

# CESIUM

(Data in metric tons of cesium oxide unless otherwise noted)

**Domestic Production and Use:** In 2022, no cesium was mined domestically, and the United States was 100% net import reliant for cesium minerals. Pollucite, mainly found in association with lithium-rich, lepidolite-bearing or petalite-bearing zoned granite pegmatites, is the principal cesium ore mineral. Cesium minerals are used as feedstocks to produce a variety of cesium compounds and cesium metal. The primary application for cesium, by gross weight, is in cesium formate brines used for high-pressure, high-temperature well drilling for oil and gas exploration and production. With the exception of cesium formate, cesium is used in relatively small-scale applications, using only a few grams for most applications. Owing to the lack of global availability of cesium, many applications have used mineral substitutes and the use of cesium in any particular application may no longer be viable.

Cesium metal may be used in the production of cesium compounds and photoelectric cells. Cesium bromide may be used in infrared detectors, optics, photoelectric cells, scintillation counters, and spectrophotometers. Cesium carbonate may be used in the alkylation of organic compounds and in energy conversion devices, such as fuel cells, magneto-hydrodynamic generators, and polymer solar cells. Cesium chloride may be used in analytical chemistry applications as a reagent, in high-temperature solders, as an intermediate in cesium metal production, in isopycnic centrifugation, as a radioisotope in nuclear medicine, as an insect repellent in agricultural applications, and in specialty glasses. Cesium hydroxide may be used as an electrolyte in alkaline storage batteries. Cesium iodide may be used in fluoroscopy equipment—Fourier-transform infrared spectrometers—as the input phosphor of X-ray image intensifier tubes, and in scintillators. Cesium nitrate may be used as a colorant and oxidizer in the pyrotechnic industry, in petroleum cracking, in scintillation counters, and in X-ray phosphors. Cesium sulfates are often used as an intermediate form of cesium and may be used in water treatment, fuel cells, and to improve optical quality for scientific instruments.

Cesium isotopes, which are obtained as a byproduct in nuclear fission or formed from other isotopes, such as barium-131, may be used in electronic, medical, metallurgical, and research applications. Cesium isotopes are used as an atomic resonance frequency standard in atomic clocks, playing a vital role in aircraft guidance systems, global positioning satellites, and internet and cellular telephone transmissions. 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 1 second is based on the cesium atom. The U.S. civilian time and frequency standard is based on a cesium fountain clock at the National Institute of Standards and Technology in Boulder, CO. The U.S. military frequency standard, the United States Naval Observatory (USNO) timescale, is based on 48 weighted atomic clocks, including 25 USNO cesium fountain clocks.

A company in Richland, WA, produced a range of cesium-131 medical products for treatment of various cancers. Cesium-137 may be used in industrial gauges, in mining and geophysical instruments, and for sterilization of food, sewage, and surgical equipment. Because of the danger posed by the radiological properties of cesium-137, efforts to find substitutes in its applications continued.

**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. No more than a few thousand kilograms of cesium chemicals are thought to be consumed in the United States every year. The United States was 100% net import reliant for its cesium needs.

In 2022, one company offered 1-gram ampoules of 99.8% (metal basis) cesium for \$76.97 and 99.98% (metal basis) cesium for \$97.86, 10% increases from \$69.90 and \$88.90 in 2021, respectively. In 2022, the prices for 50 grams of 99.9% (metal basis) cesium acetate, cesium bromide, cesium carbonate, 99.99% (metal basis) cesium chloride, and cesium iodide were \$134.62, \$82.43, \$118.66, \$119.70, and \$137.34, respectively, with increases ranging from 3% to 9% from prices in 2021.

The price for a cesium-plasma standard solution (10,000 micrograms per milliliter) in 2022 was \$84.53 for 50 milliliters and \$129.15 for 100 milliliters, increases of 8% from \$78.60 and \$120.00 in 2021, respectively. The price for 25 grams of 98% (metal basis) cesium formate was \$46.10, an 8% increase from \$42.60 in 2021.

**Recycling:** Cesium formate brines are typically rented by oil and gas exploration clients. After completion of the well, the used cesium formate brine is returned and reprocessed for subsequent drilling operations. Cesium formate brines are recycled, recovering nearly 85% of the brines for recycling to be reprocessed for further use.

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**Import Sources (2018–21):** No reliable data have been available to determine the source of cesium ore imported by the United States since 1988. Prior to 2016, Canada was thought to be the primary supplier of cesium ore and refined chemicals. Based on recent import data, it is thought that Germany was a source of refined cesium chemicals.

<b>Tariff:</b>	<b>Item</b>	<b>Number</b>	<b>Normal Trade Relations 12–31–22</b>
	Alkali metals, other	2805.19.9000	5.5% ad valorem.
	Chlorides, other	2827.39.9000	3.7% ad valorem.
	Bromides, other	2827.59.5100	3.6% ad valorem.
	Iodides, other	2827.60.5100	4.2% ad valorem.
	Sulfates, other	2833.29.5100	3.7% ad valorem.
	Nitrates, other	2834.29.5100	3.5% ad valorem.
	Carbonates, other	2836.99.5000	3.7% ad valorem.
	Cesium-137, other	2844.43.0021	Free.

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

**Government Stockpile:** None.

**Events, Trends, and Issues:** Domestic cesium occurrences will likely remain subeconomic unless market conditions change. No known human health issues are associated with exposure to naturally occurring cesium, and its use has minimal environmental impact. Manufactured radioactive isotopes of cesium have been known to cause adverse health effects. Certain cesium compounds may be toxic if consumed. Food that has been irradiated using the radioisotope cesium-137 has been found to be safe by the U.S. Food and Drug Administration.

During 2022, no primary cesium mine production was reported globally but cesium was thought to have been mined in China. Mine production of cesium from all countries, excluding China, ceased within the past two decades. Mining of cesium in Namibia ceased in the early 2000s. Potential extraction of cesium from pollucite mining at the Tanco Mine in Canada ended in 2015. The Bikita Mine in Zimbabwe was depleted of pollucite ore reserves in 2018. The Sinclair Mine in Australia completed the mining and shipments of all economically recoverable pollucite ore in 2019. Recent reports indicate that, with current processing rates, the world's commercial stockpiles of cesium ore, excluding those in China, may be depleted in the near future.

Throughout 2022, multiple projects that would produce cesium through lepidolite, pollucite, spodumene, and zinnwaldite mining, focused primarily on lithium or cesium extraction, were in the feasibility and exploration stage, and one company was working on mine development. Beginning in late 2021 and early 2022, pollucite ore from the Tanco Mine was being shipped to China for lithium recovery.

**World Mine Production and Reserves:**<sup>1</sup> There were no official sources for cesium production data in 2022. Cesium reserves are, therefore, estimated based on the occurrence of pollucite, a primary lithium-cesium-rubidium mineral. Most pollucite contains 5% to 32% cesium oxide. No reliable data were available to determine reserves for specific countries; however, Australia, Canada, China, and Namibia were thought to have reserves totaling less than 200,000 tons. Existing stockpiles at multiple former mine sites have continued feeding downstream refineries, though recent reports have indicated stockpiles will be depleted within a few years.

**World Resources:**<sup>1</sup> Cesium is associated with lithium-bearing pegmatites worldwide, and cesium resources have been identified in Australia, Canada, Namibia, the United States, and Zimbabwe. In the United States, pollucite occurs in pegmatites in Alaska, Maine, and South Dakota. Lower concentrations occur in brines in Chile and China and in geothermal systems in China, Germany, and India. China was thought to have cesium-rich deposits of geyserite, lepidolite, and pollucite, with concentrations highest in Yichun, Jiangxi Province, although no resource, reserve, or production estimates were available.

**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. However, rubidium is mined from similar deposits, in relatively smaller quantities, as a byproduct of cesium production in pegmatites and as a byproduct of lithium production from lepidolite (hard-rock) mining and processing, making it no more readily available than cesium.

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