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Research Reactor Uranium Supply and Export from the Y-12 National Security Complex

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ABSTRACT

The Foreign Research Reactor (FRR) Uranium Supply Program at the Y-12 National Security Complex (Y-12) serves as the United States (U.S.) supplier of enriched uranium for fuel and medical isotope production targets to research reactors around the world. The FRR Supply Program supports several of the National Nuclear Security Administration (NNSA) Programs, including the Global Threat Reduction Initiative (GTRI), HEU Disposition, the Reduced Enrichment Research and Test Reactors (RERTR), the United States (U.S.) FRR Spent Nuclear Fuel (SNF) Acceptance and the Russian Research Reactor Fuel Return (RRRFR) Programs. This support complies with the important U.S. government 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 Low-Enriched Uranium (LEU) fuel or targets.

The NNSA Production Office Y-12 (NPO Y-12) manages the prime contracts with foreign government agencies for the supply of 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. In addition to uranium metal feedstock for fuel and target fabrication, Y-12 can produce LEU in different forms to support new fuel development or target fabrication for medical isotope production.

A major coordination challenge is the control and shipment of nuclear materials for use in research reactors. This presentation will focus on the unique processes for the supply and export of uranium from Y-12 to the foreign research reactors and/or fabrication facilities and some improvements to the processes to ensure timely and safe and secure delivery of the U.S.-origin material to 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, primarily in the form of uranium metal. For small-scale research and development, Y-12 has the capability to provide various forms and enrichments of LEU based on research reactor requirements. The LEU is produced at Y-12 by down blending surplus U.S.-origin HEU. In 1995, approximately 174 metric tons (MT) of highly enriched uranium (HEU) were declared surplus to the national security needs by the President of the United States. A commitment was made by the U.S. to permanently remove this material from the U.S. defense stockpile and to use it for peaceful uses to the extent possible. In 2005, an additional 200 MT were declared excess to national defense purposes. Between the two surplus declarations, approximately 20 MT HEU have been designated for disposition to research and test reactor fuel and targets for medical isotope production through at least 2030.

The down blending and sale of the LEU for FRR fuel or targets for medical isotope production supports the Record of Decision for the Surplus HEU Disposition Program to make the weapons non-weapons usable and to recover the economic value of the uranium to the extent feasible. As of the end of September 2012, over 141 MT of surplus HEU have been delivered for down blending and approximately 4.5 MT have been down blended at Y-12 for research reactor fuel and target feedstock.

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 NNSA Production Office Y-12 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 NNSA is authorized to distribute special nuclear material to countries that 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.” The Energy Policy Acts of 1992 and 2005 amended the Atomic Energy Act with more stringent criteria for exports of HEU for fuel and medical isotope production. In rare cases, a Project and Supply Agreement among the U.S. Government, the International Atomic Energy Agency and the government desiring

U.S.-origin EU without an Agreement for Cooperation in place may be used for uranium supply.

In support of the NNSA Office of Global Threat Reduction, the FRR Spent Nuclear Fuel (SNF) Acceptance Program and the Russian Research Reactor Fuel Return (RRRFR) Program goals for the safe, secure removal of spent and unirradiated HEU from foreign research reactors, NNSA may offer 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 an LEU supply contract with NNSA Y-12.

EU Supply Process

The research reactor customer 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); material form and fuel/target fabricator. 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 delivery of the uranium supply is contingent on the timely submission and receipt of an export license issued by the U.S. Nuclear Regulatory Commission (NRC). The export license process is often the limiting factor for finalizing the delivery schedule because it requires foreign government assurances for the peaceful use of the requested enriched uranium and it may require Executive Branch concurrence. 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.

LEU Demand

The LEU demand for foreign research and isotope production reactors is approximately 1,200 to 1,500 kilograms per year and is expected to increase as reactors convert from HEU to LEU. The demand is expected to increase significantly beyond 2014-15 when the high flux HEU research reactors are targeted for conversion (potentially a 2 to 5 times increase in LEU demand). How does Y-12 maintain an LEU inventory to meet this demand?

First, Y-12 forecasts the yearly demand by current and potential FRR customer and, coordinating with the customer's fuel/target fabrication schedules, projects the deliveries by month. Based on these quantities and timeframes, the LEU production schedule is established for the fiscal year. The objective is to maintain an on-the-shelf LEU inventory to ensure material is available to meet customer orders and to allow more efficient project campaigning in processing areas. Figure 1 is an example of the total inventory, production casting quantities and the forecasted delivery quantities. The bars illustrate the various FRR customers and quantities.

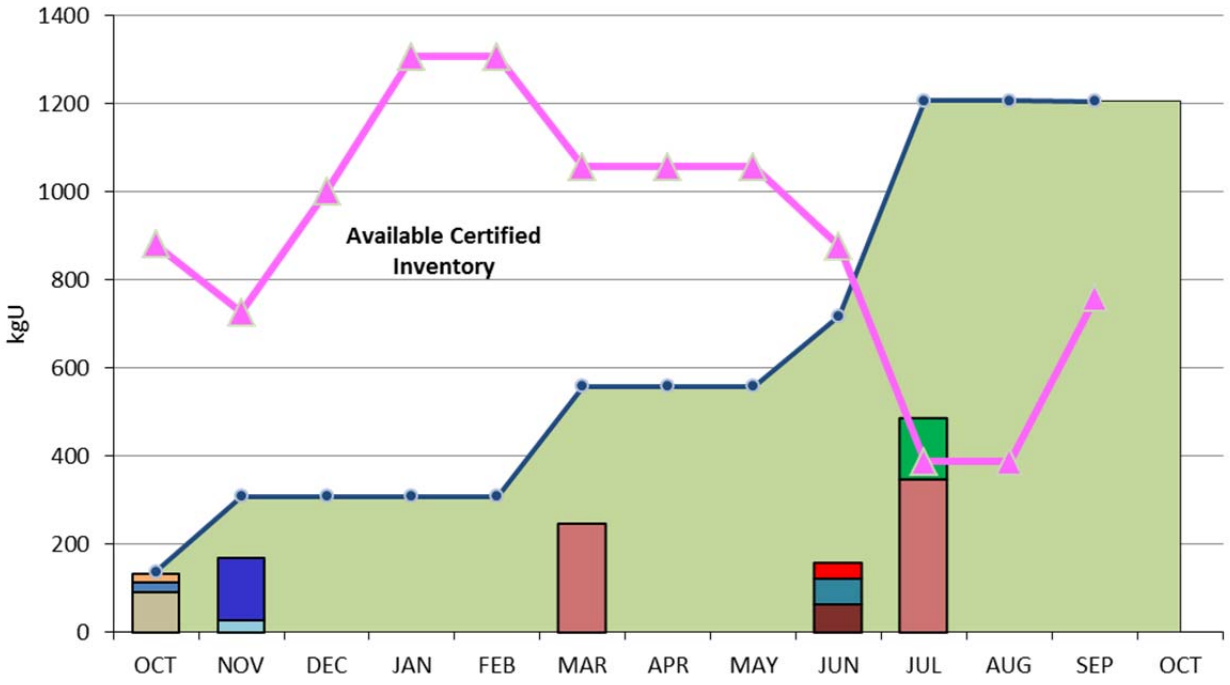

Figure 1. LEU Production and Inventory in Support of Research Reactor Supply

LEU Production Process

The normal form of uranium produced at Y-12 is as broken metal. 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 items are selected based on the chemical characterization and availability. The feed materials are melted in a vacuum induction furnace and cast into a right annular cylinder (or hollow log), which has a critically safe geometry. The batch sizes range between 18 and 20 kgs U. The logs are sampled and analyzed to ensure enrichment, uranium isotopic composition and impurities meet the material specifications for each batch. The logs are stored, ready for processing to meet a customer's order.

When a customer's order is placed, 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 4¼ inches (10.8 cm) by either 4¾ (12.1 cm), 8¾ (22.2 cm) or 10 (25.4 cm) inches tall based on the customer's can loading requirements. The cans are lined with either aluminum or carbon steel mesh to minimize damage to the cans during transport.

A sample per casting batch can be provided to the customer with the bulk metal. The sample is then placed inside one of the inner cans with the bulk metal. 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 whenever the transport agent arranges for pick up from Y-12 and only after Y-12 receives the authorization to ship from Export Control Office.

The U.S. DOE-designed ES-3100 Type-B shipping container is currently certified for air transport of unirradiated, bulk uranium metal, certain uranium compounds, and specific fuel elements. An amendment to the ES-3100 Certificate of Compliance authorizing air transport of uranium oxides is expected from the U.S regulator before the end of 2012. The ES-3100 containers are available at Y-12 which allows the LEU to be packaged in a more efficient manner. Loading of the shipping containers can be campaigned in the production work schedule to maximize use of resources. The loaded ES-3100s can then be stored at Y-12 well in advance of the scheduled delivery. The containers can be staged for shipment

Y-12 is also actively involved in the development of new LEU fuels in support of the RERTR Program and advanced fuel development for metallic fuel and space reactor applications. Y-12 continues working to develop and validate a production oriented, monolithic uranium molybdenum (U-Mo) fabrication process. Y-12 is currently evaluating the re-implementation of its metal powder atomization and oxide processes for production of research and development scale quantities for the development of new LEU fuels and targets.

EU Export Process

An NRC issued export license is required for all U.S. exports of EU to the FRR customers. The export license applications for LEU are typically submitted to the NRC by the customer's transport agent. Y-12 reviews the applications to confirm quantities, timeframes, addresses, etc. and the license may cover multi-year deliveries. For HEU exports, DOE/NNSA coordinates the transportation logistics including the secure transportation mode. The export license application includes an extensive justification checklist prepared by the customer identifying the usage, inventory, export history, and conversion progress and is submitted to the NRC by the NNSA Production Office Y-12. HEU export licenses are only approved for an annual delivery quantity.

After the NRC documents receipt of the application, the export license review process begins with the U.S. Government Executive Branch review, led by the Department of State. The review ensures the export is consistent with the U.S. nonproliferation laws and policy; the export is not inimical to the common defense and security of the U.S.; the facilities receiving the material meet the physical protection requirements of INFCIRC/225 Rev 4/5; and assurance from the foreign government for Agreement for Cooperation compliance for peaceful use of the nuclear material. For HEU, the reviewers verify the HEU need and confirm that there is no LEU alternative. Then, NRC

conducts final Policy, Safeguards and Legal reviews before submitting the package to the NRC Commissioners for final approval and issuance of the export license.

It is sometimes a challenge to obtain the export license in time to meet the customer's fabrication schedules as final contract negotiations and transportation arrangements take time to coordinate. However, some recent improvements to the process have helped expedite the supply and export process. For LEU, Y-12 encourages multi-year supply contracts with multi-year, multi-delivery export licenses with the FRR customers. The customer benefits by better pricing, assurance of supply, and timely delivery of material. To help expedite the export license process, Y-12 provides monthly status updates for planned/projected EU exports to the NRC and the NNSA Office of Nuclear Safeguards. The information is used to schedule the physical protection bilateral site assessments and to know deadlines when export license needs to be issued to meet delivery schedules.

Summary

In Fiscal Year 2012, Y-12 supplied and safely and securely delivered over 1400 kgs EU to 11 different FRR customers in 9 separate deliveries. The Y-12 production and export processes help ensure a reliable and cost-effective uranium supply program to support the global research reactor community.