SHINE Snapshot

**SHINE is building new irradiation and processing infrastructure**

• Dedicated to being the world leader in the safe, clean, affordable production of medical isotopes

• One of few projects aggressively pursuing new irradiation and processing infrastructure

• Since last year:
  • GE tested SHINE Mo-99 in November 2015 and found it met all specifications
  • US Nuclear Regulatory Commission construction permit issued in February 2016
  • HTA agreement

• Over $50M invested to date in technology and regulatory process

• Leading efforts to establish domestic fission-based isotope supply
SHINE Technology

A modernized approach to making Mo-99

• Integrated production and refining
• SHINE irradiation unit is a hybrid
  • Accelerator creates D-T neutrons that drive reactions in the target
  • Neutrons multiply in subcritical uranium sulfate solution, allowing for very high yield
• 100% LEU
• Cost effective approach
  • Elimination of reactor results in 100s of times less waste than conventional production
  • Reusable target
Demonstrated Technology

The world’s strongest neutron generators

• Plant-scale accelerator at Monona, Wisconsin facility
• March 2016 demonstration
  • 132 consecutive hours of operation
  • 97% uptime
• Thousands of hours of operation logged on similar accelerators
### Demonstrated Technology

_Every part of the process demonstrated_

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<th>Process Step</th>
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| Irradiation  | ✓             | • Plant-scale neutron driver operational  
               |               | • Operation at plant cadence demonstrated |
| Target       | ✓             | • Many SHINE-specific uranyl sulfate irradiations performed at ANL and LANL  
               |               | • Uranyl sulfate solutions routinely used in critical reactors at 2x power density (Argus) |
| Processing   | ✓             | • Separations demonstrated from sulfate solutions (Argus, LANL, ANL)  
               |               | • Cintichem process was used for decades |
Market Acceptance

**Supply chain compatibility**

- Fission-based, high-specific activity
  - No changes to pharmacy practices
  - Ensures access to other isotopes, including I-131 and Xe-133
- Supply agreements
  - 2014 - GE Healthcare and Lantheus Medical Imaging
  - June 2016 - HTA Co., Ltd.
GE Drytec Generator and Kit Test

Mo-99 produced by the SHINE process met all GE quality requirements

- Mo-99 produced by the SHINE process at Argonne National Laboratory was loaded on a GE DryTec generator
- Eluted Tc-99m was used with Myoview and Ceretec kits
- Mo-99, Tc-99m and both drugs met all GE specifications
- Demonstrates SHINE chemistry is compatible with DryTec generators and drugs
NRC Construction Permit Issued

**SHINE noted as model applicant**

- NRC issued SHINE Construction Permit February 2016
  - Culmination of over four years of work
  - Only U.S. medical isotope producer with NRC approval to construct
Production Facility Design

**Designed for logistical efficiency**

- SHINE facility to be built in Janesville, Wisconsin, USA
- 57,000 ft\(^2\) production facility
- Plant capacity of 4000 6-day Ci/week
  - Over 1/3 global demand
- 8 independent irradiation units – ensures high reliability, flexible production schedule
- Independent hot cell chains further increase reliability and flexibility
Next Steps

Industry-leading progress

• Current key activities
  • Construction team selected
  • Preparing operating license
  • Completing detailed design
  • Negotiating additional supply agreements

• Construction to begin early 2017
• Commercial production in 2019
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