

TUNGSTEN

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Tungsten's unique high-temperature properties are beneficial in the production of numerous end-use items. The high melting point, high density, good corrosion resistance, good thermal and electrical conductivity of tungsten and its alloys, and the excellent cutting and wear-resistant properties of its carbides continued to provide important items for consumption in the domestic and military sectors.

Total reported domestic consumption of tungsten in primary end-use categories decreased by about 14% in 1996 compared with that of 1995. Demand generally decreased in the cemented carbide end-use sectors that included the combined cutting tool, mining tool, oil drilling equipment, and wear-resistant component industries. In addition, demand for mill products made from metal powder significantly decreased. Counter to these decreases was a increase in the demand for directly reusable tungsten scrap owing to more tungsten scrap being specified into alloys. Tungsten consumption was healthy because the U.S. economy remained strong, but was not at the record levels of late 1994—early 1995.

During 1996, prices for tungsten concentrates, which had built up in the second half of 1994, weakened. A major liquidation of stockpiles of tungsten ore in Russia and Kazakstan occurred; however, the perception was that there were plenty of concentrates available for conversion to ammonium paratungstate (APT) (Ryan's Notes, 1997b). Because of the uncertainty of the tungsten market, Western mine operators continued to leave their mines on care-and-maintenance status or to keep the mines closed.

The pattern of imports of tungsten materials by U.S. processors during the year showed an increase in APT and unwrought tungsten. China continued to be the dominant supplier of tungsten materials to the United States, providing about 36% of all imported tungsten materials. Competition continued to come from the Russians, but at a lesser degree.

A summary of the important U.S. and international statistics for 1996 and the previous 4 years are shown in table 1.

Tungsten concentrate is sold in units of tungsten trioxide (WO_3). In the United States, sales are in short ton units of WO_3 . A short ton unit is 1% of a short ton (20 pounds). Tungsten trioxide is 79.3% tungsten. Therefore, a short ton unit of WO_3 equals 20 pounds of WO_3 and contains 7.19 kilograms (15.86 pounds) of tungsten. In most other countries, tungsten concentrates are sold in metric ton units. A metric ton unit is 1% of a metric ton (10 kilograms). A metric ton unit of WO_3 contains 7.93 kilograms (17.48 pounds) of tungsten.

Legislation and Government Programs

The Defense Logistics Agency (DLA) proposed to sell its entire inventory of tungsten through the year 2005. This U.S. Defense Department Agency sent the legislation that called for proposals to Congress on April 16. DLA would conduct sales of a specified amount per year which would be subject to a Congressional mandate not to disrupt markets (Platt's Metals Week, 1996c). Congress, however, voted in August to eliminate tungsten from the list of materials authorized for disposal in the final proposal (American Metal Market, 1996b). Forms of tungsten in the U.S. National Defense Stockpile included: tungsten ore and concentrates, metal, carbides, and ferrotungsten.

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Production

Domestic production data for tungsten were developed by the U.S. Geological Survey by means of two separate, voluntary surveys. These surveys are entitled "Tungsten Ore and Concentrate" and "Tungsten Concentrate and Tungsten Products." Of the 15 mining and 14 processing operations to which survey requests were sent, response was received from 53% and 100%, respectively, of those operations surveyed. Production and stock totals for the survey respondents are shown in table 1.

No tungsten mining activity occurred in the United States in 1996, as the uncertainties in the tungsten market continued. Avocet Mining PLC (Avocet), London, United Kingdom, modernized its conversion facility in Bishop, CA, with some equipment upgrades and processed tungsten ores from Avocet mines in Peru and Portugal, as well as imported feed from the Commonwealth of Independent States (CIS). This facility has an annual APT design capacity of 4,100 metric tons of contained tungsten but is not operating at capacity. Avocet sold approximately 355,000 metric tons units of tungsten trioxide in various concentrate and intermediate forms during 1996. This was equivalent to about 12% of the market outside Russia and China. About 34% of Avocet's sales were produced from the company's tungsten mines and the remainder was obtained from inventory drawdown or bought from third parties (Avocet Mining PLC, 1997).

Major processors of tungsten materials in 1996 were Avocet Tungsten Inc., Bishop, CA; Buffalo Tungsten Inc., Depew, NY; General Electric Co., Euclid, OH; Osram Sylvania, Inc. (formerly GTE Products Corp.), Towanda, PA; Kennametal Inc., Latrobe, PA, and Fallon, NV; and Teledyne Advanced Materials (formerly Teledyne Wah Chang Huntsville),

Huntsville, AL. Net production statistics for tungsten metal powders, carbides, and chemicals are shown in table 2.

Consumption

Total reported domestic consumption of tungsten in primary end-use categories (table 3) decreased by almost 14% in 1996 compared with that of 1995. Demand generally decreased in the cemented carbide end-use sectors that included the combined cutting tool, mining tool, oil drilling equipment, and wear-resistant component industries. In addition, demand for mill products made from metal powders; ferrotungsten used in steels that included the tool, alloy, and stainless steel sectors; and tungsten chemicals significantly decreased.

Counter to these decreases was an increase in the demand for directly reusable tungsten scrap owing to more tungsten scrap being specified into alloys. Consumption of obsolete tungsten scrap, reprocessed either chemically or physically for reuse, increased to 2,560 metric tons of contained tungsten in 1996 from 2,380 tons in 1995. When tungsten prices increased as they did in the first half of 1995, tungsten scrap became more available. Generally, this scrap was in the form of tungsten carbide cutting tools, drill bits, circuit bed drills, and rollers.

Demand for cemented carbide components in the oil drilling industry fluctuated. The number of operating oil drilling rigs in the United States rapidly declined from a high of 745 in early January to a yearly low of 693 rigs in mid-March and then gradually increased to a yearly high of 861 rigs by yearend, according to figures reported weekly in American Metal Market by the International Association of Drilling Contractors and Baker Hughes Inc.

Prices

The average Metal Bulletin (London) combined price for wolframite and scheelite concentrates, instituted in April 1992, decreased about 18% in 1996 compared with that of 1995. The concentrate price decreased to an average of \$52.53 per metric ton unit tungsten oxide from an average of \$63.80 per metric ton unit in 1995. This trend for 1996 reversed the upward trend that started in 1994.

In order to facilitate the availability of tungsten scrap in the United States, when tungsten prices increased as they did in the first half of 1995, tungsten scrap market prices follow after a typical time lag of 7 to 12 months. Scrap containing 80% or more tungsten is the most sensitive to price fluctuations. Generally, this scrap is in the form of tungsten carbide cutting tools, drill bits, circuit bed drills, and rollers. An estimated 40% to 50% of all tungsten consumed in the United States is in the form of tungsten scrap (Metal Bulletin, 1996a).

World market prices for APT decreased during 1996, consistent with the decreasing prices for concentrates. According to quotations in Metal Bulletin (London), the average price for APT on the U.S. market, duty-paid and delivered to processing plants, decreased 9% from an average of \$75.75 per metric ton unit in January to an average of \$68.95 per metric ton

unit by yearend. Similarly, quotations for Chinese No. 1 Grade APT in Hong Kong decreased 18% during the year from an average price of \$76 per metric ton unit to an average of \$62 per metric ton unit. The average price of APT on the European free market decreased 22%, from \$78 to \$61 per metric ton unit, according to quotations published in Metal Bulletin (London). The actual lowest APT prices per metric ton unit reached during 1996 were \$66.22 on the U.S. market (February 8, 1996), \$53.50 on the Hong Kong market (September 25, 1996), and \$56 on the European free market (November 1, 1996). Mine executives at the Seventh International Tungsten Symposium said APT prices would need to climb above \$100 per metric ton unit and that tungsten concentrate would need to stay above \$80 per metric ton unit to prove economically viable to revive the more than 10,000 tons of annual capacity lost during the past 15 years (American Metal Market, 1996c).

Foreign Trade

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Comprehensive lists of U.S. export and import trade statistics by material, quantity, value and by country of destination and origin are shown in tables 5 through 13.

The pattern of imports of tungsten materials by U.S. processors during 1996 showed an increase in the amount of the intermediate ammonium paratungstate. Concentrate prices decreased during this period with a decrease in demand and the appearance of a depletion of Chinese inventories. In 1996, concentrate represented a 50% share of the combined imports of concentrate and intermediates from all sources compared with a 52% share in 1995, a 44% share in 1994, a 36% share in 1993, a 63% share in 1992, a 67% share in 1991, and an 87% share in 1990, prior to the imposition of an antidumping tariff late in 1991. The share of these combined imports of concentrate and intermediate materials provided by China as intermediate materials was 44% in 1996, up from 33% in 1995.

Total U.S. imports of all tungsten materials decreased 8% in 1996 compared with those of 1995. China continued to be the dominant supplier, providing about 36% of all imported 1996 tungsten materials. In 1996, China's share of the total quantity of tungsten materials imported by the United States was up 11% compared with that of 1995. The total quantity of tungsten materials imported from China increased from 3,800 tons of contained tungsten in 1995 to 4,200 tons in 1996. Of the total tungsten imports from China, the percentage imported as intermediate products was 87% in 1996, 78% in 1995, less than 72% in 1994, and 74% in 1993 and 1992. Russia continued to be competitive with China as one of the dominant suppliers, providing about 20% of all imported tungsten materials. Major suppliers of concentrates to the United States included Russia (40%), Bolivia (19%), Portugal (12%), and Peru (9%).

World Review

Rated world capacity for mines and mills as of December 31, 1996, was approximately 36,000 tons of contained tungsten. Estimated annual mine production capacity declined by about

10% in 1996 compared with that of 1995. The situation was made worse by significant growth in private mines in China and by the threat of further stockpile releases in China, Kazakstan, Russia, and the United States. Tungsten prices have fallen to levels well below the operating cost for the majority of mines still operating. As a result, production levels worldwide have fallen sharply, and there has been a halt to development of new mines and reserves.

Annual world production of concentrate is shown by country in table 14 and as a total in table 1.

Canada.—Vancouver-based North American Tungsten agreed to purchase all the assets of Canada Tungsten owned by Aur Resources (Aur) for \$5 million Canadian dollars. In December 1996, Aur increased its holdings of Canada Tungsten from 48% to 100%. Canada Tungsten's assets include the CanTung Mine in the Northwest Territories that has been shut down for 10 years, the MacTung property near CanTung, and the Hemerdon Mine in England that has not been in operation since World War II (Ryan's Notes, 1997a). In addition, North American Tungsten has taken over the APT equipment at Bishop, CA, that is currently leased to Avocet. The APT equipment can produce about 30,000 metric ton units annually.

China.—China resumed production in approximately half their major tungsten mines in 1996. Most of their small-sized mines remained closed, however, because of shortages of electrical supply. A Chinese delegation visited some tungsten producers in Russia, Romania, and Ukraine during May 1996 to discuss ways to stabilize international tungsten prices (Platt's Metals Week, 1996b).

Mitsubishi Materials Corp. and China's Tianjin Tool Works established a joint venture to build a new tungsten carbide tool plant in China. This facility will be located in an existing Tianjin Tool Works plant in Tianjin, northern China. Operation began in September 1996; about 50 people were employed; and indexable inserts and carbide solid end mills were produced for local company supplies (American Metal Market, 1996a).

China's traders have stopped quoting prices for tungsten and ferrotungsten and have stopped selling these metals officially in the face of dumping from outside China. The dumping allegedly is mainly from European sources (Platt's Metals Week, 1997).

The Chinese government purchased 3,000 metric tons of fine tungsten concentrate from major state-owned mines for its stockpile. This amount of tungsten concentrate is equivalent to 2 months of output by state-owned mines. The first 2,000 metric tons of tungsten ore have been purchased, and the remaining 1,000 metric tons will be purchased in 1997 (Platt's Metals Week, 1996a)

International Tungsten Industry Association (ITIA).—ITIA held its Seventh International Tungsten Symposium in Goslar, Germany, September 24-27, 1996. For the first time, all industries that are involved with tungsten, from mining to end-users, were included. The subjects of the talks reflected the needs of raw material producers as well as companies that use tungsten in their end products. Speakers from 12 countries presented a wide range of papers that focused on all sectors of the tungsten industry—from ores and concentrates, raw

materials and powders, hardmetals and heavy metals to traditional uses like lamp wire and modern areas of application, such as welding technology, electronics, chemical production, and medical technology. In addition to the technical content of the symposium, the program offered tours of H.C. Starck GmbH & Co. KG's main plant and headquarters in Goslar and of the Volkswagen plants in Braunschweig and Wolfsburg. One of the highlights was the final session on the tungsten market where Japanese, Eastern and Western European, Russian, Chinese, and United States points of view were presented.

Russia.—Principal Russian mines resumed intermittent production of tungsten during 1995 after being at a standstill for most of 1994. Lermontov Mine (in Primorsky Krai) produced 3,000 tons of tungsten concentrate in the first 9 months of 1995 and only 1,000 tons of tungsten concentrate in the first 6 months of 1996 before stopping production (Platt's Metals Week, 1996d); Primorsky-Gok Mine (also in Primorsky Krai) operated for about one-half of 1995; and Tyrny-Auz Mine (in the Caucasus) operated intermittently. Tyrny-Auz abandoned their open pit operations and produced at a very low level late in 1996 from their underground mines. Some resumption in tungsten production had also taken place in 1996 from Dzinsky Mine at Dzida in the Lake Baikal region and from Kazakstan (Engineering & Mining Journal, 1996).

Most of Russia's tungsten mines closed in 1996 and will be unable to reopen until tungsten prices are higher. On the other hand, most of Russia's stockpile sales have been uncontrolled, and tungsten material has been sold at lower and lower price levels. Hence, Russia's mines have found themselves in competition with their own state stockpile (Metal Bulletin, 1996b).

Current Research and Technology

A nickel-base superalloy is being developed that can reportedly be used as the matrix material for tungsten wire-reinforcement metal matrix composites. This modified chemical composition is formulated to retard interfacial interdiffusion between the tungsten wire and the matrix. As a result, the composite can operate at temperatures up to 2,000° F for applications such as advanced gas turbine engines (Advanced Materials & Processes, 1996a).

A cold-forming technology was recently described at the 1996 World Congress on Powder Metallurgy and Particulate Materials in Washington, DC. The technology uses a patented, one step technique to coat copper onto tungsten powder at ambient temperature. The powders are then pressed to net shape and 100% density to meet the need for a high-temperature, heat-spreading material. This cold-forming process imparts very close tolerances and 100% density without sintering (Advanced Materials & Processes, 1996b).

Tool steels reinforced with tungsten carbide particles have been developed to provide improved thermal fatigue performance and wear resistance. Materials are produced by the hot isostatic pressing of powders of tungsten carbide, carbon, and tool steel. These tool-steel composites have been

successfully applied in steel mill hot-working rolls, leaf spring hot-work rolls, and aluminum diecasting. The composite may also be clad to the surface of industrial rolls, tools, and dies (Advanced Materials & Processes, 1996c).

Outlook

Based on the first quarter consumption of all tungsten products, the total annual demand for tungsten materials in the United States in 1997 was estimated to be about 6,550 tons of contained tungsten. This would represent about 13% less consumption than the 7,530 tons reported for 1996. The economic recovery rate in 1997 is expected to continue with the substantial gains the economy experienced in 1996. As a result, overall demand for cutting and wear-resistant components integrally associated with the metalworking, machining, construction, transportation, mining, and oil and gas drilling industries is expected to remain high in 1997. In particular, the consumption of cemented carbide tool bit inserts is expected to continue to be strong as the automobile market grows and the requirement for machined automobile parts correspondingly rises. In the short term, demand for tungsten in the lighting, electrical, and electronic sectors is expected to continue to increase slowly; although there could be a significant erosion of this demand should the recent breakthroughs in the development of tungsten-free light bulbs begin to capture a significant portion of the lighting market. The general rate of growth in tungsten demand continued to be dampened by the effects of substitution in the cutting and wear-resistant component industries as well as by technological improvements within the industry that result in more efficient use of tungsten.

The sources of future supplies of tungsten concentrate and intermediate materials for U.S. consumption became even less certain by the end of 1996 as observers indicated that further clearing of inventories by traders had taken place. There is a definite slowdown in the release of tungsten from CIS stockpiles, but is believed to be just a temporary lull (Ryan's Notes, 1997b).

China remained the principal supplier of tungsten products to the world market during 1996; however, many observers believed that stocks of Chinese concentrate have been depleted. A number of Chinese mines were reported as almost exhausted, low in grade, and high in cost to operate. As a result, several of these mines have recently closed, and other mines are expected to follow over the next 10 years. On the other hand, the quantity of tungsten materials available from Russia and certain other members of the CIS continued to be competitive with China. Uncertainties remained regarding the extent to which the CIS might be a source of tungsten supply to the world market as it makes the transition to a market economy. Given all of these tungsten market factors, tungsten sellers maintain that the supply side is tightening at the same time that demand is building and consumer ore stocks are low (Ryan's Notes, 1997b).

Specifically, the future supply of APT from China, the predominant world provider, will continue because of the country's cash needs (Ryan's Notes, 1997b). In addition, China

has exhausted its supply of concentrate stocks. Hence, in the short term, the tungsten market is beginning to correct the transition from an oversupply of tungsten to a more closely balanced supply and demand, effectively allowing for the entrance of more producers into the market.

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¹Prior to January 1996, published by the U.S. Bureau of Mines.

TABLE 1
SALIENT TUNGSTEN STATISTICS 1/

(Metric tons of tungsten content unless otherwise specified)

	1992	1993	1994	1995	1996
United States:					
Concentrate:					
Mine production	W	W	W	W	W
Mine shipments	W	W	W	W	W
Value	thousands	W	W	W	W
Consumption	4,310	2,870 2/	3,630 2/	6,320	5,420
Exports	38	63	44	20 r/	72
Imports for consumption	2,480	1,720	2,960	4,660 r/	4,190
Stocks, Dec. 31:					
Producer	44	44	44	44	44
Consumer	702	592	756	631	569
Ammonium paratungstate:					
Production	5,760	4,730 3/	536 4/	2,580 5/	4,450 6/
Consumption	7,010	6,970	7,080	7,920 r/	7,800
Stocks, Dec. 31: Producer and consumer	333	420	82	727 r/	558
Primary products:					
Net production	8,450	9,410	7,410	8,410 r/	7,810
Consumption	6,910	7,580	8,110	8,800 r/	7,530
Stocks, Dec. 31:					
Producer 7/	1,510	1,480	1,160	1,300 r/	1,400
Consumer	601	716	849	547	399
World:					
Concentrate:					
Production	42,900 r/	34,400 r/	34,300 r/	38,500 r/	31,900 e/
Consumption 8/	36,500	31,900	31,600	31,000 e/	(9/)

e/ Estimated. r/ Revised. W Withheld to avoid disclosing company proprietary data.

1/ Data are rounded to three significant digits.

2/ Excludes 3 months of "Withheld" data.

3/ Excludes 2 months of "Withheld" data.

4/ Excludes 11 months of "Withheld" data.

5/ Excludes 7 months of "Withheld" data.

6/ Excludes 4 months of "Withheld" data.

7/ Excludes cast and crystalline tungsten carbide powder.

8/ Based on data received from United Nations Conference on Trade and Development, Jan. 1996.

9/ The United Nations is no longer collecting and publishing this information.



TABLE 2
NET PRODUCTION 1/ AND STOCKS OF TUNGSTEN PRODUCTS IN THE UNITED STATES 2/

(Metric tons of tungsten content)

	Hydrogen reduced metal powder	Tungsten carbide powder		Chemicals	Total
		Made from metal powder	Cast and crystalline		
Net production 1996	3,720	4,090	W	W	7,810
Net production 1995	2,910	5,500 r/	W	W	8,410 r/
Producer stocks, Dec. 31, 1996	867	406	W	131	1,400
Producer stocks, Dec. 31, 1995	818	357 r/	W	126	1,300 r/

r/ Revised. W Withheld to avoid disclosing company proprietary data.

1/ Gross production less quantity used to make other products in table.

2/ Data are rounded to three significant digits; may not add to totals shown.

TABLE 3
 REPORTED CONSUMPTION AND STOCKS OF TUNGSTEN PRODUCTS
 IN THE UNITED STATES IN 1996, BY END USE 1/

(Metric tons of tungsten content)

End use	Ferro-tungsten	Tungsten metal powder	Tungsten carbide powder	Tungsten scrap 2/	Other tungsten materials 3/	Total
Steel:						
Stainless and heat-resisting	W	--	--	W	2	2
Alloy	33	--	--	--	--	33
Tool	434	--	--	--	W	434
Superalloys	W	W	W	W	W	W
Alloys (excludes steels and superalloys):						
Cutting and wear-resistant materials	--	W	W	W	W	W
Other alloys 4/	W	W	W	W	--	W
Mill products made from metal powder	--	551	--	--	--	551
Chemical and ceramic uses	--	--	--	--	90	90
Miscellaneous and unspecified	55	158	5,760	415	32	6,420
Total	522	709	5,760 5/	415	123	7,530
Consumer stocks, Dec. 31, 1996	27 6/	36	298 5/	24	14	399

W Withheld to avoid disclosing company proprietary data; included with "Miscellaneous and unspecified."

1/ Data are rounded to three significant digits; may not add to totals shown.

2/ Does not include that used in making primary tungsten products.

3/ Includes tungsten chemicals and others.

4/ Includes welding and hard-facing rods and materials and nonferrous alloys.

5/ Based on reported consumption plus information from secondary sources on companies not canvassed; includes estimates.

6/ Includes scheelite, natural and synthetic.

TABLE 4
 MONTHLY PRICE QUOTATIONS OF TUNGSTEN CONCENTRATE IN 1996

Month	Metal Bulletin (London), European market, 65% WO3 basis, c.i.f. 1/				Metals Week, U.S. spot quotations, 65% WO3 basis, c.i.f. U.S. ports, including duty 2/				
	Dollars per metric ton unit			Dollars per short ton unit,	Dollars per short ton unit			Dollars per metric ton unit,	
	Low	High	Average	average	Low	High	Average	average	
January	50.00	62.00	56.00	50.80	55.00	65.00	60.00	66.14	
February	50.00	58.00	54.00	48.99	55.00	65.00	60.00	66.14	
March	50.00	62.00	56.00	50.80	55.00	65.00	60.00	66.14	
April	52.00	62.00	57.00	51.71	55.00	65.00	60.00	66.14	
May	52.00	62.00	57.00	51.71	55.00	65.00	60.00	66.14	
June	52.00	62.00	57.00	51.71	55.00	65.00	60.00	66.14	
July	45.00	62.00	53.50	48.53	55.00	65.00	60.00	66.14	
August	45.00	55.00	50.00	45.36	55.00	65.00	60.00	66.14	
September	45.00	55.00	50.00	45.36	55.00	65.00	60.00	66.14	
October	40.00	55.00	47.50	43.09	55.00	65.00	60.00	66.14	
November	40.00	50.00	45.00	40.82	55.00	65.00	60.00	66.14	
December	43.00	53.00	48.00	43.54	55.00	65.00	60.00	66.14	

1/ Combined wolframite and scheelite quotations. Low and high prices are reported semiweekly. Monthly averages are arithmetic averages of semiweekly low and high prices. The average annual price per metric ton unit of WO3 of all semiweekly low and high prices was \$52.53 for 1996. The average equivalent price per short ton unit of WO3 was \$47.65 for 1996.

2/ Low and high prices are reported weekly. Monthly averages are arithmetic averages of weekly low and high prices. The average annual price per short ton unit of WO3 of all weekly low and high prices was \$60.00 for 1996. The average equivalent price per metric ton unit of WO3 was \$66.14 for 1996.

TABLE 5
U.S. EXPORTS OF TUNGSTEN ORE AND CONCENTRATE, BY COUNTRY

Country	1995		1996	
	Tungsten content 1/ (metric tons)	Value (thousands)	Tungsten content 2/ (metric tons)	Value (thousands)
China	--	--	57	\$428
Germany	19 r/	\$151 r/	1	4
Hong Kong	--	--	1	7
Ireland	--	--	(3/)	3
Japan	--	--	3	26
Mexico	1 r/	5 r/	(3/)	3
Netherlands	--	--	5	38
Singapore	--	--	1	6
United Kingdom	(3/)	3 r/	3	24
Total	20 r/	159 r/	72	539

r/ Revised.

1/ Calculated based upon an estimated value of \$62 per metric ton unit WO₃.

2/ Calculated based upon an estimated value of \$59 per metric ton unit WO₃.

3/ Less than 1/2 unit.

Source: Bureau of the Census.

TABLE 6
U.S. EXPORTS OF AMMONIUM PARATUNGSTATE, BY COUNTRY 1/

Country	1995		1996	
	Tungsten content (metric tons)	Value (thousands)	Tungsten content (metric tons)	Value (thousands)
Belgium	52	\$659	81	\$970
Germany	--	--	4	33
Japan	129	1,710	65	303
Korea, Republic of	7	58	--	--
Netherlands	50	331	--	--
Venezuela	--	--	(2/)	3
Total	238	2,760	150	1,310

1/ Data are rounded to three significant digits; may not add to totals shown.

2/ Less than 1/2 unit.

Source: Bureau of the Census.

TABLE 7
U.S. EXPORTS OF TUNGSTEN CARBIDE POWDER, BY COUNTRY 1/

Country	1995		1996	
	Tungsten content (metric tons)	Value (thousands)	Tungsten content (metric tons)	Value (thousands)
Argentina	(2/)	\$20	(2/)	\$3
Australia	12	616	9	546
Austria	99	1,590	39	749
Belgium	4	209	4	199
Brazil	12	271	4	111
Canada	387	9,990	372	8,940
Chile	(2/)	30 r/	2	86
China	--	--	1	15
Denmark	53	716	4	138
Ecuador	--	--	(2/)	11
Finland	(2/)	5	1	98
France	53	1,370	38	655
Germany	288	5,330	318	5,100
Hong Kong	(2/)	8	1	28
India	1	90	(2/)	3
Ireland	14	153	3	227
Israel	11	734	18	678
Italy	128	4,230	106	3,680
Japan	52	1,280	29	833
Korea, Republic of	4	432	9	597
Luxembourg	5	136	16	498
Mexico	2	76	7	308
Netherlands	97	1,500	12	238
New Zealand	(2/)	14	11	23
Portugal	4	182	4	97
Saudi Arabia	2	82	(2/)	5
Singapore	2	138	9	348
South Africa	63	931	28	426
Sweden	84	1,880	107	4,150
Switzerland	7	608	4	523
Taiwan	25	883	24	994
Thailand	11	89	(2/)	62
Turkey	1	47	1	43
United Arab Emirates	1	50	1	34
United Kingdom	237	3,100	107	1,260
Venezuela	5	199	3	122
Other	(2/)	22 r/	2	135
Total	1,660	37,000	1,290	32,000

r/ Revised.

1/ Data are rounded to three significant digits; may not add to totals shown.

2/ Less than 1/2 unit.

Source: Bureau of the Census.

TABLE 8
U.S. EXPORTS OF TUNGSTEN AND TUNGSTEN ALLOY POWDER, BY COUNTRY 1/

Country	1995			1996		
	Gross weight (metric tons)	Tungsten content 2/ (metric tons)	Value (thousands)	Gross weight (metric tons)	Tungsten content 2/ (metric tons)	Value (thousands)
Argentina	--	--	--	2	2	\$54
Australia	4	3	\$70	2	1	50
Austria	7	5	136	(3/)	(3/)	8
Belgium	2	1	80	(3/)	(3/)	5
Brazil	11	9	334	3	3	212
Canada	49	39	1,210	48	38	1,330
China	(3/)	(3/)	8	10	8	143
Finland	5	4	47	--	--	--
France	18	14	421	6	5	209
Germany	245	196	6,070	91	72	2,350
Honduras	--	--	--	23	18	70
Hong Kong	--	--	--	2	1	54
India	--	--	--	1	1	33
Israel	17	13	113	36	29	159
Italy	44	35 r/	219	2	1	112
Japan	19	15	96	5	4	184
Korea, Republic of	4	3	113	4	3	151
Mexico	9	7	255	7	5	191
Netherlands	42	33	524	2	2	11
Singapore	46	37	821	30	24	538
South Africa	1	1	22	1	1	41
Spain	18	14	52	1	(3/)	16
Sweden	2	1	10	8	6	475
Switzerland	5	4	316	4	3	166
Taiwan	18	14	442	2	1	62
Turkey	--	--	--	1	1	34
United Kingdom	40	32	389	8	6	502
Vietnam	--	--	--	3	2	87
Other	3	3 r/	28 r/	1	1	30
Total	606 r/	485 r/	11,800	300	240	7,280

r/ Revised.

1/ Data are rounded to three significant digits; may not add to totals shown.

2/ Tungsten content estimated by multiplying gross weight by 0.80.

3/ Less than 1/2 unit.

Source: Bureau of the Census.

TABLE 9
U.S. EXPORTS OF MISCELLANEOUS TUNGSTEN-BEARING MATERIALS, BY COUNTRY 1/

Product and country	1995		1996	
	Tungsten content e/ (metric tons)	Value (thousands)	Tungsten content e/ (metric tons)	Value (thousands)
Tungsten and tungsten alloy wire:				
Argentina	1	\$23	(2/)	\$18
Belgium	2	195	(2/)	30
Brazil	2	202	1	116
Canada	4	228	9	409
France	1	120	2	305
Germany	(2/)	68	10	435
Guatemala	--	--	1	132
Hong Kong	6 r/	235	3	1,000
India	9	557	14	1,020
Indonesia	1	83	(2/)	26
Italy	1	86	3	277
Japan	6	903	13	1,760
Korea, Republic of	2	140	1	95
Malaysia	2	399	1	306
Mexico	17 r/	1,340	12	1,150
Netherlands	1	62	(2/)	102
Singapore	2	127	(2/)	20
Spain	1	55	6	320
Sweden	1	45	1	144
Switzerland	(2/)	13	(2/)	7
Taiwan	3 r/	233	9	905
United Kingdom	(2/)	167	1	392
Other	1 r/	115 r/	(2/)	85
Total	61 r/	5,400 r/	88	9,050
Unwrought tungsten and alloy in crude form, waste and scrap:				
Australia	70 r/	378	7	74
Brazil	11	70	5	34
Canada	37 r/	308	7	102
Chile	--	--	6	35
France	1 r/	16	8	46
Germany	357 r/	2,320	336	1,850
Israel	4 r/	31	15	88
Italy	28 r/	161	19	128
Japan	53 r/	303	9	60
Mexico	11 r/	97	42	279
Netherlands	13	70	--	--
Spain	24 r/	135	--	--
Sweden	--	--	43	379
Taiwan	--	--	4	21
Ukraine	40	165	--	--
United Kingdom	39 r/	289	45	412
Other	9 r/	60 r/	17	127
Total	697 r/	4,400 r/	565	3,630
Other tungsten metal:				
Australia	1	63	2	171
Belgium	(2/)	5	4	365
Brazil	3	294	3	248
Canada	6	326	6	339
Colombia	(2/)	21	1	64
France	1	114	1	142
Germany	2 r/	1,260	11	855
Hong Kong	4	416	2	144
India	4	226	4	268
Ireland	6 r/	780	(2/)	161
Israel	3	1,060	1	222
Italy	1	85	1	89
Japan	3	858	6	1,460

See footnotes at end of table.

TABLE 9--Continued
U.S. EXPORTS OF MISCELLANEOUS TUNGSTEN-BEARING MATERIALS, BY COUNTRY 1/

Product and country	1995		1996	
	Tungsten content e/ (metric tons)	Value (thousands)	Tungsten content e/ (metric tons)	Value (thousands)
Other tungsten metal-Continued:				
Korea, Republic of	3	\$237	2	\$899
Mexico	11 r/	665	13	1,240
Netherlands	1	366	2	315
Singapore	3	714	2	573
South Africa	1	62	1	116
Sweden	(2/)	47	1	100
Switzerland	1	184	1	136
Taiwan	10	847	7	902
Thailand	1	69	1	256
United Kingdom	11 r/	861	13	921
Venezuela	(2/)	47	(2/)	39
Other	1 r/	175 r/	1	129
Total	77 r/	9,780	85	10,200
Ferrotungsten and ferrosilicon tungsten:				
Canada	--	--	2	22
Korea, Republic of	(2/)	7	--	--
Mexico	26 r/	62	--	--
Netherlands	(2/)	3	--	--
Total	27 r/	72	2	22
Wrought tungsten:				
Belgium	(2/)	43	1	151
Brazil	2	169	(2/)	11
Canada	31 r/	1,130	19	772
Chile	2	228	1	43
China	(2/)	108	(2/)	82
France	4	545	22	736
Germany	91 r/	2,650	36	975
India	10	595	2	142
Israel	3 r/	263	1	55
Italy	4	370	5	353
Japan	9 r/	1,420	8	1,020
Korea, Republic of	9	453	2	113
Mexico	(2/)	24	3	165
Netherlands	(2/)	40	(2/)	8
Singapore	1	71	1	64
Spain	8 r/	447	6	336
Sweden	2	219	(2/)	28
Taiwan	9	725	6	532
United Kingdom	8	508	2	219
Other	1 r/	94 r/	2	234
Total	193 r/	10,100 r/	113	6,040
Other tungsten compounds: 3/				
Brazil	5	81	(2/)	8
Canada	2	7	2	10
France	2	362	--	--
Netherlands	10	15	11	16
Taiwan	3	5	--	--
United Kingdom	1	24	--	--
Total	23	494	13	34

e/ Estimated. r/ Revised.

1/ Data are rounded to three significant digits; may not add to totals shown.

2/ Less than 1/2 unit.

3/ Includes only other tungstates.

Source: Bureau of the Census.

TABLE 10
U.S. IMPORTS FOR CONSUMPTION OF TUNGSTEN ORE AND CONCENTRATE, BY COUNTRY 1/

Country	1995		1996	
	Tungsten content (metric tons)	Value (thousands)	Tungsten content (metric tons)	Value (thousands)
Australia	201 r/	\$1,280 r/	--	--
Bolivia	499 r/	3,210 r/	782	\$4,190
Brazil	11	77	11	69
Burma	61 r/	447 r/	33	190
Canada	1	2	--	--
China	1	15	--	--
Kazakstan	53	272	125	689
Mexico	134 r/	931 r/	166	644
Mongolia	35	166	--	--
Netherlands	126	934	202	1,160
Peru	500 r/	3,450 r/	385	2,450
Portugal	164 r/	1,080 r/	518	3,360
Russia	2,540 r/	11,400 r/	1,690	7,190
Rwanda	--	--	13	65
Singapore	76	469	--	--
Spain	--	--	6	45
Sweden	78	480	--	--
Thailand	98	512	60	361
Uganda	85	522	--	--
United Kingdom	--	--	203	1,080
Total	4,660 r/	25,200 r/	4,190	21,500

r/ Revised.

1/ Data are rounded to three significant digits; may not add to totals shown.

Source: Bureau of the Census.

TABLE 11
U.S. IMPORTS FOR CONSUMPTION OF AMMONIUM PARATUNGSTATE, BY COUNTRY 1/

Country	1995		1996	
	Tungsten content (metric tons)	Value (thousands)	Tungsten content (metric tons)	Value (thousands)
Austria	16	\$140	--	--
China	987	8,550	1,440	\$9,690
Germany	85	1,250	63	524
Hong Kong	113	797	15	69
Japan	--	--	18	124
Netherlands	--	--	1	12
Russia	42	347	--	--
Sweden	50	103	38	193
Switzerland	(2/)	1	--	--
Total	1,290	11,200	1,580	10,600

1/ Data are rounded to three significant digits; may not add to totals shown.

2/ Less than 1/2 unit.

Source: Bureau of the Census.

TABLE 12
U.S. IMPORTS FOR CONSUMPTION OF FERROTUNGSTEN, BY COUNTRY 1/

Country	1995		1996	
	Tungsten content (metric tons)	Value (thousands)	Tungsten content (metric tons)	Value (thousands)
Austria	27	\$130	--	--
China	362	2,160	312	\$2,010
Germany	43	213	1	16
Hong Kong	--	--	13	88
Latvia	88	305	--	--
Mexico	21	123	--	--
Russia	82	379	163	993
Sweden	--	--	(2/)	1
United Kingdom	29	160	45	302
Total	652	3,470	535	3,410

1/ Data are rounded to three significant digits; may not add to totals shown.

2/ Less than 1/2 unit.

Source: Bureau of the Census.



TABLE 13
U.S. IMPORTS FOR CONSUMPTION OF MISCELLANEOUS TUNGSTEN-BEARING MATERIALS, BY COUNTRY 1/

Product and country	1995		1996	
	Tungsten content (metric tons)	Value (thousands)	Tungsten content (metric tons)	Value (thousands)
Waste and scrap:				
Australia	7	\$31	16	\$71
Austria	41	283	33	208
Belgium	21	107	--	--
Canada	35	214	25	175
China	16	101	7	54
Denmark	5	44	3	13
France	63	431	68	322
Germany	635	3,890	272	2,180
Ireland	20	133	32	224
Israel	101	516	48	257
Italy	43	242	22	136
Japan	408	2,480	347	1,860
Korea, Republic of	--	--	63	279
Mexico	15	110	10	55
Netherlands	22	158	48	359
Pakistan	25	78	49	198
Peru	--	--	9	54
Portugal	--	--	1	6
Russia	23	86	289	1,880
Singapore	25	133	57	290
South Africa	75	432	58	293
Sweden	25	177	70	432
Taiwan	--	--	7	48
United Kingdom	492	1,780	310	1,560
Other	15 r/	95 r/	--	--
Total	2,110	11,500	1,840	11,000
Unwrought tungsten, except alloys, in lumps, grains, and powders:				
Belgium	4	175	5	220
Canada	18 r/	437	10	310
China	196	2,520	15	235
Czech Republic	5	81	10	176
France	(2/)	17	23	147
Germany	28	1,200	37	1,450
Japan	36	1,690	27	2,340
Russia	11	227	57	782
South Africa	8	33	--	--

See footnotes at end of table.

TABLE 13--Continued
U.S. IMPORTS FOR CONSUMPTION OF MISCELLANEOUS TUNGSTEN-BEARING MATERIALS, BY COUNTRY 1/

Product and country	1995		1996	
	Tungsten content (metric tons)	Value (thousands)	Tungsten content (metric tons)	Value (thousands)
Unwrought tungsten, except alloys, in lumps, grains, and powders--Continued:				
Sweden	--	--	46	\$1,600
United Kingdom	(2/)	\$5	170	1,530
Other	6 r/	83 r/	5	47
Total	312 r/	6,470 r/	404	8,840
Unwrought tungsten, ingots, shot, alloy, and other: 3/				
Austria	3	118	3	139
Korea, Republic of	--	--	6	32
Russia	(2/)	3	14	100
Switzerland	--	--	2	198
Other	(2/)	8 r/	1	74
Total	3	129	26	543
Wrought tungsten wire, plate, sheet, strip, foil, and other: 3/				
Austria	46 r/	3,650	27	4,490
Belgium	1	100	(2/)	21
Canada	1	68	(2/)	26
China	41 r/	1,660	35	1,620
France	1	166	2	427
Germany	10	1,560	4	709
Hong Kong	4	284	5	369
Hungary	7	748	5	583
Israel	10 r/	538	8	539
Japan	37 r/	7,170	44	7,990
Mexico	6 r/	751	6	936
Netherlands	2	386	3	346
Russia	1	32	2	143
Switzerland	7	960	2	413
United Kingdom	5 r/	664	5	985
Other	1 r/	230 r/	1	189
Total	180 r/	19,000	149	19,800
Calcium tungstate:				
Australia	24	135	--	--
Bolivia	10	43	--	--
China	52	314	53	240
Ireland	--	--	10	20
Japan	1	40	1	88
Total	86	532	65	348
Tungsten oxides:				
Austria	19	170	--	--
China	1,240	12,300	1,530	11,800
Germany	3	69	2	39
Hong Kong	36	272	145	1,010
Russia	822	6,660	152	1,130
United Kingdom	1	27	(2/)	2
Uzbekistan	--	--	30	65
Other	2 r/	20	--	--
Total	2,120	19,600	1,860	14,000
Other metal-bearing materials in chief value of tungsten:				
China	1 r/	32	--	--
Germany	1	55	--	--
Italy	5 r/	168	--	--
Mexico	(2/)	13	--	--
Total	7 r/	268	--	--
Chlorides of tungsten:				
Canada	--	--	(2/)	2
China	--	--	2	13
Russia	(2/)	2	--	--
Total	(2/)	2	2	15
Sodium tungstate:				
Australia	18	108	--	--
Bolivia	28	145	--	--
China	761	5,260	683	4,230

See footnotes at end of table.

TABLE 13--Continued
 U.S. IMPORTS FOR CONSUMPTION OF MISCELLANEOUS TUNGSTEN-BEARING MATERIALS, BY COUNTRY 1/

Product and country	1995		1996	
	Tungsten content (metric tons)	Value (thousands)	Tungsten content (metric tons)	Value (thousands)
Sodium tungstate--Continued:				
Germany	10	\$266	(2/)	\$35
Hong Kong	26	133	28	170
Ireland	1	40	--	--
Japan	(2/)	17	(2/)	4
Malaysia	14	78	--	--
Switzerland	--	--	(2/)	3
Zambia	(4/)	(4/)	--	--
Total	858	6,040	711	4,440
Tungsten carbide:				
Austria	(2/)	31	(2/)	11
Canada	52	1,670	58	1,490
China	149	3,090	134 5/	2,540 5/
France	(2/)	2	(2/)	3
Germany	165	4,550	150	4,740
Hong Kong	--	--	13	404
Israel	13	188	3	50
Japan	13	129	2	274
Korea, Republic of	3	72	(2/)	5
Switzerland	(2/)	4	3	100
United Kingdom	78 r/	541	40	386
Other	2	42 r/	1	54
Total	476	10,300	404	10,100

r/ Revised.

1/ Data are rounded to three significant digits; may not add to totals shown.

2/ Less than 1/2 unit.

3/ Content estimated from reported gross weight.

4/ Revised to zero.

5/ Not included in total is 8 metric tons of material from China with a value of \$107,000 with content not yet verified.

Source: Bureau of the Census.

TABLE 14
TUNGSTEN: WORLD CONCENTRATE PRODUCTION, BY COUNTRY 1/ 2/

(Metric tons of tungsten content)

Country	1992	1993	1994	1995	1996 e/
Australia	159	23	11 e/	-- r/	-- 3/
Austria	1,489	104	--	188 r/	360 3/
Bolivia	851	287	462	655 r/	582 3/
Brazil	205	245	155	98 r/	100
Burma 4/	531	524	548	531	328
China e/ 5/	25,000	21,600	27,000	27,400 r/	24,000
India	2	1	2	2	2
Japan	347	66	--	--	--
Kazakstan e/	200	200 r/	200 r/	225 r/	220
Korea, North e/	1,000	1,000	900	900	900
Korea, Republic of	247	200 e/	--	--	--
Malaysia	3 e/	2	--	--	--
Mexico e/	162 3/	-- r/	-- r/	228 r/	149
Mongolia e/	260	250	150	200	200
Peru	543 r/	388 r/	259 r/	728 r/	331 3/
Portugal	1,126 r/	768 r/	100 r/	1,511 r/	1,343 3/
Russia e/	10,000	8,000	4,000	5,400	3,000
Rwanda e/	175	175	30	--	--
Tajikistan e/	200	150	100	75	50
Thailand	70	80	40 r/	60 r/ e/	50
Uganda	16 r/	5 r/	12 r/	17 r/	-- 3/
United States	W	W	W	W	W
Uzbekistan e/	300	300	300	300	300
Total	42,900 r/	34,400 r/	34,300 r/	38,500 r/	31,900

e/ Estimated. r/ Revised. W Withheld to avoid disclosing company proprietary data; not included in "Total."

1/ World totals and estimated data are rounded to three significant digits; may not add to totals shown.

2/ Table includes data through June 9, 1997.

3/ Reported figure.

4/ Includes content of tin-tungsten concentrate.

5/ Based upon data published in the Yearbook of Nonferrous Industry of China, 1993-96.

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