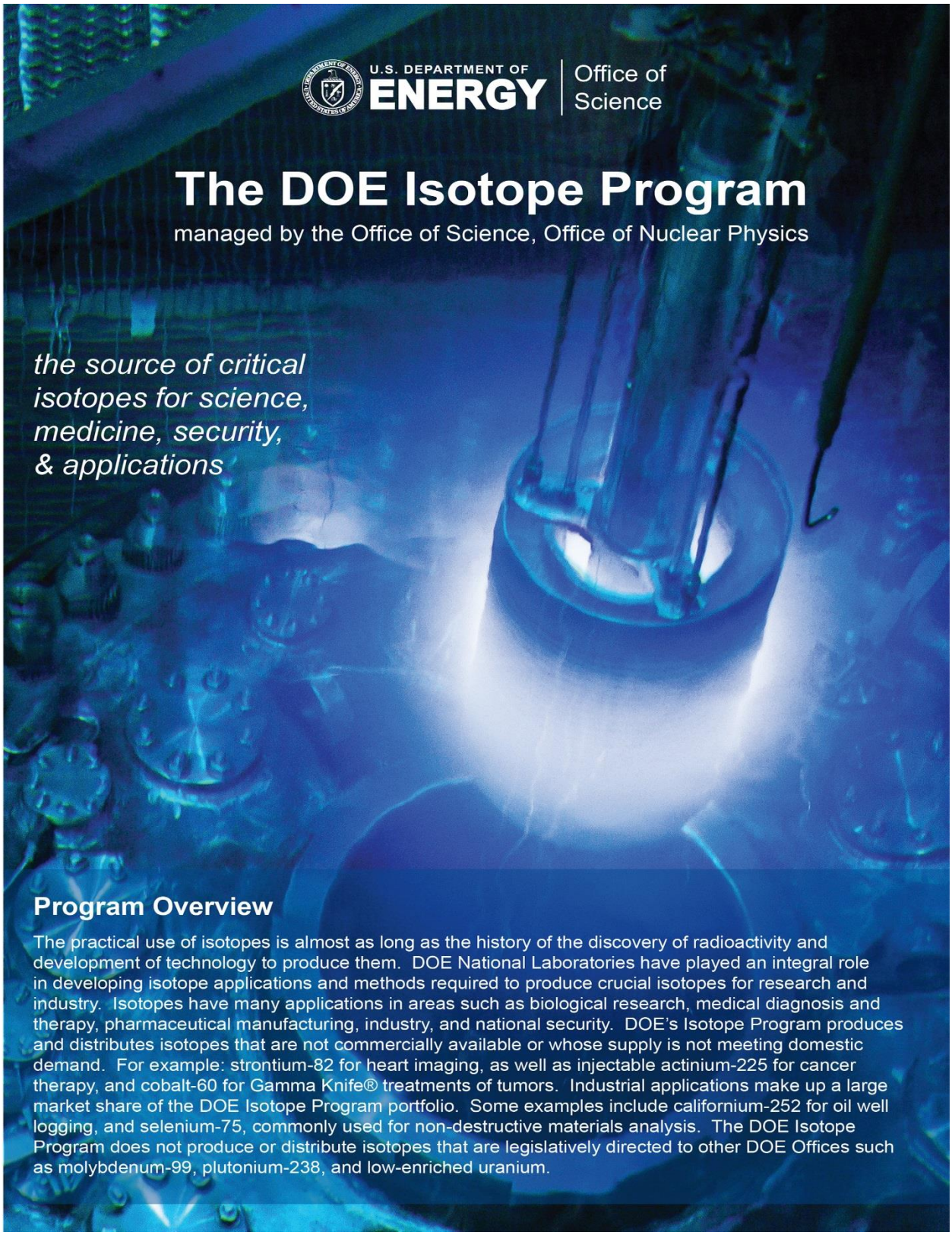


U.S. DEPARTMENT OF ENERGY | Office of Science

The DOE Isotope Program

managed by the Office of Science, Office of Nuclear Physics

the source of critical isotopes for science, medicine, security, & applications

Program Overview

The practical use of isotopes is almost as long as the history of the discovery of radioactivity and development of technology to produce them. DOE National Laboratories have played an integral role in developing isotope applications and methods required to produce crucial isotopes for research and industry. Isotopes have many applications in areas such as biological research, medical diagnosis and therapy, pharmaceutical manufacturing, industry, and national security. DOE's Isotope Program produces and distributes isotopes that are not commercially available or whose supply is not meeting domestic demand. For example: strontium-82 for heart imaging, as well as injectable actinium-225 for cancer therapy, and cobalt-60 for Gamma Knife® treatments of tumors. Industrial applications make up a large market share of the DOE Isotope Program portfolio. Some examples include californium-252 for oil well logging, and selenium-75, commonly used for non-destructive materials analysis. The DOE Isotope Program does not produce or distribute isotopes that are legislatively directed to other DOE Offices such as molybdenum-99, plutonium-238, and low-enriched uranium.

Mission and Authorization

- Produce and/or distribute radioactive & stable isotopes that are in short supply, associated byproducts, surplus materials, & related isotope services
- Maintain infrastructure required to produce & supply isotope products & services
- Conduct R&D on new & improved isotope production & processing techniques that can make new isotopes available for research & applications
- Atomic Energy Act (AEA) of 1954 provides the statutory & legal authorities under which the DOE can produce its products & provide related services
- In 1990, Public Law 101-101, as amended by PL 103-316, centralized the Isotope Program as one point of contact at DOE under the Office of Nuclear Energy (NE)
- In FY 2009, the DOE Isotope Program moved from NE to the Office of Nuclear Physics within the Office of Science

Front Cover: Withdrawal of the High Flux Isotope Reactor (HFIR) core assembly at ORNL. (Source: ORNL)

Above Image: Archival image of stable isotope packaging and labeling. (Source: ORNL)

Advisory Committee

The Nuclear Science Advisory Committee (NSAC) is a federal advisory committee chartered jointly by the DOE and the National Science Foundation (NSF) to provide advice on the national program for basic nuclear science research. In 2014, the NSAC was charged with the responsibility of creating a subcommittee for the DOE Isotope Program (NSAC-I) to review progress since the last study in 2009 and identify priorities and opportunities for isotope research and production. The NSAC-I report found that all recommendations from its 2009 report had been successfully addressed.

> **"DOE-NP has done an outstanding job of reorganizing the program and setting it on a firm footing."**
>
> *- From the 2015 NSAC-I Long Range Plan*

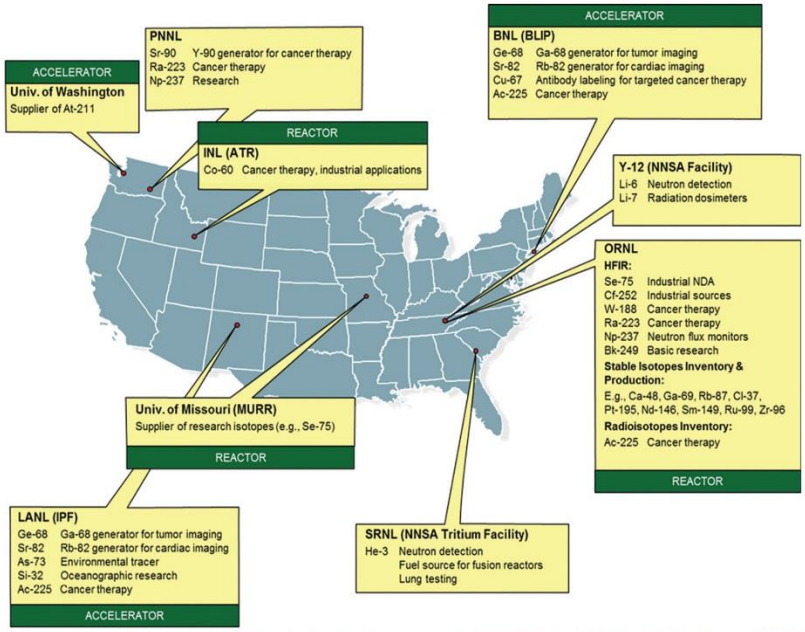
R&D and Production Programs

Research activities, supported by the DOE Isotope Program, have increased the number of isotopes available for cancer therapy, diagnostic imaging, fundamental nuclear science research, and industrial applications. Sustained funding has also introduced new technologies for improving production and processing efficiencies; additionally, continued research enables workforce development in STEM fields.

DOE National Laboratory facilities produce isotopes to meet the demand for stable and radioactive isotopes. The DOE Isotope Program uses reactors, accelerators, and extraction from legacy waste to produce isotopes in short supply. It is the synergy among the different DOE science offices, National Nuclear Security Administration (NNSA), and NE that enables the breadth of isotope availability. A high priority of the DOE Isotope Program is to establish university networks to coordinate the regional production of short-lived biomedical isotopes, leveraging university production potential. The DOE Isotope Program is also re-establishing a general enriched stable isotope production capability in the U.S., which begins operation in 2016.

The production of isotopes at a suite of facilities is coordinated by the National Isotope Development Center (NIDC), which interfaces with the user community. NIDC's Isotope Business Office generates contracts and manages distribution of isotopes.

DOE Isotope Program Production Sites



Development of isotope production capabilities is also being supported at UC Davis, Duke Univ., Texas A&M Univ., Washington Univ., and Univ. of Wisconsin.

Some Critical Isotopes Whose Availability Was Recently Increased

Ac-225	Developing large-scale accelerator production for alpha particle cancer therapy research
At-211	Developing production network to provide national availability for alpha particle cancer therapy research
Bk-249	Produced for the discovery of element 117 and other super-heavy element research
Cf-251	Provided for superheavy element research to discover new elements on the periodic table
Cf-252	Reestablished production in FY 2009 for well-logging and many other industrial applications
Co-60	Reestablished domestic production for cancer therapy, industrial applications
Cu-67	Cancer therapy research
He-3	Mitigated shortage for use in cryogenics, homeland security, medicine, and research
Li-6	Production of metal form for neutron detector nuclear materials smuggling interdiction
Li-7	Generating reserve for nuclear power industry to mitigate potential shortage; new production R&D
Np-237	Inventory for dispensing bulk quantities and capability to fabricate reactor dosimeters
Pb-212/ Bi-212	Established production of Ra-224 generators for the provision of Pb-212 and Bi-212 for alpha particle cancer therapy research
Se/As-72	Developed production capability for Se-72 for As-72 generator; medical diagnostic imaging
Se-75	Alternative to Ir-192 for gamma radiography, industrial quality control
Si-32	Oceanographic and climate modeling research; replenished depleted inventory
Sr-82	Generator of Rb-82 for cardiac imaging
Th-227/ Ra-223	Established Ac-227 feedstock for the provision of Th-227 and Ra-223 for alpha particle cancer therapy research
U-233	Established inventory of high-purity U-233 and Th-229 for scientific research
U-234	Neutron flux monitors for nuclear reactors
W-188	Reestablished routine reactor production for therapeutic medical applications
Y-86	Established production capability for medical diagnostic imaging applications

~250 Stable Isotopes for Sale

72 Radioisotopes for Sale

165 Graduates & Undergrads Supported

39 Isotope R&D Grants

22 Fed Agency Missions Supported

3 Accelerators

3 Reactors

Progress on Production of Alpha-emitting Radioisotopes for Cancer Therapy

Alpha emitting radioisotopes have great potential for effective and safe treatment of a wide variety of cancer types. High-yield production of nuclides such as Ac-225 for application in emerging treatment of metastatic cancer via targeted alpha-immunotherapy and Ra-223 for the treatment of metastatic bone cancer would accelerate development of promising clinical applications.

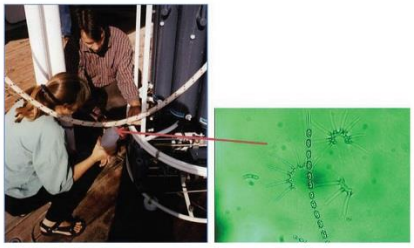
Full Highlight: http://science.energy.gov/np/highlights/2012/np-2012-07-a/

Actinium-225 samples held in two vials. (Source: ORNL)

Silicon-32 Is an Important Radiotracer in Assessing Global Climate Models

The DOE Isotope Program has made silicon-32 available for marine research which is valuable to understanding and modeling the global climate. Marine biologists have successfully used silicic acid tagged with various silicon isotopes as a tracer to measure silica production rates in coastal seawater. The radiotracer Si-32, a pure beta-emitting isotope, has advantages over stable isotope tracers because it is significantly easier to use due to the easily detected low energy radioactive emissions. This enables real-time quantitative radioanalytical measurements of silicic acid uptake rates in samples at sea.

Full Highlight: http://science.energy.gov/np/highlights/2014/np-2014-05-a/



Left photo shows researchers collecting sea-water samples containing diatoms from an oceanographic sampling device. Photo at right shows microscopic image of a small colony of diatoms in the sea water. (Source: LANL)

DOE Isotope Program Provides Target Material for the Discovery of Superheavy Elements

Bk-249 target material was provided by the DOE Isotope Program enable the experiments which discovered element 117 and subsequent experiments which confirmed its existence, as well as searches for other superheavy elements. Evidence supporting the possible existence of the Island of Stability for very heavy elements has been provided by the discovery of several of these heavy nuclei that are somewhat stabilized with respect to radioactive decay. The enhanced stability is a result of quantum effects and related shell structure in these nuclei which opens up the world of nuclei and atoms to further expansion toward even heavier elements. The longer half-lives of the isotopes observed in the decay chains of these new elements provide an opportunity to measure nuclear masses and determine chemical properties of superheavy elements, allowing the expansion of knowledge of the behavior of atomic and nuclear matter in new ways. The discovery of element 117 was officially recognized by the Division of Inorganic Chemistry of the International Union of Pure and Applied Chemistry in December 2015.

Full Highlight: http://science.energy.gov/np/highlights/2016/np-2016-05-a/

The green dot at the bottom of the glass vial is a solution containing 22 milligrams of ultra-pure Bk-249 produced at ORNL's High Flux Isotope Reactor and Radiochemical Engineering Development Center at ORNL. (Source: ORNL)

For More Information

- **U.S. Department of Energy Isotope Program:** http://science.energy.gov/np/research/idpra/
- **NIDC Website:** https://isotopes.gov/ (U.S. Department of Energy Isotope Program overview video available here.)
- **The Nuclear Science Advisory Committee – Isotopes report:** "*Meeting Isotope Needs and Capturing Opportunities for the Future: The 2015 Long Range Plan for the DOE-NP Isotope Program*" http://science.energy.gov/~/media/np/nsac/pdf/docs/2015/2015_NSACI_Report_to_NSAC_Final.pdf