## **SCANDIUM**

(Data in kilograms of scandium oxide content, unless noted)

<u>Domestic Production and Use</u>: Demand for scandium decreased in 1995. Although scandium was not mined domestically in 1995, quantities sufficient to meet demand were available from concentrates and tailings. Principal domestic sources of scandium were byproduct concentrates previously produced at Bingham Canyon, UT, and tailings previously generated by mining fluorite at Crystal Mountain, MT. Companies in Mead, CO, Urbana, IL, and Garfield, NJ, processed scandium ores, concentrates, and low-purity compounds to produce refined scandium products. Capacity to produce ingot and distilled scandium metal was located in Phoenix, AZ, Urbana, IL, and Ames, IA. Scandium used in the United States was derived from both domestic and foreign sources. Principal uses for scandium in 1995 were metallurgical research, high-intensity metal halide lamps, analytical standards, electronics, and laser research.

| Salient Statistics—United States:                       | <u>1991</u> | <u> 1992</u> | <u> 1993</u> | <u> 1994</u> | <u>1995</u> ° |
|---|-------------|--------------|--------------|--------------|---------------|
| Production, refinery                                    | W           | W            | W            | W            | W             |
| Imports for consumption                                 | NA          | NA           | NA           | NA           | NA            |
| Exports   | NA          | NA           | NA           | NA           | NA            |
| Consumption   | W           | W            | W            | W            | W             |
| Price, yearend, dollars:                                |             |              |              |              |               |
| Per kilogram, oxide, 99.0% purity                       | 2,000       | 1,500        | 1,600        | 1,600        | 1,500         |
| Per kilogram, oxide, 99.9% purity                       | 3,500       | 3,000        | 3,300        | 3,300        | 3,300         |
| Per kilogram, oxide, 99.99% purity                      | 6,000       | 5,000        | 5,200        | 5,200        | 5,100         |
| Per kilogram, oxide, 99.99% purity                      | 10,000      | 10,000       | 9,000        | 9,000        | 7,650         |
| Per gram, powder, metal <sup>1</sup>                    | 296.00      | 372.00       | 372.00       | 372.00       | 372.00        |
| Per gram, sublimed, metal <sup>2</sup>                  | 248.20      | 312.00       | 312.00       | 169.00       | 169.00        |
| Per gram, scandium bromide, 99.99% purity <sup>3</sup>  | NA          | NA           | 80.00        | 80.00        | 80.00         |
| Per gram, scandium chloride, 99.99% purity <sup>3</sup> | NA          | NA           | 62.00        | 37.00        | 37.00         |
| Per gram, scandium fluoride, 99.99% purity <sup>3</sup> | NA          | NA           | 129.00       | 77.00        | 77.00         |
| Per gram, scandium iodide, 99.999% purity <sup>3</sup>  | NA          | NA           | 78.00        | 78.00        | 78.00         |
| Stocks  | NA          | NA           | NA           | NA           | NA            |
| Employment  | 10          | 12           | 12           | 12           | 8             |
| Net import reliance <sup>4</sup> as a percent of        |             |              |              |              |               |
| apparent consumption                                    | NA          | NA           | NA           | NA           | NA            |

Recycling: Minor, recovered from laser crystal rods.

Import Sources (1991-94): Not available.

| <u>Tariff</u> : Item  | Number       | Most-favored-nation (MFN)<br>12/31/95 | Non-MFN⁵<br>12/31/95 |
|---|--------------|---------------------------------------|----------------------|
| Mineral substances not elsewhere specified or included:   | 2530.90.0000 | Free                                  | Free                 |
| Including scandium ores Rare-earth metals, scandium and yttrium, whether or not intermixed  | 2530.90.0000 | riee                                  | Free.                |
| or inter-alloyed including scandium Mixtures of rare-earth oxides except cerium oxide, including  | 2805.30.0000 | 5.0% ad val.                          | 31.3% ad val.        |
| scandium oxide mixtures Rare-earth compounds, including individual rare-earth oxides, hydroxides, nitrates, and other individual compounds, | 2846.90.2010 | Free                                  | 25% ad val.          |
| including scandium oxide Aluminum alloys, other:  | 2846.90.8000 | 3.7% ad val.                          | 25% ad val.          |
| Including scandium-aluminum   | 7601.20.9090 | Free                                  | 10.5% ad val.        |

**Depletion Allowance**: Percentage method, 14% (Domestic), 14% (Foreign).

Government Stockpile: None.

## **SCANDIUM**

**Events, Trends, and Issues**: Nominal prices for domestically produced scandium compounds were unchanged or lower for the third consecutive year. The supply of domestic and foreign scandium remained sufficient to meet demand. Demand decreased in the United States in 1995 and the total market remained small. Domestic increases in demand were almost exclusively the result of increased demand for metal halide lighting.

The price of scandium materials varies greatly based on purity and quantity. The weight-to-price ratio of scandium metals and compounds was generally much higher for gram quantities than for kilogram quantities. Kilogram prices for scandium metal ingot were typically double the cost of the starting scandium compound while higher-purity distilled or sublimed metal ranged from four to six times the cost of the starting material.

<u>World Mine Production, Reserves, and Reserve Base</u>: Scandium was produced as a byproduct material in China, Kazakstan, and Russia. Foreign mine production data was not available. No scandium was mined in the United States in 1995. Scandium occurs in many ores in trace amounts but has not been found in sufficient quantities to be considered a reserve or reserve base. As a result of its low concentration, scandium has been produced exclusively as a byproduct during processing of various ores or recovered from previously processed tailings or residues.

**World Resources**: Resources of scandium are abundant, especially when considered in relation to actual and potential demand. Scandium is rarely concentrated in nature because it lacks affinity to combine with the common ore-forming anions. It is widely dispersed in the lithosphere and forms solid solutions in over a 100 minerals. In the Earth's crust, scandium is primarily a trace constituent of ferromagnesium minerals. Concentrations in these minerals (amphibole-hornblende, pyroxene, and biotite) typically range from 5 to 100 parts per million equivalent Sc<sub>2</sub>O<sub>3</sub>. Ferromagnesium minerals commonly occur in the igneous rocks, basalt and gabbro. Enrichment of scandium also occurs in rare-earth minerals, wolframite, columbite, cassiterite, beryl, garnet, muscovite, phosphates, and the aluminum phosphate minerals. Recent domestic production has been primarily from the scandium-yttrium silicate mineral, thortveitite, and from byproduct leach solutions from uranium operations. Future production is expected as a byproduct from tantalum tailings.

The principal domestic scandium resource is fluorite tailings from the Crystal Mountain deposit near Darby, Montana. Tailings from the mined-out fluorite operations, which were generated from 1952 to 1971, contain thortveitite and other associated scandium-enriched minerals. Resources are also contained in the tungsten, molybdenum, and titanium minerals from the Climax molybdenum deposit in Colorado, and in kolbeckite (sterrettite), varisite, and crandallite at Fairfield, UT. Other low-grade domestic resources are present in ores of aluminum, iron, molybdenum, nickel, phosphate, tantalum, tin, titanium, tungsten, zinc, and zirconium. Process residues from tungsten and tantalum operations in the United States also contain significant amounts of scandium.

Foreign resources are known in China, Kazakstan, Madagascar, Norway, and Russia. China's resources are in tin, tungsten, and iron in Fujian, Guangdong, Guangxi, Jiangxi, and Zhejian Provinces. Resources in Russia and Kazakstan are in the Kola Peninsula apatites and in uranium-bearing deposits, respectively. Scandium also occurs as an accessory mineral in the aplites of the Shilovo-Konveno Massif in the Ural Mountains. Scandium in Madagascar is concentrated in pegmatites in the Befanamo area. Resources in Norway are contained in the thortveitite-rich pegmatites of the Iveland-Evje region and a deposit to the north near Finnmark. An occurrence of the mineral, thortveitite is reported for Kobe, Japan. Undiscovered scandium resources are believed to be very large.

Substitutes: In scandium's few applications, such as lighting and lasers, it is generally not subject to substitution.

<sup>&</sup>lt;sup>e</sup>Estimated. NA Not available. W Withheld to avoid disclosing company proprietary data.

<sup>&</sup>lt;sup>1</sup>Less than 250 micron, 99.9% purity, 1991 through 1995 prices converted from 0.5 gram price, from Alfa Aesar.

<sup>&</sup>lt;sup>2</sup>Lump, sublimed dendritic 99.99% purity, from Alfa Aesar.

<sup>&</sup>lt;sup>3</sup>Bromide, chloride, and fluoride in crystalline or crystalline aggregate form and scandium iodide as powder from Alfa Aesar.

<sup>&</sup>lt;sup>4</sup>Defined as imports - exports + adjustments for Government and industry stock changes.

<sup>&</sup>lt;sup>5</sup>See Appendix B.

<sup>&</sup>lt;sup>6</sup>See Appendix C for definitions.