

## CESIUM

(Data in kilograms of cesium content unless otherwise noted)

**Domestic Production and Use:** The United States is 100% import reliant on the principal cesium mineral, pollucite; however, occurrences of pollucite are known in pegmatites in Maine and South Dakota. Pollucite occurs in zoned pegmatites worldwide, associated with lepidolite, petalite, and spodumene, with the largest known deposit at Bernic Lake, Manitoba, Canada. Canada is the leading producer and supplier of pollucite concentrate, which is imported for processing by one company in the United States. The principal end use of cesium is in formate brines, a high-density, low-viscosity fluid used for high-pressure/high-temperature (HPHT) oil and gas drilling and exploration. Other significant end uses of cesium are in biomedical, chemical, and electronic applications, as well as in research. Cesium nitrate is used as a colorant and oxidizer in the pyrotechnic industry, in petroleum cracking, in scintillation counters, and in x-ray phosphors.

Cesium is used as an atomic resonance frequency standard in atomic clocks, playing a vital role in global positioning satellites, Internet, and cellular telephone transmissions and aircraft guidance systems. Cesium clocks monitor the cycles of microwave radiation emitted by cesium's electrons and use these cycles as a time reference. Owing to the high accuracy of the cesium atomic clock, the international definition of a second is based on the cesium atom. The U.S. primary time and frequency standard is based on a cesium fountain clock at the National Institute of Standards and Technology in Boulder, CO.

Reactor-produced cesium-131 and cesium-137 are used primarily to treat cancer. Both have been used in brachytherapy, where the radioactive source is placed within the cancerous area. With a shorter half-life and higher energy, cesium-131 is used as an alternative to iodine-125 and palladium-103 in the treatment of prostate cancer. Cesium-137 also is widely used in industrial gauges, in mining and geophysical instruments, and for sterilization of food, sewage, and surgical equipment. Cesium can be used in ferrous and nonferrous metallurgy to remove gases and other impurities, as well as being a "getting" agent in vacuum tubes.

**Salient Statistics—United States:** Consumption, import, and export data for cesium have not been available since the late 1980s. Because cesium metal is not traded in commercial quantities, a market price is unavailable. Only a few thousand kilograms of cesium are consumed in the United States every year. In 2012, one company offered 1-gram ampoules of 99.8% (metal basis) cesium for \$55.50 each and 99.98% (metal basis) cesium for \$68.20, an increase of 3.5% from that of 2011 for both products. The price for 50 grams of 99.8% (metals basis) cesium was \$684.00, and 100 grams of 99.98% (metal basis) cesium was priced at \$1,876.00, an increase of 3.5% from that of 2011 for both products.

**Recycling:** Cesium formate brines are typically rented by oil and gas exploration clients. After completion of the well, the used cesium formate is returned and reprocessed for subsequent drilling operations. Approximately 85% of the cesium formate can be retrieved and recycled for further use. There is no data available on the amount used or recovered.

**Import Sources (2008–11):** Canada is the chief source of pollucite concentrate imported by the United States.

<u>Tariff:</u> Item	Number	Normal Trade Relations <u>12–31–12</u>
Alkali metals, other	2805.19.9000	5.5% ad val.
Chlorides, other	2827.39.9000	3.7% ad val.

**Depletion Allowance:** 14% (Domestic and foreign).

**Government Stockpile:** None.

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**Events, Trends, and Issues:** Domestic cesium occurrences will remain uneconomic unless market conditions change, such as the discovery of new end uses or increased consumption for existing end uses. Commercially useful quantities of inexpensive cesium are available as a byproduct of the production of lithium. Increases in lithium exploration may yield discoveries of additional cesium resources, which may lead to expanded commercial applications. No known human health issues are associated with naturally occurring cesium, and its use has minimal environmental impact. Radioactive isotopes of cesium have been known to cause adverse health effects.

The International Atomic Energy Agency has indicated that cesium-137 is one of several radioactive materials that may be used in radiological dispersion devices or “dirty bombs.” Cesium-137 is regulated in the United States by the U.S. Nuclear Regulatory Commission (NRC) and the Environmental Protection Agency (EPA). The NRC monitors devices containing cesium-137 and requires users to obtain specific licenses for these devices. The EPA places a maximum allowance of cesium-137 that can be released into the air by nuclear facilities and requires the cleanup of contaminated soil and groundwater. The NRC agreed to encourage research into finding and implementing alternatives but concluded that a near-term replacement was not practical and would be detrimental to current emergency medical capabilities.

Health officials in Japan have been monitoring radioactive cesium levels for food safety associated with the 2011 Fukushima nuclear disaster. Between April 1 and September 19, 2012, approximately 12% of the meat and produce inspected by local health ministry officials was found to exceed cesium levels designated as safe for human consumption. Of the contaminated food items, about one-half originated from the Fukushima Prefecture and were banned from shipment until the radiation levels drop to within normal limits. In September, independent researchers reported that cesium-137 and cesium-135 particles had been identified throughout the Northern Hemisphere as a result of the migration of radioactive materials from the Fukushima-Daiichi site through global wind currents.

**World Mine Production and Reserves:** Pollucite, mainly formed in association with lithium-rich, lepidolite-bearing or petalite-bearing zoned granite pegmatites, is the principal cesium ore mineral. Cesium reserves are therefore estimated based on the occurrence of pollucite, which is mined as a byproduct of the lithium mineral lepidolite. Most pollucite contains 5% to 32% Cs<sub>2</sub>O. Data on cesium resources and mine production are either limited or not available. The main pollucite zone at Bernic Lake in Canada contains approximately 390,000 tons of pollucite, with an average Cs<sub>2</sub>O content of 24%, and a secondary zone of approximately 100,000 tons of pollucite contains an average of 5% Cs<sub>2</sub>O. Sites near Lake Ontario have identified cesium resources; plans for estimation and production are scheduled to begin spring of 2013. Zimbabwe currently produces cesium in small quantities as a byproduct of lithium operations. Reserve data were altered to reflect changes in estimates based on information from National Resources Canada.

	<b>Reserves<sup>1</sup></b>
Canada	99,000,000
Zimbabwe	64,000,000
Other countries	<u>NA</u>
World total (rounded)	163,000,000

**World Resources:** World resources of cesium have not been estimated. Cesium is associated with lithium-bearing pegmatites worldwide, and cesium resources have been identified in the United States, Canada, Namibia, and Zimbabwe. Lower concentrations are also known in brines in Chile and China and in geothermal systems in Germany, India, and Tibet.

**Substitutes:** Cesium and rubidium can be used interchangeably in many applications because they have similar physical properties and atomic radii. Cesium, however, is more electropositive than rubidium, making it a preferred material for some applications.

NA Not available.

<sup>1</sup>See Appendix C for resource/reserve definitions and information concerning data sources.