

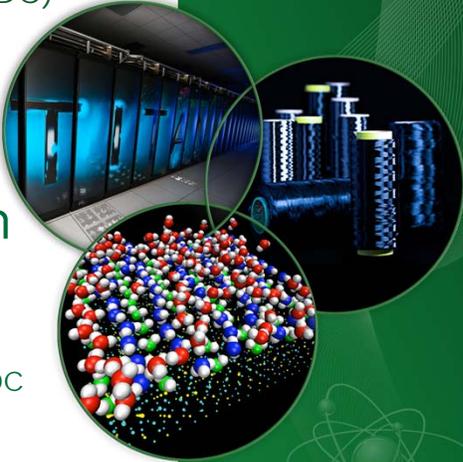
National Isotope
Development Center (NIDC)

Isotope Program Transportation

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Isotope Business Office
Transportation Manager, NIDC

National Transportation
Stakeholders Forum Meeting
May 13-15, 2014

ORNL is managed by UT-Battelle
for the US Department of Energy



Outline

- Overview of DOE Isotope Program
- Isotope Research and Uses
- IP Transportation and Packaging Program and Activities
- T&P Challenges and Successes
- Discussion and Questions

Isotope Program Mission

The mission of the DOE Isotope Program is threefold:

1. Produce and/or distribute radioactive and stable isotopes that are in short supply, associated byproducts, surplus materials and related isotope services.
2. Maintain the infrastructure required to produce and supply isotope products and related services.
3. Conduct R&D on new and improved isotope production and processing techniques which can make available new isotopes for research and applications.



Isotope Production Facility (LANL)



High Flux Isotope Reactor Facility (ORNL)



Brookhaven Linac Isotope Producer

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Isotope Program History

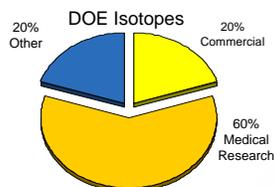
On August 2, 1946, the director of Oak Ridge National Laboratory, presented the first small container of Carbon-14 to the director of the Barnard Free Skin and Cancer Hospital in St. Louis, MO, for medical use and treatment

1947, the Atomic Energy Commission established a program and policy to handle the sale and distribution of isotopes for R&D and medical treatment.

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 allowed prices charged to be based on costs of production, market value, U.S. research needs and other factors

Congressionally appropriated funds are provided to maintain infrastructure capability and to perform research and development initiatives

Majority of isotopes produced are for medical community

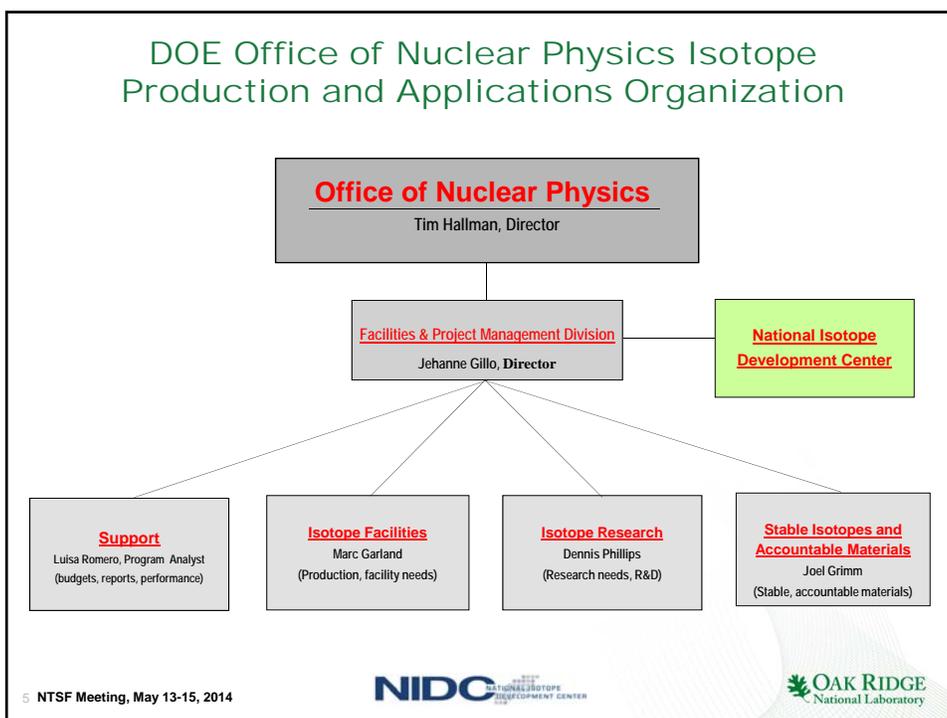


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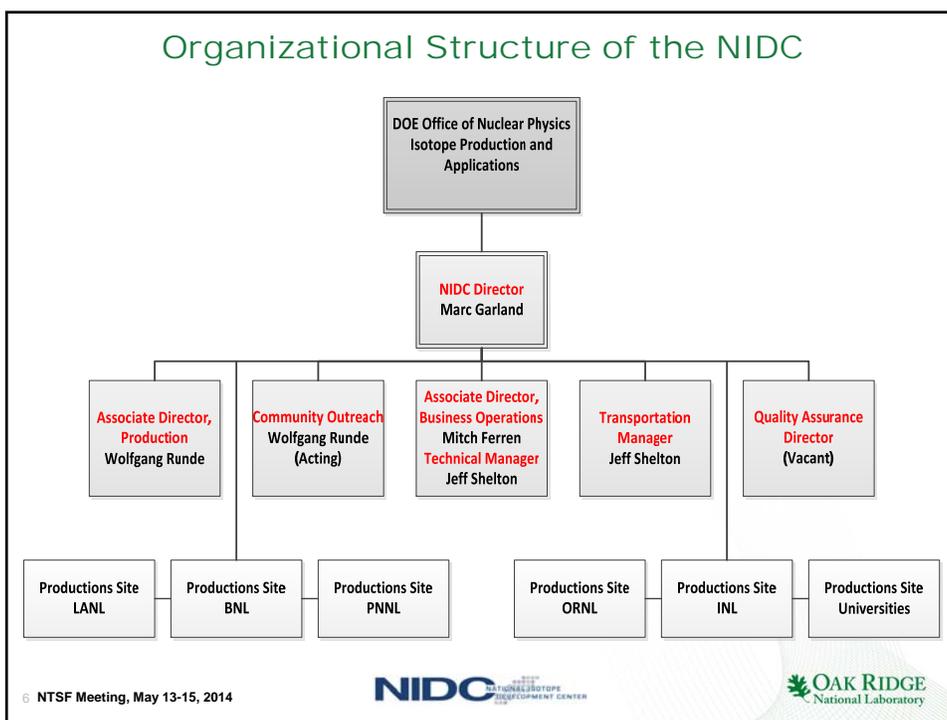
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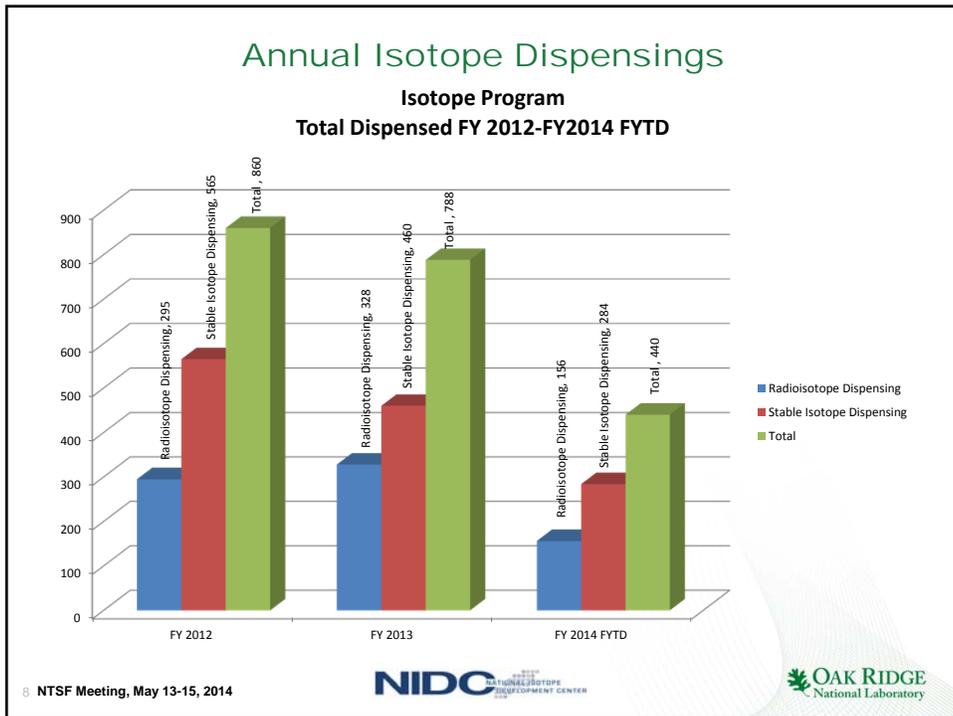
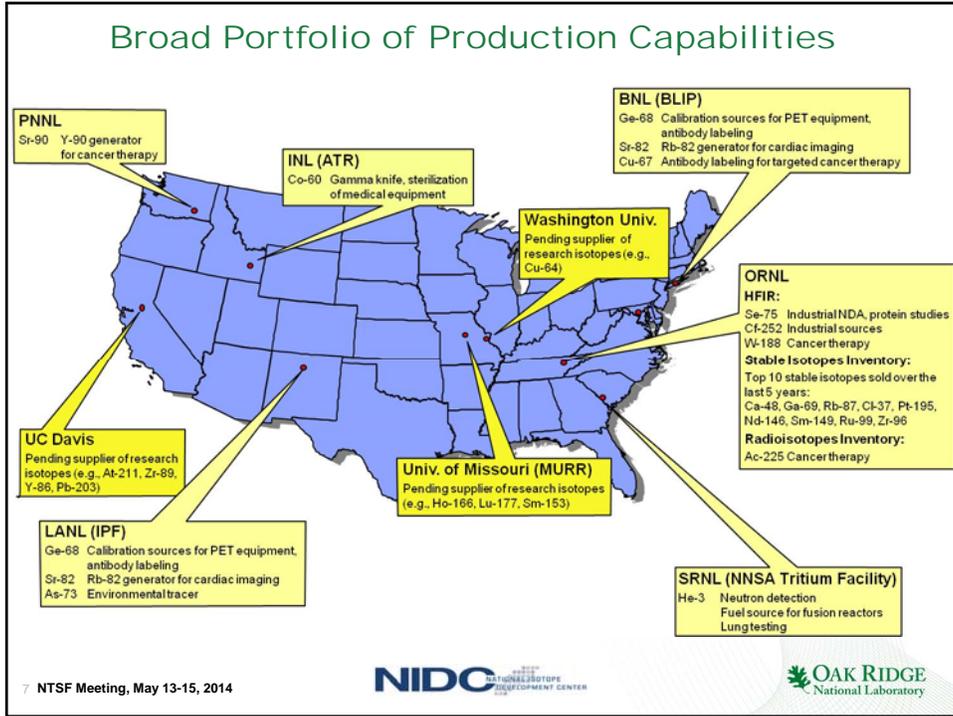
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DOE Office of Nuclear Physics Isotope Production and Applications Organization



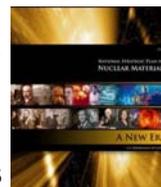
Organizational Structure of the NIDC





Isotope Program Distribution Services

- **The IP also provides services to manage the distribution of isotopes that are owned by other programs**
 - Most of these are legacy materials owned by other DOE organizations
 - IP is involved with internal working groups for legacy isotope stewardship
 - IP has access to nuclear materials before dispositioning and evaluates those caches for potential use
 - IP participates in the National Strategic Plan for Nuclear Materials
 - Provides effective interface for communication and strategic planning across multiple agencies



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Why are Isotopes Important?

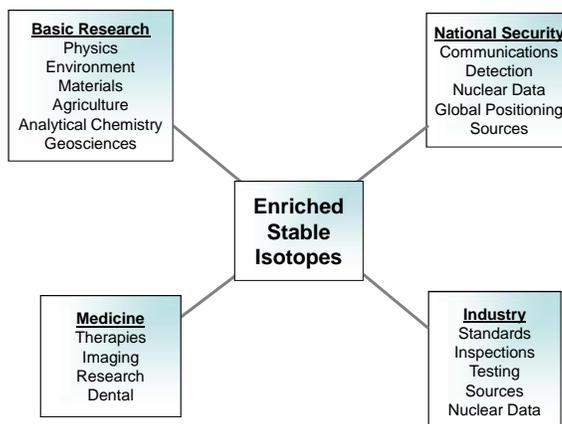
Discovered less than 100 years ago, Isotopes are now used in a wide variety of scientific applications that touch the lives of almost every citizen. These include:

- Radiopharmaceuticals used for medical imaging in the diagnosis of a wide range of ailments, from pneumonia to heart diseases to cancer (i.e., Sr-82, Ge-68, Cu-67)
- Radiopharmaceuticals for cancer treatment and other therapeutic applications (i.e., Ac-225, Bi-213, Pb-212, Ra-223);
- Smoke detectors used in our home and offices (i.e., Am-241);
- Batteries that power NASA satellites in the far reaches of our solar system (i.e., Pu-238);
- Reactor start-up sources for safe operation of nuclear power plants (i.e., Cf-252);
- As a "fingerprint" used in forensic analysis and techniques (i.e., stable isotopes);
- To calibrate detectors used to keep our shipping ports safe from terrorism (i.e., U-235);
- Explosives and narcotics detectors based on electron capture technology for airports security and other sensitive locations (i.e., Ni-63); and
- Many other applications in energy production, industrial diagnostic methods, archeology, geology, ecology, astronomy, and physics.

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Stable Isotopes are Used in Many Fields Either Directly or as Precursors to Radioisotopes



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New Isotopes in IP

- **Bk-249**: Produced 22 mg target that led to the discovery of element 117; produced 26 mg for further super-heavy element research
- **Cf-249**: Provided for actinide borate research
- **Cf-252**: Re-established production in FY 2009; new six-year contract for FY 2013-2018
- **Li-6**: Production of metal form for neutron detector isotope sales
- **Np-237**: Established inventory for dispensing bulk quantities and capability to fabricate reactor dosimeters
- **Se-72/As-72**: Developed production capability for Se-72 for use in a generator to provide the positron emitter As-72
- **Si-32**: Produced in the 1990s for oceanographic and climate modeling research, inventory depleted, processing of targets are now completed to make this isotope available again
- **Th-227/Ra-223**: Established Ac-227 cows for the provision of Th-227 and Ra-223 (alpha emitters for medical applications)
- **Y-86**: Established production capability of the positron emitter Y-86

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Isotopes Under Development

- [Ac-225](#): Developing production capability
- [At-211](#): Funding production development at four institutions to establish nationwide availability
- [Am-241](#): Initiated project to produce Am-241 in association with an industrial consortium
- [C-14](#): Investigating economic feasibility of reactor production
- [Cd-109](#): Working with industry to assess product specific activity
- [Cm-243](#): Acquired curium with a high Cm-243 content for research applications
- [Co-57](#): Evaluating production of Co-57 for commercial source fabricators
- [Cu-64](#): Funding production development at multiple institutions
- [Gd-153](#): Pursuing feasibility of reactor production
- [Ho-166](#): Establishing reactor production capability
- [I-124](#): Funding production development at one institution
- [K-40](#): Evaluating possibility of reactor production by irradiating K rather than electromagnetically enriching K-40
- [Li-7](#): Working to establish reserve for nuclear power industry to mitigate potential shortage
- [Pa-231](#): Purifying 100 mg for applications such as fuel cycle research
- [Sr-89](#): Investigating economic feasibility of reactor production
- [U-233](#): Evaluating acquisition of mass separated U-233 for research applications
- [U-234](#): Investigating alternatives for provision of U-234 for neutron flux monitors
- [Zn-62/Cu-62](#): Funding production development for Zn-62 for use in a generator to provide the positron emitter Cu-62
- [Zr-89](#): Funding production development at multiple institutions

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Overview of IP Transportation Activities

The DOE Isotope Program has the responsibility to oversee a wide variety of radioactive and hazardous material shipments

- Primary goal is to continue maintaining our excellent safety record for shipments in commerce (protect the public and environment)
- This is done through:
 - Transportation activities conducted in compliance with all regulations
 - Extensive coordination with other DOE Programs and external regulators
 - Proactive stakeholder involvement
 - Robust internal oversight of transportation activities at each production site

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Types of Shipments Associated with the Isotope Program

➤ Stable Isotope Shipments

- The majority of our stable isotopes are dispensed in milligram amounts and shipped as DOT/IATA Small and DeMinimis quantities
- Occasionally, we have orders large enough to require full DOT regulation

➤ Radioactive Isotope Shipments

- Most radioactive isotopes are shipped as small DOT exempt, limited quantity, or Type-A quantities
- Typically packaged in Type A, special form packaging with the occasional use of a Type B package
- Sources are shipped to customer facilities around the world from national laboratories, to universities/research institutes, to private companies

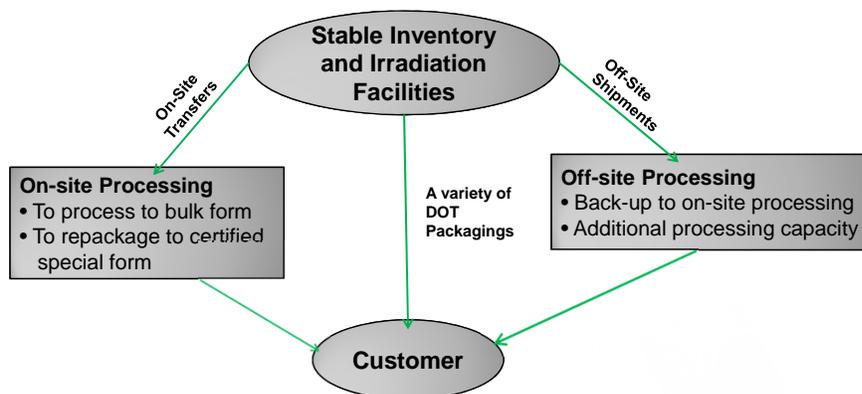


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The process flow for the Isotope Program requires multiple transfers and flexibility to efficiently meet our needs.



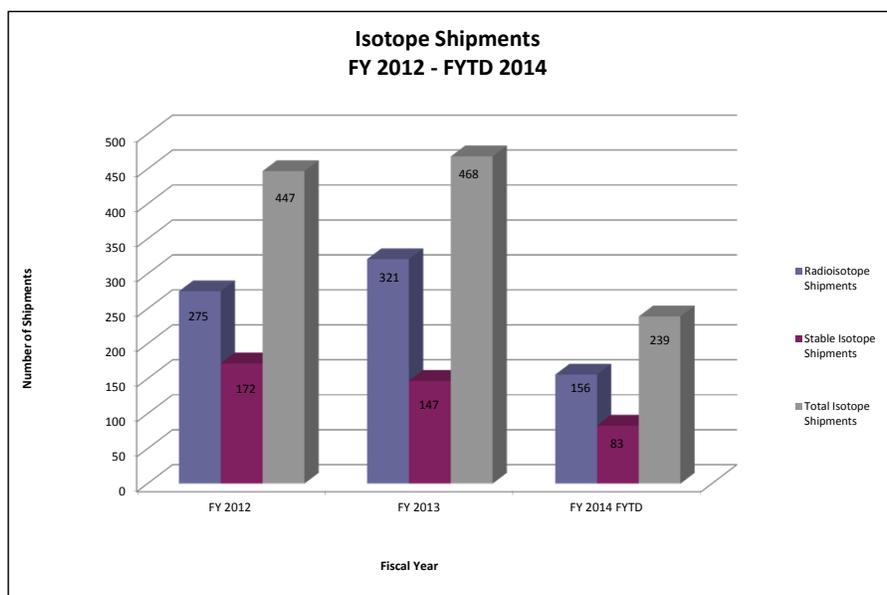
Certified containers offer multiple destinations for the irradiated products from accelerator and reactor facilities used by the Isotope Program.

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Transportation Activities



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Stable Isotope Packaging and Shipping

- The Isotope Program through Oak Ridge National Laboratory (ORNL) maintains and distributes the national inventory of stable isotopes
- Dispense isotopes in inventory form (generally powders) to fill customer orders
- Maintain analytical certification and MSDS files
- Package all stable isotopes for shipment in conformance with DOT and international shipping regulations
- Process lease agreements for stable isotopes



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Radioisotope Packaging and Shipping DOT Certified Packaging Categories

DOT Container Type	Test Requirements	Typical Package
Type A Package (Lower Activity)	Normal transport conditions – Vendor/user certified to DOT.	Boxes and drums for low volume processed liquids and solids.
Type B Package (Higher Activity)	Hypothetical transport conditions – NRC or DOE certified.	Heavier shielded larger casks for high activity solids.
Special Form Capsule (Inner package to Type A or B)	DOT specified tests: Heat, puncture, bending, etc. - Vendor/user certified to DOT.	Welded stainless steel capsules. Can increase activity capacity for Type A packages. Required inner package for many Type B containers.

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Type A Packages



Biodex Reusable
Solutions of W-188, Ge-68, & Sr-82

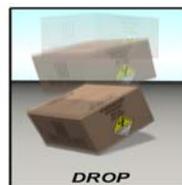


ORNL Non-returnable
W/Re Generators & Ac-225

Type A Package Testing



Water spray for 1 hour to simulate rainfall of 2 inches per hour.



Free drop test onto a flat, hard surface.



Stacking test of at least 5 times the weight of the package. This test is conducted for at least 24 hours.



Penetration test by dropping a 13-pound, 1.25-inch diameter bar vertically onto the package from a height of 3.3 feet.

“Normal Transport Conditions”

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Type B Packages



Large Cask for Co-60



Smaller source changer for Ir-192 and Se-75 used by industry

Type B Package Testing



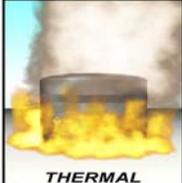
FREE DROP

A 30-foot free drop onto a flat, essentially unyielding surface so that the package's weakest point is struck



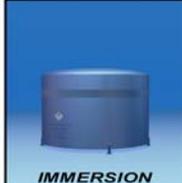
PUNCTURE

A 40-inch free drop onto a 6-inch diameter steel rod at least 8 inches long, striking the package at its most vulnerable spot.



THERMAL

Exposure of the entire package to 1475°F for 30 minutes.



IMMERSION

Immersion of the package under 50 feet of water for at least 8 hours.

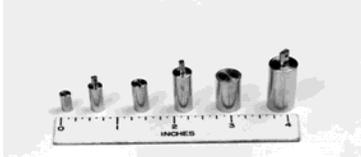
“Hypothetical Accident Conditions”

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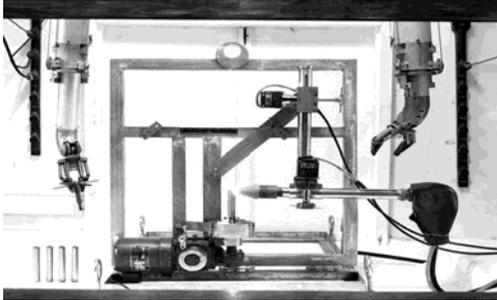
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Inner Packaging - DOT Special Form Shipping Capsules



Remotely Welded Capsules

Required for Cf-252, Se-75, and Ir-192. Capsule design must pass special form performance testing (i.e. heat, puncture, bending, leak testing, etc.)



Hot Cell Remote Welding Rig

DOT welded special form capsules used for inner packaging:

- Increases the amount of activity allowed in Type A packages.
- Meets the inner containment requirements for Type B packages.

Facility requirements:

- Hot cell welding rig for remote welding.
- Remote helium or bubble leak-testing for testing weld integrity.

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IP Challenges And Successes

- **Challenges**

- Available carriers for radioactive isotopes (FedEx and YRC are the only two LTL carriers available)
- International transport of RAM
- Knowledgeable freight forwarders familiar with hazmat regulations

- **Successes**

- The commitment of our staff to produce an outstanding service while maintaining exceptional compliance with the regulations
- Our excellent safety record related to thousands of shipments in commerce around the world over multiple years

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Discussion and Questions

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