The DOE Isotope Program and Facilities and the SBIR/STTR Program
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DOE Isotope Program Mission

Produce and/or distribute radioactive and stable isotopes that are in short supply; includes by-products, surplus materials and related isotope services

Maintain the infrastructure required to produce and supply priority isotope products and related service

Conduct R&D on new and improved isotope production and processing techniques which can make available priority isotopes for research and application. Develop workforce.

*Produce isotopes that are in short supply only – we do not compete with industry*

*Mitigation of U.S. reliance on foreign supplies of isotopes is a priority*
Public Law 101-101 (1990), as modified by Public Law 103-316 (1995) created the Isotope Production and Distribution Program Fund (called a revolving fund) and allow prices charged to be based on costs of production, market value, U.S. research needs and other factors.

Isotope Program in DOE has sole governmental authority to produce isotopes for sale and distribution – labs may not embark on isotope production on their own.

Program costs are financed by two resources: appropriation and revenue.
- Appropriation supports mission readiness and R&D program
- Revenue supports production and distribution of isotope

We try to understand and anticipate isotope demand for federal missions, research and U.S. industry
- Increase availability of isotopes in short supply
- Mitigate potential shortages
- Develop new production and processing techniques of isotopes currently unavailable
- Reduce U.S. dependencies on foreign supply
- We are prepared to make investments on behalf of research, medicine, & industry
  - Annual Federal Isotope Needs Surveys and interacting with POC’s
Guided by NSAC Report released July 20, 2015

Recommendations:  All in Progress

- Significant increase in R&D funding
  - Continue R&D on alpha-emitters (Ac-225, At-211)
  - High specific activity theranostic isotopes
  - Electron accelerators for isotope production
  - Irradiation materials for targets

- Complete stable isotope capability

- Increase in infrastructure investments and operating base
  - Isotope harvesting at FRIB
  - Separator for radioactive isotopes
    - DOE to host meetings in the new year; focus on additional mission needs
    - Several programs looking at actinide EMIS
    - Potential needs for medical and research isotopes
  - BLIP intensity upgrade and second target station
  - IPF intensity, stability and energy upgrades

- Continue integration of university facilities

- The DOE NIDC coordinates the distribution of all DOE isotope products and services for the DOE IP.

- All contractual discussions with customers.

- Responsibilities in transportation, Q&A, public relations (website, newsletter, booth), cross-cutting technical topics, marketing strategy and

- Receive updates and request quotes for products.
DOE Isotope Program Production and/or Development Sites

- **PNNL (ATR)**
  - Sr-90 Y-90 generator for cancer therapy
  - Ra-223 Cancer therapy
  - Np-237 Research

- **BNL (BLIP)**
  - Ge-68 Ga-68 generator for tumor imaging
  - Sr-82 Rb-82 generator for cardiac imaging
  - Cu-67 Antibody labeling for targeted cancer therapy

- **UC Davis**
  - Development of research isotopes (e.g., At-211, Zr-89, Y-86, Pb-203)

- **INL (ATR)**
  - Co-60 Gamma knife, sterilization of medical equipment

- **Y-12 (NNSA Facility)**
  - Li-6 Neutron detection
  - Li-7 Radiation dosimeters

- **LANL (IPF)**
  - Ge-68 Ga-68 generator for tumor imaging
  - Sr-82 Rb-82 generator for cardiac imaging
  - As-73 Environmental tracer
  - Si-32 Oceanographic research

- **ANL (LEAF)**
  - Cu-67 Antibody labeling for targeted cancer therapy

- **ORNL**
  - HFIR:
    - Se-75 Industrial NDA
    - Cf-252 Industrial sources
    - W-188 Cancer therapy
  - Radioisotopes Inventory:
    - Ac-225 Cancer therapy
    - Ra-223 Cancer therapy
  - Stable Isotopes Inventory:
    - E.g., Ca-48, Ga-69, Rb-87, Cl-37
  - Stable Isotope Production

- **Univ. of Missouri (MURR)**
  - Supplier of research isotopes (e.g., Se-75, Ho-166, Lu-177, Sm-153)

- **Washington Univ.**
  - Development of research isotopes (e.g., Cu-64)

- **Michigan State Univ.**
  - FRIB isotope harvesting development

- **Mich. Univ.**
  - Development of research isotopes (e.g., Cu-64)

- **ANL (LEAF)**
  - Cu-67 Antibody labeling for targeted cancer therapy

- **Duke University**
  - Development of research isotopes (e.g., At-211)

- **SRNL (NNSA Tritium Facility)**
  - He-3 Neutron detection
  - Fuel source for fusion reactors
  - Lung testing
Brookhaven National Laboratory Brookhaven Linac Isotope Producer (BLIP)

- The BLIP beam line directs protons up to 105µA intensity to targets; parasitic operation with nuclear physics programs for more cost effective isotope production.
- Accelerator improvement project completed in 2016
  - Beam rastering increased isotope yield and decrease target fatigue.

Los Alamos National Laboratory Isotope Production Facility (IPF)

- Diversion of 100 MeV proton beam to target station.
- Irradiates targets while LANSCE operates for NNSA.
- Accelerator improvement project recently completed
  - IPF beam transport system upgraded to increase isotope yields and enhance R&D capabilities.
  - Final review to occur in September.
Major Initiatives to Increase Isotope Production Capabilities

- **Brookhaven Linac Isotope Producer (BLIP) Beam Raster System**
  - Added equipment to:
    - Raster the proton beam
    - Provide enhanced beam diagnostics
  - Enabled increase in beam current on target (greater isotope yields)
    - Max. design current increased from 125 to 140 µA due to project to modify proton pulses
    - Actually achieved >160 µA
    - Current had been limited to <100 µA to prevent target failure
  - Lowered possibility of target failures

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Integral of beam distribution is the same for both plots.
- **LANL Isotope Production Facility (IPF) Beam Transport Upgrade**
  - Project completed on time - prior to IPF operating cycle in summer 2017
  - Enables increase in beam current from 230 µA to 380 µA
    - Anticipated 65% increase in production yields
  - Improves R&D capabilities and enhances facility reliability
    - Beam energy, current, profile, and emittance measurements
Idaho National Laboratory Advanced Test Reactor (ATR)
- Co-60 target design in collaboration with ORNL
- High Specific Activity Co-60 for medical applications

Oak Ridge National Laboratory High Flux Isotope Reactor (HFIR)
- Radiochemical Engineering Development Center (REDC)
Other Isotope Program Sites

Y-12

- Li-6
- Li-7
- Establishing reserve of Li-7 for nuclear power industry

Argonne National Laboratory

- Low Energy Accelerator Facility (LEAF)
  - e⁻ accelerator
  - Theranostic production by phototransmutation for cancer therapy

Pacific Northwest National Laboratory

- Radiochemical Processing Laboratory
  - Automated target processing and separations

SRS

- He-3 extraction from NNSA tritium
Isotope Program Development and Areas of Overlap with SBIR/STTR
SBIR and the Isotope Program

**SBIR/STTR**

- Support R&D toward products or services and process improvements with broad impact
- Encourage collaboration between Labs and Industrial Partners
- SPP (Strategic Partnership Project; replaces WFO), CRADA, IBO Contract

**Expectations**

- No adverse impacts on programmatic mission (facilities, personnel resources)
- Development to commercialization primarily responsibility of the industrial partner
- Private industry may not use Government facilities for commercial production of proprietary end products.
Subtopic A: Novel or Improved Isotope Production Techniques

- Targetry design, fabrication and thermal modeling
  - Withstand higher-current and power densities from commercial accelerators
  - In situ target monitoring
  - Novel self-healing materials
  - Extreme radiation resistance
  - In-hot cell techniques

- Advanced Accelerator or Reactor Technologies
  - High-gradient particle accelerating structures
  - High-energy/high-current cyclotrons
  - Compact sources

- Automation or robotics to handle and process large mass, highly radioactive thick targets
A. Subtopic A (continued)

- Isotopic decay by high Linear Energy Transfer particulate emission for targeted therapy
  - Alpha-particle emitters
  - Auger-electron emitters

- Isotopes capable of functioning as diagnostic/therapeutic (theranostic) pairs or single isotopes combining both traits
Subtopic B: Improved Radiochemical Separation Methods for Preparing High-Purity Radioisotopes

- Particular interest in lanthanide and actinide separations
- Developments in automation and remote handling using radiation hardened modular systems
  - Separation, purification, elution, radiolabeling, and dispensing
  - Reduced worker dose and labor hours
  - Easily adaptable to multiple processes and hot-cell configurations
  - Ease of compliance with cGMP practices for clinically relevant isotopes

- Developments of separation technologies to improve binding capacity, separation efficiencies, resin selectivities, void volume decreases, and minimize waste streams
  - High-radiation field resistant ion exchange resins, sorbents and extractants
  - Lanthanide and actinide separations
  - Scale up of separation techniques
**Subtopic B: (continued)**

**He-3 (beta decay tritium, SRNL):** Neutron Detection (proportional counter tube), cryogenic systems (below 300 mK)

**New Production:**
- We anticipate longer term He-3 demand growth in areas including:
  - Cryogenics
  - Oil/gas exploration
  - Medical diagnostics
- Proposals are sought for efforts leading to terrestrial production of He-3
  - Potential methodologies might include natural gas, reactors, or other means of production not listed

**D₂O (Heavy Water) Remediation and Tritium Capture:**
- Current need to process contaminated D₂O (Heavy Water)
- Proposals are sought for novel processes that:
  1. remove head-gas He-3
  2. remove and capture residual tritium from U.S. Government (USG)-owned heavy water
- After purification, the residual tritium levels in the heavy water must be below the established EPA limit of 2 uCi/Kg.
Strong synergy with US Private Sector (Medical and Industrial Applications) – would like to see growth fostered by SBIR/STTR interactions

Potential areas of opportunity with SBIR/STTR:

- Target Optimization – new modeling capabilities, new materials and designs can be considered, novel fabrication techniques
- General Equipment – areas related to improved accelerator and reactor technologies as well as general diagnostics
- Process Optimization – automation of processing and associated activities (product dispensing)
- Production of alpha-emitters, auger-electron emitters, and theranostics
Thank You!