

*Consider a*

**MURR®**

*Collaboration*

*Do More with MURR*



University of Missouri Research Reactor Center

*Consider  
how a collaboration with MURR  
can leverage your efforts*



**GMP SCALE UP CAPABILITIES**



**CONTRACT RESEARCH AND  
DEVELOPMENT**



**ANALYTICAL SERVICES using  
Neutron Activation Analysis and ICP-MS**



**SBIR/STTR COLLABORATION**

## Who We Are

The University of Missouri Research Reactor Center (MURR<sup>®</sup>) is more than a nuclear facility. We are the heart of a singular, world-class interdisciplinary environment for the research, development and production of major advances in nuclear medicine.

Operated by the University of Missouri in Columbia (MU), MURR—the most powerful and productive university research reactor in the world—affords unparalleled nuclear capabilities to a major teaching hospital, a leading college of veterinary medicine and distinguished programs in life sciences, chemistry and engineering.



Our 10 megawatt reactor is versatile and compact in design, allowing multiple irradiations and experiments *around the clock*. In the entire global community of nuclear research reactors, MURR has an unmatched operating record, safely and reliably operating 24 hours a day, 6½ days each week, 52 weeks each year.

*At MURR, nuclear medicine is both science and art.*

As the home of the leading university research reactor in the US, the MURR Center has a four-fold mission of promoting basic and applied research in neutron-related science and engineering; offering rare educational opportunities to faculty and students; providing irradiation and isotope production services for public and private organizations; and promoting economic development.

The breadth and quality of the research programs and the range of facilities and equipment are a true national resource. The scientific programs made possible by MURR span a broad spectrum of research disciplines and techniques from A to Z. Most have strong ties to other universities, national and industrial research laboratories. The MURR Center's broad capabilities for nuclear-based R&D include deeply experienced research and technical support staff who can nurture a project *from inception to practical application*. These resources afford powerful leverage not only to the University's R&D and educational efforts, but to those of the nation and beyond.

### A Sampling of MURR-Based Research and Education Areas



<b>A</b> griculture	Mechanical Engineering
Anthropology	Nuclear Engineering
Art and Archaeology	Nuclear Medicine
Art History	Nutrition
Chemical Engineering	Physics
Chemistry	Physiology
Child Health	Radiochemistry
Electrical Engineering	Radiology
Epidemiology	Radiopharmaceutical Science
Geological Sciences	Veterinary Medicine
Health Physics	
Immunology	<b>Z</b> oology
Materials Science	
Medicine	

MURR<sup>®</sup> *means More for you...*

## Where We Have Been

MU and MURR have a *35-year history of successful and innovative radiopharmaceutical R&D and collaborations with academia and industry*, and MURR continues to supply key medical isotopes throughout the earth:

- *Ceretec<sup>TM</sup>* (with Tc-99m), a diagnostic used to evaluate cerebral blood flow in patients and label white blood cells to identify infection, was developed at MU
- *Quadramet<sup>®</sup>* (with Sm-153), a therapeutic for easing pain associated with metastatic bone cancer, was an MU-MURR collaboration with private industry. MURR continues to be the sole provider of Sm-153 to North America.
- *TheraSphere<sup>®</sup>* (with Y-90), a glass microsphere used to treat patients with inoperable liver cancer, was a collaborative effort with Missouri University of Science and Technology, MURR and private industry.
- Radioisotope for *Cs-131* brachytherapy seeds to treat prostate cancer
- *Gd-159* and *Ho-166* for research in skeletal targeted radiopharmaceuticals
- *Ir-192* brachytherapy seeds to treat solid tumors
- *Lu-177* for receptor-targeted radiopharmaceuticals, supporting 30 research and clinical trials
- Research quantities with scale-up in progress for high specific activity *Ho-166*, *Lu-177*, *Pm-149* and *Tb-161* for receptor-targeted radiopharmaceuticals
- *Se- 75* and *P-33* biomedical radiotracers
- *Au-198* for radiotracer and targeted nanoparticle approaches
- *Re-186* for labeled antibody, peptide and liposome targeted therapy

We also provide irradiation services, analyses and products for multiple industries. Our skilled and outfitted Science Instrument Shop serves reactor and consumer needs for routine and custom design and fabrication of parts, custom equipment and consumables.



Centrally located in North America

Operating on a consistent schedule

24 hours per day  
6½ days per week  
52 weeks a year

Routinely packaging and shipping to international customers

Regularly producing radioisotopes used for diagnosis and treatment

Providing Neutron Activation Analysis (NAA) and Inductively Coupled Plasma Mass Spectrometry (ICP-MS) in a variety of academic and commercial uses

## Resources We Can Tap

As one of the University of Missouri's key Research Centers, MURR is able to provide support for a variety of academic and industry needs through a network of assets in the MU College of Veterinary Medicine (including Veterinary Oncology), School of Medicine, Ellis Fischel Cancer Center, Life Sciences Center, College of Engineering, Department of Chemistry, Radiopharmaceutical Sciences Institute, Life Sciences Business Incubator and the International Institute for Nano and Molecular Medicine.



We are available to collaborate on projects involving radionuclide production, development or evaluation of imaging or therapeutic agents. We are your academic research partner for an SBIR/STTR, having experience in the development and evaluation of radiopharmaceuticals, utilizing bioinorganic and radioanalytical chemistry to develop and evaluate radiopharmaceuticals for both diagnosis and therapy. Our network of MU collaborators has expertise in developing and evaluating radiopharmaceuticals for the diagnosis and treatment of cancer and was instrumental in the University's having commercialized three radiopharmaceuticals—Ceretek™, Therasphere® and Quadramet®.

Our MURR scientists are accomplished in developing methods for radioisotope production and novel separation methods to provide carrier-free isotopes, as well as in implementing methods to provide large scale production of radioisotopes for commercial use, clinical trials and medical applications. Additional areas include investigating strategies to incorporate radiometals into targeting molecules, discerning radiation dose requirements to destroy cancer cells, targeting radiomolecules to tumors, developing new generations of targeting molecules and evaluating radiolabeled agents in appropriate animal models.

## Where We Are Going

We have expanded our laboratory, classroom, office and processing facilities and installed an LLC-partnered 16.5 MeV cyclotron that produces a complementary set of radioisotopes for research, clinical and commercial use. With our FDA-registered GMP facilities and extensive Quality Assurance program, we are solidly positioned for customized contract manufacturing and R&D.

### **How We Can Help You Do More**

We have the key skills and components in radiochemistry to provide the foundation for research and development in isotope production and chelation chemistry. Our network includes receptor biologists, pharmacologists and oncologists to evaluate the radiomolecules *in vivo* to determine safety, efficacy, targeting capabilities and toxicity from induced models to spontaneous disease models. We have a demonstrated ability to translate basic research concepts into applications for human clinical studies and approved drugs. Our strengths and successes in basic radiochemical and biomolecular research and applied radiopharmaceutical development, coupled with our uniquely reliable isotope production capabilities, make ours one of the preeminent programs in radiopharmaceutical research and development in the country.

We invite you to collaborate with MURR to successfully transform your research concept into an approved product and/or process.

For more information on how MURR® can help meet your needs—whether for research isotopes, contract R&D, collaboration on SBIR/STTR projects, analytical services using neutron activation analysis or ICP-MS, or routine supply of radiochemicals with GMP compliance—please contact us:

#### **FOR RESEARCH INQUIRIES:**

[MURRResearchDirector@missouri.edu](mailto:MURRResearchDirector@missouri.edu) or 573-882-5346.

#### **FOR OTHER INQUIRIES:**

[MURRCustomerService@missouri.edu](mailto:MURRCustomerService@missouri.edu) or 573-884-3183.

# MURR<sup>®</sup> Online Ordering means MORE...



**MURR<sup>®</sup>  
Online  
Ordering  
System**

**Simple. Convenient. Effective.**

Learn more and register at:  
<https://murrorders.missouri.edu>

- Simplicity** At MURR, we understand your time is valuable—no need for complicated paperwork or cumbersome ordering systems.
- Convenience** Ready when you are, 24 hours a day. Once you are approved, ordering isotopes and services from MURR is just a few clicks away.
- Effectiveness** Timely order confirmation and notification of shipments assure you and your RSO that you will be receiving what you ordered.

## What MOOS means for you:

- Complete history of your orders with MURR
- Ability to upload your important documents, such as CoAs
- Opportunity for your RSO to supervise RAM ordering
- Easy two-way communication—you to MURR and back again—never wonder about your order again
- User's Manual and training options

**Please contact MURR Customer Service  
for more information:**

(573) 884-3183

[murrcustomerservice@missouri.edu](mailto:murrcustomerservice@missouri.edu)



**University of Missouri Research Reactor Center**

1513 Research Park Drive  
Columbia, MO 65211-3400

573/882-4211

[www.murr.missouri.edu](http://www.murr.missouri.edu)

O u r  
entire staff is  
committed to the best  
utilization of MURR, a truly unique  
resource for the global community.

We are committed to improving the quality  
of life for all through nuclear science and  
technology, anchored in a culture of keen  
safety and reliability. Our mission echoes  
the University's interlocked missions of  
research, education, service and economic  
development, and our concerted  
efforts improve the lives of our  
fellow man and animal  
companions.





**SELECTED ISOTOPE BETA, GAMMA AND DECAY INFORMATION**

<b>Isotope</b>	<b>Beta max. (MeV)</b>	<b>Beta avg. (MeV)</b>	<b>Primary Gamma (keV)</b>	<b>Decays to: (stable)</b>
<b>Au-198</b>	<b>0.961</b>	<b>0.31</b>	<b>412</b>	<b>Hg-198</b>
<b>Ho-166</b>	<b>1.86</b>	<b>0.61</b>	<b>80</b>	<b>Er-166</b>
<b>Lu-177</b>	<b>0.5</b>	<b>0.13</b>	<b>208</b>	<b>Hf-177</b>
<b>P-33</b>	<b>0.25</b>	<b>0.077</b>	<b>none</b>	<b>S-33</b>
<b>Pd-109</b>	<b>1.028</b>	<b>0.36</b>	<b>88</b>	<b>Ag-109</b>
<b>Re-186</b>	<b>1.07</b>	<b>0.35</b>	<b>137</b>	<b>Os-186</b>
<b>Re-188</b>	<b>2.118</b>	<b>0.77</b>	<b>155</b>	<b>Os-188</b>
<b>Rh-105</b>	<b>0.566</b>	<b>0.15</b>	<b>319</b>	<b>Pd-105</b>
<b>Sm-153</b>	<b>0.81</b>	<b>0.23</b>	<b>103</b>	<b>Eu-153</b>
<b>Se-75</b>	<b>ε</b>	<b>ε</b>	<b>265</b>	<b>As-75</b>

**MURR**<sup>®</sup>

Research Grade

**<sup>198</sup>Au**1513 Research Park Drive  
Columbia, MO 65211Information: [www.murr.missouri.edu](http://www.murr.missouri.edu)Ordering: <https://murrorders.missouri.edu>

Main Phone: (573)882-4211

Customer Service: (573)884-3183

**gold tetrachloroaurate****Please Note: This radiochemical is not intended for human use in its delivered form. Verification of suitability for use in humans is the sole responsibility of the purchaser.****Information****Typical Specifications**

Half life:	2.7 days	Compound:	HAuCl <sub>4</sub> in 0.1 M HCl
Availability:	Made to Order	Specific Activity:	≤ 95 mCi/mg on production date
Production Day:	Monday-Friday	Activity Concentration:	per customer request
Order Deadline:	At least 2 weeks prior to shipment	Radionuclidic purity:	≥ 85% Au-198, 1-15% Au-199
Shipments:	Monday-Friday	Radiochemical purity:	99% HAuCl <sub>4</sub>
Storage:	Room Temperature		
Packaging:	2 or 5 mL v-bottom vial		
Dispensing parameters:	per customer request		

<b>Au-198 Decay Table</b>		<b>Half-life: 2.695 days</b>								
<b>Days</b>	<b>0</b>	<b>0.1</b>	<b>0.2</b>	<b>0.3</b>	<b>0.4</b>	<b>0.5</b>	<b>0.6</b>	<b>0.7</b>	<b>0.8</b>	<b>0.9</b>
0	1.0000	0.9746	0.9499	0.9257	0.9022	0.8793	0.8570	0.8352	0.8140	0.7934
1	0.7732	0.7536	0.7344	0.7158	0.6976	0.6799	0.6626	0.6458	0.6294	0.6134
2	0.5979	0.5827	0.5679	0.5535	0.5394	0.5257	0.5124	0.4994	0.4867	0.4743
3	0.4623	0.4505	0.4391	0.4279	0.4171	0.4065	0.3962	0.3861	0.3763	0.3668
4	0.3574	0.3484	0.3395	0.3309	0.3225	0.3143	0.3063	0.2985	0.2910	0.2836
5	0.2764	0.2694	0.2625	0.2559	0.2494	0.2430	0.2369	0.2308	0.2250	0.2193
6	0.2137	0.2083	0.2030	0.1978	0.1928	0.1879	0.1831	0.1785	0.1740	0.1695
7	0.1652	0.1610	0.1570	0.1530	0.1491	0.1453	0.1416	0.1380	0.1345	0.1311
8	0.1278	0.1245	0.1214	0.1183	0.1153	0.1123	0.1095	0.1067	0.1040	0.1014
9	0.0988	0.0963	0.0938	0.0915	0.0891	0.0869	0.0847	0.0825	0.0804	0.0784
10	0.0764	0.0744	0.0726	0.0707	0.0689	0.0672	0.0655	0.0638	0.0622	0.0606



Research Grade

 $^{166}\text{Ho}$ 

1513 Research Park Drive  
Columbia, MO 65211  
Information: [www.murr.missouri.edu](http://www.murr.missouri.edu)  
Ordering: <https://murrorders.missouri.edu>  
Main Phone: (573)882-4211  
Customer Service: (573)884-3183

**holmium chloride**

Please Note: This radiochemical is not intended for human use in its delivered form.  
Verification of suitability for use in humans is the sole responsibility of the purchaser.

**Information****Typical Specifications**

Half life: 1.1 days  
Availability: Made to Order  
Production Day: Monday  
Order Deadline: At least 2 weeks prior to shipment  
Shipments: Monday-Friday  
Storage: Room Temperature  
Packaging: 2 or 5 mL v-bottom vial or 1.5 mL plastic screw-cap  
Dispensing parameters: per customer request

Compound:  $^{166}\text{HoCl}_3$  in 0.05 M HCl  
Specific Activity:  $\leq 2.2$  Ci/mg on production date  
Activity Concentration: per customer request  
Radionuclidic purity: 95%  
Radiochemical purity: 99.5% holmium chloride  
pH: 1-2

Ho-166 Decay Table		Half-life: 1.118 days									
Days	0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	
0	1.0000	0.9399	0.8834	0.8303	0.7804	0.7335	0.6894	0.6479	0.6090	0.5724	
1	0.5380	0.5056	0.4752	0.4466	0.4198	0.3946	0.3708	0.3485	0.3276	0.3079	
2	0.2894	0.2720	0.2556	0.2403	0.2258	0.2123	0.1995	0.1875	0.1762	0.1656	
3	0.1557	0.1463	0.1375	0.1293	0.1215	0.1142	0.1073	0.1009	0.0948	0.0891	
4	0.0837	0.0787	0.0740	0.0695	0.0654	0.0614	0.0577	0.0543	0.0510	0.0479	
5	0.0451	0.0423	0.0398	0.0374	0.0352	0.0330	0.0311	0.0292	0.0274	0.0258	
6	0.0242	0.0228	0.0214	0.0201	0.0189	0.0178	0.0167	0.0157	0.0148	0.0139	
7	0.0130	0.0123	0.0115	0.0108	0.0102	0.0096	0.0090	0.0084	0.0079	0.0075	
8	0.0070	0.0066	0.0062	0.0058	0.0055	0.0051	0.0048	0.0045	0.0043	0.0040	
9	0.0038	0.0035	0.0033	0.0031	0.0029	0.0028	0.0026	0.0024	0.0023	0.0022	
10	0.0020	0.0019	0.0018	0.0017	0.0016	0.0015	0.0014	0.0013	0.0012	0.0012	

**MURR**<sup>®</sup>

Research Grade

**<sup>177</sup>Lu**1513 Research Park Drive  
Columbia, MO 65211Information: [www.murr.missouri.edu](http://www.murr.missouri.edu)Ordering: <https://murrorders.missouri.edu>

Main Phone: (573)882-4211

Customer Service: (573)884-3183

**lutetium chloride****Please Note: This radiochemical is not intended for human use in its delivered form.  
Verification of suitability for use in humans is the sole responsibility of the purchaser.****Information****Typical Specifications**

Half life:	6.65 days	Compound:	<sup>177</sup> LuCl <sub>3</sub> in 0.05 M HCl
Availability:	Weekly	Specific Activity:	≤ 25 Ci/mg on production date
Production Day:	Monday	Activity Concentration:	up to 3 Ci/mL
Order Deadline:	Thursday before shipment week	Radionuclidic purity:	> 99%
Shipments:	Monday-Friday	Radiochemical purity:	≥ 97.0% on day of production
Storage:	Room Temperature	pH:	~1.0 – 2.0
Packaging:	2 or 5 mL v-bottom vial, or 1.5 mL screw-cap		
Dispensing Tolerances:	Min: 20 µL, per customer request		

Lu-177 Decay Table		Half-life: 6.65 days								
Days	0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9
0	1.0000	0.9896	0.9794	0.9692	0.9592	0.9492	0.9394	0.9296	0.9200	0.9105
1	0.9010	0.8917	0.8824	0.8733	0.8642	0.8553	0.8464	0.8376	0.8289	0.8203
2	0.8118	0.8034	0.7951	0.7868	0.7787	0.7706	0.7626	0.7547	0.7469	0.7391
3	0.7315	0.7239	0.7164	0.7090	0.7016	0.6943	0.6871	0.6800	0.6730	0.6660
4	0.6591	0.6522	0.6455	0.6388	0.6322	0.6256	0.6191	0.6127	0.6063	0.6001
5	0.5938	0.5877	0.5816	0.5755	0.5696	0.5637	0.5578	0.5520	0.5463	0.5407
6	0.5350	0.5295	0.5240	0.5186	0.5132	0.5079	0.5026	0.4974	0.4922	0.4871
7	0.4821	0.4771	0.4721	0.4672	0.4624	0.4576	0.4529	0.4482	0.4435	0.4389
8	0.4344	0.4299	0.4254	0.4210	0.4166	0.4123	0.4080	0.4038	0.3996	0.3955
9	0.3914	0.3873	0.3833	0.3793	0.3754	0.3715	0.3676	0.3638	0.3601	0.3563
10	0.3526	0.3490	0.3454	0.3418	0.3382	0.3347	0.3313	0.3278	0.3244	0.3211



Research Grade

<sup>109</sup>Pd

1513 Research Park Drive  
Columbia, MO 65211  
Information: [www.murr.missouri.edu](http://www.murr.missouri.edu)  
Ordering: <https://murrorders.missouri.edu>  
Main Phone: (573)882-4211  
Customer Service: (573)884-3183

# palladium metal

Please Note: This radiochemical is not intended for human use in its delivered form. Verification of suitability for use in humans is the sole responsibility of the purchaser.

## Information

## Typical Specifications

Half life: 0.6 days  
Availability: Made to order  
Production Day: Monday  
Order Deadline: At least 3 weeks prior to shipment  
Shipments: Monday-Friday  
Storage: Room Temperature  
Packaging: 2 or 5 mL v-bottom vial  
Dispensing parameters: per customer request

Compound: Pd-109  
Specific Activity: ≤ 100 mCi/mg on production date  
Activity Concentration: per customer request

Pd-109 Decay Table		Half-life: 0.561 days									
Days	0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	
0	1.0000	0.8838	0.7811	0.6903	0.6100	0.5391	0.4765	0.4211	0.3722	0.3289	
1	0.2907	0.2569	0.2270	0.2006	0.1773	0.1567	0.1385	0.1224	0.1082	0.0956	
2	0.0845	0.0747	0.0660	0.0583	0.0515	0.0456	0.0403	0.0356	0.0314	0.0278	
3	0.0246	0.0217	0.0192	0.0170	0.0150	0.0132	0.0117	0.0103	0.0091	0.0081	
4	0.0071	0.0063	0.0056	0.0049	0.0044	0.0038	0.0034	0.0030	0.0027	0.0023	
5	0.0021	0.0018	0.0016	0.0014	0.0013	0.0011	0.0010	0.0009	0.0008	0.0007	
6	0.0006	0.0005	0.0005	0.0004	0.0004	0.0003	0.0003	0.0003	0.0002	0.0002	
7	0.0002	0.0002	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	
8	0.0001	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	
9	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	
10	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	

**MURR**<sup>®</sup>

Research Grade

**<sup>33</sup>P**1513 Research Park Drive  
Columbia, MO 65211Information: [www.murr.missouri.edu](http://www.murr.missouri.edu)Ordering: <https://murrorders.missouri.edu>

Main Phone: (573)882-4211

Customer Service: (573)884-3183

**orthophosphate****Please Note: This radiochemical is not intended for human use in its delivered form.  
Verification of suitability for use in humans is the sole responsibility of the purchaser.****Information**

Half life: 25.3 days

Availability: Any time

Production Day: Wednesday

Order Deadline: At least 2 weeks prior to shipment

Shipments: Monday-Friday

Storage: Room Temperature

Packaging: 2 or 5 mL v-bottom vial

Dispensing parameters: 0.5 mL to 4 mL ±15%

**Typical Specifications**

Compound: Dilute H<sub>3</sub>PO<sub>4</sub> in H<sub>2</sub>O

Specific Activity: ≥ 4300 Ci/mmol on production date

Activity Concentration: 3 Ci/mL

Radionuclidic purity: ≥ 99%

Radiochemical purity: ≥ 80%

<b>P-33 Decay Table</b>		<b>Half-life: 25.3 days</b>									
<b>Days</b>	<b>0</b>	<b>0.1</b>	<b>0.2</b>	<b>0.3</b>	<b>0.4</b>	<b>0.5</b>	<b>0.6</b>	<b>0.7</b>	<b>0.8</b>	<b>0.9</b>	
0	1.0000	0.9973	0.9945	0.9918	0.9891	0.9864	0.9837	0.9810	0.9783	0.9756	
1	0.9730	0.9703	0.9677	0.9650	0.9624	0.9597	0.9571	0.9545	0.9519	0.9493	
2	0.9467	0.9441	0.9415	0.9389	0.9364	0.9338	0.9312	0.9287	0.9262	0.9236	
3	0.9211	0.9186	0.9161	0.9136	0.9111	0.9086	0.9061	0.9036	0.9011	0.8987	
4	0.8962	0.8938	0.8913	0.8889	0.8864	0.8840	0.8816	0.8792	0.8768	0.8744	
5	0.8720	0.8696	0.8672	0.8648	0.8625	0.8601	0.8578	0.8554	0.8531	0.8507	
6	0.8484	0.8461	0.8438	0.8415	0.8392	0.8369	0.8346	0.8323	0.8300	0.8278	
7	0.8255	0.8232	0.8210	0.8187	0.8165	0.8143	0.8120	0.8098	0.8076	0.8054	
8	0.8032	0.8010	0.7988	0.7966	0.7944	0.7923	0.7901	0.7879	0.7858	0.7836	
9	0.7815	0.7793	0.7772	0.7751	0.7730	0.7708	0.7687	0.7666	0.7645	0.7624	
10	0.7604	0.7583	0.7562	0.7541	0.7521	0.7500	0.7480	0.7459	0.7439	0.7418	



Research Grade

 $^{186}\text{Re}$ 

1513 Research Park Drive  
Columbia, MO 65211  
Information: [www.murr.missouri.edu](http://www.murr.missouri.edu)  
Ordering: <https://murrorders.missouri.edu>  
Main Phone: (573)882-4211  
Customer Service: (573)884-3183

**aluminum perrhenate**

Please Note: This radiochemical is not intended for human use in its delivered form.  
Verification of suitability for use in humans is the sole responsibility of the purchaser.

**Information****Typical Specifications**

Half life:	3.7 days	Compound:	$^{186}\text{Re}-\text{Al}(\text{ReO}_4)_3$ in $\text{H}_2\text{O}$
Availability:	Made to Order	Specific Activity:	$\leq 3$ Ci/mg on production date
Production Day:	Monday	Activity Concentration:	per customer request
Order Deadline:	At least 2 weeks prior to shipment	Radionuclidic purity:	95% Re-186, 3.2% Re-188
Shipments:	Monday-Friday	Radiochemical purity:	$\geq 99\%$ aluminum perrhenate
Storage:	Room Temperature		
Packaging:	2 or 5 mL v-bottom vial, or 1.5 mL screw-cap or Holister stier vial		
Dispensing parameters:	per customer request		

Re-186 Decay Table.		Half-life: 3.718 days									
Days	0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	
0	1.0000	0.9815	0.9634	0.9456	0.9281	0.9110	0.8942	0.8777	0.8614	0.8455	
1	0.8299	0.8146	0.7995	0.7848	0.7703	0.7561	0.7421	0.7284	0.7149	0.7017	
2	0.6888	0.6760	0.6636	0.6513	0.6393	0.6275	0.6159	0.6045	0.5933	0.5824	
3	0.5716	0.5611	0.5507	0.5405	0.5305	0.5207	0.5111	0.5017	0.4924	0.4833	
4	0.4744	0.4656	0.4570	0.4486	0.4403	0.4322	0.4242	0.4164	0.4087	0.4011	
5	0.3937	0.3864	0.3793	0.3723	0.3654	0.3587	0.3520	0.3455	0.3392	0.3329	
6	0.3267	0.3207	0.3148	0.3090	0.3033	0.2977	0.2922	0.2868	0.2815	0.2763	
7	0.2712	0.2662	0.2612	0.2564	0.2517	0.2470	0.2425	0.2380	0.2336	0.2293	
8	0.2250	0.2209	0.2168	0.2128	0.2089	0.2050	0.2012	0.1975	0.1939	0.1903	
9	0.1868	0.1833	0.1799	0.1766	0.1733	0.1701	0.1670	0.1639	0.1609	0.1579	
10	0.1550	0.1521	0.1493	0.1466	0.1439	0.1412	0.1386	0.1360	0.1335	0.1311	

**MURR**<sup>®</sup>

Research Grade

**<sup>188</sup>Re**1513 Research Park Drive  
Columbia, MO 65211Information: [www.murr.missouri.edu](http://www.murr.missouri.edu)Ordering: <https://murrorders.missouri.edu>

Main Phone: (573)882-4211

Customer Service: (573)884-3183

**aluminum perrhenate****Please Note: This radiochemical is not intended for human use in its delivered form. Verification of suitability for use in humans is the sole responsibility of the purchaser.****Information**

Half life: 0.7 days

Availability: Made to Order

Production Day: Monday-Friday

Order Deadline: At least 3 weeks prior to shipment

Shipments: Monday-Friday

Storage: Room Temperature

Packaging: 2 or 5 mL v-bottom vial

Dispensing parameters: per customer request

**Typical Specifications**

Compound: <sup>188</sup>Re- Al (ReO<sub>4</sub>)<sub>3</sub> in H<sub>2</sub>O

Specific Activity: ≤ 3 Ci/mg on production date

Activity Concentration: Made to order

Radionuclidic purity: > 90% on production date

Radiochemical purity: > 90% on production date

Re-188 Decay Table		Half-life: 0.709 days								
Days	0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9
0	1.0000	0.9069	0.8224	0.7458	0.6763	0.6133	0.5562	0.5044	0.4574	0.4148
1	0.3762	0.3412	0.3094	0.2806	0.2544	0.2307	0.2093	0.1898	0.1721	0.1561
2	0.1415	0.1283	0.1164	0.1055	0.0957	0.0868	0.0787	0.0714	0.0647	0.0587
3	0.0532	0.0483	0.0438	0.0397	0.0360	0.0327	0.0296	0.0269	0.0244	0.0221
4	0.0200	0.0182	0.0165	0.0149	0.0135	0.0123	0.0111	0.0101	0.0092	0.0083
5	0.0075	0.0068	0.0062	0.0056	0.0051	0.0046	0.0042	0.0038	0.0034	0.0031
6	0.0028	0.0026	0.0023	0.0021	0.0019	0.0017	0.0016	0.0014	0.0013	0.0012
7	0.0011	0.0010	0.0009	0.0008	0.0007	0.0007	0.0006	0.0005	0.0005	0.0004
8	0.0004	0.0004	0.0003	0.0003	0.0003	0.0002	0.0002	0.0002	0.0002	0.0002
9	0.0002	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001
10	0.0001	0.0001	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000





Research Grade

 $^{105}\text{Rh}$ 

1513 Research Park Drive  
Columbia, MO 65211  
Information: [www.murr.missouri.edu](http://www.murr.missouri.edu)  
Ordering: <https://murrorders.missouri.edu>  
Main Phone: (573)882-4211  
Customer Service: (573)884-3183

**rhodium chloride**

Please Note: This radiochemical is not intended for human use in its delivered form.  
Verification of suitability for use in humans is the sole responsibility of the purchaser.

**Information****Typical Specifications**

Half life: 1.5 days

Availability: Made to Order

Production Day: Monday

Order Deadline: At least 3 weeks prior to shipment

Shipments: Monday-Friday

Storage: Room Temperature

Packaging: 5 mL v-bottom vial or holister stier vial

Dispensing parameters: varies

Compound:  $^{105}\text{RhCl}_3$ 

Specific Activity: carrier-free

Activity Concentration: per customer request

Radionuclidic purity: 99% Rh-105

Radiochemical purity: 99% as rhodium chloride

Rh-105 Decay Table		Half-life: 1.475 days								
Days	0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9
0	1.0000	0.9541	0.9103	0.8685	0.8286	0.7906	0.7543	0.7197	0.6866	0.6551
1	0.6250	0.5964	0.5690	0.5429	0.5179	0.4942	0.4715	0.4498	0.4292	0.4095
2	0.3907	0.3727	0.3556	0.3393	0.3237	0.3089	0.2947	0.2812	0.2683	0.2559
3	0.2442	0.2330	0.2223	0.2121	0.2023	0.1931	0.1842	0.1757	0.1677	0.1600
4	0.1526	0.1456	0.1389	0.1326	0.1265	0.1207	0.1151	0.1098	0.1048	0.1000
5	0.0954	0.0910	0.0868	0.0829	0.0791	0.0754	0.0720	0.0687	0.0655	0.0625
6	0.0596	0.0569	0.0543	0.0518	0.0494	0.0471	0.0450	0.0429	0.0409	0.0391
7	0.0373	0.0356	0.0339	0.0324	0.0309	0.0295	0.0281	0.0268	0.0256	0.0244
8	0.0233	0.0222	0.0212	0.0202	0.0193	0.0184	0.0176	0.0168	0.0160	0.0153
9	0.0146	0.0139	0.0133	0.0126	0.0121	0.0115	0.0110	0.0105	0.0100	0.0095
10	0.0091	0.0087	0.0083	0.0079	0.0075	0.0072	0.0069	0.0066	0.0062	0.0060

**MURR**<sup>®</sup>

Research Grade

**<sup>153</sup>Sm**1513 Research Park Drive  
Columbia, MO 65211Information: [www.murr.missouri.edu](http://www.murr.missouri.edu)Ordering: <https://murrorders.missouri.edu>

Main Phone: (573)882-4211

Customer Service: (573)884-3183

**samarium chloride****Please Note: This radiochemical is not intended for human use in its delivered form. Verification of suitability for use in humans is the sole responsibility of the purchaser.****Information**

Half life: 1.9 days

Availability: Made to Order

Production Day: Monday-Friday

Order Deadline: At least 2 weeks prior to shipment

Shipments: As Requested

Storage: Room Temperature

Packaging: 2 or 5 mL v-bottom vial or 1.5 mL screw-cap tube

Dispensing parameters: per customer request

**Typical Specifications**

Compound: <sup>153</sup>SmCl<sub>3</sub> in 0.1 N HCL or 0.05 M HCl

Specific Activity: ≤ 6 Ci/mg on production date

Activity Concentration: per customer request

Radionuclidic purity: 98%

Radiochemical purity: 99% as samarium chloride

<b>Sm-153 Decay Table</b>		<b>Half-life: 1.928 days</b>									
<b>Days</b>	<b>0</b>	<b>0.1</b>	<b>0.2</b>	<b>0.3</b>	<b>0.4</b>	<b>0.5</b>	<b>0.6</b>	<b>0.7</b>	<b>0.8</b>	<b>0.9</b>	
0	1.0000	0.9647	0.9306	0.8978	0.8661	0.8355	0.8060	0.7775	0.7501	0.7236	
1	0.6980	0.6734	0.6496	0.6266	0.6045	0.5832	0.5626	0.5427	0.5235	0.5051	
2	0.4872	0.4700	0.4534	0.4374	0.4220	0.4071	0.3927	0.3788	0.3654	0.3525	
3	0.3401	0.3281	0.3165	0.3053	0.2945	0.2841	0.2741	0.2644	0.2551	0.2461	
4	0.2374	0.2290	0.2209	0.2131	0.2056	0.1983	0.1913	0.1846	0.1781	0.1718	
5	0.1657	0.1598	0.1542	0.1488	0.1435	0.1384	0.1335	0.1288	0.1243	0.1199	
6	0.1157	0.1116	0.1076	0.1038	0.1002	0.0966	0.0932	0.0899	0.0868	0.0837	
7	0.0807	0.0779	0.0751	0.0725	0.0699	0.0674	0.0651	0.0628	0.0606	0.0584	
8	0.0564	0.0544	0.0524	0.0506	0.0488	0.0471	0.0454	0.0438	0.0423	0.0408	
9	0.0393	0.0379	0.0366	0.0353	0.0341	0.0329	0.0317	0.0306	0.0295	0.0285	
10	0.0275	0.0265	0.0256	0.0246	0.0238	0.0229	0.0221	0.0213	0.0206	0.0199	



Research Grade

<sup>75</sup>Se

1513 Research Park Drive  
Columbia, MO 65211  
Information: [www.murr.missouri.edu](http://www.murr.missouri.edu)  
Ordering: <https://murrorders.missouri.edu>  
Main Phone: (573)882-4211  
Customer Service: (573)884-3183

## selenious acid

Please Note: This radiochemical is not intended for human use in its delivered form. Verification of suitability for use in humans is the sole responsibility of the purchaser.

### Information

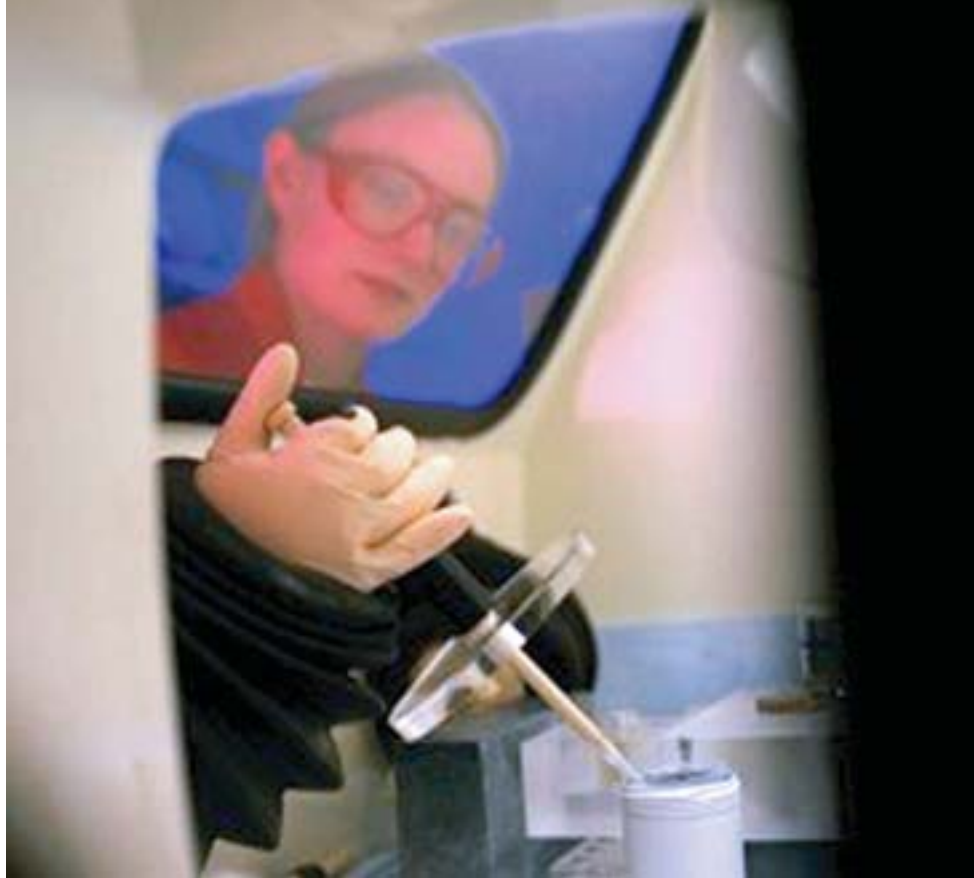
### Typical Specifications

Half life: 119.8 days  
Availability: Any time  
Productions: March and September  
Order Deadline: At least 1 week prior to shipment  
Shipments: As Requested  
Storage: Room Temperature  
Packaging: 1.5 mL flat-bottom vial, screw top with septum  
Dispensing parameters: Min. ≥ 1 mCi as needed  
Max. 5 mCi per vial

Compound: H<sub>2</sub><sup>75</sup>SeO<sub>3</sub> in HNO<sub>3</sub>  
Specific Activity: Variable—call for current  
Activity Concentration: Variable—call for current

Se-75 Decay Table		Half-life: 119.78 days								
Days	0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9
0	1.0000	0.9994	0.9988	0.9983	0.9977	0.9971	0.9965	0.9960	0.9954	0.9948
1	0.9937	0.9931	0.9925	0.9919	0.9914	0.9908	0.9902	0.9896	0.9891	0.9885
2	0.9879	0.9873	0.9868	0.9862	0.9856	0.9851	0.9845	0.9839	0.9834	0.9828
3	0.9822	0.9817	0.9811	0.9805	0.9799	0.9794	0.9788	0.9783	0.9777	0.9771
4	0.9766	0.9760	0.9754	0.9749	0.9743	0.9737	0.9732	0.9726	0.9720	0.9715
5	0.9709	0.9704	0.9698	0.9692	0.9687	0.9681	0.9676	0.9670	0.9664	0.9659
6	0.9653	0.9648	0.9642	0.9636	0.9631	0.9625	0.9620	0.9614	0.9609	0.9603
7	0.9597	0.9592	0.9586	0.9581	0.9575	0.9570	0.9564	0.9559	0.9553	0.9548
8	0.9542	0.9537	0.9531	0.9526	0.9520	0.9515	0.9509	0.9504	0.9498	0.9493
9	0.9487	0.9482	0.9476	0.9471	0.9465	0.9460	0.9454	0.9449	0.9443	0.9438
10	0.9432	0.9427	0.9421	0.9416	0.9410	0.9405	0.9400	0.9394	0.9389	0.9383





*Interested in a reactor-produced isotope not listed?*

**Please contact us:**

**FOR RESEARCH INQUIRIES:**

[MURRResearchDirector@missouri.edu](mailto:MURRResearchDirector@missouri.edu) or 573-882-5346.

**FOR OTHER INQUIRIES:**

[MURRCustomerService@missouri.edu](mailto:MURRCustomerService@missouri.edu) or 573-884-3183.



# MURR®

means **MORE** for you...

**more power, more isotopes, more expertise,**

**more versatility, more customization,**

**more discovery,**

**more solutions**

*From groundbreaking research,  
to clinical trials, to routine supply...*

*...we are here to help you.*



University of Missouri Research Reactor Center  
1513 Research Park Drive • Columbia, MO 65211-3400 • 573-882-4211  
[www.murr.missouri.edu](http://www.murr.missouri.edu)