

Isotope Program

Enriched Stable Isotopes

Product Description

A large inventory of enriched stable isotopes is available and managed under an ISO-9001 quality program. Also, a wide variety of custom-order chemical and materials processing services are available from ORNL's Isotope Development Group. Inorganic compound synthesis is available to process inventory-form stable isotopes into the desired chemical forms to meet most customer needs. Metallurgical, ceramic, and high-vacuum processing methods are available to prepare enriched stable isotopes in a wide variety of chemical and physical forms. An indication of typical alternate chemical and physical forms available for each element is given on the individual enriched stable isotope catalog pages. The preparation of other alternate forms may also be investigated, upon request. A lease program for enriched stable isotopes is also available.

Current Capabilities Include

- Inorganic chemical conversions
- Arc melting and alloying
- Arc melting and drop casting
- Wire rolling
- Metal and ceramic powder consolidation
- Metal and ceramic hot-pressing
- High-vacuum evaporation to produce thin films and coatings
- Plasma sputtering to produce thin films and coatings
- Ion beam sputtering to produce thin films and coatings
- Crystal bar reduction processing
- Pyrochemical conversions
- Hot and cold rolling of metal foils
- Crucible melting and casting
- Wire swaging and drawing
- Vanadium-encapsulated neutron dosimeters

Contact Information

For Isotope Quotations/Orders:

National Isotope Development Center
Isotope Business Office
Phone: 865.574.6984
Fax: 865.574.6986
E-mail: contact@isotopes.gov

For Technical Information:

Dr. David Dean
ORNL Isotope Program Manager
Oak Ridge National Laboratory
Phone: 865.576-5229
Fax: 865.576.8746
E-mail: deandj@ornl.gov

Isotope Program

The Brookhaven Linac Isotope Producer (BLIP)

BLIP Description

Built in 1972. Uses high energy protons for radioisotope production by diverting excess beam of the 200 MeV proton Linac.

Proton Energies: Energies of 118, 140, 162, 184 or 202 MeV are diverted down a 30 m long beamline.

Target Channels: Six mechanically independent target channels are available. Most recently, target channels have been grouped into two boxes holding up to four targets each

Operating Cycles

Production of isotopes in the BLIP is dependent upon the operating cycle of the Linac. The schedule and duration of Linac operation is determined by the plans and funding of the nuclear physics experiments. The average BLIP intensity in this parasitic mode is about 20% less than full Linac output.

Radioisotopes

Beryllium-7*	Arsenic-73	Cadmium-109
Magnesium-28*	Strontium-82	Tin-117m*
Zinc-65	Yttrium-88	Yttrium-86
Copper-67	Technetium-95m*	Rubidium-83
Germanium-68	Technetium-96*	

*Production not scheduled

Currently in Development: Iron-52

Hot Cell and Processing Facilities

- Eight radiochemistry development labs
- Nine lead and steel hot cells
- Instrumentation lab for radionuclide assay by HpGe, gamma ray spectroscopy, NaI spectroscopy or liquid scintillation and elemental assay by ICP-OES, labeling determinations with HPLC

Contact Information

For Isotope Quotations/Orders:

National Isotope Development Center
Isotope Business Office
Phone: 865.574.6984
Fax: 865.574.6986
E-mail: contact@isotopes.gov

For Technical Information:

Dr. Cathy Cutler
Director of Medical Isotope Research
and Production Program (MIRP)
Brookhaven National Laboratory
Phone: 631.344.3873
Fax: 631.344.5962
E-mail: ccutler@bnl.gov

Isotope Program

The ORNL High Flux Isotope Reactor (HFIR)

Reactor Description

Highest thermal flux and most versatile irradiation facilities in the world.
Thermal flux – up to 2.6×10^{15} neutrons/cm²/sec at 85 MW. Operation since 1965.
Thermal/epithermal = 25–40/1.
22 day operating cycles – expected 6 cycles/year
Beryllium reflector replaced in 2002. Expected operation through 2030.

Irradiation Positions

Hydraulic Tube (HT) Facility

An HT facility with nine HT high-flux irradiation positions in high-flux core region permit insertion/removal of targets any time during reactor operation. Ideally suited for short-term irradiations, e.g., maximum 4.8 gm W-186/target loading possible.

High-Volume/High-Flux Large Target Positions

Core region also has unparalleled space for very large targets such as currently used for californium-252 production.

Peripheral Target Positions

Located on edge of flux trap. Permit thermal flux values of $1-1.7 \times 10^{15}$ neutrons/cm²/sec at 85 MW – 42 positions available for full-cycle irradiations. Accessible only during refueling and used for long-term and multi-cycle irradiations.

High-Volume Irradiation Positions also Available in Beryllium Reflector Region

RB units, CRAP holes, VXF positions, and so forth

Examples of Current Routinely Produced Radioisotopes

HT/core – Californium-252, Iron-55, Lutetium-177, Nickel-63, Selenium-75, Tungsten-188

Contact Information

For Isotope Quotations/Orders:

National Isotope Development Center
Isotope Business Office
Phone: 865.574.6984
Fax: 865.574.6986
E-mail: contact@isotopes.gov

HFIR Technical Information:

Ronald J. Reagan
HFIR Plant Manager
Oak Ridge National Laboratory
Phone: 865.574.9187
Fax: 865.574.9175
E-mail: reaganrj@ornl.gov

Isotope Program

LANL Isotope Production Facilities

Accelerator Description

The Isotope Production Facility (IPF) is a 100 MeV proton beam line spurred off of the Los Alamos Neutron Science Center (LANSCCE) 800 MeV accelerator at Los Alamos National Laboratory. The target station has three irradiation positions. The facility was commissioned in 2004.

Currently IPF operates for ~3000 $\mu\text{A/h}$ per year at a maximum current of 450 μA but is available to run in dedicated mode for additional operation hours. Current run cycle for LANSCCE is from June to December. The capability is expected to be expanded in the next few years to maximize the current with which targets can be irradiated, and to allow for the irradiation of alpha-emitting targets.

Target sizes are nominally tens of grams.

Anticipated lifetime is 2024.

Irradiation Positions

High energy slot – 90–70 MeV. (p,xn) and (p,xnyp) reactions

Medium energy slot – 65–45 MeV (p,xn) and (p, α xn) reactions

Low energy slot – 30–0 MeV (p,xn) and (p, α xn) reactions

Cross Section Measurements

Facilities at the LANSCCE accelerator also allow for the measurement of proton-induced cross sections at 800 MeV and 200 to 100 MeV using a proton beam with an ~100 nA current to optimize irradiation parameters and improve purity.

Hot Cell and Processing Facilities

The LANL hot cell facility at TA-48 contains <13 hot cells.

Examples of Current Routinely Produced Radioisotopes

Arsenic-73, Germanium-68, Strontium-82, Yttrium-88

Contact Information

For Isotope Quotations/Orders:

National Isotope Development Center
Isotope Business Office
Phone: 865.574.6984
Fax: 865.574.6986
E-mail: contact@isotopes.gov

For Technical Information:

Eva Birnbaum
LANL Isotope Program Manager
Los Alamos National Laboratory
Phone: 505.665.7167
E-mail: eva@lanl.gov

Isotope Program

Actinium-225 (10 d) and Actinium-225/Bismuth-213 (46 min) Generator

Production Method/Specific Activity – Routinely Available

Carrier-free actinium-225 obtained by chemical processing from decay of thorium-229 (from uranium-233). Specific activity = 5.80×10^4 Ci/g.

Produced to meet demand.

Parent of Bi-213.

Actinium-225 provided as radiochemical, either loaded on generator column, or provided as dry nitrate with generator components and instructions for loading.

Chemical Form

Actinium nitrate or actinium chloride solid, or actinium adsorbed on cation exchange resins (e.g., BioRad AG-50 or MP-50).

Chemical Purity

>99.9 %, with <0.1 $\mu\text{g}/\text{mCi}$ for all detectable cations

Radionuclidic Purity

^{225}Ac , >98 %; ^{225}Ra , <2 %; ^{224}Ra , <0.2 %; ^{229}Th , < 1×10^{-3} %; all fissionable material, < 5×10^{-3} %

Type A Shipment Levels

IATA limit = 6 TBq (~160 millicuries)

Contact Information

For Isotope Quotations/Orders:

National Isotope Development Center
Isotope Business Office
Phone: 865.574.6984
Fax: 865.574.6986
E-mail: contact@isotopes.gov

For Technical Information:

Dr. David Dean
ORNL Isotope Program Manager
Oak Ridge National Laboratory
Phone: 865.576-5229
Fax: 865.576.8746
E-mail: deandj@ornl.gov

Isotope Program

Arsenic-73

Production Method/Specific Activity – Routinely Available

Arsenic-73 is produced in the Los Alamos National Laboratory Isotope Production Facility via $^{nat}\text{Ge}(p,pxn)^{73}\text{As}$ reactions in the nominal energy range 90–70 MeV.

Properties

Half life/daughter	80.3 days to germanium-73
Major radiation	Gamma – 53.4 keV
Specific activity	>38 Ci/g (current batch) ~22,280 Ci/g (theoretical) >10 mCi/ml (concentration)
Radiopurity	>99.9% (exclusive of As-74)

Chemical Form

Arsenic (V) in 0.1M HCl

Type A Shipment Levels

IATA limit = 40 TBq (~1000 curies)

Contact Information

For Isotope Quotations/Orders:

National Isotope Development Center
Isotope Business Office
Phone: 865.574.6984
Fax: 865.574.6986
E-mail: contact@isotopes.gov

For Technical Information:

Eva Birnbaum
LANL Isotope Program Manager
Los Alamos National Laboratory
Phone: 505.665.7167
E-mail: eva@lanl.gov

Isotope Program

Cadmium-109

Production Method/Specific Activity – Occasionally Available

Cd-109 is produced at the Los Alamos National Laboratory Isotope Production Facility via $^{nat}\text{In}(p,X)^{109}\text{Cd}$ reactions in the nominal energy range 90–70 MeV. The current batch in inventory was processed in 2002 at the hot cell facility at Los Alamos National Laboratory.

Properties

Half life/daughter	462.6 days to silver-109
Major radiation	Gamma – 88 keV
Specific activity	>9 Ci/g (current batch) ~2,582 Ci/g (theoretical) >10 mCi/ml (concentration)
Radiopurity	>99.9% (exclusive of Cd-133m)

Chemical Form

Cadmium (II) in 0.1M HCl

Type A Shipment Levels

IATA limit = 2.0 TBq (~54 curies)

Contact Information

For Isotope Quotations/Orders:

National Isotope Development Center
Isotope Business Office
Phone: 865.574.6984
Fax: 865.574.6986
E-mail: contact@isotopes.gov

For Technical Information:

Eva Birnbaum
LANL Isotope Program Manager
Los Alamos National Laboratory
Phone: 505.665.7167
E-mail: eva@lanl.gov

Isotope Program

Californium-252

Product Description – Routinely Available

Produced in the Oak Ridge National Laboratory High Flux Isotope Reactor target positions. Multiple cycle irradiation: Thermal neutron flux = up to 2.6×10^{15} neutrons/cm²/sec at 85 MW. Production method: Curium-244 oxide production targets undergo multiple neutron captures for the production of Cf-252 and other heavy element isotopes such as Bk-249, Es-253, and Fm-257.

Product form: High-specific-activity bulk Pd-Cf₂O₃ composite wire @ 500 µg Cf-252/inch or alternate forms.

Shipment Information

Bulk Cf-252 is encapsulated in stainless steel special form capsules. Quantities of up to 5 milligrams can be packaged in approved DOT Type A containers.

Contact Information

For Isotope Quotations/Orders:

National Isotope Development Center
Isotope Business Office
Phone: 865.574.6984
Fax: 865.574.6986
E-mail: contact@isotopes.gov

For Technical Information:

Dr. David Dean
ORNL Isotope Program Manager
Oak Ridge National Laboratory
Phone: 865.576-5229
Fax: 865.576.8746
E-mail: deandj@ornl.gov

Isotope Program

Germanium-68

Production Method/Specific Activity – Routinely Available

Germanium-68 is produced in the Los Alamos National Laboratory Isotope Production Facility and in the Brookhaven National Laboratory Brookhaven Linac Isotope Producer via $^{nat}\text{Ga}(p,xn)^{68}\text{Ge}$ reactions in the nominal energy range 30–10 MeV.

Properties

Half life/daughter	270.8 days to gallium-68
Major radiation	Positron – 511 keV
Specific activity	~6,638 Ci/g (theoretical) >10 mCi/ml (concentration)
Radiopurity	>99.9%

Chemical Form

Germanium (IV) in <1.0M HCl

Type A Shipment Levels

IATA Type A limits = 0.5 TBq (~14 curies)

Contact Information

For Isotope Quotations/Orders:

National Isotope Development Center
Isotope Business Office
Phone: 865.574.6984
Fax: 865.574.6986
E-mail: contact@isotopes.gov

For Technical Information:

Eva Birnbaum
LANL Isotope Program Manager
Los Alamos National Laboratory
Phone: 505.665.7167
E-mail: eva@lanl.gov

Isotope Program

Holmium-166m (1200 y)

Production Method

Holmium-166m obtained by neutron capture on Ho-165 target followed by chemical processing to remove impurities

Specific Activity

>1 mCi/g

Availability

MicroCi levels available throughout the year. Up to 5 milliCi can be made available by advance arrangements.

Chemical Form

Holmium nitrate or chloride in 0.1 M HNO₃ or 0.1 M HCl

Chemical Purity

>99.9 % (provided by the manufacturer of Ho-165 target)

Radionuclidic Purity

^{166m}Ho, 99%; ¹⁶⁰Tb (72.3 d), 1%; ^{177m}Lu (160.1 d), ¹⁷⁰Tm (128.6 d), ¹⁵²Eu (13.3 y), ¹⁵⁴Eu (8.8 y), ¹⁴¹Ce (32.5 d), ¹⁹²Ir (74 d), ⁶⁰Co (5.27 y), and ⁴⁶Sc (83.8 d), <0.1%

Type A Shipment Levels

IATA limit = 13.5 Ci

Contact Information

For Isotope Quotations/Orders:

National Isotope Development Center
Isotope Business Office
Phone: 865.574.6984
Fax: 865.574.6986
E-mail: contact@isotopes.gov

For Technical Information:

Dr. David Dean
ORNL Isotope Program Manager
Oak Ridge National Laboratory
Phone: 865.576-5229
Fax: 865.576.8746
E-mail: deandj@ornl.gov

Isotope Program

Lutetium-177

Production Method/Specific Activity – Available by Special Order

Produced in Oak Ridge National Laboratory High Flux Isotope Reactor Hydraulic Tube Facility (5–6 day irradiation: thermal neutron flux = up to 2.6×10^{15} neutrons/cm²/sec at 85 MW).

High multi-curie levels of lutetium-177 can be provided as a radiochemical from the Lu-176(n,γ)Lu-177 reaction. Maximum specific activity = 50–80 curies/mg of Lu-176.

Theoretical specific activity of Lu-177 is 109 curies/mg Lu

Lu-177m ($T_{1/2} = 160$ days)/Lu-177 ratio at reactor push = $\sim 7-8 \times 10^{-5}$.

cGMP program to provide a bulk pharmaceutical ingredient being considered depending on potential market size and interest.

Chemical Form

As chloride in 0.1M HCl solution crimp cap or screw cap glass V-vial

Type A Shipment Levels

IATA Limit = 0.7 TBq (~19 curies)

Contact Information

For Isotope Quotations/Orders:

National Isotope Development Center
Isotope Business Office
Phone: 865.574.6984
Fax: 865.574.6986
E-mail: contact@isotopes.gov

For Technical Information:

Dr. David Dean
ORNL Isotope Program Manager
Oak Ridge National Laboratory
Phone: 865.576-5229
Fax: 865.576.8746
E-mail: deandj@ornl.gov

Isotope Program

Nickel-63

Production Method/Specific Activity – Routinely Available

Nickel-63 produced in the ORNL High Flux Isotope Reactor central flux trap high-thermal-flux region (thermal neutron flux = up to 2.6×10^{15} neutrons/cm²/sec at 85 MW) for up to 15 cycles.

Maximum nickel-63 specific activity = >10 curies/gm Ni by the Ni-62(n, γ) \rightarrow Ni-63 route.

Chemical Form

Nickel chloride in HCl solution or as dry nickel chloride

Type A Shipment Levels

IATA limit = 30 TBq (~800 curies)

Contact Information

For Isotope Quotations/Orders:

National Isotope Development Center
Isotope Business Office
Phone: 865.574.6984
Fax: 865.574.6986
E-mail: contact@isotopes.gov

For Technical Information:

Dr. Cathy Cutler
Director of Medical Isotope Research
and Production Program (MIRP)
Brookhaven National Laboratory
Phone: 631.344.3873
Fax: 631.344.5962
E-mail: ccutler@bnl.gov

U.S. Department of Energy

Isotope Program

Radium-223

Production Method

Ion exchange separation from actinium-227 nitrate

Specific Activity

Carrier-free Ra-223 in near equilibrium with its decay products

Availability

New! Routinely available during the calendar year or by special request through the National Isotope Development Center in amounts ranging from 18 MBq (0.5 mCi) to 6.47 GBq (175 mCi) per production campaign

Chemical Form

99.99% pure radium nitrate dry solid (soluble), near zero mass

Type A Shipment Levels

IATA limit = 0.007 TBq (189 mCi)

Contact Information

For Isotope Quotations/Orders:

National Isotope Development Center
Isotope Business Office
Phone: 865.574.6984
Fax: 865.574.6986
E-mail: contact@isotopes.gov

For Technical Information:

Dr. Gertrude K. Patello
PNNL Isotope Program Manager
Pacific Northwest National Laboratory
Phone: 509.375.5330
Fax: 509.375.5322
E-mail: gert.patello@pnnl.gov

Isotope Program

Radium-226 (1600 y)

Production Method

Chemical processing of Ra needles

Specific Activity

Carrier-free (theoretical Sp. Act.: 0.989 mCi/mg)

Availability

Limited quantities up to 20 mCi per batch available by special arrangements

Chemical Form

Radium nitrate

Chemical Purity

TBD

Radionuclidic Purity

100% (recently was separated from Pb-210 daughters)

Type A Shipment Levels

IATA limit = 18 mCi

Contact Information

For Isotope Quotations/Orders:

National Isotope Development Center
Isotope Business Office
Phone: 865.574.6984
Fax: 865.574.6986
E-mail: contact@isotopes.gov

For Technical Information:

Dr. David Dean
ORNL Isotope Program Manager
Oak Ridge National Laboratory
Phone: 865.576-5229
Fax: 865.576.8746
E-mail: deandj@ornl.gov

Isotope Program

Rhenium-186

Production Method/Specific Activity – Special Order

Produced in Oak Ridge National Laboratory High Flux Isotope Reactor Hydraulic Tube Facility (7-day irradiation: thermal neutron flux = up to 2.6×10^{15} neutrons/cm²/sec at 85 MW).

Multi-curie batches of rhenium-186 provided as a radiochemical.

Maximum specific activity = up to 15-17 curies/mg of Re-185 available by the Re-185(n, γ) Re-186 reaction.

Theoretical specific activity is about 188 curies/mg.

Chemical Form

As a sodium perrhenate in saline solution.

Type A Shipment Levels

IATA limit = 0.6 TBq (~16 curies)

Contact Information

For Isotope Quotations/Orders:

National Isotope Development Center
Isotope Business Office
Phone: 865.574.6984
Fax: 865.574.6986
E-mail: contact@isotopes.gov

For Technical Information:

Dr. David Dean
ORNL Isotope Program Manager
Oak Ridge National Laboratory
Phone: 865.576-5229
Fax: 865.576.8746
E-mail: deandj@ornl.gov

Isotope Program

Sodium-22

Production Method/Specific Activity – Occasionally Available

Sodium-22 is produced in the Los Alamos National Laboratory Isotope Production Facility via $^{27}\text{Al}(p,X)^{22}\text{Na}$ reactions in the nominal energy range 90–70 MeV. The material is produced on a limited basis, as it can take an entire year run cycle to produce curie quantities.

Properties

Half life/daughter	2.605 years to neon-22
Major radiation	Positron – 546 keV Gamma – 1,274.5 keV
Specific activity	>1,500 Ci/g (current batch) ~6,240 Ci/g (theoretical) >10 mCi/ml (concentration)
Radiopurity	>99.9%

Chemical Form

Sodium chloride in H₂O

Type A Shipment Levels

IATA Limit = 0.5 TBq (~13 curies)

Contact Information

For Isotope Quotations/Orders:

National Isotope Development Center
Isotope Business Office
Phone: 865.574.6984
Fax: 865.574.6986
E-mail: contact@isotopes.gov

For Technical Information:

Eva Birnbaum
LANL Isotope Program Manager
Los Alamos National Laboratory
Phone: 505.665.7167
E-mail: eva@lanl.gov

Isotope Program

Strontium-82

Production Method/Specific Activity – Routinely Available - Provided as cGMP Non-Sterile Product (Pharmaceutical Ingredient)

Strontium-82 is produced in the Los Alamos National Laboratory Isotope Production Facility and in the Brookhaven National Laboratory Brookhaven Linac Isotope Producer via $^{nat}\text{Rb}(p,xn)^{82}\text{Sr}$ reactions in the nominal energy range 90–45 MeV.

Properties

Half life/daughter	25.55 days to rubidium-82
Major radiation	Positron – 511 keV
Specific activity	~62,300 Ci/g (theoretical) >10 mCi/ml (concentration)
Radiopurity	>99% (exclusive of Sr-85)

Chemical Form

Strontium chloride in 0.1–0.5M HCl

Type A Shipment Levels

IATA limit = 0.2 TBq (~5 curies)

Contact Information

For Isotope Quotations/Orders:

National Isotope Development Center
Isotope Business Office
Phone: 865.574.6984
Fax: 865.574.6986
E-mail: contact@isotopes.gov

For Technical Information:

Eva Birnbaum
LANL Isotope Program Manager
Los Alamos National Laboratory
Phone: 505.665.7167
E-mail: eva@lanl.gov

Isotope Program

Thorium-227

Production Method

Ion exchange separation from actinium-227 nitrate

Specific Activity

Carrier-free Th-227 in partial equilibrium with Ra-223 and decay products

Availability

New! Routinely available during the calendar year or by special request through the National Isotope Development Center in amounts ranging from 18 MBq (0.5 mCi) to 4.62 GBq (125 mCi) per production campaign

Chemical Form

99.99% pure thorium-227 nitrate dry solid (soluble), near zero mass

Type A Shipment Levels

IATA limit = 0.005 TBq (134 mCi)

Contact Information

For Isotope Quotations/Orders:

National Isotope Development Center
Isotope Business Office
Phone: 865.574.6984
Fax: 865.574.6986
E-mail: contact@isotopes.gov

For Technical Information:

Dr. Gertrude K. Patello
PNNL Isotope Program Manager
Pacific Northwest National Laboratory
Phone: 509.375.5330
Fax: 509.375.5322
E-mail: gert.patello@pnnl.gov

Isotope Program

High-Purity Thorium-229 (7340 ± 160 y)

Production Method

Thorium-229 obtained by chemical processing of mass-separated uranium-233

Specific Activity

Two batches are available with the following specific activities:

Batch A: 0.16 $\mu\text{Ci}/\mu\text{g}$ of total Th

Batch B: 0.2129 $\mu\text{Ci}/\mu\text{g}$ of total Th (theoretical Sp. Act.: 0.2130 $\mu\text{Ci}/\mu\text{g}$)

Availability

microCi levels available throughout the year

Chemical Form

Thorium nitrate, $\text{Th}(\text{NO}_3)_4 \cdot x\text{H}_2\text{O}$, solid (readily soluble in dilute inorganic acids)

Chemical Purity

>99.9% total thorium

Batch A: ^{229}Th (75.6 %), ^{230}Th (0.48 %), ^{232}Th (23.8 %)

Batch B: ^{229}Th (99.97 %), ^{230}Th (8.71×10^{-3} %), ^{232}Th (3.13×10^{-2} %)

Radionuclidic Purity

Batch A: ^{229}Th (99.3 %), ^{228}Th (0.7 %)

Batch B: ^{229}Th (98.36 %), ^{228}Th (1.64 %)

Type A Shipment Levels

IATA limit = 13.5 mCi

Contact Information

For Isotope Quotations/Orders:

National Isotope Development Center
Isotope Business Office
Phone: 865.574.6984
Fax: 865.574.6986
E-mail: contact@isotopes.gov

For Technical Information:

Dr. David Dean
ORNL Isotope Program Manager
Oak Ridge National Laboratory
Phone: 865.576-5229
Fax: 865.576.8746
E-mail: deandj@ornl.gov

Isotope Program

Tungsten-188/Rhenium-188 Generator

Production Method/Specific Activity – Routinely Available - Provided as cGMP Non-Sterile Product (Pharmaceutical Ingredient)

Tungsten-188 produced in the Oak Ridge National Laboratory High Flux Isotope Reactor central flux trap high-thermal-flux region (thermal neutron flux = up to 2.6×10^{15} neutrons/cm²/sec at 85 MW).

Generator provided as a radiochemical and has an extended useful shelf-life.

Processed tungsten-188 can also be provided.

Availability of cGMP-produced products (as pharmaceutical ingredients) expected in 2008.

Maximum tungsten-188 specific activity = 3–4 curies/gm W (one cycle) by the W-186(n,γ)W-187(n,γ)W-188(β⁻ →)Re-188 route.

Large inventory of enriched (> 95%) tungsten-186 available at ORNL. Tungsten-186 can also be recovered from used generators for recycling.

Generator provided as a non-sterile cGMP bulk pharmaceutical ingredient ready for elution of rhenium-188. Detailed guidelines for setup, quality control, and bolus concentration methodology can be provided.

Rhenium-188 obtained carrier-free by positive elution of generator with saline.

Very high rhenium-188 specific volume solutions are obtained by post-elution tandem ion exchange column concentration (total rhenium-188 volume = < 1 mL).

Chemical Form

Rhenium-188 obtained as sodium perrhenate in saline eluant solution

Type A Shipment Levels

IATA limit = 0.3 TBq (~8 curies); generators up to 3 curies available as Type A package.

Contact Information

For Isotope Quotations/Orders:

National Isotope Development Center
Isotope Business Office
Phone: 865.574.6984
Fax: 865.574.6986
E-mail: contact@isotopes.gov

For Technical Information:

Dr. David Dean
ORNL Isotope Program Manager
Oak Ridge National Laboratory
Phone: 865.576-5229
Fax: 865.576.8746
E-mail: deandj@ornl.gov

Isotope Program

Yttrium-88

Production Method/Specific Activity – Routinely Available

Zirconium-88 decays via electron capture to produce Y-88. Zirconium-88 is produced in the Los Alamos National Laboratory Isotope Production Facility via $^{93}\text{Nb}(p,x)^{88}\text{Zr}$ reactions in the nominal energy range 90–70 MeV.

Properties

Half life/daughter	106.6 days to strontium-88
Major radiation	Positron – 760 keV Gamma – 1,836 keV
Specific activity	Not measured, carrier-free (current batch) ~13,900 Ci/g (theoretical) >1 mCi/ml (concentration)
Radiopurity	>99%

Chemical Form

Yttrium (III) in 0.1M HCl

Type A Shipment Levels

IATA limit = 0.4 TBq (~10 curies)

Contact Information

For Isotope Quotations/Orders:

National Isotope Development Center
Isotope Business Office
Phone: 865.574.6984
Fax: 865.574.6986
E-mail: contact@isotopes.gov

For Technical Information:

Eva Birnbaum
LANL Isotope Program Manager
Los Alamos National Laboratory
Phone: 505.665.7167
E-mail: eva@lanl.gov

Isotope Program

Isotope Availability News

Isotope	Application
Al-26	By-product of Si-32 production; used for biological research
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 6-year contract for FYs 2013–2018
Li-6	Performed chemical conversion to metal form to establish kilogram quantities for use in the neutron detection devices
Np-237	Established inventory for dispensing bulk quantities and capability to fabricate reactor dosimeters (flux monitors)
Ra-224/Pb-212	Cancer metastases treatment
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 nearing completion to make 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)
W-188	Cancer treatment
W-188/Re-188	Therapeutic radioisotope cancer treatment
Y-86	Established production capability of the positron emitter Y-86

Isotope Program

Isotopes Under Development

Isotope	Status
Ac-225	Developing production capability to supplement current decay-product-based supply
At-211	Funding production development at institutions to establish nationwide availability
Am-241	Initiated process to supply 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-166m	Investigating reactor production capability
I-124	Funding production development at one institution
K-40	Evaluating possibility of reactor production rather than electromagnetic enrichment
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 for research applications
U-234	Investigating alternatives for reactor power monitors application
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

