Progress Towards Eliminating Use of Highly Enriched Uranium in Medical Isotope Production and Research and Test Reactor Fuel and Repatriation of Excess HEU

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GTRI’s mission is to reduce and protect vulnerable **nuclear** and **radiological** materials at civilian sites around the world that could be used by terrorists to make an improvised nuclear device or radiological dispersal device.

- All GTRI efforts are **First-Line of Defense** (at site location)

- GTRI implements **permanent threat reduction** through HEU minimization
  - Convert HEU research reactors and HEU isotope production facilities to LEU (eliminate need for HEU)
  - Remove HEU (eliminate HEU as terrorist target)

- While GTRI has significantly accelerated threat reduction efforts since its creation in 2004, additional intensified efforts are needed to meet President Obama’s 4-year goal by the end of 2013.
GTRI Mission & Program Goals

**MISSION**

Reduce and protect vulnerable nuclear and radiological material located at civilian sites worldwide.

**GOALS**

1. **Convert**
   - Convert research reactors and isotope production facilities from the use of highly enriched uranium (HEU) to low enriched uranium (LEU).
   - These efforts result in permanent threat reduction by minimizing and, to the extent possible, eliminating the need for HEU in civilian applications – each reactor converted or shut down eliminates a source of bomb material.

2. **Remove**
   - Remove and dispose of excess nuclear and radiological materials.
   - These efforts result in permanent threat reduction by eliminating bomb material at civilian sites – each kilogram or cure of this dangerous material that is removed reduces the risk of a terrorist bomb.

3. **Protect**
   - Protect high priority nuclear and radiological materials from theft and sabotage.
   - These efforts result in threat reduction by improving security on the bomb material remaining at civilian sites – each vulnerable building that is protected reduces the risk until a permanent threat reduction solution can be implemented.
Global Effort
Goal: Remove 5,350 kg of nuclear material by 2019; enough for more than 200 nuclear bombs

- Russian-origin highly enriched uranium (HEU) fresh and spent fuel from research reactors
- U.S.-origin fresh and spent nuclear fuel from research reactors
- Additional nuclear materials not covered by other GTRI removal efforts

Status: 3,641 kg have been removed (68% complete)

- These efforts result in permanent threat reduction because each kilogram of this dangerous material that is secured and disposed of removes it from possible diversion for malevolent purposes.

- All HEU material has been removed from 23 countries:
  - Austria, Brazil, Bulgaria, Chile, Colombia, Czech Republic, Denmark, Greece, Latvia, Libya, Mexico, Philippines, Portugal, Romania, Serbia, Slovenia, South Korea, Spain, Sweden, Taiwan, Thailand, Turkey, and Ukraine.
GTRI’s Conversion Objective: Work domestically and internationally to convert or verify the shut down of ~200 HEU-fueled research reactors and isotope production facilities by 2030

GTRI’s Convert Program is organized into three elements:

1. Reactor Conversion
   • Converting HEU-fueled research reactors worldwide to the use of LEU fuel

2. Isotope Production Conversion (Mo-99)
   • Converting HEU-based isotope production facilities to the use of LEU targets
   • Accelerating commercial production of non-HEU-based Mo-99 in the United States

3. Fuel Development
   • Developing a new high-density LEU fuel to convert the U.S. high-performance research reactors that cannot convert on existing fuels
   • Providing technical support to European and Russian partners in their development of new high-density LEU fuels for the conversion of their high-performance research reactors
Recent Accomplishments in Reactor Conversion

**Status:** 88 HEU research reactors and isotope production facilities have successfully been converted from the use of HEU to LEU or verified to be shutdown prior to conversion. (44% complete)

- **Recent Accomplishments:**

  - Poland’s Maria Reactor inserted first LEU fuel assemblies (Autumn 2012)
  
  - Conversion of Kazakhstan Institute of Nuclear Physics’ VVR-K Critical Assembly (Autumn 2012)
  
  - U.S.-Russia Joint Statement on Research Reactor Conversion (Summer 2012)
  
  - Multiple high-level joint statements issued Nuclear Security Summit to focus on research reactor and isotope production fabrication facility conversions (Spring 2012)
  
  - Confirmed Indonesia no longer uses HEU to produce medical isotopes (Autumn 2012)
U.S. Domestic Reactor Conversion

**Target:** 28 U.S. reactors  
**Status:** 20 addressed (71% completed)

- The 20 U.S. HEU-fueled research reactors that could convert with existing and qualified LEU fuels have all been successfully converted to the use of LEU fuel

- Over the past ten years, the U.S. has converted seven domestic research reactors from HEU to LEU; **one-time removals resulted in 80 kg HEU eliminated (~3 nuclear weapons worth of material)**

- GTRI has confirmed the shutdown of two HEU-fueled research reactors; **one-time removals resulted in 3,007 kg HEU eliminated (~120 nuclear weapons worth of material)**

- Six U.S. High Performance Research Reactors (USHPRRs) remain in scope:
  - ATR
  - ATR-Critical Assembly
  - HFIR
  - MITR
  - MURR
  - NBSR

- Two additional domestic reactors remain in scope: GE-NTR & TREAT
**June 2012 Poneman – Kiriyenko Joint Statement on Reactor Conversion**

“The Russian side informed the U.S. side that according to existing plans the conversion of one or two research reactors is expected to be carried out, as feasible, in 2014.....the U.S. side will continue to make efforts to convert its remaining research reactors as promptly as possible.”

**September 2012 Chu – Kiriyenko Joint Statement at the IAEA GC**

Highlights June 2012 Joint Statement “in which Russia indicated its intent to convert up to two research reactors from HEU to LEU by 2014 and the United States committed to continue working to convert its HEU reactors to LEU fuel.”

- **Russia and the U.S. are working on multiple fronts to continue advancing our cooperative efforts:**
  - Kurchatov Institute approved a contract for all activities to convert the first Russian research reactor – ARGUS – to LEU fuel (September 2012). **Argus conversion is planned for 2014.**
  - In the fall of 2012, Russia announced its own program to convert Russian research reactors and has begun a feasibility study for the conversion of the WWR-TS reactor at Karpov Institute.
  - Continued U.S. technical and political support for these efforts will be critical.
  - Multiple fuel development efforts are ongoing – LTA irradiation and qualification of the IRT-3M fuel is the next major step in this work.
  - **The June 2011 NAS-RAS Symposium played a very positive role in helping advance this cooperation. Since that time, and especially since the 2012 Security Summit, Russia has taken unprecedented initiative to work toward conversion of its domestic HEU reactors.**
Three HEU reactors remain in Kazakhstan

- Work is underway to convert the VVR-K reactor at the Institute of Nuclear Physics
- Initial studies to assess the feasibility of converting the EWG and IGR reactors at the Institute for Atomic Energy showed positive results; additional work is ongoing

There are seven operational Chinese-origin Miniature Neutron Source Reactors (MNSRs); two within China and five in other countries (Ghana, Iran, Nigeria, Pakistan, and Syria)

- All participants are cooperating through the IAEA to convert the MNSRs to LEU fuel
- In January 2012, China approved a contract to build the Zero Power Test Facility (ZPTF) and agreed to convert the first MNSR in China to LEU (by summer 2015); the ZPTF project is currently underway.

There are three operational HEU Slowpoke reactors, two in Canada and one in Jamaica

- GTRI is working with Jamaica to convert their Slowpoke to LEU by summer 2015
- Agreement is still needed regarding the conversion of the two operational Slowpokes in Canada
### Global Mo-99 Market – Major Producers

<table>
<thead>
<tr>
<th>HEU</th>
<th>Non-HEU</th>
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<tbody>
<tr>
<td>ANSTO (Australia)</td>
<td>NTP Radioisotopes (South Africa)</td>
</tr>
<tr>
<td>Mallinckrodt (Netherlands)</td>
<td>IRE (Belgium)</td>
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<tr>
<td>AECL-Nordion (Canada)</td>
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### U.S. Domestic Mo-99 Projects

1. 2. 3. 4.
Under its long-standing HEU minimization mission, GTRI provides assistance to research reactors and isotope production facilities to convert from the use of HEU to LEU.

GTRI’s mission includes accelerating the establishment of a reliable U.S. domestic supply of Mo-99 produced without the use of HEU.
GTRI & International Mo-99
Assisting Conversion from HEU Targets to LEU Targets

• Four-party joint statement at the 2012 Nuclear Security Summit on the minimization of HEU and the reliable supply of medical radioisotopes
  “...Belgium, the Netherlands, and France, in cooperation with the United States, reaffirm their determination to support conversion of European production industries to non-HEU-based processes by 2015.....”

• GTRI offers support to international Mo-99 producers to convert Mo-99 production from HEU targets to LEU targets
  South Africa
  GTRI has provided NTP Radioisotopes in South Africa up to $25M in support to convert Mo-99 production from HEU targets to LEU targets by the end of 2015, and to address the HEU in Mo-99 waste residue.

  In June 2010 South Africa successfully achieved the first large-scale production of Mo-99 using LEU targets, and the first shipment of FDA-approved Mo-99 produced with LEU targets was received in the United States in December 2010.

  Belgium
  GTRI has contributed $4.8M towards the conversion of the IRE isotope production facility in Belgium from HEU targets to LEU targets for completion by the end of 2015.

  The Netherlands
  Covidien is leading the conversion project to LEU targets by the end of 2015.

  Canada
  The NRU reactor in Canada is expected to cease isotope production in 2016.
Objective: To accelerate existing commercial projects to meet at least 100% of the U.S. demand of Mo-99 produced without HEU.

NorthStar Medical Radioisotopes, LLC
• NNSA has awarded a total of $25 million to NorthStar Medical Radioisotopes to pursue accelerator technology.

Morgridge Institute for Research/SHINE Medical Technologies
• NNSA has awarded a total of $10.7 million to Morgridge Institute for Research to pursue accelerator with LEU fission technology in cooperation with SHINE Medical Technologies.

Babcock and Wilcox (B&W):
• NNSA has awarded $9.1 million to B&W to pursue LEU solution reactor technology.

General Electric-Hitachi (GEH):
• NNSA awarded $2.3 million to General Electric-Hitachi to pursue neutron capture technology. On February 7, 2012, GEH announced its business decision to suspend progress on the project indefinitely due to market conditions.

Each cooperative agreement is currently limited to $25M, under a 50% - 50% cost-share arrangement.
U.S. Government Public Statement
Encouraging Reliable Supplies of Molydenum-99 Produced without Highly Enriched Uranium

Issued by the White House Press Secretary on June 7, 2012

• Calling upon the Mo-99 industry to voluntarily establish a unique product code or similar identifying markers for Mo-99-based radiopharmaceutical products that are produced without the use of HEU;

• Preferentially procuring, through certain U.S. government entities, Mo-99-based products produced without the use of HEU, whenever they are available, and in a manner consistent with U.S. obligations under international trade agreements;

• Examining potential health-insurance payment options that might promote a sustainable non-HEU supply of Mo-99;

• Taking steps to further reduce exports of HEU that will be used for medical isotope production when sufficient supplies of non-HEU-produced Mo-99 are available to the global marketplace;

• Continuing to encourage domestic commercial entities in their efforts to produce Mo-99 without HEU during the transition of the Mo-99 industry to full-cost-recovery, and directing those resources to the projects with the greatest demonstrated progress; and

• Continuing to provide support to international producers to assist in the conversion of Mo-99 production facilities from HEU to LEU.
The American Medical Isotopes Production Act of 2012


- Intended to help establish a reliable domestic supply of Mo-99 produced without the use of HEU and includes a number of short, medium, and long-term actions.

  - Requires the Secretary of Energy to establish a technology-neutral program to provide assistance to commercial entities to accelerate production of Mo-99 in the United States without the use of HEU

  - Requires public participation and review of the program

  - Requires development assistance for fuels, targets, and processes

  - Establishes a Uranium Lease and Take Back program

  - Requires DOE and NRC to coordinate environmental reviews where practicable

  - Provides a cutoff in exports of HEU for isotope production in 7 years, with possibility for extension in the event of a supply shortage

  - Requires a number of reports to be submitted to Congress, including a National Academies of Sciences report.