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Conversion of Research and Test Reactors: Status and Current Plans

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Program Mission Statement

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The Reactor Conversion program mission supports the minimization and, to the extent possible, elimination of the use of HEU in civil nuclear applications by working to convert research and test reactors and radioisotope production processes to the use of LEU fuel/LEU targets throughout the world.

Specific activities include:

- Providing assistance to research reactors for feasibility studies, conversion analyses, and licensing
- Assisting with the LEU conversion of research reactors
- Developing advanced, high-density LEU fuels
- Developing and demonstrating LEU-based ^{99}Mo production techniques
- Working with reactor operators and suppliers to ensure that new reactors are designed to use LEU fuels

Acceleration

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- **The GTRI Conversion Program has been provided increased funding and governmental support to meet its accelerated mission.**

  - 3 Russian origin reactors converted in past 15 months.
  - Expecting to maintain the rate of 6 or more reactor conversions per year, for the lifetime of the program.
  - The program has increased its ability to minimize the cost and impact of conversion to LEU fuel/targets for owners and operators.
    - Compensation for HEU removed from service
  - The program has been given the authority to lead U.S. domestic reactor conversions.
    - SPP commitment, 2 US conversions in September 2006.
    - Expect in the U.S. a total of 4 (+1) by 2009
    - Assumed responsibility from DOE-NE University Programs
    - USHPR WG
  - Evaluating how to include more HEU reactors into the program
    - Total of 207 HEU facilities, the current scope is 129 reactors in the program
    - Fuel Development and/or Alternate fuels.

Current Program Participants

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Assistant Deputy Administrator – Andrew Bieniawski
Director Office of North and South American Threat Reduction – Nicole Nelson-Jean
Reactor Conversions Program Manager – Parrish Staples
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Argonne NATIONAL LABORATORY

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Other facilities and organizations supported by the Program: BNL, BWXT, General Atomics, MIT, MURR, Oregon State University, ORNL, Purdue University, Washington State University, and Y-12.

Joint fuel development projects and collaborations: Argentina, Canada, France, IAEA, Korea, Republic of South Africa, and Russia (over 30 scientists in Russian Institutes, including VNIINM, NIKIET, NIIAR, IRM, NCCP, RRC-KI)

Conversion activities: Argentina, Bulgaria, Ghana, Hungary, Kazakhstan, Libya, Nigeria, Poland, Portugal, Republic of South Africa, Uzbekistan, and Vietnam.

Mo-99 technology development: Argentina, Chile, Indonesia, Romania, other countries through IAEA

Reactor Conversion Universe

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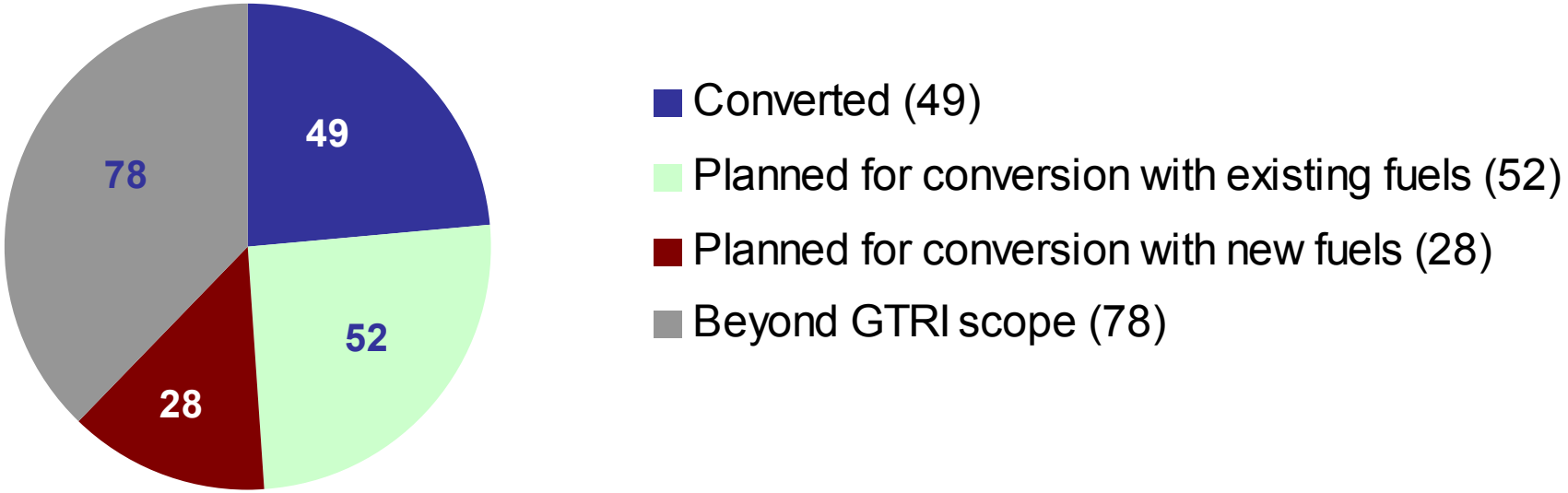
Scope of GTRI Reactor Conversion program is 129 of the 207 identified HEU reactors

REACTORS CONVERTED AS OF MARCH 2007



Conversion & Threat Reduction

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- **The Program's core mission is to minimize the use of HEU in civil applications.**
- **The Program funding is not used to support the cost of continued operations at the facility.**
- **Reactor facilities need to demonstrate that they have a long-term mission and they must be responsible for funding the day-to-day costs of operating the facility.**
- **Reactor conversions are coordinated with GTRI fuel disposition programs to promote HEU minimization.**
- **The program works either bilaterally or in coordination with the IAEA to facilitate reactor conversions.**

Approach

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The program has the overall objective of implementing reactor conversions to LEU fuel with the following goals:

1. Satisfy fuel assembly criteria for LEU conversion for each reactor,
- LEU fuel provides a similar service lifetime as the HEU fuel;
- There is no significant penalty in reactor performance;
- Safety criteria are satisfied.

2. Develop schedule based upon operational requirements, capabilities, regulatory processes,

3. Achieve LEU fuel conversions without requiring major changes in reactor structures or equipment,

4. Demonstrate the conversion and subsequent operation can be accomplished safely,

5. Determine, to the extent possible, that the overall costs associated with conversion to LEU fuel do not increase the annual operating expenditure for the owner/operator, and

6. Obtain/verify agreement and authorities are in place to proceed

Program Execution

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The program includes three main elements:

1. Conversion and Analysis

- Feasibility Studies & Operational and Safety Analyses
- Regulatory Assistance
- Reactor Analysis/Code Development
- Working with reactor operators to ensure that new reactors are designed to use LEU fuels
- Funding assistance for LEU fuel qualification and LEU fuel purchase

2. LEU Fuel Development

- Previous fuel development efforts enables the conversion of 52 additional reactors
- Very high-density U-Mo fuel will enable 19 additional reactors to convert
- Additional development or alternative fuels needed for remaining reactors

3. ^{99}Mo Target and Process Development

- Technical demonstration with LEU of all commercial processes
- Cooperation with commercial enterprises and developing producers

Current Conversion Projects

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Facility/ Country	Analysis Initiated	Analysis or regulatory review under way	Fuel Procurement under way
Purdue University, US		✔	✔
Washington State University	✔		✔
Oregon State University	✔		
RA-6, Argentina		✔	✔ (CNEA Fabrication)
DRR, Vietnam		✔	✔
BRR, Hungary		✔	
IRT-200, Bulgaria		✔	
WWR-SM, Uzbekistan	✔		✔
RPI, Portugal		✔	✔ (IAEA procurement)
SAFARI-1, RSA		✔	✔ (NECSA fabrication)

**See next for MARIA, WWR-K, MNSR and US HP reactors*

Current Conversion Projects

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Program provides flexibility to adapt to the specific needs of each project, within the bounds of the general Program principles.

- **Current conversion projects requiring qualification of fuel assembly (Lead Test Assembly – LTA - irradiation)**
  - MARIA, Poland
    - LEU LTA and fuel procurement is conducted through IAEA
    - LTA irradiation for ~18 months followed by regulatory approval for LEU fuel
    - Status: LTA and fuel procurement initiated; LTA safety analysis underway
  - WWR-K, Kazakhstan
    - LTA irradiation expected to take ~24 months
    - Status: Analysis for irradiation of LTA being completed: core configuration for fuel qualification
- **Multinational activities**
  - IAEA Coordinated Research Project for conversion of MNSR reactors – China, Syria, Iran, Pakistan, Ghana, Nigeria MNSRs participating
  - Analysis has been conducted for Ghana and Nigeria
- **Multi-facility projects**
  - A U.S. High Performance reactor group (ATR, HFIR, MITR, MURR, NBSR) has been formed:
    - Interact with high-density (U-Mo) fuel development activities
    - Coordinate and share experience and approach on LEU conversion feasibility and safety analysis

^{99}Mo LEU Technology Development

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- Technical Objective:
  - Development of LEU targets and chemical processing methods for the production of ^{99}Mo.
- Collaboration with BATAN (Indonesia) has been successful. Demonstrations have been conducted in FY2005 and FY2006. Conversion to LEU foil target expected in 2008.
- Cooperation with the CNEA (Argentina) has led to the successful implementation of a basic process applied to LEU targets developed by CNEA. Current focus is the demonstration of the LEU foil target process.
- Participation in IAEA Coordinated Research Project to demonstrate Mo-99 production processes based on LEU fission or neutron activation.
- Support of U.S. foil technology demonstration at MURR and support for National Academy of Sciences (NAS) study.

NAS ^{99}Mo study

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Background

- **Congressional Guidance in 2005 EPA, Section 630**
- **Through the GTRI-Reactor Conversions Program, ANL has over 20 years of experience in developing LEU based ^{99}Mo production techniques.**
- **HEU Minimization/Threat Reduction objectives of DOE/NNSA**

Important Points

- **Reliable and Secure Supply of ^{99}Mo**
- **Economically Viable**
- **Independent Study performed by the NAS**

- **Study findings will be presented to the Congress.**

- **During the course of the study, NNSA hopes to achieve a better understanding of the issues faced by the producers and users of ^{99}Mo.**

- **Result is expected to be a strategy to achieve a safe, secure, reliable, and economically viable supply of ^{99}Mo to the medical community that also supports the goal of minimizing the civilian use of HEU.**

- **May also identify strategies to be developed that will reduce overall civilian commerce of HEU material.**