

## THORIUM

(Data in metric tons of thorium oxide (ThO<sub>2</sub>) equivalent unless otherwise noted)

**Domestic Production and Use:** The world's primary source of thorium is the rare-earth and thorium phosphate mineral monazite. Monazite itself may be recovered as a byproduct of processing heavy-mineral sands for titanium and zirconium minerals. In 2013, monazite was not recovered domestically as a salable product. Essentially all thorium compounds and alloys consumed by the domestic industry were derived from imports, stocks of previously imported materials, or materials previously shipped from U.S. Government stockpiles. About eight companies processed or fabricated various forms of thorium for uses such as catalysts, high-temperature ceramics, and welding electrodes. Thorium's use in most products has generally decreased because of its naturally occurring radioactivity. The estimated value of thorium compounds imported for consumption by the domestic industry was \$54,000, a significant decrease compared with that of 2012.

<b>Salient Statistics—United States:</b>	<b>2009</b>	<b>2010</b>	<b>2011</b>	<b>2012</b>	<b>2013<sup>e</sup></b>
Production, refinery <sup>1</sup>	—	—	—	—	—
Imports for consumption:					
Thorium ore and concentrates (monazite), gross weight	26	—	30	43	—
Thorium compounds (oxide, nitrate, etc.), gross weight <sup>2</sup>	2.25	3.03	5.71	4.40	0.83
Thorium compounds (oxide, nitrate, etc.), ThO <sub>2</sub> content <sup>2</sup>	1.66	2.24	4.22	3.26	0.61
Exports:					
Thorium ore and concentrates (monazite), gross weight	18	1	—	—	—
Thorium compounds (oxide, nitrate, etc.), gross weight <sup>2</sup>	4.73	1.50	4.28	3.16	2.20
Thorium compounds (oxide, nitrate, etc.), ThO <sub>2</sub> content <sup>2</sup>	3.50	1.11	3.17	2.34	1.60
Consumption, apparent <sup>2</sup>	(3)	1.13	1.05	0.92	(3)
Price, thorium compounds, gross weight, dollars per kilogram: <sup>4</sup>					
France	193	131	158	153	NA
India	51	58	58	60	65
Net import reliance <sup>5</sup> as a percentage of apparent consumption <sup>1</sup>	100	100	100	100	100

**Recycling:** None.

**Import Sources (2009–12):** Monazite: United Kingdom, 100%. Thorium compounds: India, 84%; and France, 16%.

<b>Tariff:</b>	<b>Item</b>	<b>Number</b>	<b>Normal Trade Relations 12–31–13</b>
	Thorium ores and concentrates (monazite)	2612.20.0000	Free.
	Thorium compounds	2844.30.1000	5.5% ad val.

**Depletion Allowance:** Monazite, 22% on thorium content, and 14% on rare-earth and yttrium content (Domestic); 14% (Foreign).

**Government Stockpile:** None.

**Events, Trends, and Issues:** Domestic mine production of thorium-bearing monazite ceased at the end of 1994 as world demand for ores containing naturally occurring radioactive thorium declined. Imports and existing stocks supplied essentially all thorium consumed in the United States in 2013. Domestic demand for thorium alloys, compounds, metals, and ores has exhibited a long-term declining trend.

On the basis of data through September 2013, the average value of imported thorium compounds decreased to \$65 per kilogram from the 2012 average of \$68 per kilogram (gross weight). The average value of exported thorium compounds increased to \$480 per kilogram based on data through September 2013, compared with \$232 per kilogram for 2012. The increase was attributed to variations in the type and purity of compounds exported in each year.

Global production of monazite was primarily for its rare-earth element content, and only a small fraction of the byproduct thorium produced was consumed. Monazite-producing countries were, in decreasing order of production, India, Malaysia, Vietnam, and Brazil. Thorium consumption worldwide is relatively small compared with that of most other mineral commodities. Issues associated with thorium's natural radioactivity represented a significant cost to those companies involved in its mining, processing, manufacture, transport, and use.

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In Australia, mining at the Mount Weld, Western Australia, operation was idled during a portion of the year pending the ramp up of rare-earth separation operations in Malaysia. In April, a second concentration plant circuit was commissioned at the Mount Weld operation. As of June 2013, 15,700 tons of concentrate containing 5,626 tons of rare-earth oxides and trace amounts of thorium were stockpiled in Australia. In South Africa, plans were underway to resume mining and processing monazite at the Steenkampskraal operation for the production of rare earths. The thorium produced at Steenkampskraal during the production of rare earths was expected to be sold or stored onsite in a recoverable form.

Interest in thorium as an energy source increased worldwide, as various countries continued research and development of thorium-fueled nuclear power as an alternative to uranium. The Chinese Academy of Sciences continued a research initiative to develop thorium molten-salt reactor technologies. The Indian Department of Atomic Energy continued development of a 300-MW advanced heavy water reactor fueled by a thorium-mixed oxide fuel (MOX). In Norway, a testing program backed by an international consortium of utilities, industry, and research organizations was hoping to demonstrate that thorium-MOX fuel could operate safely in a commercial reactor.

In 2013, exploration and development of rare-earth projects associated with thorium were underway in Australia, Brazil, Canada, Greenland, India, South Africa, the United States, and Vietnam. Greenland's parliament voted to remove a 25-year-old ban on mining thorium and uranium. The policy change may allow the commercialization of the Kvanefjeld mining project currently in the feasibility stage of development.

### World Refinery Production and Reserves:

	Refinery production		Reserves <sup>6</sup>
	2012	2013	
United States	—	—	440,000
Australia	NA	NA	<sup>7</sup> 410,000
Brazil	NA	NA	<sup>8</sup> 16,000
Canada	NA	NA	100,000
India	NA	NA	290,000
Malaysia	NA	NA	4,500
South Africa	—	—	35,000
Other countries	NA	NA	90,000
World total	NA	NA	1,400,000

Reserves are contained primarily in the rare-earth ore mineral monazite and the thorium mineral thorite. Without demand for the rare earths, monazite would probably not be recovered for its thorium content. Other ore minerals with higher thorium contents, such as thorite, would be more likely sources if demand significantly increased. New demand is possible with the development and testing of thorium nuclear fuel in Russia and India. Reserves exist primarily in recent and ancient placer deposits and in thorium vein deposits such as those in the Lemhi Pass area of Idaho. Lesser quantities of thorium-bearing monazite and thorite occur in certain iron ore deposits and carbonatites. Thorium enrichment is known to occur in iron (Fe)-rare-earth-element-thorium-apatite (FRETA) deposits, such as Mineville, NY; Pea Ridge, MO; and Scrub Oaks, NJ.

**World Resources:** The world's leading thorium resources occur in placer deposits. Resources of more than 500,000 tons are contained in placer, vein, and carbonatite deposits. Disseminated deposits in various other alkaline igneous rocks contain additional resources of more than 2 million tons. Large thorium resources are found in Australia, Brazil, Canada, Greenland (Denmark), India, South Africa, and the United States.

**Substitutes:** Nonradioactive substitutes have been developed for many applications of thorium. Yttrium compounds have replaced thorium compounds in incandescent lamp mantles. A magnesium alloy containing lanthanides, yttrium, and zirconium can substitute for magnesium-thorium alloys in aerospace applications.

<sup>6</sup>Estimated. NA Not available. — Zero.

<sup>1</sup>All domestically consumed thorium was derived from imported materials.

<sup>2</sup>Apparent consumption calculation excludes ore and concentrates.

<sup>3</sup>Apparent consumption calculations in 2009 and 2013 resulted in a negative number, but all exported materials were produced from imported materials.

<sup>4</sup>Based on U.S. Census Bureau customs value.

<sup>5</sup>Defined as imports – exports + adjustments for Government and industry stock changes.

<sup>6</sup>[See Appendix C for resource/reserve definitions and information concerning data sources.](#)

<sup>7</sup>Includes thorium contained in mineralized sands.

<sup>8</sup>Reserves for Brazil were under review pending new information from the Departamento Nacional de Produção Mineral.