

## YTTRIUM<sup>1</sup>

[Data in metric tons of yttrium oxide (Y<sub>2</sub>O<sub>3</sub>) equivalent content unless otherwise noted]

**Domestic Production and Use:** Yttrium is one of the rare-earth elements. Bastnaesite (or bastnäsite), a rare-earth fluorocarbonate mineral, was mined in 2018 as a primary product at the Mountain Pass Mine in California, which was restarted in the first quarter after being put on care-and-maintenance status in the fourth quarter of 2015. Monazite, a rare-earth phosphate mineral, also may have been produced as a separated concentrate or included as an accessory mineral in heavy-mineral concentrates. Yttrium was estimated to represent about 0.12% of the rare-earth elements in the Mountain Pass bastnaesite ore.

The leading end uses of yttrium were in ceramics, metallurgy, and phosphors. In ceramic applications, yttrium compounds were used in abrasives, bearings and seals, high-temperature refractories for continuous-casting nozzles, jet-engine coatings, oxygen sensors in automobile engines, and wear-resistant and corrosion-resistant cutting tools. In metallurgical applications, yttrium was used as a grain-refining additive and as a deoxidizer. Yttrium was used in heating-element alloys, high-temperature superconductors, and superalloys. In electronics, yttrium-iron garnets were components in microwave radar to control high-frequency signals. Yttrium was an important component in yttrium-aluminum-garnet laser crystals used in dental and medical surgical procedures, digital communications, distance and temperature sensing, industrial cutting and welding, nonlinear optics, photochemistry, and photoluminescence. Yttrium was used in phosphor compounds for flat-panel displays and various lighting applications.

<b>Salient Statistics—United States:</b>	<b>2014</b>	<b>2015</b>	<b>2016</b>	<b>2017</b>	<b>2018<sup>e</sup></b>
Production, mine <sup>2</sup>	NA	NA	—	—	NA
Imports for consumption:					
Yttrium, alloys, compounds, and metal <sup>e, 3</sup>	200	360	340	380	390
Exports, compounds <sup>e, 4</sup>	NA	39	2	2	14
Consumption, estimated <sup>5</sup>	200	300	300	400	400
Price, dollars per kilogram, average:					
Yttrium oxide, minimum 99.999 purity <sup>6</sup>	16	8	4	3	3
Yttrium metal, minimum 99.9% purity <sup>6</sup>	60	48	35	35	36
Net import reliance <sup>2, 7</sup> as a percentage of apparent consumption	>95	>95	100	100	>95

**Recycling:** Insignificant.

**Import Sources (2014–17):<sup>8</sup>** Yttrium compounds: China, 76%; Estonia, 13%; Japan, 4%; Republic of Korea, 3%; and other, 4%. Nearly all imports of yttrium metal and compounds are derived from mineral concentrates processed in China. Import sources do not include yttrium contained in value-added intermediates and finished products.

<b>Tariff: Item</b>	<b>Number</b>	<b>Normal Trade Relations 12–31–18</b>
Rare-earth metals, unspecified, whether or not intermixed or interalloyed	2805.30.0090	5.0% ad val.
Mixtures of rare-earth oxides containing yttrium or scandium as the predominant metal	2846.90.2015	Free.
Mixtures of rare-earth chlorides containing yttrium or scandium as the predominant metal	2846.90.2082	Free.
Yttrium-bearing materials and compounds containing by weight >19% to <85% Y <sub>2</sub> O <sub>3</sub>	2846.90.4000	Free.
Other rare-earth compounds, including yttrium and other compounds	2846.90.8000	3.7% ad val.

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

**Government Stockpile:<sup>9</sup>**

<b>Material</b>	<b>Inventory As of 9–30–18</b>	<b>FY2018</b>		<b>FY 2019</b>	
		<b>Potential Acquisitions</b>	<b>Potential Disposals<sup>10</sup></b>	<b>Potential Acquisitions</b>	<b>Potential Disposals<sup>10</sup></b>
Yttrium oxide	25	10	—	10	—

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**Events, Trends, and Issues:** China produced most of the world's supply of yttrium, from its weathered clay ion-adsorption ore deposits in the southern Provinces—primarily Fujian, Guangdong, and Jiangxi—and from a lesser number of deposits in Guangxi and Hunan Provinces. Processing was primarily at facilities in Guangdong, Jiangsu, and Jiangxi Provinces. China's mining quota was estimated to include about 4,800 tons of yttrium, but illegal mining in China may have added significantly to the available supply. Programs to stem the undocumented production of rare earths in China were ongoing.

Globally, yttrium was mainly consumed in the form of oxide compounds for ceramics and phosphors. Lesser amounts were consumed in electronic devices, lasers, optical glass, and metallurgical applications. Prices for yttrium metal and oxide remained nearly unchanged in 2018.

In Nebraska, a rare-earth separation facility was being commissioned whose primary feedstock was expected to be recycled fluorescent lamp phosphors. The plant's initial production capacity was reported to be 430 tons per year, including 144 tons per year of yttrium oxide. An expansion plan was expected to raise the production capacity to 3,500 tons per year of separated oxides using mineral feedstocks. Ionic clays from Chile and domestic monazite mineral concentrates were being evaluated as potential sources.

In May 2018, the U.S. Department of the Interior, in coordination with other executive branch agencies, published a list of 35 critical minerals (83 FR 23295), including the rare-earth-elements group. This list was developed to serve as an initial focus, pursuant to Executive Order 13817, "A Federal Strategy to Ensure Secure and Reliable Supplies of Critical Minerals" (82 FR 60835).

**World Mine Production and Reserves:**<sup>11</sup> World production of yttrium oxide was almost entirely from China in 2018 and was estimated to be 5,000 to 7,000 tons. Reserves of yttrium are associated with those of rare earths. Global reserves of yttrium oxide were estimated to be more than 500,000 tons. The leading countries for these reserves included Australia, Brazil, Canada, China, and India. Although reserves may be sufficient to satisfy near-term demand at current rates of production, economics, environmental issues, and permitting and trade restrictions could affect the mining or availability of many of the rare-earth elements, including yttrium.

**World Resources:** Large resources of yttrium in monazite and xenotime are available worldwide in placer deposits, carbonatites, uranium ores, and weathered clay deposits (ion-adsorption ore). Additional resources of yttrium occur in apatite-magnetite-bearing rocks, deposits of niobium-tantalum minerals, nonplacer monazite-bearing deposits, sedimentary phosphate deposits, and uranium ores.

**Substitutes:** Substitutes for yttrium are available for some applications but generally are much less effective. In most uses, especially in electronics, lasers, and phosphors, yttrium is generally not subject to direct substitution by other elements. As a stabilizer in zirconia ceramics, yttrium oxide may be substituted with calcium oxide or magnesium oxide, but the substitutes generally impart lower toughness.

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

<sup>1</sup>See also Rare Earths; trade data for yttrium are included in the data shown for rare earths.

<sup>2</sup>Includes yttrium contained in rare-earth ores and mineral concentrates.

<sup>3</sup>Estimated from Trade Mining LLC shipping records.

<sup>4</sup>Estimated from Harmonized Tariff System-based Schedule B code: 2846.90.2015.

<sup>5</sup>Rounded to one significant digit. Yttrium consumed domestically was imported or refined from imported materials.

<sup>6</sup>Free on board China. Source: Argus Media group-Argus Metals International, London, United Kingdom.

<sup>7</sup>Defined as imports – exports. In 2014, insufficient data were available to determine exports and were excluded from the calculation.

<sup>8</sup>Includes estimated yttrium oxide equivalent content from the following Harmonized Tariff Schedule codes: 2846.90.2015, 2846.90.2082, 2846.90.4000, 2846.90.8050, and 2846.90.8060.

<sup>9</sup>See Appendix B for definitions.

<sup>10</sup>Disposals are defined as any barter, rotation, sale, or upgrade of National Defense Stockpile stock.

<sup>11</sup>See Appendix C for resource and reserve definitions and information concerning data sources.