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, and 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 as an addition in superalloys.

Salient Statistics—United States:	1993	1994	1995	1996	1997[e]
Production: Zircon (ZrO_2 content)[1]	W	W	W	W	W
Imports:					
Zirconium, ores and concentrates (ZrO_2 content)	45,500	53,300	60,800	60,100	41,600
Zirconium, alloys, waste and scrap (ZrO_2 content)	798	837	884	830	993
Zirconium oxide (ZrO_2 content)	1,990	2,400	4,370	5,240	3,870
Hafnium, unwrought, waste and scrap	3	5	5	8	8
Exports:					
Zirconium ores and concentrates (ZrO_2 content)	23,400	20,800	26,200	22,780	24,900
Zirconium, alloys, waste and scrap (ZrO_2 content)	2,020	1,640	1,680	1,480	1,690
Consumption, zirconium ores and concentrates, apparent, (ZrO_2 content)	W	W	W	W	W
Prices:					
Zircon, dollars per ton:					
Domestic	NA	278	319	419	400
Imported, f.o.b. U.S. east coast	200	220	325	411	400
Zirconium sponge, dollars per pound	9-12	9-12	9-12	9-12	9-12
Hafnium sponge, dollars per kilogram	165-210	165-210	165-210	165-210	165-210
Net import reliance[2] 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 (1993-96): Zirconium ores and concentrates: Australia, 53%; South Africa, 46%; and other, 1%. Zirconium, wrought, unwrought, waste and scrap: France, 53%; Canada, 17%; Germany, 12%; Japan, 10%; and other, 8%. Hafnium, unwrought, waste and scrap: France, 91%; Germany, 5%; the United Kingdom, 3%; and Hong Kong, 1%.

Tariff: Item	Number	Most favored nation (MFN) 12/31/97	Non-MFN[3] 12/31/97
Zirconium ores and concentrates	2615.10.0000	Free	Free.
Germanium oxides and ZrO_2	2825.60.0000	3.7 ad val.	25% ad val.
Ferrozirconium	7202.99.1000	4.2% ad val.	25% ad val.
Zirconium, waste and scrap	8109.10.3000	Free	Free.
Zirconium, other unwrought, powders	8109.10.6000	4.2% ad val.	25% ad val.
Zirconium, other wrought, alloys	8109.90.0000	4.4% ad val.	45% ad val.
Unwrought hafnium, waste and scrap	8112.91.2000	Free	25% ad val.

Depletion Allowance: 22% (Domestic), 14% (Foreign).

Government Stockpile: In addition to 14,500 tons of baddeleyite ore 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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Material	Stockpile Status—9-30-97[4] Uncommitted inventory	Committed inventory	Authorized for disposal	Disposal plan FY 1997	Disposals FY 1997
Baddeleyite	15,800	—	—	—	—

Events, Trends, and Issues: The global supply and demand of zirconium mineral concentrates was largely in balance in 1997 and 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 decreased 31% while exports increased 10% compared with 1996. A new mining operation was commissioned at the Old Hickory deposit near Richmond, VA. Initial capacity was expected to include up to 30,000 tons per year of zircon with a mine life of 16 years. 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.

Zirconium and hafnium exhibit nearly identical properties and are not separated for most applications. However, zirconium and hafnium are separated for certain nuclear applications. Zirconium-clad fuel rods in nuclear reactors are hafnium-free to improve reactor efficiency because hafnium is a strong absorber of thermal neutrons. At the same time, hafnium is used in reactor control rods to regulate the fission process through neutron absorption.

World Mine 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[e] (thousand metric tons)		Reserves[5] (million metric tons, ZrO_2)	Reserve base[5]	Reserves[5] (thousand metric tons, HfO_2)	Reserve base[5]
	1996	1997[e]				
United States	W	W	1.7	5.3	32	97
Australia	462	500	6.3	27.0	114	484
Brazil	17	17	.4	.4	7	7
China[e]	15	15	.5	1.0	NA	NA
India	19	21	3.4	3.8	42	46
South Africa	260	265	14.3	14.3	259	259
Ukraine[e]	55	55	4.0	6.0	NA	NA
Other countries	29	30	.9	4.1	NA	NA
World total (rounded)	[6]857	[6]903	32	62	450	890

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]Defined as imports - exports + adjustments for Government and industry stock changes.

[3]See Appendix B.

[4]See Appendix C for definitions.

[5]See Appendix D for definitions.

[6]Excludes the United States.