

THORIUM

(Data in kilograms, gross weight, unless otherwise noted)

Domestic Production and Use: The world's primary source of thorium is the rare-earth and thorium phosphate mineral monazite. In 2021, monazite may have been produced as a separated concentrate or included as an accessory mineral in heavy-mineral concentrates. Essentially, all thorium compounds and alloys consumed by the domestic industry were derived from imports. The number of companies that processed or fabricated various forms of thorium for commercial use was not available. Thorium's use in most products was generally limited because of concerns over its naturally occurring radioactivity. Imports of thorium compounds are sporadic owing to changes in consumption and fluctuations in consumer inventory levels. The estimated value of thorium compounds imported for consumption by the domestic industry in 2021 was \$427,000 (through August 2021), compared with \$55,400 in 2020.

<u>Salient Statistics—United States:</u>	<u>2017</u>	<u>2018</u>	<u>2019</u>	<u>2020</u>	<u>2021^e</u>
Production, mine ¹	—	² 500,000	² 1,700,000	² 960,000	W
Imports for consumption:					
Ore and concentrates (monazite)	—	1,000	—	3,000	—
Compounds (oxide, nitrate, and so forth)	8,510	9,000	3,970	1,920	8,000
Exports:					
Ore and concentrates (monazite)	—	520,000	1,700,000	960,000	—
Compounds (oxide, nitrate, and so forth) ³	2,060	3,260	1,660	213	2,500
Consumption, apparent: ⁴					
Ore and concentrates (monazite)	—	1,000	—	3,000	—
Compounds (oxide, nitrate, and so forth)	6,450	5,740	2,310	1,710	5,500
Price, average value, compounds, India, ⁵ dollars per kilogram	73	72	72	NA	NA
Net import reliance ⁶ as a percentage of apparent consumption	NA	NA	NA	NA	NA

Recycling: None.

Import Sources (2017–20): Monazite: United Kingdom, 75%; and Canada, 25%. Thorium compounds: India, 74%; and France, 26%.

<u>Tariff:</u>	<u>Item</u>	<u>Number</u>	<u>Normal Trade Relations</u>
			<u>12–31–21</u>
	Thorium ore and concentrates (monazite)	2612.20.0000	Free.
	Thorium compounds	2844.30.1000	5.5% ad valorem.

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 demand for thorium alloys, compounds, and metals was limited. In addition to research purposes, various commercial uses of thorium included catalysts, high-temperature ceramics, magnetrons in microwave ovens, metal-halide lamps, nuclear medicine, optical coatings, tungsten filaments, and welding electrodes.

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Exports of unspecified thorium compounds were estimated to be 2,500 kilograms in 2021. More than 90% of the exports have a unit value of less than \$50 per kilogram, so it is likely that they were misclassified. Only the quantity of compounds with unit values more than \$50 per kilogram were included in the total export estimate. Owing to potentially misclassified material and variations in the type and purity of thorium compounds, the unit value of exports varied widely by month and by exporting customs district.

Globally, monazite was produced primarily for its rare-earth-element content, and only a small fraction of the byproduct thorium produced was consumed. Madagascar was the leading producer of monazite. Thorium consumption worldwide is relatively small compared with that of most other mineral commodities. In international trade, China was the leading importer of monazite; Brazil, Madagascar, Thailand, and Vietnam were China's leading import sources. The United States exported monazite to China, including Hong Kong. China's exports became more regulated and were optimized to add value.

The Eneabba mineral sands project (Australia) was exporting monazite but had upgraded its processing facilities and was studying the feasibility of an integrated rare-earth refinery. Monazite from the Moma Mine (Mozambique) was being exported. The status of the Kvanefjeld project (Greenland) was in flux because of environmental concerns. The Steenkrampskraal Mine (South Africa) made several improvements to its plant and was working with an energy company in Norway to develop fuel pellets for use in nuclear powerplants.

Several companies and countries were active in the pursuit of commercializing thorium as a fuel material for a new generation of nuclear reactors. Thorium-based nuclear research and development programs have been or were underway in Australia, Belgium, Brazil, Canada, China, Czechia, Denmark, Finland, France, Germany, India, Israel, Italy, Japan, the Republic of Korea, the Netherlands, Norway, Russia, the United Kingdom, and the United States.

World Mine Production and Reserves:⁷ Production and reserves are associated with the recovery of monazite in heavy-mineral-sand deposits. Without demand for the rare earths, monazite likely would not be recovered for its thorium content under current market conditions.

World Resources:⁷ The world's leading thorium resources are found in placer, carbonatite, and vein-type deposits. Thorium is found in several minerals, including monazite, thorite, and thorianite. According to the World Nuclear Association,⁸ worldwide identified thorium resources were estimated to total 6.4 million tons of thorium. Thorium resources are found throughout the world, most notably in Australia, Brazil, India, and the United States. India has the largest resources (850,000 tons), followed by Brazil (630,000 tons) and Australia and the United States (600,000 tons each).

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. Cerium, lanthanum, yttrium, and zirconium oxides can substitute for thorium in welding electrodes. Several replacement materials (such as yttrium fluoride and proprietary materials) are in use as optical coatings instead of thorium fluoride.

⁰Estimated. NA Not available. W Withheld to avoid disclosing company proprietary data. — Zero.

¹Monazite may have been produced as a separate concentrate or included as an accessory mineral in heavy-mineral concentrates.

²Estimates based on exports.

³Excludes estimates of material that may have been misclassified.

⁴Defined as production + imports – exports. Shown separately for ore and concentrates and for compounds. Production is only for ore and concentrates.

⁵Calculated from U.S. Census Bureau import data.

⁶Defined as imports – exports; however, a meaningful net import reliance could not be calculated owing to uncertainties in the classification of material being imported and exported.

⁷See Appendix C for resource and reserve definitions and information concerning data sources.

⁸World Nuclear Association, 2017, Thorium: London, United Kingdom, World Nuclear Association, February.