A World Leader in Isotope Production

Since building the first continuously operating nuclear reactor and ushering in the nuclear age, Oak Ridge National Laboratory has pioneered world-changing technologies and applications enabled by harnessing the atom. Soon after the Manhattan Project, ORNL began research, development, and production of isotopes of strategic importance to the United States. That work continues more than 75 years later and remains an essential part of the laboratory's impact on various industries, national security, and basic science research.

Real-World Impacts

Researchers use ORNL's High Flux Isotope Reactor to irradiate targets with a steady stream of neutrons. They then process those targets to extract and purify isotopes in ORNL's shielded hot cells. This unique research and development environment supports a range of nuclear science and technology activities, including a focus on producing isotopes that cannot be made anywhere else in the world. ORNL's isotopes enable:

- Cutting-edge cancer treatments
- Deep space missions
- Security at our airports and other points of entry across the country
- Discovery of new elements

ORNL started producing actinium-227 in 2018 to meet the high demand for Xofigo, a highly effective drug used in the treatment of prostate cancer. The work is part of a 10 year agreement between the DOE Isotope Program and Bayer.

88
Half-life of plutonium-238 in years, making it an excellent source of power for space exploration

70%
Percentage of world's californium-252 that is produced at ORNL

1946
ORNL ships the world's first reactor-produced radioisotope to a cancer hospital in St. Louis, Missouri

2010
Tennessine, element 117, is discovered by using ORNL-produced berkelium-249

"My curiosity is the greatest inspiration. Could a new idea make the process better?"

Susan Hogle,
Nuclear Engineer

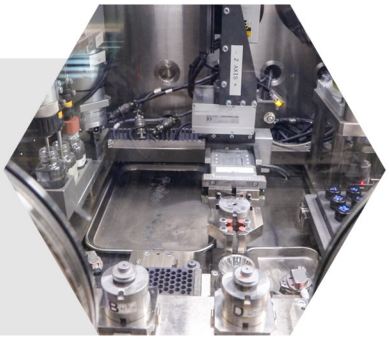
OAK RIDGE National Laboratory

U.S. DEPARTMENT OF ENERGY | Office of Science

Current Isotope Production

Californium-252	Californium-252 is an intense neutron source used in detecting impurities in coal and cement, determining potential productivity of oil wells, calibrating radiation detection instruments in port security operations, and starting up nuclear reactors. ORNL is the only US producer of this isotope and one of two producers in the entire world.
Plutonium-238	Full-scale production—expected by 2025—will provide electrical and thermal energy for NASA's deep space missions such as Mars 2020.
Actinium-225	Promising clinical trials show actinium-225 as a possible treatment for leukemia and glioblastoma.
Actinium-227	Actinium-227 is the source for Bayer's FDA-approved treatment for metastasized prostate cancer, Xofigo. ORNL is the only near-term production site for actinium-227.
Berkelium-249	A by-product of californium-252 production, berkelium-249 was essential in the discovery of tennessine, one of several new elements on the periodic table.
Selenium-75	Selenium-75 is a gamma emitter used by industry for weld inspections and other nondestructive tests.
Nickel-63	Explosives detectors at airports and narcotics detectors use nickel-63.
Tungsten-188	Researchers continue to use tungsten-188 in numerous clinical trials, with promising treatments for bone pain and lung and liver cancers.
Strontium-89	Strontium-89 is used to relieve bone pain during the treatment of various metastasized cancers.

In 2015, ORNL began producing plutonium-238 to support NASA's deep space missions and reestablish the nation's capability, since the United States stopped producing the material in the late 1980s. Researchers are developing unique radiochemical methods and technology upgrades to reach 1.5 kilograms annually by 2025. In 2019, ORNL automated the pressing of neptunium oxide–aluminum pellets, removing a key bottleneck in their production.



The Radiochemical Engineering Development Center is the largest hot cell facility at ORNL, with 15 hot cells that allow scientists to safely handle radioactive materials for processing, testing, recovery, and purification. The facility includes unique laboratory spaces to chemically process materials and pursue new isotope production techniques that reduce costs and improve outcomes.

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