focus. Customer Alignment. Global Impact.

With decades of hands-on experience and expertise, the Y-12 National Security Complex has global leaders in:

- Nuclear Nonproliferation
- Advanced Manufacturing
- Global Security
- Nuclear Material Initiatives
- Material Innovation

Valued Partners

NNSA	DOE	U.S. Federal Agencies	Non-Federal Entities
• Defense Programs • Defense Nuclear Nonproliferation • Counterterrorism & Counterproliferation • Naval Reactors	• Office of Intelligence/ Counterintelligence • Office of Science • Other National Laboratories and Sites	• Department of Homeland Security • Department of Defense • Department of Justice • Office of Personnel Management • National Aeronautics and Space Administration • Intelligence Community	• Mutual Defense • Foreign Government Research Reactors • Academic Institutions • Commercial Companies

Mission

- Providing the nuclear deterrent
- Fueling the Nuclear Navy
- Reducing the global nuclear threat

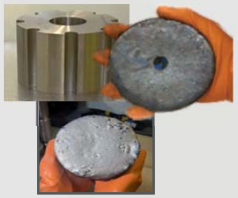
Protecting Materials and Capabilities

Pantex and Y-12 are fortresses for staging and storing weapons components, weapons materials, and production processes:

- Highly Enriched Uranium Materials Facility
  - Central repository for highly enriched uranium (HEU).
  - Provides maximum security for HEU
- Uranium Processing Facility
  - Built to ensure long-term viability, safety, and security of enriched uranium capabilities
  - Multi-building, $6.5B complex to be complete by the end of 2025

Overview of Capabilities

Nuclear Weapon Component Manufacturing, Assembly, Disassembly, Testing and Surveillance



SPECIAL MATERIAL

Cradle-to-grave enriched uranium weaponization processes

EU machining, fabrication, processing, recycle, & salvage

Specialty nuclear fuel fabrication

Packaging

Reactor and fuel supply

Lithium processing

Lithium component manufacturing

Lithium R&D

Distribution of Certified Reference Materials

ENERGETIC MATERIAL

Cradle-to-grave capabilities

Synthesis

Formulation

Pressing

Machining

Extrusion

Custom components

Chemical & mechanical testing

Test-fire and disposition

Blast effects engineering & analysis

Forensics

Characterization

SECURITY & RESPONSE

International Nuclear Security

Nuclear smuggling detection & deterrence

Vlunerability assessment

Radiological/nuclear detection & response training

Secure storage/transportation

Remove and secure missions

Counter-Terrorism Response & Training

Radiological control / response

MATERIALS CHARACTERIZATION

Analytical chemistry

Material evaluation

Nuclear forensics

National Material Information Center

Destructive and Non-Destructive Testing, evaluation, and surveillance

Nuclear Materials Information Program

DETECTION & ANALYSIS

Dedicated measurement sites

HEU components and assemblies

Monitored Dismantlement

Technology Testing

EU-HEU metallic enrichment standards

Specialized Test & Evaluation Equipment

Nuclear forensics

Treaty verification

MANUFACTURING & PROTOTYPING

Classified, precision machining and metal metrology

Additive in polymer, metals, & special materials

Large-scale

Advanced prototyping

Thermo-mechanical processing

Welding and joining

Design for manufacture

Machine design

Specialized tooling, enclosures & molds

Manufacturing Supply

Chain Cybersecurity

OTHER WEAPON CAPABILITIES

Nuclear production hands-on expertise

Inert trainer design, development, manufacturing & refurbishment

Intrinsic radiation units

Component availability

High consequence test equipment

High consequence facilities

Specialized handling equipment design & manufacture

Special Manufacturing, Nuclear Nonproliferation, Global Security, Intelligence Analysis and Training

Uranium Center of Excellence

- Purified HEU metal production
- Uranium machining, fabrication, processing, recycle, and salvage operations
- HEU storage and inventory management
- EU supply and fuel component development

Providing the Nuclear Deterrent for Our Nation and Allies

Life Extension Programs

- Build canned subassemblies for Life Extension Programs
- Help ensure an effective nuclear deterrent by extending weapon life
- Maintain specialized skills to support inspection, retrofit, and surveillance of our stockpile

Fueling the Nuclear Navy that Stays on Watch

- Supply nuclear payloads for weapons on ballistic missile submarines
- Provide highly enriched uranium to power submarines and aircraft carriers

Reducing the Total Nuclear Warheads in the Stockpile

Dismantlement

- Dismantle retired weapons and disposition the various components and materials
- Reduce the number of nuclear weapons in the world
- Ensure the nuclear material is in safe and secure storage

Reducing the Global Nuclear Threat

- Provide special materials expertise to government agencies
- Develop technologies to detect uranium and weapons
- Conduct research to enhance understanding of material signatures
- Repatriate highly enriched uranium (HEU)
- Supply high assay low enriched uranium (HALEU)

Recovering Material Across the Globe

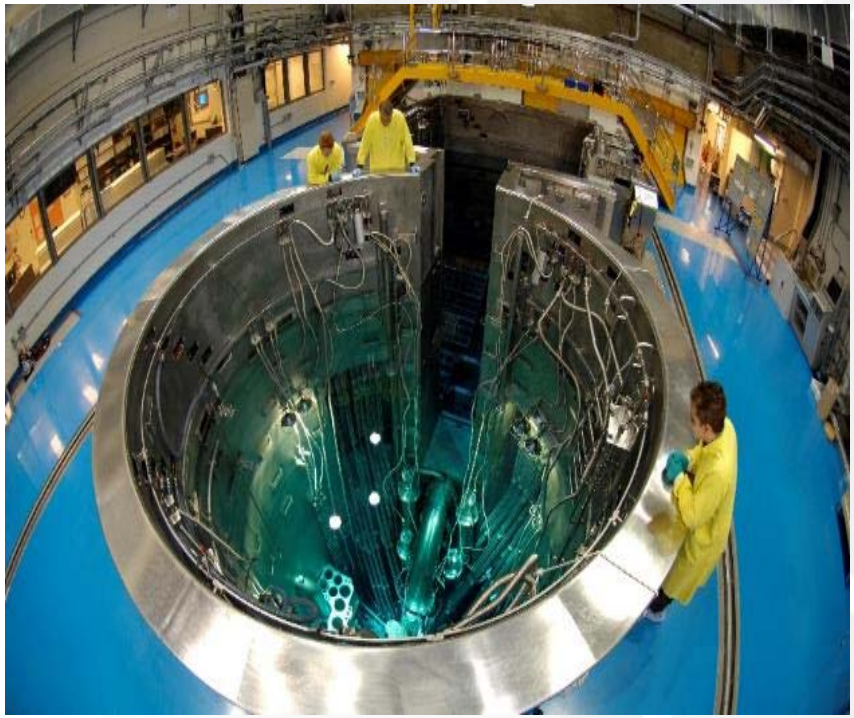
Foreign Research Reactor (FRR) Supply

- Y-12 supplies over 80% of the research reactors around the world (excluding Russia and China designed reactors)
- Approximately 85% of nuclear medical procedures performed worldwide originate with uranium supplied by Y-12
- Provide LEU (19.75% ^{235}U) and small quantities of HEU (93.15% ^{235}U) to fuel research reactors and produce isotopes for medical and/or industrial use
- Supports nonproliferation objectives of NNSA's Office of Material Management & Minimization - NA-23 (HEU Convert, Remove, and Dispose)

RA-6 Reactor, Bariloche, Argentina

CEA OSIRIS Reactor, France

Supply - Start to Finish

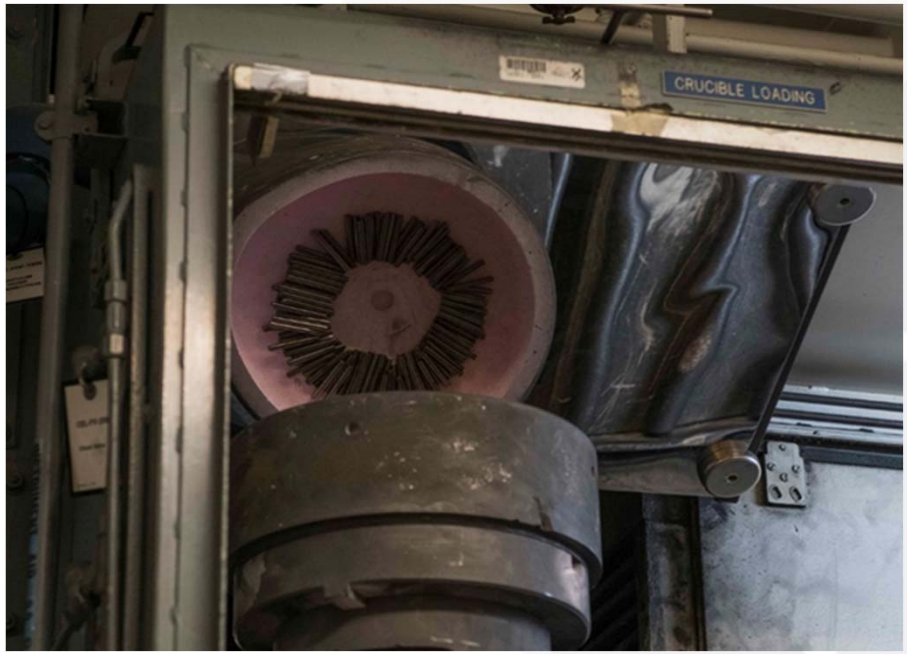


Supply - Arrival & Offload

Footprint of Foreign Research Reactor Supply

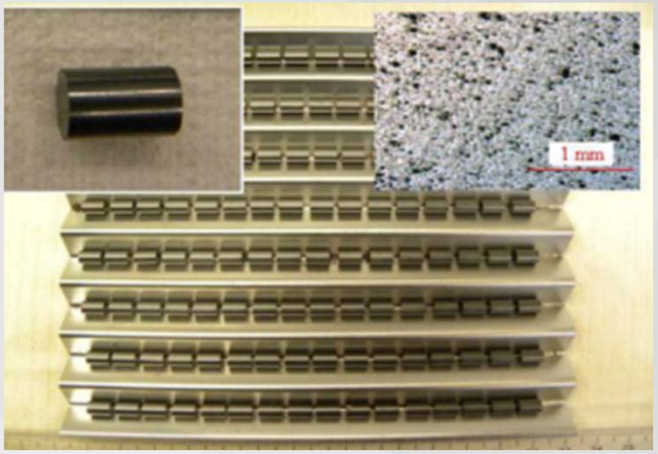
U(10)Mo Conversion of the USHPRRs

Batch Make Up

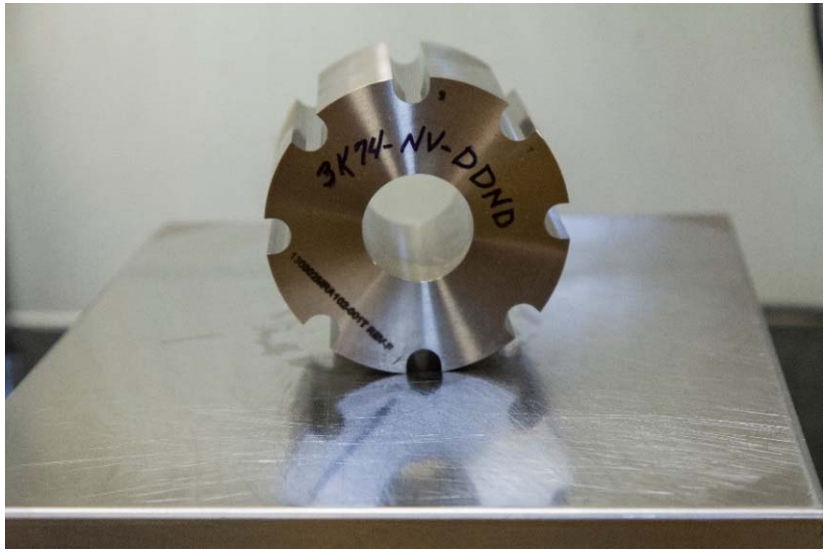


High Assay Low Enrich Uranium (HALEU)

- Currently supply HALEU (235U% >5%<20%), HEU, DU
- Relocating, upgrading, and optimizing HALEU production
- Recent and current fuel projects



HEU-Mo Machining



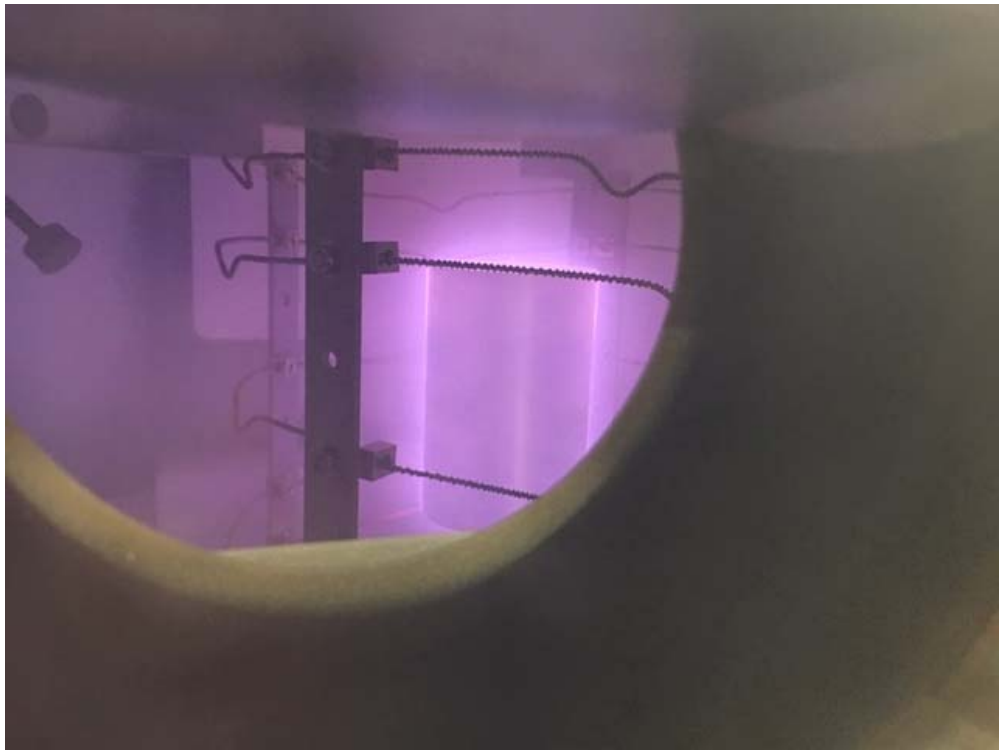
Notable Partnerships: KRUSTY Core & WSMR

- KRUSTY, or Kilopower Reactor Using Stirling Technology, is a kilopower reactor using Stirling technology
- KRUSTY shown being tested by LANL/NASA to support deep space travel
- Y-12 experts manufactured and delivered the uranium reactor core in 2017

- WSMR Upgraded Fuel

New Technologies Being Deployed

Physical Vapor Deposition (PVD)



Part with Plasma

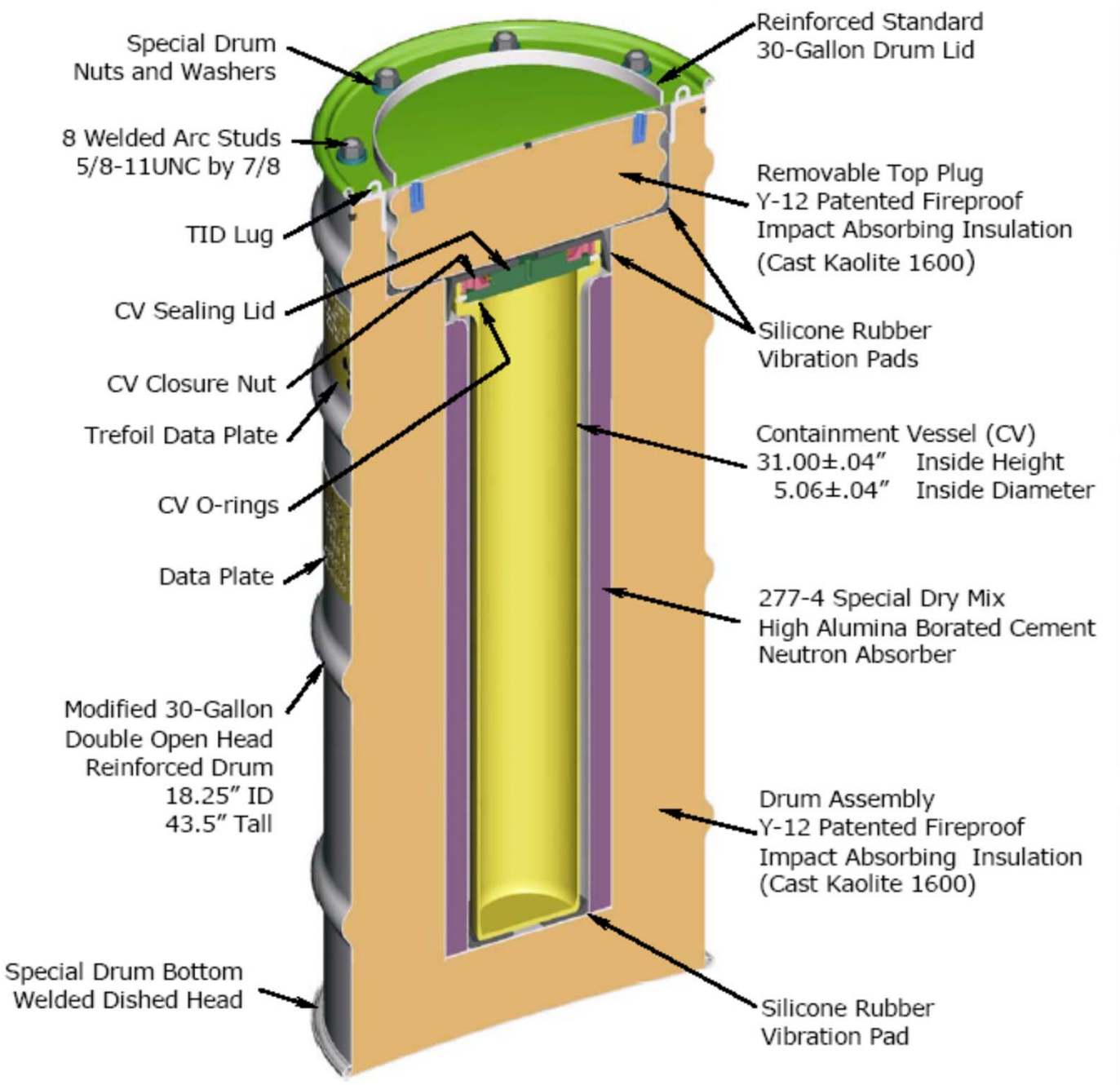
Coated Part

Additional Technologies Being Pursued for HALEU Applications and HALEU/HEU Pursuits

- Bulk Oxide Production
- Atomized Powder
- U rope
- Advanced Manufacturing
- HALEU Fabrication Line
- Multiple plate type fuel requests (Unv. RRx, NASA/DOD Rx Concepts, etc.)
- HALEU Feed Support
- Support for aspects of advanced fuel fabrication

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