

## Isotope Production and Distribution Program Fund

### Overview

The Department of Energy's Isotope Program produces and sells radioactive and stable isotopes, byproducts, surplus materials, and related isotope services worldwide. It operates under a revolving fund, the Isotope Production and Distribution Program Fund, established by the 1990 Energy and Water Development Appropriations Act (Public Law 101-101), as amended by the 1995 Energy and Water Development Appropriations Act (Public Law 103-316). Funding for the Isotope Production and Distribution Program Fund is provided by the combination of annual appropriations from the Isotope Development and Production for Research and Applications subprogram within the Nuclear Physics (NP) program in the Science appropriation account, and collections from isotope sales; both are needed to maintain the Isotope Program's viability. This revolving fund allows continuous and smooth operations of isotope production, sales, and distribution independent of the federal budget cycle and fluctuating sales revenue. An independent cost review of the fund's revenues and expenses is conducted annually by an external contractor.

Annual appropriations in NP funds a payment into the revolving fund to maintain mission-readiness of facilities, including the support of core scientists and engineers needed to carry out the Isotope Program and the maintenance of isotope facilities to assure reliable production. In addition, appropriated funds provide support for research and development (R&D) activities associated with development of new production and processing techniques for isotopes, production of research isotopes, and training of new personnel in isotope production. Each site's production expenses, including processing and distributing isotopes, are offset by revenue generated from sales. About 80 percent of the resources in the revolving fund are used for operations, maintenance, isotope production, and R&D for new isotope production techniques, with approximately 20 percent available for process improvements, unanticipated changes in volume, and purchases of small capital equipment, such as assay equipment and shipping containers needed to ensure on-time deliveries.

The Department supplies isotopes and related services to the Nation under the authority of the Atomic Energy Act of 1954, which specifies the role of the U.S. Government in isotope distribution. Substantial national and international scientific, medical, and research infrastructure relies upon the use of isotopes and is strongly dependent on the Department's products and services. Isotopes are used for hundreds of applications that benefit society every day, such as diagnostic medical imaging, cancer therapy, smoke detectors, neutron detectors for homeland security applications, explosives detection, oil exploration, and tracers for environmental research. For example, radioisotopes are used in the diagnosis or treatment of about one-third of all patients admitted to hospitals.<sup>a</sup> More than 20 million Americans benefit each year from nuclear medicine procedures used to diagnose and treat a wide variety of diseases.<sup>b</sup> Such nuclear procedures are among the safest and most effective diagnostic tests available and enhance patient care by avoiding exploratory surgery and other invasive procedures. The Isotope Program continuously assesses isotope needs to inform program direction including biennial Federal workshops to evaluate stakeholder requirements in order to optimize the utilization of resources and assure the greatest availability of isotopes.

Radioisotopes are primarily produced and processed at three facilities stewarded by the Isotope Program: the Brookhaven Linac Isotope Producer (BLIP) and associated processing labs at Brookhaven National Laboratory (BNL), the Isotope Production Facility (IPF) and associated processing labs at Los Alamos National Laboratory (LANL), and the processing labs at Oak Ridge National Laboratory (ORNL); while enriched stable isotopes are produced at the Enriched Stable Isotope Prototype Plant (ESIPP) also at ORNL. In addition, production and distribution activities are supported at the Advanced Test Reactor (ATR) at Idaho National Laboratory, the High Flux Isotope Reactor (HFIR) at ORNL, the Y-12 National Security Complex near ORNL, the Low Energy Accelerator Facility (LEAF) at Argonne National Laboratory (ANL), and processing facilities at the Pacific Northwest National Laboratory (PNNL) and the Savannah River Site. IPF, BLIP, and LEAF provide accelerator production capabilities, while HFIR and ATR provide reactor production capability. HFIR has the highest neutron flux available for isotope production in the United States. ESIPP represents the re-establishment of general enriched stable isotope production capabilities in the U.S. and started operations in 2016. The Isotope Program is further broadening

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<sup>a</sup> <http://www.nrc.gov/reading-rm/doc-collections/fact-sheets/med-use-radioactive-materials.html>

<sup>b</sup> <http://www.snmmi.org/ClinicalPractice/content.aspx?ItemNumber=4825>

capability by including university-supported accelerator and reactor facilities used for research, education, and isotope production that can provide cost-effective and unique production capabilities, as the University of Washington and the Missouri University Research Reactor are now part of the DOE Isotope Program University Production Network. Many other universities have expressed interest in participating in the network.

In FY 2018, a total of \$112.5 million was deposited into the revolving fund. This consists of the FY 2018 appropriation of \$40.7 million paid into the revolving fund from the Nuclear Physics program, plus collections of \$71.8 million to recover costs related to isotope production and isotope services. Collections in FY 2018 include, for example, sales of actinium-227 (Ac-227), californium-252, helium-3 (He-3), selenium-75, cobalt-60, nickel-63, germanium-68, actinium-225, strontium-82, and strontium-89. Actinium-227 provides radium-223 (Ra-223) for Xofigo<sup>®</sup>, which was the first alpha particle-emitting radioisotopic drug approved by the Federal Drug Administration; Xofigo<sup>®</sup> extends patient survival as well as alleviates the excruciating pain associated with cancer that has metastasized to bone. Californium-252 has a variety of industrial applications, including oil and gas well-logging, and fission start-up in nuclear reactors; He-3 is used in neutron detectors for national security; selenium-75 is used as a radiography source; cobalt-60 is used in gamma-ray cancer surgery; nickel-63 enhances national security through its use in detectors for explosives and illicit material; germanium-68 supports development of gallium-68 diagnostic imaging pharmaceuticals; Ac-225 is used in pharmaceuticals under development to more effectively treat cancer and other diseases; strontium-82 has gained world-wide acceptance for use in heart imaging; and strontium-89 alleviates the pain associated with bone metastases. In FY 2018, the Isotope Program sold 161 different radioactive and stable isotopes to a broad range of research and commercial customers, including major pharmaceutical companies, industrial users, and researchers at hospitals, national laboratories, other Federal agencies, universities, and private companies. Among the isotopes produced, nine are high-volume isotopes with commercial applications; the remaining are low-volume, mostly research isotopes, which are more expensive to produce. Commercial isotopes are priced to recover full cost or the market price, whichever is higher and in consideration of the commercial value of the product.

#### **Program Accomplishments**

*Development of Production of Alpha-Emitting Isotope for the Treatment of Metastatic Prostate Cancer.* A multi-year research and development effort was completed to establish a large-scale production capability for Ac-227. A radioactive decay product of Ac-227, Ra-223, is the active ingredient in Bayer's drug Xofigo<sup>™</sup> which is a treatment for metastatic prostate cancer that not only alleviates excruciating pain associated with bone metastases, but also extends patient survival. A collaboration between the Oak Ridge National Laboratory and Bayer developed radiopharmaceutical-grade production of Ac-227 and, upon completion, the DOE Isotope Program signed a multi-year contract with Bayer to supply their global demand for Ac-227.

*Reestablishment of Domestic Production of Americium-241.* Since 2003, the U.S. has been completely dependent upon a single foreign source of americium-241 (Am-241), an isotope with a variety of industrial applications such as neutron sources for oil and gas exploration and an ionization source for household smoke detectors. The DOE Isotope Program facilitated the formation of an industrial consortium that, in partnership with the Isotope Program, funded the reestablishment of a modest domestic Am-241 production capability at the Los Alamos National Laboratory. The production development effort was completed and routine production of Am-241 commenced in FY 2018. This domestic supply alleviates a significant concern of U.S. industry: the dependence on a single foreign supplier of Am-241.

*Tri-Lab Effort Increases Availability of Ac-225 for Medical Applications Research.* Scientists at Brookhaven, Los Alamos, and Oak Ridge National Laboratories are engaging in a collaboration that uses their unique facilities and expertise to develop large-scale production of Ac-225, an alpha-emitting radioisotope that shows great promise in treating a range of diseases—from metastatic cancer to fungal and even viral infections like HIV. Development of applications such as these has been inhibited by the lack of availability of sufficient quantities of Ac-225 to support laboratory research and clinical trials. In FY 2018, the Tri-Laboratory collaboration achieved routine production of up to 50 millicuries (mCi) of Ac-225 and will soon be capable of routine production runs of 100 mCi. Ultimately, the effort will be scaled up to two-week production runs of at least 1,000 mCi, which is the equivalent of the current U.S. annual production of Ac-225 from the decay of legacy thorium-229.

### **Highlights of the FY 2020 Request**

For FY 2020, the Department foresees growth in isotope demand, with particular interest in alpha-emitters for cancer therapy and stable isotopes to exploit the newly established domestic production capabilities. The portfolio of the Isotope Program continues to grow rapidly as isotope availability is increased by the program. The FY 2020 Request provides \$6,741,000 of additional funding to meet the needs of the expanding portfolio. Revolving fund resources will be used to support efforts to produce isotopes and develop production capabilities and availability to meet demand, increased He-3 extraction capabilities, enriched radioisotope capabilities, stable isotope electromagnetic separation enrichment capabilities, and development of enriched lithium-7 production capabilities. The Isotopes Program will make investments with revolving fund resources in aging isotope production infrastructure to maintain productivity and to provide enhanced facility infrastructure for increased production of Ac-225, a promising cancer therapeutic. The FY 2020 Request for the Isotope Program increases the development and production of specialized isotopes for Quantum Information Science.

The FY 2020 Request for Nuclear Physics includes a request for funding of the Stable Isotope Production Facility (SIPF) Major Item of Equipment, with planned completion of the facility in FY 2024 based on a technically-driven schedule. Initiated in 2017, SIPF (\$25.5–28.0M Total Project Cost range) will provide increased domestic capability for cost-effective production of critically needed enriched stable isotopes and reduce the nation's dependence on foreign suppliers.

The Request for Nuclear Physics includes support to initiate the Facility for Rare Isotope Beams (FRIB) Isotope Harvesting accelerator improvement project (\$9-11M Total Project Cost range). FRIB is a next generation scientific user facility being constructed at Michigan State University for nuclear structure and astrophysics measurements. This accelerator improvement project will add isotope harvesting capabilities to the FRIB, which will provide access to a wide range of isotopes, including unusual isotopes for exploratory studies.

The FY 2020 Request for the Nuclear Physics program requests \$5.0 million to initiate the U.S. Stable Isotope Production and Research Center at ORNL, which will consolidate and significantly enhance stable isotope production capacity for the Nation. This Line item construction project has a preliminary Total Project Cost (TPC) range of \$150-200M. This proposed new facility will build upon the expertise in centrifuge and electromagnetic isotope separation technology nurtured by SIPF.

