OAK RIDGE NATIONAL LABORATORY

A World Leader in Isotope Production

Since building the first continuously operating nuclear reactor and ushering in the nuclear age, Oak Ridge National Laboratory (ORNL) 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 medicine, industry, 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, extracting and purifying isotopes in ORNL's shielded hot cells. This unique R&D 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:

- Energy production for the nation's needs
- Cutting-edge cancer treatments
- Deep space missions
- Security at our airports and other points of entry across the country
- Discovery of new elements



ORNL produces most of the world's californium-252, a versatile radioisotope used across industry and in port security. Californium-252 is also used to start up nuclear reactors, including the 2024 startups of Plant Vogtle Units 3 and 4, the first new reactors built in the United States in more than 30 years.

"The fact that your research has a societal impact motivates you to keep going."

Sandra Davern, Radioisotope researcher

10 Years

Length of contract for ORNL to produce actinium-227 for Xofigo, the highly effective prostate cancer drug

Of the world's californium-252 is produced at ORNL

1946

2010

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

National Laboratory



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Selected ORNL-Produced Isotopes

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 producer of this isotope in the Western Hemisphere and one of two producers in the entire world.
Plutonium-238	Full-scale production will provide electrical and thermal energy for NASA's deep space missions, as it did for Mars 2020.
Actinium-225	Promising clinical trials show actinium-225 as a possible treatment for leukemia, glioblastoma, and other cancers.
Actinium-227	Actinium-227 is the source for Xofigo, Bayer's FDA-approved treatment for metastasized prostate cancer. 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 newly discovered superheavy 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	Airport explosive detectors at airports and narcotics detectors use nickel-63.
Strontium-89	Strontium-89 is used to relieve bone pain during the treatment of various metastasized cancers.
Tungsten-188	Researchers continue to use tungsten-188 in numerous clinical trials, with promising treatments for bone pain and lung, liver, and skin cancers.
Promethium-147	Recovered by ORNL from the waste streams of plutonium-238 production, promethium-147 is used in nuclear batteries; promethium-147 is used in nuclear batteries; for thin film measurements; light sources; and luminous paints.

In July 2020, ORNL-produced plutonium-238 (Pu-238) was on board NASA's Perseverance rover, part of a supply to fuel the multimission radioisotope thermoelectric generator that moves the rover across Mars and powers its data-collecting instruments. In 2015, ORNL achieved the first US-produced Pu-238 in nearly 30 years. In 2024, the lab shipped a production-quantity amount of Pu-238 and aims for 1.5 kilograms of plutonium oxide by 2026—enough for NASA's deep space needs. ORNL-produced Pu-238 will be on board the upcoming Dragonfly mission to Saturn's moon Titan.



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 optimize isotope production.

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