U.S. DEPARTMENT OF ENERGY

National Nuclear Security Administration

DOE Support for Mo-99 Production in the United States

2015 Mo-99 Topical meeting
Boston

MATERIAL MANAGEMENT AND MINIMIZATION
CONVERT, REMOVE, DISPOSE

U.S. DEPARTMENT OF ENERGY

National Nuclear Security Administration

Material Management and Minimization

Achieving Permanent Threat Reduction by Managing and Minimizing Nuclear Materials

Convert

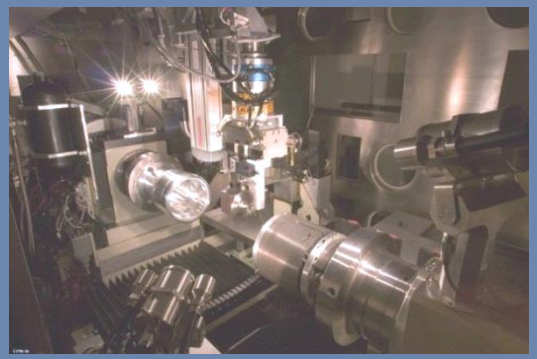
Convert research reactors and isotope production facilities to non-weapons-usable nuclear material both domestically and abroad

- **Research Reactor Conversion**
- **Mo-99 Program**

Remove

Remove or confirm the disposition of excess weapons-useable nuclear material at civilian facilities across the globe and consolidate those materials that remain

- **International Nuclear Material Removal and Consolidation**
- **International Nuclear Material Down-blending**



Dispose

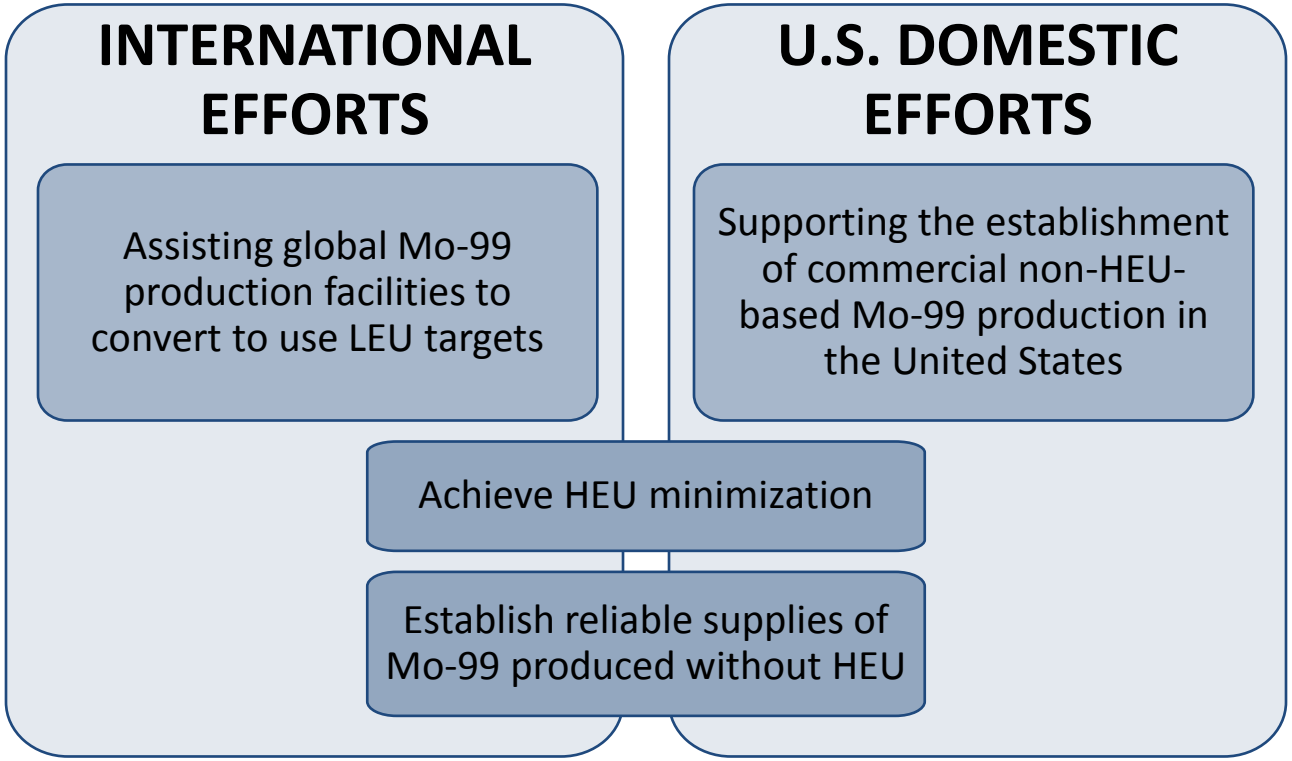
Dispose of and manage excess weapons-useable nuclear material, from both domestic stockpiles and material returned from abroad, and implement the Plutonium Management Disposition Agreement (PMDA) with Russia

- **HEU and Plutonium Disposition**
- **Uranium Supply for Peaceful Uses**

International and Domestic Approaches

Objective: To accelerate the establishment of reliable supplies of the medical isotope molybdenum-99 (Mo-99) produced without highly enriched uranium (HEU)

- Under its HEU minimization mission, NNSA provides assistance to existing isotope production facilities to convert from HEU to LEU targets.
- NNSA's mission includes supporting the establishment of a reliable U.S. domestic supply of Mo-99 produced without the use of HEU.



The American Medical Isotopes Production Act

- AMIPA, enacted on January 2, 2013, is 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 DOE to carry out a technology-neutral program to support projects for the production of Mo-99 in the United States without the use of HEU.**
    - awarded under a 50% - 50% cost-share cooperative agreement, per the Energy Policy Act; and
    - limited to $25M in NNSA contributions per project, consistent with the OECD-NEA policy guidelines.
  - Requires annual public participation and NSAC reviews
  - Requires development assistance for fuels, targets, and manufacturing 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

NNSA Cooperative Agreements

RadioGenix™ – NorthStar ^{99m}Tc Generating System

NorthStar Medical Radioisotopes has two Cooperative Agreements for two different technical approaches to producing Mo-99. Both would use NorthStar's RadioGenix generator system.

Neutron Capture Technology:

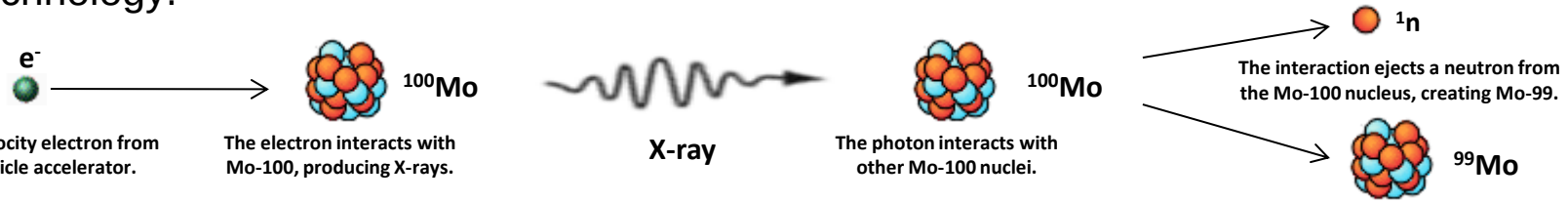
NNSA has awarded a total of $16.1 million to NorthStar to develop its neutron capture technology.

The neutron is captured by the Mo-98 nucleus.

The atomic weight of Mo-98 increases by one and becomes Mo-99.

Accelerator Technology:

NNSA has awarded a total of $5.7 million to NorthStar to develop its accelerator-based technology.



High velocity electron from a particle accelerator.

The electron interacts with Mo-100, producing X-rays.

The photon interacts with other Mo-100 nuclei.

The interaction ejects a neutron from the Mo-100 nucleus, creating Mo-99.

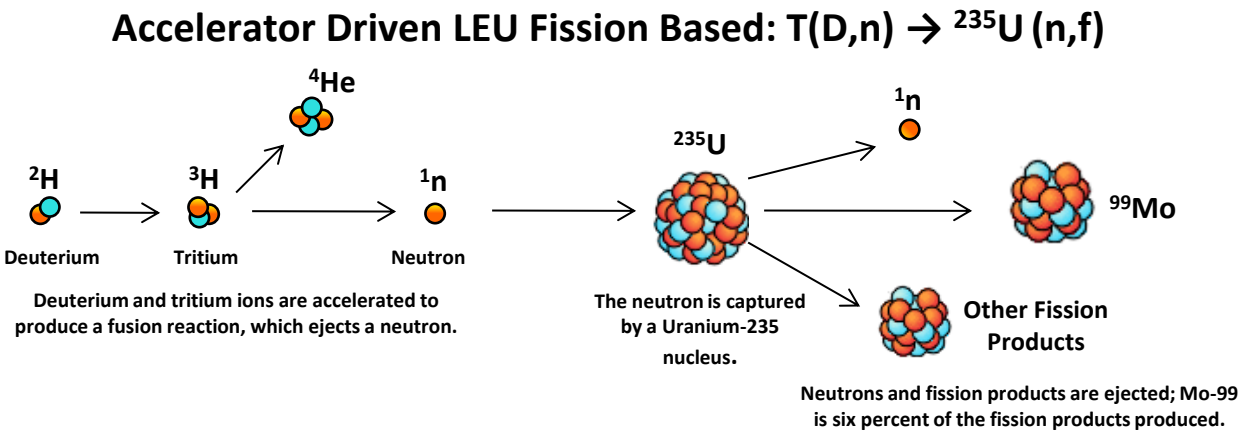
NNSA Cooperative Agreements

SHINE Medical Technologies has one cooperative agreement for its fission-based Mo-99 production technology. The Mo-99 to be produced by SHINE would be able to be used in existing generators.

Accelerator with LEU Fission:

NNSA has awarded a total of $14 million to Morgridge Institute for Research ($10.7M) and SHINE Medical Technologies ($3.3M), to develop its accelerator with LEU fission technology.

SHINE Medical Technologies Accelerator-Driven LEU Subcritical Assembly for Medical Isotope Production

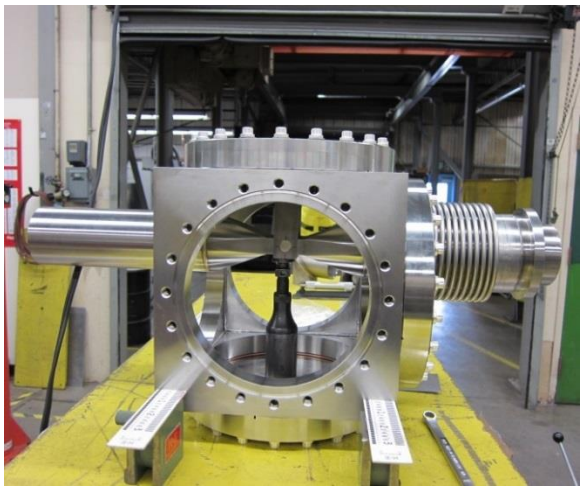


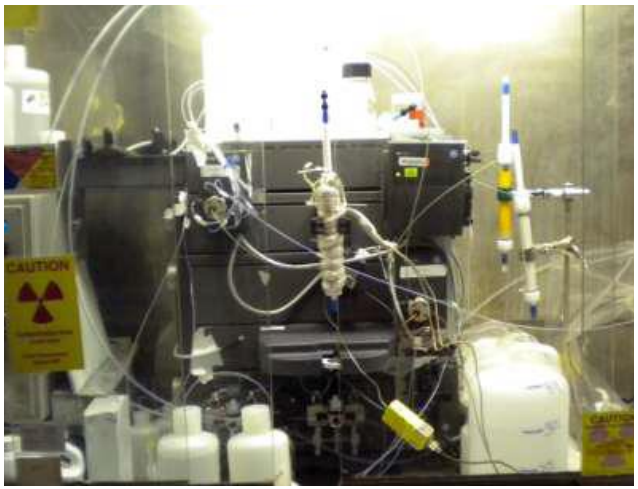
U.S. National Laboratories Support

NNSA makes the expertise of the U.S. National Laboratories available to:

- Support technical development of each of the Mo-99 technical pathways
- Ensure the expertise at the national laboratories is available to support the acceleration of commercial projects using non-HEU technologies

All work packages funded by NNSA outside the cooperative agreement are public domain, non-proprietary, non-critical-path activities.





U.S. National Laboratories Support

	A	B	C	D	E	F
21	21.2.94.1.4	ANL/CSE-14/31	Superconducting Electron Linac Concepts for Molybdenum-99 Production	P.N. Ostroumov, Z.A. Conway, and M.P. Kelly	1-Oct-2014	http://www.osti.gov/scitech/servlets/purl/1165452
22	21.2.94.1.6	ANL/CSE-14/32	Scalability of the Cintichem Process Modified for Low Enriched Uranium	Peter Tkac, David A. Rotsch, Kevin Quigley, and George F. Vandegrift	1-Oct-2014	http://www.osti.gov/scitech/servlets/purl/1165454
23	21.2.94.1.6	ANL/CSE-14/33	Progress Report on Peroxide Formation, Destruction, and Precipitation in Uranyl Sulfate Solutions: Simple Addition and Radiolytically-Induced Formation	Amanda J. Youker, James Jerden, Michael Kalensky, Kevin Quigley, Charles Jonah, Sergey Chemerisov, and George F. Vandegift	14-Oct-2014	http://www.osti.gov/scitech/servlets/purl/1165455
24	21.2.94.1.6	ANL/CSE-14/35	Progress Report on Peroxide Formation, Destruction, and Precipitation in Uranyl Sulfate Solutions: Simple Addition and Radiolytically-Induced Formation	Amanda J. Youker, James Jerden, Michael Kalensky, Kevin Quigley, Charles Jonah, Sergey Chemerisov, and George F. Vandegift	14-Oct	http://www.ipd.anl.gov/anlpubs/2014/12/110941.pdf
25	21.2.94.1.4	LA-UR-14-28019	Target Quick Release Design Report	Woloshun, Keith Albert; Naranjo, Angela Carol; Romero, Frank Patrick	14-Oct-2014	http://permalink.lanl.gov/object/tr?what=info:lanl-repo/lareport/LA-UR-14-28019
26	21.2.94.1.4	LA-UR-14-28325	Production Facility Beam Line Design Report	Bishofberger, Kip A.	24-Oct-2014	http://permalink.lanl.gov/object/tr?what=info:lanl-repo/lareport/LA-UR-14-28325
27	21.2.94.1.6	ANL/CSE-14/34	Formulation and Analysis of Compliant Grouted Waste Forms for SHINE Waste Streams	William Ebert, Candido Pereira, Thad Heltemes, Amanda Youker, Vakho Makarashvili, and George F. Vandegrift	Nov-14	http://www.osti.gov/scitech/servlets/purl/1177198
28	21.2.94.1.4	LA-UR-14-29061	Local target shielding	Mocko, Michael	23-Nov-2014	http://permalink.lanl.gov/object/tr?what=info:lanl-repo/lareport/LA-UR-14-29061
29	21.2.94.1.4	LA-UR-14-29062	Radiation hardness testing for cameras utilized in Mo-99 production facility	Mocko, Michal	11/23/2014	http://permalink.lanl.gov/object/tr?what=info:lanl-repo/lareport/LA-UR-14-29062
30	21.2.94.1.4	LA-UR-14-29068	Target Removal and Conveyance System Design Report	Woloshun, Keith Albert; Dale, Gregory E.; Naranjo, Angela Carol and Hurtle, Kenneth P.	24-Nov-2014	http://permalink.lanl.gov/object/tr?what=info:lanl-repo/lareport/LA-UR-14-29068
31	21.2.94.1.4	LA-UR-14-29067	Helium Loop Cooling Channel Hydraulic Characterization	Olivas, Eric Richard	24-Nov-2014	http://permalink.lanl.gov/object/tr?what=info:lanl-repo/lareport/LA-UR-14-29067
32	21.2.94.1.4	LA-UR-14-29070	Design and Thermal-Hydraulic Performance of a He-Cooled Target for the Production of Isotope 99mTc	Woloshun, Keith A.; Dale, Gregory E.; Olivas, Eric R.; Romero, Frank P.; Naranjo, Angela C.; Chemerisov, Sergey; Harvey, James	24-Nov-2014	http://permalink.lanl.gov/object/tr?what=info:lanl-repo/lareport/LA-UR-14-29070
33	21.2.94.1.6	ANL-NE-15/2	Micro-Bubble Experiments at the V	Z. J. Sun, K. Wardle, K. Quigley, R. Gromov, A. J. Youker,V. Makarashvili, J. Bailey, D. Stepinski, S. Chemerisov and G. F. Vandegrift	Dec-14	http://www.ipd.anl.gov/anlpubs/2015/05/113420.pdf

FY15 | FY14 | FY13 | FY12 | FY11 and earlier | Publications

Thanks
for your support and attention!