Transactions

RRFM 2010

Marrakech, Morocco
21 -25 March 2010

organised in cooperation with:

IAEA
International Atomic Energy Agency
Atoms For Peace

European Nuclear Society
Rue Belliard 65
1040 Brussels, Belgium
Phone + 32 2 505 30 54
Fax +32 2 502 39 02
E-mail ens@euronuclear.org
Internet www.euronuclear.org

ISBN 978-92-95064-10-2

These transactions contain all contributions submitted by 19 March 2010.

Session I:

International Programmes

The NNSA Global Threat Reduction Initiative's Efforts to Minimize the Use of Highly Enriched Uranium for Medical Isotope Production

Parrish Staples
Director, Office of European and African Threat Reduction,
National Nuclear Security Administration,
United States Department of Energy

ABSTRACT: *The mission of the National Nuclear Security Administration's (NNSA) Office of Global Threat Reduction (GTRI) is to reduce and protect vulnerable nuclear and radiological materials located at civilian sites worldwide. GTRI is a key organization for supporting domestic and global efforts to minimize and, to the extent possible, eliminate the use of highly enriched uranium (HEU) in civilian nuclear applications.*

GTRI implements the following activities in order to achieve its threat reduction and HEU minimization objectives:

- *Converting domestic and international civilian research reactors and isotope production facilities from the use of HEU to low enriched uranium (LEU);*
- *Demonstrating the viability of medical isotope production technologies that do not use HEU;*
- *Removing or disposing excess nuclear and radiological materials from civilian sites worldwide; and*
- *Protecting high-priority nuclear and radiological materials worldwide from theft and sabotage.*

This paper provides a brief overview on the recent developments and priorities for GTRI program activities in 2010, with a particular focus on GTRI's efforts to demonstrate the viability of non-HEU based medical isotope production technologies.

1. Introduction

On April 5, 2009, U.S. President Barack Obama announced a new international effort to secure all vulnerable nuclear material around the world within four years.[1] Over the ensuing months, President Obama further outlined his comprehensive strategy for nuclear security to reduce the danger of nuclear terrorism, prevent the spread of nuclear weapons capabilities, and strengthen the nuclear nonproliferation regime. The U.S. National Nuclear Security Administration's Global Threat Reduction Initiative (GTRI) is a key organization for implementing this strategy due to its mission to reduce and protect vulnerable nuclear and radiological material located at civilian sites worldwide.

On September 24, 2009, President Obama chaired an historic meeting of the United Nations Security Council (UNSC), during which the UNSC unanimously cosponsored and adopted a resolution committing to work toward a world without nuclear weapons and endorsing a broad framework of actions to reduce the threat of nuclear terrorism. Specifically, UNSC Resolution 1887 "calls upon all States to manage responsibly and minimize to the greatest extent that is technically and economically feasible the use of highly enriched uranium for civilian purposes, including by working to convert research reactors and radioisotope production processes to the use of low enriched uranium fuels

[1] Remarks by President Barack Obama," White House website, http://www.whitehouse.gov/the_press_office/Remarks-By-President-Barack-Obama-In-Prague-As-Delivered April 5, 2009.

and targets."[2] GTRI is responsible for supporting these efforts to minimize and, to the extent, possible, eliminate the use of highly enriched uranium (HEU) in civilian nuclear applications.

GTRI has three elements – Convert, Protect, and Remove – that provide a comprehensive approach to achieving President Obama's objective to secure and protect all vulnerable nuclear material within four years. This paper discusses the status of these activities, with a particular focus on GTRI's efforts in reducing the use of HEU in medical isotope production.

2. GTRI Program Overview

Implementation of GTRI's Convert, Remove, and Protect subprograms are critical elements to achieving the objective to reduce and protect vulnerable nuclear and radiological material located at civilian sites worldwide. Following is the status of GTRI's Convert, Remove, and Protect activities.

2.1 Convert

GTRI's Convert Program, also known as the Reduced Enrichment for Research and Test Reactors (RERTR), supports the conversion of domestic and international civilian research reactors and isotope production facilities from HEU to LEU. These efforts result in permanent threat reduction by minimizing, or to the extent possible, eliminating the use of HEU in civilian applications. Each reactor converted or shutdown eliminates a source of bomb material. Once the need is eliminated, any remaining HEU fresh and spent fuel can be permanently disposed of by GTRI's Remove Program.

The goal of the Convert Program is to convert or verify shutdown prior to conversion of 200 HEU reactors by 2020. To date, GTRI has converted or verified the shutdown of 67 reactors. Since October 2004, acceleration of the program has resulted in 28 HEU research reactors being converted or shutdown prior to conversion, including 19 international and 9 domestic conversions. In 2009, GTRI completed the conversion of all U.S. research reactors that could convert using existing fuels two years ahead of schedule. GTRI is also collaborating with four international facilities that will convert or shutdown their research reactors to LEU fuel before October 2010.

The Convert Program is also developing and qualifying new high-density U-Mo LEU fuel to enable the conversion of high-performance research reactors. In conjunction with the fuel development effort, GTRI established the fuel fabrication capability (FFC) project to work with industry, the U.S. Nuclear Regulatory Commission (NRC), the U.S. national laboratories and other entities to accelerate efforts to create a sustainable commercial-scale capability to fabricate and supply new ultra-high density U-Mo LEU fuel.

---

[2] UN Security Council, Resolution 1887, S/RES/1887, September 24, 2009, www.un.org/Docs/sc/unsc_resolutions09.htm

GTRI recently down selected the fuel design to a monolithic Uranium-Molybdenum fuel foil with a thin Zirconium sheath serving as a diffusion barrier. Key fuel performance and safety basis experiments will be conducted in 2010. This new capability will allow the U.S. to meet its international commitment to HEU minimization, and it is hoped that this model will encourage other countries to meet their commitments to minimizing the use of HEU in civilian applications.

2.2 Remove

GTRI's Remove Program supports the removal and disposal of excess nuclear and radiological material from civilian sites. These efforts result in permanent threat reduction by eliminating nuclear and radiological materials that terrorists could potentially acquire. The materials include U.S.-origin, Russian-origin, and "gap" material that are not covered under U.S. or Russian programs. Excellent cooperation with partner countries has enabled the removal of 55% of targeted vulnerable material, or 2,531.6 kilograms of 4,603.9 kilograms, to date.

All HEU material has been removed from 17 countries, including: Brazil, Bulgaria, Colombia, Denmark, Greece, Latvia, Libya, Philippines, Portugal, Romania, Slovenia, South Korea, Spain, Sweden, Taiwan, Thailand, and Turkey. GTRI completed the clean-out of all HEU from Romania, Taiwan, and Libya in 2009, and Turkey in early 2010. Upcoming shipments in 2010 will remove all HEU from Serbia and Chile.

Removal of abandoned radiological materials in other countries include radioisotopic thermoelectiric generators (known as RTGs), with emphasis on recovery within Russia. GTRI has established the ambitious goal of removal or disposal of 860 Russian RTGs by 2013. The close cooperation with Russian partners has resulted in the successful removal of 59% to date. The GTRI domestic radiological material removal program is working in cooperation with Federal, state, and local agencies, and private industry to recover and permanently dispose of excess radiological sources in the United States. Over 23,022 domestic sources have been recovered to date.

To secure all vulnerable nuclear materials, GTRI has identified the material for inclusion in its Remove Program scope. In order to secure these materials within four years, these materials are protected until a permanent threat reduction solution (conversion and removal) can be implemented.

2.3 Protect

GTRI's Protect Program protects high priority nuclear and radiological materials from theft and sabotage. These efforts result in threat reduction by improving the physical security of bomb material remaining at civilian sites until a permanent threat reduction solution can be implemented. GTRI's Protect Program involves both international and domestic material protection. Work is conducted to ensure material security building by building. Many of the buildings holding nuclear and radiological materials require a different approach since they are accessible to the public, such as hospitals and university facilities. A systematic and comprehensive methodology is applied to evaluate and implement security measures.

Working with Federal, state and local agencies, GTRI is targeting about 2,500 high priority buildings containing risk-significant quantities of nuclear and radiological materials in the U.S. This work has recently begun, and 106 have already been completed to date. GTRI has identified 1,756 international buildings with nuclear and radiological material that require security installations and/or protection upgrades. To date, 37% have been completed.

3. Minimizing the Use of HEU in Medical Isotope Production

GTRI is working to demonstrate a sustainable means of producing the medical isotope molybdenum-99 (Mo-99) without the use of HEU.

Mo-99 is a crucial radioisotope that is used in approximately 80 percent of all nuclear medicine diagnostic procedures, and in roughly 50,000 diagnostic and therapeutic nuclear medicine procedures performed everyday in the United States. Its primary uses include diagnosing heart disease, treating cancer, and studying organ structure and function. The isotope’s short half-life and excellent binding properties make it uniquely suited for medical procedures, however due to its short half-life it must be produced continuously to meet the medical community's requirements.

The United States does not currently have a domestic production capability for Mo-99 and imports all of its supply from ageing reactors that use HEU in their production processes. As part of its nuclear nonproliferation mission, GTRI’s mandate is to assist in the conversion of global isotope production facilities to use LEU, and to accelerate the commercialization of a reliable Mo-99 supply network in the United States that does not use HEU.

3.1 Development of LEU-Based Technologies to Enable Conversion of Global Medical Isotope Producers

As part of its nuclear nonproliferation mission, GTRI makes technical expertise available, on a non-proprietary basis, to all global isotope producers to assist with converting their Mo-99 production processes to use LEU.

GTRI provides technical support in a number of areas, including foil rolling, target fabrication, target irradiation, target disassembly, target dissolution, product recovery and purification, and waste treatment. GTRI also develops alternative LEU-based processes that increase the Mo-99 extraction efficiency and reduce the waste volumes generated, in order to facilitate the replacement of current HEU-based technologies. GTRI has long-standing relationships with current and potential Mo-99 producers through its development of LEU-based Mo-99 technology and cooperation with research reactor facilities converting to LEU fuel.

GTRI’s efforts to develop LEU technology for isotope production were validated by a January 2009 National Academy of Sciences report, entitled *Medical Isotope Production*

Without the Use of Highly Enriched Uranium.[3] Released on January 14, 2009, the study provides confirmation of the viability of the technical progress made by GTRI and found the production of Mo-99 using non-HEU-based methods to be economically feasible. Specifically, the National Academies concluded that "LEU targets that could be used for large-scale production of Mo-99 have been developed and demonstrated," and that "the anticipated average cost increase to convert to the production of medical isotopes without the use of HEU would likely be less than 10 percent."

To further support non-HEU-based medical isotope production, GTRI participates in related efforts of the International Atomic Energy Agency (IAEA), such as the IAEA Coordinated Research Project on "Current and Novel, Non-HEU based Isotope Production and Supply Technologies for Mo-99 and Tc-99m Suitable for Medical Procedures."

3.2 Accelerating the Establishment of Domestic Commercial Sources of Mo-99
Over the past two years, technical difficulties and shutdowns at the major Mo-99 production facilities have caused serious Mo-99 supply shortages. The current supply shortage highlights the need for a reliable supply network in the United States, comprised of alternative production options (e.g. new non-HEU-based technologies and facilities) that will meet the demand of the medical community.

GTRI is working to develop a reliable and diversified Mo-99 commercial production capability in the U.S. that does not use HEU, an effort that requires strong cooperation between government and industry. It is imperative to ensure that this critical medical isotope is readily available for the medical community because of the current and projected isotope supply shortages. The goal is to develop a reliable Mo-99 commercial supply network in the United States to meet daily patient needs that is consistent with HEU minimization policy and avoids a single point-of-failure.

To further this critical effort, GTRI is supporting the U.S. private sector to accelerate the establishment of a reliable commercial Mo-99 production capability without the use of HEU. GTRI is demonstrating four non-HEU based technologies, in cooperation with commercial partners and the U.S. national laboratories. These technologies include LEU target technology, LEU solution reactor technology, accelerator technology, and neutron capture technology. The projects utilize resources and the wide-ranging expertise from the U.S. national laboratories and U.S. commercial entities.

Two Cooperative Agreements were awarded to commercial partners on September 30, 2009 to accelerate the production of Mo-99 in the U.S. without the use of HEU. These commercial partners are Babcock and Wilcox (B&W) for solution reactor technology and General Electric Hitachi for neutron capture technology. Cooperative Agreements are cost-share arrangements that require the private company to provide no less than 50-percent of total project funding.

---

[3] Committee on Medical Isotope Production Without Highly Enriched Uranium, National Research Council, Medical Isotope Production Without the Use of Highly Enriched Uranium, January 2009, <http://www.nap.edu/catalog.php?record_id=12569#description>.

3.3 The American Medical Isotope Production Act (H.R. 3276)

On July 21, 2009, U.S. Representative Edward J. Markey, Chairman of the House Energy and Commerce Committee Subcommittee on Energy and the Environment, and Representative Fred Upton, the Ranking Member of the Subcommittee, introduced The American Medical Isotope Production Act of 2009 (H.R. 3276).

The pending legislation would direct the U.S. Department of Energy (DOE) to establish a technology-neutral program to evaluate and support projects for the production of significant quantities of Mo-99 in the United States without the use of highly enriched uranium to be carried out in cooperation with non-Federal entities. In addition, H.R. 3276 directs DOE to establish a program to make LEU available, through lease contracts, to domestic commercial entities for Mo-99 production and to retain responsibility for the final disposition of waste created by the irradiation, processing, or purification of leased uranium. The legislation would also phase out the export of HEU for medical isotope production in 7 to 13 years.

On September 9, 2009, GTRI testified at the hearing of the House Subcommittee on Energy and the Environment on the legislation, and again on December 3, 2009 before the Senate Energy and Natural Resources Committee. NNSA supports H.R. 3276 because it recognizes the urgency of two important national priorities: nuclear nonproliferation and stability of the supply of medical isotopes.

3. Conclusion

Through GTRI's efforts to convert research reactors and isotope production facilities to use LEU, remove vulnerable nuclear and radiological materials, and protect thousands of facilities from the threat of sabotage and theft until a permanent threat reduction alternative can be implemented, GTRI is a critical element to meeting the international effort to secure all vulnerable nuclear material around the world within four years. GTRI's efforts to demonstrate and develop non-HEU based technologies for civilian nuclear applications, including in the production of medical radioisotopes, will achieve the important nonproliferation objective to phase-out the use of HEU in the civilian sector.

2010 National Progress Report on R&D on LEU Fuel and Target Technology in ARGENTINA

Silvia Balart, Herman Blaumann, Pablo Cristini, Alfredo G. Gonzalez, Rubén González
J. Daniel Hermida, Marisol López, Marcela Mirandou, Horacio Taboada

Comisión Nacional de Energía Atómica
Avenida Libertador 8250-1429 Buenos Aires ARGENTINA

ABSTRACT

Since last RRFM meeting, CNEA has deployed several related tasks. The RA-6 MTR type reactor, converted its core from HEU to a new LEU silicide one is scaling up the power, according to a protocol requested by the national regulatory body, ARN.

CNEA is deploying an intense R&D activity to fabricate both dispersed U-Mo (Al-Si matrix and Al cladding) and monolithic (Zry-4 cladding) miniplates to develop possible solutions to VHD dispersed and monolithic fuels technical problems. Some monolithic 58% enrichment U8%Mo and U10%Mo are being delivered to INL-DoE to be irradiated in ATR reactor core. A conscientious study on compound interphase formation in both cases is being carried out.

CNEA, a worldwide leader on LEU technology for fission radioisotope production is providing Brazil with these radiopharmaceutical products and Egypt and Australia with the technology through INVAP SE. CNEA is also committed to improve the diffusion of LEU target and radiochemical technology for radioisotope production and target and process optimization. Future plans include:

- Fabrication of a LEU dispersed U-Mo fuel prototype following the recommendations of the IAEA's Good Practices document, to be irradiated in a high flux reactor in the frame of the ARG/4/092 IAEA's Technical Cooperation project.
- Development of LEU very high density monolithic and dispersed U-Mo fuel plates with Zry-4 or Al cladding as a part of the RERTR program.
- Optimization of LEU target and radiochemical techniques for radioisotope production.

1. RA-6 reactor with its new LEU core: from restart to its regime power

The RA-6 reactor is a pool-type one sited at San Carlos de Bariloche city, Province of Río Negro, Argentina, and its core was recently converted into a new LEU-based one[I]. This successful conversion process started in October 30th, 2005 with the signature of two contracts between CNEA and NNSA-DoE and comprised swapping of HEU-LEU inventories, exportation of HEU SNF US-origin to USA, and fabrication of the conversion core and new graphite reflectors and improvements on primary and secondary loops. During 2009 and up to date the following steps took place:

- Criticality start-up operations, started on January 19th, 2009.
- Formal re-inauguration took place on March 16th, 2009.
- Scale up of power to a first step of 1 MW, to reach 3 MW during 2010, according to a plan authorized by ARN, the national nuclear regulatory body.
- Refurbishment and relicensing of BNCT facility for experimental therapeutic melanoma treatment, Neutron Activation Analysis and other facilities.

2. Applied R&D on dispersed and monolithic U-Mo fuels.

- The final analysis on the interaction U(Mo,1%Zr)/Al (7%Si) developed in out-of-pile tests using high intensity synchrotron X-rays diffraction techniques performed in the LNLS Campinas, Brazil, was carried out. It showed the precipitation of Zr as Zr_3Al_5 in the interaction zone.

- Other research activities already performed are the irradiation of a set of microplates in the RA3 reactor and computational methods applied to thermodynamic and kinetic calculations. Concerning calculations, a thermodinamic database was built to calculate phase equilibria. The diffusion problem was simulated using the DICTRA package which articulates thermodinamic data with a mobility database. The equilibria obtained in the Al-U system and a first model of UAl3/Al diffusion couple that succesfully simulates the growth of the Al4U phase are presented in the poster session.

3. Development and irradiation of promissory solutions to VHD monolithic and dispersed fuels technical problems

- Improvements in the development of dispersed and monolithic fuels made with Uranium-molybdenum alloy were done. The purpose is to have additional alternatives to cover HEU-LEU conversion possibilities.
- CNEA is working in the fabrication of depleted U-7Mo based miniplates. Once this process is stable and repetitive, the fabrication of a LEU prototypic fuel assembly will follow. To enhance the expertise of human resources in rolling techniques, the technical visit of Dr. Wiencek to CNEA laboratories, an US-ANL expert was produced. This visit was done through IAEA'S Tecnical Cooperation MANPOWER program.
- The project ARG/4/092, in the frame of IAEA's Technical Cooperation, looks for the irradiation in a high flux reactor and PIE a full scale LEU-Mo/Al-Si based dispersed fuel assembly prototype. Procurement activities are finished and the contract with the irradiadiation and PIE services provider will take place soon.
- In order to avoid an undesirable porosity in the aluminium side of the interaction zone with U-Mo due to the migration of gas fission products, and according to studies done on the convenience to add a proper component to matrix powder, Al-Si alloys are being tested. After results, fabrication conditions of dispersed U-Mo plate full size will be obtained.
- Concerning very high density monolithic U-Mo both miniplates and plates, using MEU and LEU fuel meat with Zry-4 cladding to be irradiated in USDoE-ATR Reactor, are being developed
- In order to improve material performance and plate dimensioning fabrication conditions were studied and modified, like hot co-lamination of U-Mo and Zry-4 sheaths. Several depleted uranium prototypes were elaborated, characterized and tested to set up process variables and fabrication conditions.

4. Improvement of the LEU target and radiochemical technology for Mo99 and other radioisotopes production: It was already presented that CNEA has decided on 2001 to turn into LEU material for target fabrication, maintaining other characteristics of the production, i.e. the alkaline chemical digestion process. CNEA has been producing Mo-99 using LEU since 2002.CNEA produces Mo-99 primarily for its domestic market and secondarily for export to other South American countries. It began producing Mo-99 using HEU targets in 1985[II] and developed and converted to LEU-based production in 2002. CNEA manufactures its own uranium-aluminum alloy plate LEU targets[III].

- CNEA has developed and is using high-density LEU-aluminum dispersion targets to produce Mo-99 for its domestic market. The target meat has a density of 2.9 gU/cm3, which is obtained by increasing the ratio of uranium aluminide to aluminum in the target meat. The mass of U-235 in the target meat is about twice that of conventional uranium-aluminum alloy targets.
- CNEA was able to convert to LEU-based production in the same set of hot cells that were being used for HEU-based production. Moreover, this conversion was made without interrupting Mo-99 production

- Targets are irradiated in the RA-3 reactor at CNEA's Ezeiza Atomic Center near Buenos Aires. Target processing is carried out in a hot cell facility at the Ezeiza site. Process wastes are also managed at the site.
- CNEA's development showed that there are no technical barriers to conversion of Mo-99 production from HEU targets to LEU targets. Production using LEU targets is technically feasible and is being carried out by CNEA in Argentina and will be shortly by the Australian National Nuclear Science and Technology Organisation (ANSTO) using CNEA technology using CNEA-developed LEU targets and target dissolution process to produce Mo-99.
- This new LEU technology satisfies the most stringent requirements of quality for its use in nuclear medicine applications. Mo-99 purity has been consistently higher than that produced using HEU targets[IV]
- Also in September 2005, CNEA began the regular production of high quality fission I-131, a by-product of Mo-99 production, meeting also international quality standards.
- New results are that HEU-LEU production process comparison costs reveals that this new technology has no significant over cost. CNEA recently presented a comparison of its variable costs for producing Mo-99 using LEU and HEU targets[V]. Variable costs for Mo-99 production for the three years prior to (i.e., 1998-2001) and three years following (2003-2007) conversion were compared. Costs were presented in three categories: (1) labor; (2) materials; and (3) services, maintenance, taxes, and miscellaneous. The costs were presented as present value estimates normalized on a per curie basis for the number of curies produced in 2007. Overall costs for LEU-based production compared to HEU-based production increased by about 5 percent.
- Since CNEA has duplicated the LEU-based radioisotope weekly production rate to provide Mo99 and other radioisotopes to Brazil.
- Conclusions: no technical, quality or financial reasons make disadvantageous to change from HEU to LEU radiochemical technology for Mo99 and other radioisotopes production. CNEA becomes a leader in LEU based isotope production technology: the production plant built up with CNEA's technology in Australia by INVAP started to produce RI, and a similar one in Egypt is scheduled to start production during 2010. Future plans: at present, CNEA is expanding Mo-99 production within its current facilities by increasing target throughputs. Such an expansion would put CNEA in the ranks of large-scale producers

  .

5. Conclusions: CNEA continues deploying development activities on LEU technology for core reactor conversion and Mo99 and related radioisotope production. Future plans include prototypic fuel irradiation and optimization of LEU targets and alkaline digestion process.

[I] Balart, S; Cristini, P; Fernández, C; González , AG; López, M; Taboada, H. 2009 CNEA Progress Reporto n the Development of LEU Fuels and Targets in Argentina. 2009 RRFM International Meeting, Vienna, Austria, 22-25 March, 2009

[II] Cols, H. J., P. R. Cristini, and A. C. Manzini. 2000. Mo-99 from low-enriched uranium. 2000 International RERTR Meeting, Las Vegas, Nevada, USA, 1-6 October, 2000. Available at http://www.rertr.anl.gov/Web2000/PDF/Cristi00.pdf

[III] Kohut, C., M. de la Fuente, P. Echenique, D. Podesta, and P. Adelfang. 2000. Target development of low enrichment for production of 99Mo for fission. 2000 International RERTR Meeting, Las Vegas, Nevada, USA, 1-6 October, 2000. Available at http://www.rertr.anl.gov/Web2000/PDF/Fuente00.pdf

[IV] Durán,A. 2005. Radionuclide Purity of Fission Mo-99 Produced from LEU And HEU. A Comparative Study. 2005 International RERTR Meeting, Boston, Massachusetts, USA, November 6-10, 2005. Available at http://www.rertr.anl.gov/RERTR27/PDF/S8-3_Duran.pdf.

[V] Cestau D., A. Novello, P. Cristini, M. Bronca, R. Centurión, R. Bavaro, J. Cestau, E. Carranza. HEU and LEU cost comparison in the production of molybdenum-99. 2008 International RERTR Meeting, Washington, DC, USA, 5-9 October 2008, and Cestau D., A. Novello, P. Cristini, M. Bronca, R. Centurión, R. Bavaro, J. Cestau, E.Carranza. 2007. HEU and LEU comparison in the production of molybdenum-99. 2007 International RERTR Meeting, Prague, Czech Republic, Sep. 23-27, 2007. Available at http://www.rertr.anl.gov/RERTR29/PDF/6-4_Cestau.pdf

Foreign Research Reactor Uranium Supply Program: The Y-12 National Security Complex Process

T. Nelson
Nuclear Technology and Nonproliferation, B&W Y-12, L.L.C.
Y-12 National Security Complex
Oak Ridge, Tennessee

B. G. Eddy
Nuclear Materials Management and Disposition
National Nuclear Security Administration Y-12 Site Office
Y-12 National Security Complex
Oak Ridge, Tennessee

The Foreign Research Reactor (FRR) Uranium Supply Program at the Y-12 National Security Complex supports the nonproliferation objectives of the HEU Disposition Program, the Reduced Enrichment Research and Test Reactors (RERTR) Program, and the United States FRR Spent Nuclear Fuel (SNF) Acceptance Program. The Y-12 National Nuclear Security Administration (NNSA) Y-12 Site Office maintains the prime contracts with foreign governments for the supply of Low-Enriched Uranium (LEU) for their research reactors. The LEU is produced by down blending Highly Enriched Uranium (HEU) that has been declared surplus to the U.S. national defense needs. The down blending and sale of the LEU supports the Surplus HEU Disposition Program Record of Decision to make the HEU non-weapons usable and to recover the economic value of the uranium to the extent feasible. This program supports the important U.S. government and nuclear nonproliferation commitment to serve as a reliable and cost-effective uranium supplier for those foreign research reactors that are converting or have converted to LEU fuel under the guidance of the NNSA RERTR Program. In conjunction with the FRR SNF Acceptance Program which supports the global nonproliferation efforts to disposition U.S.-origin HEU, the Y-12 FRR Uranium Supply Program can provide the LEU for the replacement fuel fabrication. In addition to feedstock for fuel fabrication, Y-12 supplies LEU for target fabrication for medical isotope production. The Y-12 process uses supply forecasting tools, production improvements and efficient delivery preparations to successfully support the global research reactor community.

Y-12 Foreign Research Reactor Supply Program Overview

Y-12 supplies foreign research reactors with low enriched uranium (LEU) at 19.75 wt. % ^{235}U under the Foreign Research Reactor (FRR) Uranium Supply Program. The LEU is produced at Y-12 by down blending U.S.-origin highly enriched uranium (HEU). In a 1994 Presidential declaration 174 metric tons (MT) of HEU were declared surplus to national security needs by a 1995 presidential order. Although current LEU production is primarily in the form of uranium metal, Y-12 production processes have the capability to provide various forms and enrichments of LEU, depending on research reactor requirements.

In keeping with the commitment made by the U.S. to permanently remove the declared surplus HEU from the U.S. defense stockpile and to use it for peaceful uses to the extent possible, the HEU Disposition Program, under the Office of Fissile Material Disposition, manages and integrates the surplus HEU disposition activities. The down blending and sale of the LEU for FRR fuel supports the Record of Decision for the Surplus HEU Disposition Program to make the material non-weapons usable and to recover the economic value of the uranium to the extent feasible.

As of the end of January 2010, over 131 MT of surplus HEU have been down blended and approximately 3.1 MT have been down blended at Y-12 for research reactor fuel feedstock. In 2005, an additional 200 MT were declared excess to weapons needs. Between the two surplus declarations, approximately 10 MT have been designated for disposition to research and test reactor fuel and targets for medical isotope production through at least 2016.

The FRR uranium supply program supports the important U.S. government nuclear nonproliferation commitment to serve as a reliable and cost-effective supplier of feed material for those foreign research reactors that are converting or have converted to LEU fuel under the guidance of the NNSA Reduced Enrichment for Research and Test Reactors (RERTR). The Y-12 NNSA Site Office is authorized to administer the FRR uranium supply contracts with foreign governments in accordance with Section 54a of the Atomic Energy Act of 1954, as amended, and Section 3112 (d) and (e) of the United States Enrichment Corporation (USEC) Privatization Act of 1996. DOE is authorized to distribute special nuclear material to countries who have entered into an Agreement for Cooperation with the U.S. Government concerning peaceful uses of nuclear energy and that DOE may sell enriched uranium to "any State or local agency or nonprofit, charitable, or educational institution for use other than the generation of electricity for commercial use." In addition, DOE may now sell LEU to commercial research reactors as long as the material is not necessary for national security needs; the sale will not have an adverse impact on the domestic uranium industry; and the price is not less than the fair market value of the material.

LEU Supply Process

The research reactor representative submits an expression of interest to Y-12 specifying the LEU requirements, including quantity by calendar year, desired delivery schedule by quarter, enrichment (19.75% weight percent ^{235}U, typically) and material form. Y-12 evaluates the request and determines material availability. At the customer's request, Y-12 provides a cost proposal. If the quoted price is accepted, the customer sends a letter of intent and Y-12 provides a draft contract with standardized General Terms and Conditions to begin contract negotiations.

The successful completion of the uranium supply contract is contingent on the timely submission and receipt of an export license issued by the U.S. Nuclear Regulatory Commission. The export license process is often the limiting factor for finalizing the delivery schedule because it requires NNSA and/or State Department review and approval and foreign government assurances for the peaceful use of the requested enriched uranium. The NNSA Y-12 contracts require the customer to agree to utilize the Y-12 supplied, U.S.-origin uranium in the reactors listed in the contract as well as in the export license application where the ultimate end use of the material is specified.

The LEU demand for foreign research and isotope production reactors is approximately 1,500 to 2,000 kilograms per year and is expected to increase as reactors convert from HEU to LEU. As the global LEU demand increases, it is important for a research reactor to have a reliable fuel supply. NNSA Y-12 encourages multi-year supply contracts because of several mutual benefits. The customer receives a competitive base price with the option to negotiate a lower base price each year, assurance of fuel feedstock supply, and a high quality product. An export license application can be submitted for multiple deliveries to accommodate multi-year supply contracts, thereby reducing administrative costs and potential delays in deliveries.

Y-12 benefits include better production planning and campaigning efficiencies, which results in lower production costs for the customer. Also, Y-12 can assure production capacity is available to meet the demands for LEU. In addition, the multi-year contracts provide a long-term disposition path for surplus HEU.

Pricing Policy

Y-12 utilizes a DOE pricing policy developed specifically for DOE contracts executed for the sale of LEU to authorized users for use in foreign research and test reactors. This pricing policy was developed to assure competitive pricing for NNSA sales of uranium to foreign research reactors in order to attract worldwide research reactor community support for the nonproliferation objectives of the RERTR and FRR SNF Acceptance Program. The policy requires that the LEU be sold at fair market value as well as requiring full cost recovery. Because of the extreme fluctuations in the uranium market over the past several years, implementation of the NNSA pricing strategy was modified from month-end spot prices to an averaging over a period to provide the fair market value to the FRR customer. The current pricing policy is based on the Y-12 costs to produce the LEU metal plus the average market value for 19.75% enriched uranium. The average market value, which includes the sum of the published uranium component market prices for uranium feed and separative work units (SWU), typically, averaged over the two quarters prior to contract negotiation, is used to calculate the corresponding market price per kilogram to be charged for 19.75% LEU.

In recognition of the uranium market fluctuations and the objective to provide the fair market value to its FRR customers, NNSA includes in new contracts an option for the FRR customer to negotiate a new base price if the average market value decreases below the base price of the component values in the contract. The Y-12 processing costs have to be incorporated into the price since Y-12 is a government facility which requires its operations to be full cost recovery.

In support of the NNSA Office of Global Threat Reduction and the FRR Spent Nuclear Fuel Acceptance Program goal for the safe, secure removal of U.S.–origin HEU from foreign research reactors, NNSA often negotiates the removal of HEU by offering an equivalent LEU credit based on the net value of the material to be returned. The FRR can apply the LEU credit to an order under a LEU supply contract with NNSA Y-12.

Ultimately, Y-12 strives to provide the FRR customer with the most fair and beneficial price based on the current state of the uranium market. Y-12's customer base includes research reactors in Europe, Asia, North and South America, and Australia.

LEU Production Process

Y-12 employs a molten metal casting process to down blend the surplus HEU with either depleted or natural uranium to nominally 19.75 weight percent ^{235}U. The HEU is selected based on chemical analysis and availability. The feed materials are melted in a vacuum induction furnace and cast into a right angular cylinder (or hollow log), which has a critically safe geometry.

Samples are drilled from the hollow log for analysis to ensure enrichment, uranium isotopic composition and impurities meet the material specifications. The hollow logs are broken in a hydraulic press, and then sheared to make broken metal pieces ranging in size from 80 to 300 grams. The broken metal is loaded into carbon steel or stainless steel cans with press-fit lids under an argon atmosphere. The cans are 4.25 inches by either 4.75 or 8.75 inches tall and are lined with either aluminum or carbon steel mesh to minimize movement of the material during transport.

When a customer's order is placed, then the cans are loaded into the selected shipping container certified for international transport of fissile material. A Mylar tamper indicating device is applied to the cans and/or shipping container. The containers are then staged for shipment. Y-12 coordinates with the customer's transportation services company to develop the shipping logistics and to execute the delivery.

Y-12 LEU Quality

There are over 250 research reactors worldwide, many of which operate using LEU fuel enriched from 5% to less than 20% in ^{235}U. The primary feed material form provided is uranium metal which is used to produce uranium silicide, uranium aluminum, or uranium titanium fuels. Some reactors also need U_3O_8 and UO_2 oxides. International initiatives guided by the RERTR Program are continuing to convert several of those remaining reactors using HEU into LEU fueled reactors.

The origin of the material in the production of LEU for the research reactor community is the major contributor to the quality of the LEU product. At Y-12, the LEU is produced by down blending weapons-grade HEU material with carefully selected diluent. Reprocessed material is usually less suitable due to the minor uranium isotope concentrations and the processing required to remove the impurities.

Efforts have been made in the past by research reactor suppliers to agree upon a worldwide unified technical specification for LEU. An American Standards and Test Materials (ASTM) standard specification (ASTM specification C-1462-00) was developed in order to facilitate supplies of LEU for fabrication of research reactor fuel elements. However, the effort to develop one specification that met the different organizational needs created a specification that is not acceptable to many research reactor customers. For example, C-1462-00 has higher ^{234}U, ^{236}U, and transuranic element limits to allow the use of reprocessed uranium, which is not acceptable to some of the fuel fabricators and reactor users.

Consequently, Y-12 developed a standard specification for LEU based on its understanding of the material quality and the requirements of the various FRR customers. By producing LEU that meets a standard specification, Y-12 is able to maintain an inventory of LEU metal in support of current and future NNSA uranium supply contracts.

All the limits (except for dysprosium) in the Y-12 LEU Standard Metal Specifications for Research and Test Reactors are equal to or less than the ASTM-C-1462-00 specification limits. Table 1 shows a comparison of the specification limits for several of the parameters between the Y-12 LEU metal produced from down blended HEU and the ASTM-C-1462-00 standard specification limits.

Standardization has enabled Y-12 to respond quicker to FRR customer requests by maintaining an LEU inventory that meets a standard specification and it has simplified production requirements and quality control checks which have improved Y-12's efficiency to prepare LEU orders for delivery.

Y-12 continues to evaluate ways to standardize the uranium metal form that is provided to its FRR customers. The current form is broken metal with irregular shaped pieces. One objective is to cast material into small, regular shapes at a more uniform mass that would meet a customer's equipment and process requirements. Several mold designs have been tested on surrogate material and efforts continue to develop an acceptable product. A standard form will also greatly optimize production efficiency by reducing material handling and packaging requirements.

Y-12 can provide uranium oxide (U_3O_8) and metal plates or coupons and other LEU assays. Since these are not the normal form supplied by Y-12 the production costs will be higher. Y-12 is actively involved in the development of new LEU fuels in support of the RERTR Program assisting reactors to convert from HEU to LEU fuel. Y-12 is developing and validating a production oriented, monolithic uranium molybdenum (U-Mo) foil fabrication process. Between 2006 and 2009, Y-12 produced multiple U-Mo foils and coupons for testing and evaluation.

Table 1. Comparison of Y-12 Specification to ASTM-C-1462-00

Element	Symbol	Units	Y-12 LEU Metal Y/GNSS-05-02 r2	ASTM C1462-00
Uranium	U	wt %	99.88%	99.85%
U-232	U-232	µg/gU	0.002	0.002
U-234	U-234	wt %	0.26%	1.00%
U-235	U-235	wt %	19.75%	19.75%
U-236	U-236	µg/gU	4,600	40,000
Trans-U (Alpha)	TRU	Bq/gU	100	250
Activation Products	ActProd	Bq/gU	100	
Fission Products	Gamma	Bq/gU	600	600
Carbon	C	µg/gU	350	800
Cobalt	Co	µg/gU	5	10
Dysprosium	Dy	µg/gU	5	Sum < 3
Europium	Eu	µg/gU	2	Sum < 3
Gadolinium	Gd	µg/gU	1	Sum < 3
Lead	Pb	µg/gU	5	10
Lithium	Li	µg/gU	2	10
Manganese	Mn	µg/gU	24	50
Phosphorus	P	µg/gU	50	100
Samarium	Sm	µg/gU	2	Sum < 3
Silicon	Si	µg/gU	100	250
Total Impurities	TotImp	µg/gU	1,200	1,500
Equivalent Boron Content			3	4

Summary

The Atoms for Peace initiative launched by President Eisenhower in 1954 and the creation of the International Atomic Energy Agency were successful in establishing research reactors around the world. The Department of Energy NNSA and Y-12 is honored to support the research reactor community by supplying enriched uranium.

The Y-12 process has resulted in a reliable and cost-effective FRR uranium supply program. The Y-12 supply of high-quality LEU is essential to the present and future successful operation of the world's research reactors.

DISCLAIMER

INTERNATIONAL TOPICAL MEETING ON RESEARCH REACTOR FUEL MANAGEMENT (RRFM) - UNITED STATES FOREIGN RESEARCH REACTOR (FRR) SPENT NUCLEAR FUEL (SNF) ACCEPTANCE PROGRAM: 2010 UPDATE

C. E. MESSICK, J. L. TAYLOR, M. T. NIEHUS, C. LANDERS
U.S.-Origin Nuclear Remove Program
U.S. Department of Energy, National Nuclear Security Administration
Office of Global Threat Reduction, Washington, D.C. 20585—United States of America

ABSTRACT

The Nuclear Weapons Nonproliferation Policy Concerning Foreign Research Reactor Spent Nuclear Fuel, adopted by the United States Department of Energy (DOE), in consultation with the Department of State (DOS) in May 1996, scheduled to expire May 12, 2016, to return research reactor fuel until May 12, 2019 to the U.S. is in its fourteenth year. This paper provides a brief update on the program, part of the National Nuclear Security Administration (NNSA), and discusses program initiatives and future activities. The goal of the program continues to be recovery of U.S.-origin nuclear materials, which could otherwise be used in weapons, while assisting other countries to enjoy the benefits of nuclear technology. The NNSA is seeking feedback from research reactor operators to help us understand ways to include eligible research reactors who have not yet participated in the program.

1. Introduction

This paper presents the Foreign Research Reactor (FRR) Spent Nuclear Fuel (SNF) Acceptance Program, or the U.S.-Origin Nuclear Remove Program (furthermore referred to as the Program), which is part of NNSA's Global Threat Reduction Initiative (GTRI). After an initial discussion of program history, contract issues are discussed. Planning issues are then set out to incorporate lessons learned from recent shipments in order to help FRRs understand issues which can affect their SNF disposition project. The final discussion topic is DOE efforts to advance the goals of the Acceptance Program, with a conclusion that the Acceptance Program wants to work with FRRs to plan for shipment of their eligible spent fuel as early as possible.

2. Acceptance Program Metrics

The Program, now in the fourteenth year of implementation, has safely completed Fifty (50) shipments to date, with more expected to be completed this year. Twenty-nine countries have participated so far, returning a total of 9175 spent nuclear fuel assemblies, just under 5,000 kilograms of uranium, to the United States for management at DOE sites in South Carolina and Idaho. Forty (40) of the Fifty (50) shipments contained aluminum-based spent nuclear fuel from research reactors and were placed into storage at the Savannah River Site (SRS) in South Carolina. Two shipments with fresh or slightly irradiated fuel were sent to the Y-12

National Security Complex, and the remaining eight (8) shipments consisted of Training, Research, Isotope-General Atomics (TRIGA) type fuel and were placed into storage at the Idaho National Laboratory (INL). The most recent shipment was completed without incident, arriving at SRS on January 12, 2010.

3. Contractual Requirements

3.1 Contract Extensions

Research reactors will need a contract extension to authorize shipments after May, 2009. Reactor Operators who intend to ship after May 2009 and do not have a modified contract should contact the Program office to negotiate extension of the DOE-FRR contract to authorize continued Program participation.

3.2 Contract Implementation

Each research reactor that returns SNF to the United States through the Program enters into a contract with DOE. It is very important that the contracting parties clearly understand all of the provisions in the contract. Contract requirements are usually described in detail prior to the first shipment. As time passes and personnel change, some understanding may be lost, so it is very important to review the contract and ask questions if there is any doubt about requirements. Compliance with all contract requirements must be maintained. Further discussions on contract requirements can always be addressed to the Program office. One important article which has been misunderstood in the past involves compliance with U.S. government regulations restricting public disclosure of any shipping plans, shipment information, or individual details comprising such plans or information. Compliance with this article is an important obligation to ensure security for all shipment activity. Any press release made prior to the material reaching the final storage site, even after the ship reaches international waters on the way to the United States, is a violation of the contract and makes the security of the shipment more vulnerable. Premature release of shipment related information also violates the U.S. Nuclear Regulatory Commission regulations under which the shipments are authorized. Also, The Convention on Physical Protection of Nuclear Material entered into by states which support the Program requires that each state protect the confidentiality of this information. Our ability to continue the Program depends on our customers following this critical and agreed-to process.

3.2 Contract Appendix Changes

Issuance of the DOE “Authorization to Ship” letter approves and establishes the fuel as identified and characterized in the revision of Appendix identified in the letter as “Authorized Material”. Making physical changes to a fuel assembly after the Appendix A data has been accepted can add to the cost and schedule of receipt preparations and may result in DOE refusing the material if the required safety documents cannot be completed prior to the scheduled shipping date. Any changes to the fuel assemblies after the data is submitted for evaluation must be approved in advance because the changes may require a new Appendix A and cause either delays or re-evaluation of the data. Any changes to the fuel assemblies after the formal identification of the fuel assemblies as “Authorized Material” should be communicated to DOE as soon as possible since any change would void the material being considered “Authorized Material” and would not be authorized to depart the foreign reactor facility. The calculations that provide the safety basis for accepting the material are made from the data submitted and almost every possible change could result in the need to repeat these calculations in order to repeat approval of the material as acceptable. Changes which can cause problems include location of cropping or removal of plates. Reactor operators also need to understand that the fuel assemblies must be identified exactly as indicated in the Appendix A and that no changes may be made after the data is submitted.

4. Focus on Early Planning

The Program focuses on the planning and implementation of research reactor spent fuel shipments to the United States in support of worldwide nuclear nonproliferation efforts, while allowing other countries to enjoy the benefits of nuclear technology. Along with shipment logistics, the DOE/NNSA GTRI continues to address many other issues of programmatic importance.

4.1 Shipment Scheduling

It is always important that NNSA clearly understands the intentions of all reactor operators so that our planning can be well integrated and supported to meet the reactor operator's needs. It is also important to submit the required fuel data as early as possible in order to allow adequate time for the receiving site to perform necessary reviews and prepare for receipt and storage. Early availability of this data is also important for use in verifying transport package license requirements or submitting for a license amendment, when required. Budget limitations have been known to challenge implementation of shipping plans for our customers and NNSA. Similarly, the DOE receiving facilities also face increasing challenges in providing resources to receive material, particularly when reactor operator's shipping plans are not known in time to obtain funding. The Program staff will be happy to answer questions about scheduling or clarify what type of information is needed to facilitate receipt of fuel.

Shipment delays impact DOE's ability to maintain a regular schedule of operations and adequate resources for the receipt facility. The FRRs are strongly encouraged to continue shipping as early as possible and maintain original schedules where possible. Deferring shipments when spent fuel is available for shipping could result in changes to DOE's ability to support the receipt of fuel when a shipment is desired by the customer. Also, as the Program approaches the end of the policy period, a large amount of shipments are expected. DOE may be required to exercise its authority to limit receipts to specific customers with the greatest need.

4.2 Nuclear Liability Insurance Issues

Insurance issues have been a recurring problem for reactor operators in high-income economy countries who participate in joint shipments. Nuclear liability insurance associated with the ocean transport has the potential to adversely affect the total cost of shipping. This occurs because the shippers are sometimes required to have overlapping insurance coverage and also may have different requirements for minimum coverage. It is important for reactor operators to plan early for the required coverage and determine how to provide coverage in the least expensive manner. Consideration should be given for reactor operators entering into a joint shipment to coordinate in obtaining their nuclear liability insurance with the same pool or under a joint contract, where possible, in order to mitigate overlapping insurance costs. Recently, we have experienced better results for some customers with aggressive coordination. It is also important to be conscious of this potential problem and budget for any added cost that cannot be mitigated. In some cases, DOE may be able to take title of the "Authorized Material" at an earlier point as discussed in the Title Transfer Section of this paper potential reducing the reactor operator's cost of shipping.

4.3 Cask License Review

The Program enjoys a very good working relationship with Nuclear Regulatory Commission (NRC) staff and wishes to take every measure possible to respect this relationship by ensuring that cask license applications are timely and complete. DOE has been meeting periodically with NRC to discuss planned shipments and forecasted support required to meet the needs of the Acceptance Program and our customers. Because there are limited NRC resources for review of cask licenses, our customers need to provide adequate time in the preparation process, scheduling for early application for review and approval of cask licenses.

4.4 Fuel Cropping Operations

In many cases, fuel assemblies must be cropped for shipment and storage at the receiving facility. In order to avoid complicating the shipping and receiving process at the receiving facility or preventing the capability to unload the fuel assemblies, it is essential to maintain an open line of communication with the Program and the cask vendor. The cask vendor may provide useful insight to the reactor facility concerning cropping operations and techniques. The cask vendor should be consulted to ensure that the fuel is cropped in the appropriate and agreed upon locations as well. It is also necessary to communicate any difficulties in cropping, such as bent plates or any other changes in the final cask loading as previously planned to the Program. This communication should at least be contained in the final fuel verification letter required to be sent to DOE upon completion of loading. Damage caused to a fuel assembly during cropping, or other operations, may remove this material from being approved as "Authorized Material" and would not be authorized for shipment. For any fuel damage or change in physical characteristics from the physical condition inspected by DOE during pre-inspections, the reactor operator must communicate this change. Taking pictures of any unusual condition may be helpful to the unloading personnel. This would allow for evaluation of potential for different unloading methods and helps the receiving facility to be better prepared for unloading and handling the fuel assemblies. Maintaining the condition of the fuel elements also allows for ease of fuel handling operations.

4.5 Title Transfer

In accordance with a recent revision to the Program's authorization as discussed below, under certain situations, DOE may take title to the "Authorized Material" at a point earlier than upon arrival in the United States. One significant benefit to the reactor operator is that the United States' Price Anderson Amendment Act (PAAA) provides nuclear liability indemnification in the unlikely event of a nuclear incident outside the United States when the material is titled to the United States and other conditions apply.

5. Efforts to Improve and Accelerate

The Program has now passed its approximate midpoint. More than ever, DOE and reactor operators need to work together to schedule shipments as soon as possible, to optimize shipment efficiency over the remaining years of the program. Countries interested in participating in the Program should express their interest as soon as possible so that fuel and facility assessments can be scheduled and shipments may be entered in the long-term shipment forecast. New and current Program participants should also coordinate with DOE at least 18 - 24 months in advance to ensure DOE can meet the reactor operator's plans and needs. Accelerated schedules are possible if there are no significant issues or changes from past shipments such as a change in fuel type or fuel condition. However, decreasing resources and coordination requirements with other agencies such as the NRC and Department of Transportation (DOT) have the potential to limit DOE's capability to support these accelerated schedules. Specifically, the Program may not be able to accommodate a large number of requests at the end of the program, particularly from geographically isolated regions.

5.1 Source Recovery

DOE sponsors a program to recover excess and unwanted radioactive sealed sources, the Orphan Source Recovery Program. Traditionally, the program has dealt largely with americium-241 and plutonium sources. Because of heightened concerns about the potential that radioactive sources may be diverted to use in a dirty bomb, DOE is moving aggressively to include other isotopes of concern. DOE is currently emphasizing larger excess sources containing cobalt-60 and cesium-137, such as medical irradiators. The DOE is also considering a campaign to manage large numbers of small obsolete sources, examples of which are cesium-137 brachytherapy sources, and various radium-226, americium-241, and other sources. To be considered, institutions must register their material with Los Alamos National Laboratory. Reactor operators and other Stakeholders should consider this opportunity and also communicate with and assist in any coordination within their country or region. To learn more and register online, please visit osrp.lanl.gov

Several recent shipments of SNF have provided an opportunity for ISO containers with Sources from South America, Europe and Australia to be transported to the U.S. on the same vessel used to ship SNF in support of the Radiological Remove Program of GTRI. This is an excellent opportunity for the partner country or other organizations in the partner country or surrounding countries to dispose of unwanted radioactive sealed sources, particularly sources that can not be transported by air. The Program highly encourages partner countries and reactor operators to work with neighbouring countries interested in disposing of sources to allow the Program's dedicated vessel used in the spent fuel shipment to also transport these sources to the United States for disposition. The cost of shipping an ISO container with sources on the same ship is deminimus and allows for disposition of these potential vulnerable items that would otherwise remain in unwanted or undesirable locations within that region.

Although this program is not covered by the spent fuel removal program, supporting the disposition of these items is important to the overall goals of nonproliferation and is a benefit to all countries. Consequently, one of the considerations to adjust the DOE acceptance fee under the Program's Fee Policy, is the overall benefit to DOE, Unites States, and partner counties.

5.2 Material Disposition

The DOE's Office of Environmental Management (DOE-EM), the previous organization to manage the FRR SNF Acceptance Program, is making strides to further disposition the repatriated spent nuclear fuel. DOE-EM is considering continuing with the DOE Programmatic Spent Nuclear Fuel Environmental Impact Statement [1] and associated Record of Decision

[2]. This decision included transporting fuel to place all aluminum clad spent fuel at the SRS and stainless steel fuel such as TRIGA fuel at INL. This allows for a potential decision to treat the aluminium clad fuel in the H-Canyon facilities at SRS for disposition as waste in the same fashion as other high level waste material within the DOE complex. Any decision to treat the material would be subject to further evaluation under the National Environmental Policy Act.

5.3 Potential Fee Changes

NNSA continues to evaluate ways to accelerate repatriation activities. Therefore, fees may change in the future and/or other changes may be implemented, if DOE believes the changes will positively influence program goals as well as other nonproliferation goals. Since the inception of the Program, there has not been an increase in fees nor has there been a request to do so. GTRI is dedicated to keeping the repatriation process as cost effective as possible for partner countries and reactor operators. Any suggestions of methods to accelerate repatriation of SNF, especially Highly Enriched Uranium (HEU), would be welcomed and given all due consideration.

5.4 Two revisions to Record of Decision

A revision to the Record of Decision (61 FR 25092; May 17, 1996) on the Environmental Impact Statement on a Proposed Nuclear Weapons Nonproliferation Policy Concerning Foreign Research Reactor Spent Nuclear Fuel (FRR SNF EIS) DOE/EIS-0218, February 1996) to allow the United States to take title to spent nuclear fuel and assume financial responsibility for shipments from the point at which DOE takes title. In implementing this policy, the Administrator for the National Security Administration must make, on a case-by-case basis, any decision to accept title for foreign research reactor spent nuclear fuel outside the United States. The authority for making this decision cannot be delegated.

A revision to the Record of Decision (61 FR 25092; May 17, 1996) on the Environmental Impact Statement on a Proposed Nuclear Weapons Nonproliferation Policy Concerning Foreign Research Reactor Spent Nuclear Fuel (FRR SNF EIS) DOE/EIS-0218, February 1996) to allow the United States to transport and receive a limited quantity of SNF containing non-U.S. origin Highly Enriched Uranium HEU and SNF containing U.S. origin HEU that was not previously addressed in the FRR SNF EIS.

These two decisions, (73 FR 50004; August 25, 2008) and (74 FR 4173; January 23, 2008) will enable NNSA under very limited circumstances to facilitate return of SNF to the United States that would not otherwise be possible.

5.5 Coordination with Other Programs

A primary goal of the Program is to support worldwide nonproliferation efforts by disposition of HEU which contains uranium enriched in the United States. Integral to this process is the U.S. assistance offered in helping reactor operators convert their cores to low enriched uranium (LEU) as the reduced enrichment fuels become qualified and available. In addition, DOE plays a strategic role in ensuring a supply of low enriched uranium for fuel fabrication. In the Program, the primary goal is intertwined with the missions of the Reduced Enrichment for Research and Test Reactors (RERTR) Program and the Enriched Uranium Operations group from DOE's Y-12 National Nuclear Security Complex in Oak Ridge, Tennessee as well as the Orphan Source Recovery Program. The Program staff remains committed to working with staff in other program offices within DOE to assist in smooth transition of core enrichment level and a steady supply of fuel.

6. Benefits of Participation

A research reactor operator and other organizations involved in the operation of the research reactor may reap many benefits from participation in the Program. The long term management and disposition of nuclear fuel and materials may prove to be a large burden, technically, logistically, and monetarily, on the research reactor operator and associated organizations. Participation in the Program, if eligible, would help alleviate the liability and costs involved with the long term storage and disposition of nuclear materials.

Recently, there has been a resurgence of global nuclear nonproliferation efforts. Two of the mainstays of these efforts are international cooperation and multi-national projects. Participation in the Program, in some cases, allows for cooperation between neighbouring countries in shipping nuclear fuel and radiological sources as part of GTRI's Orphan Source Recovery Program. Cooperation on this level provides for opportunities to minimize the overall cost of transporting nuclear materials being accepted under the programs and would prove to be a notable example of participation in international nuclear nonproliferation efforts.

Participation in a shipment that is part of the Program provides a great exercise for many countries that may not have an extensive background in international transportation of nuclear materials. The transportation operation involves the interaction of many different government and commercial entities, which of which may not happen often. The operation also provides practice in handling operations that may not happen often as well.

7. Conclusion

The United States remains committed to supporting worldwide nonproliferation goals while assisting other countries to enjoy the benefits of nuclear technology such as those for which this program was designed. The programmatic goal is to accept eligible fuel sooner rather than later. Reactor operators are strongly encouraged to work closely with technical points-of-contact in order to ensure shipping schedules are accurate and achievable. The GTRI staff hopes to work with all remaining eligible research reactors to plan for shipments of their eligible spent fuel as early as possible. NNSA continues to support research reactor operators' needs and would be happy to meet any interested parties to discuss the program.

8. References

[1] Final Environmental Impact Statement for Programmatic Spent Nuclear Fuel Management and Idaho National Engineering Laboratory Environmental Restoration and Waste Management Programs DOE/EIS-0203-F (60 FR 20979, April 28, 1995)

[2] Record of Decision on the Programmatic Spent Nuclear Fuel Management and Idaho National Engineering Laboratory Environmental Restoration and Waste Management Programs Final Environmental Impact Statement (60 FR 28680, June 1, 1995)

[3] Record of Decision for the Final Environmental Impact Statement on a Proposed Nuclear Weapons Nonproliferation Policy Concerning Foreign Research Reactor Spent Nuclear Fuel (61 FR 25092, May 17, 1996)

[4] Revision to the Record of Decision for the Final Environmental Impact Statement on a Proposed Nuclear Weapons Nonproliferation Policy Concerning Foreign Research Reactor Spent Nuclear Fuel (61 FR 38720, July 25, 1996)

[5] Revised Record of Decision for the Environmental Impact Statement on a Proposed Nuclear Weapons Nonproliferation Policy Concerning Foreign Research Reactor Spent Nuclear Fuel (65 FR 44767, July 19, 2000)

[6] Revised Record of Decision for the Environmental Impact Statement on a Proposed Nuclear Weapons Nonproliferation Policy Concerning Foreign Research Reactor Spent Nuclear Fuel (69 FR 69901, December 1, 2004)

[7] Revised Record of Decision for the Environmental Impact Statement on a Proposed Nuclear Weapons Nonproliferation Policy Concerning Foreign Research Reactor Spent Nuclear Fuel (73 FR 50004, August 25, 2008)

[8] Revised Record of Decision for the Environmental Impact Statement on a Proposed Nuclear Weapons Nonproliferation Policy Concerning Foreign Research Reactor Spent Nuclear Fuel (74 FR 4173; January 23, 2009)

European Nuclear Society

Rue Belliard 65, 1040 Brussels, Belgium
Telephone +32 2 505 30 54, Fax + 32 2 502 39 02
rrfm2010@euronuclear.org - www.euronuclear.org