

Californium-252: Supply and Funding Status

July 2009

Key Facts

■ Californium-252 (Cf-252) is a radioactive neutron source with widespread industrial uses. It is produced in high-energy research reactors. Cf-252 has a short decay period (2.6 years) and supplies need to be replenished regularly.

■ Cf-252 is produced at Oak Ridge National Laboratory (ORNL) and at a reactor in Russia. Historically Cf-252 has been a byproduct of a program mostly funded by the U.S. Department of Energy (DOE), in support of transuranic waste research and defense purposes. Commercial industry funds the remaining production for various uses, including reactor startup and testing during nuclear fuel manufacture; process control in the cement, coal, oil and gas industries; cancer therapy; and university research.

■ DOE has ended its transuranic test program at Oak Ridge, but Cf-252 production will continue in order to supply industrial and medical users.

■ In May 2009, industry users and Cf-252 source manufacturers reached agreements with DOE to privately fund the Cf-252 program through FY 2012 with expectations that production will continue beyond that year.

Production of Cf-252

Californium-252 is not found in nature and can only be produced in high-flux reactors. It is a strong neutron emitter by spontaneous fission; one microgram emits 170 million neutrons per minute. Its short half-life (2.6 years) means it decays at a rate of about 25 percent per year. New supplies to the user community thus need to be manufactured regularly.

Cf-252 is produced only at ORNL's High Flux Irradiation Reactor (HFIR) and, in smaller amounts, at Russia's Research Institute of Atomic Reactors facility. The output of this reactor is half that of ORNL's and is used mainly by Russia and China. Oak Ridge thus accounts for two-thirds of the world's supply, around 20 milligrams per year. DOE manages the program at an annual cost of about \$6 million.

A Cf-252 production cycle takes six to eight months of in-reactor irradiation, followed by a four-month process of cooling, radiochemical processing and recovery. The process typically yields about 100 milligrams for commercial use. The irradiated wires or pellets are shipped to commercial source manufacturers who

fabricate them into sealed capsules for sale to industry users.

Under new agreements concluded in May 2009 among DOE, source manufacturers and industry users, future irradiation campaigns will be conducted every two years.

Uses of Cf-252

In the past, the majority of the U.S. output of Cf-252 has been used by DOE for defense purposes. The U.S. Department of Homeland Security also uses it to inspect shipping containers and to calibrate radiation detectors. The remaining amount has been sold to commercial industry for various uses.

- About half of the commercial supply of Cf-252 is used by the nuclear energy industry for quality assurance testing to determine the initial uranium enrichment in nuclear fuel manufacturing. Customers include Global Nuclear Fuel (a joint venture of General Electric, Toshiba and Hitachi), Westinghouse, Mitsubishi and AREVA. The element also is used as a neutron source for commercial and naval reactor startup.

Other important uses of Cf-252:



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- It is used to treat several types of cancers and to identify chromosome damage.
- More than 400 cement plants, 150 coal mines and 75 power plants depend on Cf-based Prompt Gamma Neutron Activation Analysis (PGNAA) for process control. The technique is also used in the oil and gas, ore, and scrap metal industries.
- The element is used by nearly 25 universities and research institutions in educational tools and for low-energy physics experiments.

Demand for Cf-252 Expected to Grow

Market demand for Cf-252 is expected to grow due to expansion in the following areas:

- In the nuclear power industry, 31 reactors are under construction worldwide, with attendant increases in fuel fabrication and reactor startup. U.S. companies have filed applications for 26 new reactors.
- Sales of PGNAA analyzers have grown by 250 percent since 2003, with further growth expected by 2010. As the installed base of these analyzers grows, replenishment needs have risen dramatically.
- In the oil and gas industry, Cf-252 could replace americium-beryllium (AmBe) neutron sources used in well

logging. There is a world shortage of AmBe sources since DOE stopped producing Am-241. Russia is now the only supplier.

Long-Term Supply of Cf-252 Now Improved

In May 2008, DOE announced it was terminating its transuranic waste research and defense programs.

Although the majority of ORNL's Cf-252 output has been used by the U.S. government for research, defense and homeland security purposes, demand for the remainder of ORNL's output by its industrial users has been steadily growing.

As a result, a consortium of source manufacturers of Cf-based devices and industry users took the initiative to reach an agreement with DOE for Oak Ridge to continue production of the material at HFIR. In May 2009, the industry consortium reached agreements with DOE to privately fund the Cf-252 program through fiscal year 2012, with every expectation that production will continue beyond then.

Current Status

ORNL has begun processing the most recent batch of irradiated targets into Cf-252 wires. They will be available in late 2009 for sale to industry customers via the source manufacturers. Priority will be given to firms who have made subscription commitments for the October 2009-September 2012 period.

Oak Ridge has also begun investing in its Cf-252 program infrastructure, assisted in part by federal economic stimulus funds. DOE is making this investment based upon an expectation of continuing to manufacture Cf-252 through the next decade.

This fact sheet also is available at www.nei.org.