Enriched Stable Isotope Production

DOE Isotope Program -- Federal Workshop

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Introduction

• Stable Isotopes Uses and History
• Enrichment Technology Developments
• Enriched Stable Isotope Prototype Plant
• Accomplishments – Electromagnetic Separator
• Status – Gas Centrifuge Separator
• Stable Isotope Production Plant
• Radioactive Isotope Separator
Stable Isotopes Uses

Basic Research
- Physics
- Environment
- Materials
- Agriculture
- Analytical Chemistry
- Geosciences

Medicine
- Therapies
- Imaging
- Research
- Dental

National Security
- Communications
- Detection
- Nuclear Data
- Global Positioning Sources

Industry
- Standards
- Inspections
- Testing
- Sources
- Nuclear Data

Enriched Stable Isotopes
Stable Isotope Operations at ORNL

- Enriched >230 stable Isotopes 1945 - 1998
- Unique materials with few other suppliers
- No existing domestic broad-scope enrichment
- U.S. dependent on foreign sources for new production
- Isotope Program manages national inventory
- Inventory of 11 has been exhausted
- Answered 643 isotope quote requests
- Dispensed more than 216 items in 109 shipments

— www.isotopes.gov
Strategic Planning for Isotopes Opportunities

• The 220 stable non-gaseous isotopes are not currently produced domestically

• Most require separation and enrichment by either electromagnetic or gas centrifuge separators

NSAC Recommendations:

• Reestablish a domestic source of mass-separated stable research isotopes.

• Develop a strategy to re-establish a separator for radioactive isotopes to support research
Enrichment Technology
Pathways to Enrichment

Natural Material → Gas Centrifuge → Electromagnetic Separator

Electromagnetic Separator:
- All elements, all isotopes
- x10s enrichment
- mg to 100s g/yr

Isotopically Enriched Product

Gas Centrifuge:
- Select elements, one isotope
- x2 to x5 enrichment
- 100s g to kg/yr

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Enriched Stable Isotope Prototype Plant (ESIPP)

- Commissioned 2017
- Investment of $11M by DOE Isotope Program
- Capability established for the Federal research community
- Small-scale production (research quantities)
- First EMIS product!
  - Ruthenium-96
  - Brookhaven National Lab Quark-Gluon Plasma research
  - Delivered January 2018.
- Pre-production under way for Ytterbium-176 enrichment

Separated ruthenium ion beams entering EMIS collector pockets.
Enriched Stable Isotope Prototype

Transition to Operations FY 2017 - 2018

Production Priorities -- EMIS
• Ruthenium-96; for physics research
• Ytterbium-176; target for cancer-therapy radioisotope

Production Priorities -- GCIS
• Molybdenum-98 and -100; targets for diagnostic radioisotope
• Xenon-129 and -136; for polarized lung imaging and physics
• Silicon-28 for semiconductors

This capability is for you – let us know what you need.
Gas Centrifuge Isotope Separation

- Higher throughput
- Some isotopes can be fully enriched (e.g. Ge, Mo)
- Provide pre-enriched feedstock material for EMIS
  - Multiplies EMIS performance to help achieve g/year production
  - Reduces the number of EMIS machines needed
Expand from prototype to nominal kilogram annual production

- Mission Need (CD-0) – Approved
- Alternatives Analysis (CD-1) for Expansion -- Approved

- Kilogram goal requires focus on expanding GCIS for throughput capacity
- CD-2 will establish baseline and final centrifuge design
- Early candidates include
  - Xenon
  - Silicon
  - Germanium
  - Molybdenum
Radioactive Isotope EMIS?

- NSACi 2015 Recommendation
- Other programs are conducting development work
- Federal Information gathering 2017 - 2018:
  - $^{225}\text{Ac}$, $^{153}\text{Gd}$, $^{177}\text{Lu}$, $^{153}\text{Sm}$, and $^{166}\text{Ho}$ for medicine
  - Add $^{74}\text{Se}$ and thorium isotopes for commercial applications
  - beryllium and californium for physics research
- INL and MURR EMIS machines are candidates
- Further Mission Need is not clear. Further input is welcome.
Conclusion

- Addressed NSAC Recommendations
- Transitioned ESIPP to Operations for the Stable Isotope Community
- Input from the Community will Affect Priorities
- Next Steps?
  - FY 2019 $^{100}$Mo, $^{96}$Ru, $^{129}$Xe, $^{176}$Yb Gram-scale Production
  - Stable Isotope Production Facility
  - Maximizes Use of ESIPP Footprint
  - Kilogram-scale production achievable for selected isotopes
  - Radioactive Isotope Separator Development