# ZIRCONIUM AND HAFNIUM

(Data in metric tons, unless otherwise noted)

**Domestic Production and Use:** Zircon sand was produced at two mines in Florida and one mine in Virginia. Zirconium and hafnium metal were produced from zircon sand by two domestic producers, one each in Oregon and Utah. Both metals are present in the ore typically in a Zr to Hf ratio of 50:1. Primary zirconium chemicals were produced by the Oregon metal producer and at a plant in New Jersey. Secondary zirconium chemicals were produced by 10 other companies as well. Zirconia ($ZrO_2$) was produced from zircon sand at plants in Alabama, New Hampshire, New York, Ohio, and the metal producer in Oregon. Zircon ceramics, opacifiers, refractories, and foundry applications are the largest end uses for zirconium. Other end uses of zirconium include abrasives, chemicals, metal alloys, welding rod coatings, and sandblasting. The largest market for hafnium metal is an addition in superalloys.

| **Salient Statistics—United States:** | 1995 | 1996 | 1997 | 1998 | 1999[e] |
|---|---|---|---|---|---|
| Production: Zircon ($ZrO_2$ content)[1] | W | W | W | W | W |
| Imports: | | | | | |
| Zirconium, ores and concentrates ($ZrO_2$ content) | 60,800 | 60,100 | 40,600 | 58,200 | 38,600 |
| Zirconium, alloys, waste and scrap ($ZrO_2$ content) | 884 | 836 | 929 | 1,210 | 1,400 |
| Zirconium oxide ($ZrO_2$ content)[2] | 4,370 | 5,240 | 4,220 | 3,900 | 3,100 |
| Hafnium, unwrought, waste and scrap | 5 | 9 | 8 | 12 | 11 |
| Exports: | | | | | |
| Zirconium ores and concentrates ($ZrO_2$ content) | 26,200 | 22,780 | 28,800 | 26,600 | 44,900 |
| Zirconium, alloys, waste and scrap ($ZrO_2$ content) | 221 | 184 | 188 | 216 | 166 |
| Zirconium oxide ($ZrO_2$ content)[2] | 1,680 | 1,480 | 1,970 | 1,540 | 1,610 |
| Consumption, zirconium ores and concentrates, apparent ($ZrO_2$ content) | W | W | W | W | W |
| Prices: | | | | | |
| Zircon, dollars per metric ton (gross weight): | | | | | |
| Domestic[3] | 352 | 462 | 419 | 320 | 300 |
| Imported, f.o.b.[4] | 325 | 400 | 400 | 355 | 313 |
| Zirconium sponge, dollars per kilogram[5] | 20-26 | 20-26 | 20-26 | 20-26 | 20-26 |
| Hafnium sponge, dollars per kilogram[5] | 165-209 | 165-209 | 165-209 | 165-209 | 165-209 |
| Net import reliance[6] as a percent of apparent consumption: | | | | | |
| Zirconium | W | W | W | W | W |
| Hafnium | NA | NA | NA | NA | NA |

**Recycling:** Zirconium metal was recycled by four companies, one each in California, Michigan, New York, and Texas. The majority of the zirconium recycled came from scrap generated during metal production and fabrication. Zircon foundry mold cores and spent or rejected zirconia refractories are often recycled. Recycling of hafnium metal was insignificant.

**Import Sources (1995-98):** Zirconium ores and concentrates: South Africa, 53%; Australia, 45%; and other, 2%. Zirconium, wrought, unwrought, waste and scrap: France, 48%; Germany, 22%; Canada, 7%; Japan, 7%; and other, 16%. Hafnium, unwrought, waste and scrap: France, 71%; Australia, 17%; Germany, 8%; and United Kingdom, 4%.

| **Tariff: Item** | **Number** | **Normal Trade Relations 12/31/99** |
|---|---|---|
| Zirconium ores and concentrates | 2615.10.0000 | Free. |
| Germanium oxides and $ZrO_2$ | 2825.60.0000 | 3.7% ad val. |
| Ferrozirconium | 7202.99.1000 | 4.2% ad val. |
| Zirconium, waste and scrap | 8109.10.3000 | Free. |
| Zirconium, other unwrought, powders | 8109.10.6000 | 4.2% ad val. |
| Zirconium, other wrought, alloys | 8109.90.0000 | 3.7% ad val. |
| Unwrought hafnium, waste and scrap | 8112.91.2000 | Free. |

**Depletion Allowance:** Percentage method: 23% (Domestic), 15% (Foreign).

**Government Stockpile:** In addition to 15,769 tons of baddeleyite ore (gross weight) held in the National Defense Stockpile, the U.S. Department of Energy (DOE) held over 500 tons of zirconium in various forms. DOE also maintained a supply of approximately 35 tons of hafnium.

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# ZIRCONIUM AND HAFNIUM

| | Stockpile Status—9-30-99[7] | | | | |
|---|---|---|---|---|---|
| **Material** | **Uncommitted inventory** | **Committed inventory** | **Authorized for disposal** | **Disposal plan FY 1999** | **Disposals FY 1999** |
| Baddeleyite | 15,769 | — | 15,769 | — | — |

**Events, Trends, and Issues:** The global supply and demand of zirconium mineral concentrates was largely in balance in 1999. This trend is expected to continue over the next few years. However, long-term supply shortages may occur unless new production sources of zirconium concentrates are developed. U.S. imports of zirconium concentrates were estimated to have decreased 57%, while exports increased 69% compared with those of 1998. A new mining operation at Stony Creek, VA, began production of zircon and other heavy minerals in 1998. Initial capacity was expected to include up to 30,000 tons per year of zircon. Availability of hafnium continued to exceed supply. Surpluses were stockpiled in the form of hafnium oxide. The demand for nuclear-grade zirconium metal, the production of which necessitates hafnium's removal, produces more hafnium than can be consumed by the metal's uses.

**World Refinery Production, Reserves, and Reserve Base:** World primary hafnium production statistics are not available. Hafnium occurs with zirconium in the minerals zircon and baddeleyite.

| | Zirconium | | | | Hafnium | |
|---|---|---|---|---|---|---|
| | **Mine production (thousand metric tons)** | | **Reserves[8] (million metric tons, $ZrO_2$)** | **Reserve base[8]** | **Reserves[8] (thousand metric tons, $HfO_2$)** | **Reserve base[8]** |
| | **1998** | **1999[e]** | | | | |
| United States | W | W | 3.4 | 5.3 | 68 | 97 |
| Australia | 404 | 400 | 9.1 | 29.8 | 182 | 596 |
| Brazil | 16 | 16 | .4 | .4 | 7 | 7 |
| China[e] | 15 | 15 | .5 | 1.0 | NA | NA |
| India | 19 | 19 | 3.4 | 3.8 | 42 | 46 |
| South Africa | 270 | 270 | 14.3 | 14.3 | 259 | 259 |
| Ukraine[e] | 65 | 65 | 4.0 | 6.0 | NA | NA |
| Other countries | 25 | 30 | .9 | 4.1 | NA | NA |
| World total (may be rounded) | [9]814 | [9]815 | 36 | 65 | 560 | 1,000 |

**World Resources:** Resources of zircon in the United States included about 14 million tons associated with titanium resources in heavy-mineral sand deposits. Phosphate and sand and gravel deposits have the potential to yield substantial amounts of zircon as a future byproduct. Eudialyte and gittinsite are zirconium silicate minerals that have a potential for zirconia production. Identified world resources of zircon exceed 60 million tons.

Resources of hafnium in the United States are estimated to be about 130,000 tons, available in the 14-million ton domestic resources of zircon. World resources of hafnium are associated with those of zircon and baddeleyite and exceed 1 million tons.

**Substitutes:** Chromite and olivine can be used instead of zircon for some foundry applications. Dolomite and spinel refractories can also substitute for zircon in certain high-temperature applications. Columbium (niobium), stainless steel, and tantalum provide limited substitution in nuclear applications, while titanium and synthetic materials may substitute in some chemical plant uses.

Silver-cadmium-indium control rods are used in lieu of hafnium at numerous nuclear powerplants. Zirconium can be used interchangeably with hafnium in certain superalloys; in others, only hafnium produces the desired or required grain boundary refinement.

[e]Estimated. NA Not available. W Withheld to avoid disclosing company proprietary data.
[1]$ZrO_2$ content of zircon is typically 65%.
[2]Includes germanium oxides and zirconium oxides.
[3]E.I. du Pont de Nemours & Co. and Iluka Resources, Inc., average price.
[4]Bureau of the Census trade data.
[5]American Metal Market, daily, Miscellaneous Prices. Converted from pounds.
[6]Defined as imports - exports.
[7]See Appendix B for definitions.
[8]See Appendix C for definitions.
[9]Excludes the United States.