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 ft² of laboratory, machining dismantlement, research and development and office areas
- ~5,000 employees
- Average age: 49 / Average years of service: 13

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

**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
- Vulnerability 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

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

**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)
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)
### Table 1.3 – Authorized Content and Fissile Mass Loading Limits for Ground Transportation (cont)\(^a,\)\(^b,\)\(^c\)

<table>
<thead>
<tr>
<th>HEU metal or alloy turnings, fines, or powders (^8)</th>
<th>0.0</th>
<th>2.637</th>
</tr>
</thead>
<tbody>
<tr>
<td>&gt;80%, ≤ 90%</td>
<td>0.4</td>
<td>5.000</td>
</tr>
<tr>
<td></td>
<td>0.8</td>
<td>9.166</td>
</tr>
<tr>
<td></td>
<td>2.0</td>
<td>16.667</td>
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<tr>
<td></td>
<td>3.2</td>
<td>21.667</td>
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<tr>
<td>&gt;70%, ≤ 80%</td>
<td>0.0</td>
<td>2.967</td>
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<td></td>
<td>0.4</td>
<td>5.192</td>
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<td></td>
<td>0.8</td>
<td>8.900</td>
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<td>2.0</td>
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<td>3.2</td>
<td>19.284</td>
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<td>&gt;60%, ≤ 70%</td>
<td>0.0</td>
<td>3.249</td>
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<td>0.4</td>
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<td>21.444</td>
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<td></td>
<td>3.2</td>
<td>24.692</td>
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<tr>
<td>≤ 60%</td>
<td>0.0</td>
<td>5.576 kg U</td>
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<tr>
<td></td>
<td>0.4</td>
<td>14.872 kg U</td>
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<tr>
<td></td>
<td>0.8</td>
<td>28.814 kg U</td>
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<tr>
<td></td>
<td>2.0</td>
<td>35.20 kg U (^f)</td>
</tr>
<tr>
<td></td>
<td>3.2</td>
<td>35.20 kg U (^f)</td>
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</table>

Spacers not required
### Table 1.3 – Authorized Content and Fissile Mass Loading Limits for Ground Transportation (cont.)

<table>
<thead>
<tr>
<th>Content Description</th>
<th>Enrichment</th>
<th>CSI</th>
<th>No Spacers, $^{235}\text{U} (\text{kg})$</th>
<th>277-4 can Spacers, $^{235}\text{U} (\text{kg})$</th>
</tr>
</thead>
<tbody>
<tr>
<td>HEU oxide $^{h, i}$ (UO$_2$, UO$_3$, $U_3$O$_8$, $U_3$O$_8$-Al, UO$_2$-Mg, $^{l}$ UO$_2$-ZrO$_2$)</td>
<td>See below</td>
<td>0.0</td>
<td>15.13 kg oxide</td>
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</tr>
<tr>
<td>bulk density 2.0 – 6.54 g/cm$^3$</td>
<td>0.0</td>
<td>9.682 kg $^{235}\text{U}$</td>
<td>12.323 kg $^{235}\text{U}$</td>
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<tr>
<td>bulk density ≥1.75, &lt;2.0 g/cm$^3$</td>
<td>0.0</td>
<td>9.46 kg $^{235}\text{U}$</td>
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<tr>
<td>bulk density ≥1.5, &lt;1.75 g/cm$^3$</td>
<td>0.0</td>
<td>8.36 kg $^{235}\text{U}$</td>
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<tr>
<td>bulk density ≥1.25, &lt;1.5 g/cm$^3$</td>
<td>0.0</td>
<td>7.04 kg $^{235}\text{U}$</td>
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<tr>
<td>bulk density ≥1.0, &lt;1.25 g/cm$^3$</td>
<td>0.0</td>
<td>5.94 kg $^{235}\text{U}$</td>
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<td>bulk density ≥0.75, &lt;1.0 g/cm$^3$</td>
<td>0.0</td>
<td>4.84 kg $^{235}\text{U}$</td>
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<td>bulk density ≥0.5, &lt;0.75 g/cm$^3$</td>
<td>0.0</td>
<td>3.52 kg $^{235}\text{U}$</td>
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Spacers not required
### Table 1.3b - Loading Limits for Air Transport

<table>
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<th>Content description</th>
<th>Enrichment</th>
<th>CSI</th>
<th>$^{235}\text{U (kg)}$</th>
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</thead>
<tbody>
<tr>
<td>HEU metal or alloy</td>
<td>≤ 100%</td>
<td>—</td>
<td>7.00</td>
</tr>
<tr>
<td>HEU metal or alloy turnings, fines, or powder</td>
<td>≤ 100%</td>
<td>—</td>
<td>7.00</td>
</tr>
<tr>
<td>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)</td>
<td>≤ 20%</td>
<td>—</td>
<td>0.921</td>
</tr>
<tr>
<td></td>
<td>&gt; 20%</td>
<td>—</td>
<td>0.408</td>
</tr>
<tr>
<td>HEU oxide (UO_2, UO_3, U_3O_8, U_3O_8-Al, UO_2-Mg, j UO_2-ZrO_2):</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>bulk density ≥ 1.0, &lt; 1.5 g/cm³</td>
<td>≤ 100%</td>
<td>0.0</td>
<td>2.15</td>
</tr>
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<td>bulk density ≥ 1.5, &lt; 2.0 g/cm³</td>
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<td>bulk density ≥ 2.0, &lt; 3.0 g/cm³</td>
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<td>3.38</td>
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<td>bulk density ≥ 3.0, &lt; 4.0 g/cm³</td>
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<td>4.75</td>
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<tr>
<td>bulk density ≥ 4.0, &lt; 5.0 g/cm³</td>
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<td></td>
<td>6.02</td>
</tr>
<tr>
<td>bulk density ≥ 5.0, ≤ 6.54 g/cm³</td>
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<td>7.57</td>
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</tbody>
</table>

*(a, b, c) Refer to specific notes and conditions.*
*(d) CSI values not applicable.*
*(f, g, h, i, j) Additional specific conditions apply.*
ES-3100 CV Loading
Palletized ES-3100’s
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