TUNGSTEN

By Kim B. Shedd

Tungsten has a wide range of industrial uses. The largest use is as tungsten carbide in cemented carbides. Cemented carbides (also called hardmetals) are wear-resistant materials used by the metalworking, mining, and construction industries. Tungsten metal wires, electrodes, and/or contacts are used in lighting, electronic, electrical, heating, and welding applications. Tungsten is also used to make tool steels, wear-resistant alloy parts and coatings, superalloys for turbine blades, and heavy metal alloys for armaments and high-density uses, such as weights and counterweights. Chemical uses of tungsten include catalysts, inorganic pigments, and high-temperature lubricants.

U.S. tungsten mines remained closed in 1997 because of persistent low prices for tungsten concentrates. Concentrate prices reported in Metal Bulletin and Platt's Metals Week decreased in 1997 compared with those of the previous year.

In 1997, significant increases in U.S. imports of tungsten ores and concentrates and ammonium paratungstate enabled U.S. net production of primary tungsten products to increase by 8%. U.S. industry consumed 7% more tungsten to make alloys, cemented carbides, mill products for lighting and other applications, catalysts, and pigments than in 1996. These consumers used imported and domestically produced primary tungsten products.

China continued to be the largest supplier of tungsten imports to the United States. Russia was also a significant supplier. Nearly 60% of all tungsten imports to the United States in recent years has been from these two countries.

A summary of the important U.S. and world tungsten statistics for 1997 and the previous 4 years is listed in table 1. Most data in this report have been rounded to three significant digits. Totals and percentages were calculated from unrounded numbers.

Tungsten concentrate and ammonium paratungstate are sold in units of tungsten trioxide (WO_3), which is 79.3% tungsten. In the United States, sales are in short ton units of WO_3; a short ton unit is 1% of a short ton, or 20 pounds. Therefore, a short ton unit of WO_3 equals 20 pounds (9.07 kilograms) of WO_3 and contains 15.86 pounds (7.19 kilograms) of tungsten. In most other countries, tungsten concentrates are sold in metric ton units. A metric ton unit is 1% of a metric ton, or 10 kilograms. A metric ton unit of WO_3 contains 7.93 kilograms (17.48 pounds) of tungsten.

Legislation and Government Programs

The antidumping duty on U.S. imports of tungsten ore concentrates from China, imposed in October 1991, remained at 151%.

In August, the U.S. Fish and Wildlife Service temporarily approved tungsten-iron shot for the 1997-98 migratory bird hunting season. The shot, produced by Federal Cartridge Co. of Anoka, MN, is a two-phase alloy made by sintering tungsten and iron (U.S. Department of the Interior, 1997).

In October, the National Defense Stockpile (NDS) Market Impact Committee requested public comment on the potential impact of tungsten sales from the NDS in the event that disposal authority for tungsten was granted by Congress. The request for comments gave proposed annual disposal levels for the fiscal years beginning October 1, 1997, and October 1, 1998. For each year, the proposed maximum quantities of tungsten materials that could be sold were as follows, in tons of contained tungsten: tungsten ores and concentrates, 454; ferrotungsten, 45; tungsten carbide powder, 45; and tungsten metal powder, 45 (U.S. Department of Commerce, 1997). By yearend, the U.S. Department of Defense had not received congressional authority for disposal of the materials. The NDS inventory of combined stockpile- and nonstockpile-grade tungsten materials on December 31 was as follows, in tons of contained tungsten: tungsten ores and concentrates, 34,635; tungsten carbide powder, 922; ferrotungsten, 918; and tungsten metal powder, 861.

Production

Domestic production data for tungsten are based on data collected by the U.S. Geological Survey (USGS) by means of two separate voluntary surveys. Statistics on production, consumption, and stocks resulting from these surveys are listed in tables 1 and 2.

The annual Tungsten Ore and Concentrate survey covered the production, purchases, disposition, and stocks of tungsten ore and concentrates. No tungsten was mined in the United States in 1997. The Pine Creek Mine in Bishop, CA, owned by Avocet Mining PLC (50%) and Strategic Minerals Corp. (50%), remained under care and maintenance. New Concept Mining Inc., a subsidiary of American Technologies Group, Inc., of Monrovia, CA, planned to sell, lease, or dispose of its investments in the Tempiute mining district in Lincoln County, NV (American Technologies Group, Inc., 1997). New Concept's assets in Tempiute include the former Emerson tungsten mine and mill, which closed in 1982.

The monthly Tungsten Concentrate and Tungsten Products survey canvassed companies that produced tungsten metal powder, tungsten carbide powder, and/or tungsten chemicals from raw materials, such as tungsten concentrate, ammonium paratungstate, and tungsten-bearing scrap. The USGS received responses from all 12 processing operations on the survey. Major U.S. processors of tungsten materials in 1997 included Avocet Tungsten Inc., Bishop, CA, Buffalo Tungsten Inc., Depew, NY, Dow Chemical Co., Midland, MI, General Electric Co., Euclid, OH, Kennametal Inc., Latrobe, PA, and Fallon, NV, Osram Sylvania, Inc., Towanda, PA, and Teledyne Advanced Materials, Huntsville, AL.

In 1997, U.S. processors consumed 25% more tungsten concentrate, 19% more ammonium paratungstate, and 12% more tungsten-bearing scrap than they did in 1996. Domestic production of ammonium paratungstate increased 13% in 1997 compared with production in 1996. Total net production of all tungsten products (hydrogen-reduced metal powder, tungsten carbide powder, and tungsten chemicals) increased by 8% in 1997 compared with that of

1996.

Avocet Tungsten Inc. worked on upgrading equipment and removing bottlenecks at its tungsten-processing plant in Bishop, CA. These improvements were expected to nearly double the plant's throughput and to eliminate the need for external conversion. Production from the plant increased by 14% in the fiscal year ending March 1997 compared with that of the previous fiscal year (Avocet Mining PLC, 1997a). The plant produced ammonium paratungstate and ammonium metatungstate from imported concentrates.

N.V. Union Minière S.A. of Brussels, Belgium, purchased a 27% share in Nanodyne Inc., a New Brunswick, NJ, producer of composite metal powders of nanometer-sized grains. Nanodyne's proprietary spray-conversion process to produce nanocrystalline tungsten carbide-cobalt powder has been demonstrated on a pilot-plant scale at the New Jersey site. The investment from Union Minière will allow Nanodyne to build a commercial-scale plant in Laurinburg, NC, next to Union Minière's Carolmet cobalt metal powder plant. Nanodyne expected its Laurinburg plant to reach a production rate of 500 metric tons per year of powder in late 1998 (American Metal Market, 1997; N.V. Union Minière S.A., 1997).

Consumption

Data on U.S. consumption of tungsten materials in end-use categories were developed from the voluntary Consolidated Consumers survey of U.S. metal consumers. For this survey, nearly 75 tungsten consumers were canvassed on a monthly or annual basis. Reported consumption and stocks data in tables 1 and 3 include estimates to account for nonrespondents. Total U.S. reported consumption of tungsten materials to make alloys; cemented carbides; mill products, such as lamp filaments and electrodes; catalysts; and pigments increased by 7% in 1997 compared with that of 1996. In 1997, U.S. consumption of tungsten metal powder, tungsten carbide powder, tungsten chemicals, and tungsten-bearing scrap increased, while consumption of ferrotungsten decreased. Producers of alloys (other than superalloys), catalysts, cemented carbides, pigments, and mill products for lighting and other industries reported increased tungsten consumption in 1997. Total tungsten consumption by steel manufacturers decreased in 1997 compared with that of 1996, while tungsten consumption by superalloy melters has been basically the same for the last 2 years.

Weekly reports of the number of operating drilling rigs give an indication of the demand for cemented carbide components by the oil drilling industry. The average number of rigs operating in the United States during 1997 was 21% higher than that of 1996. Following a low of 807 rigs in February, the count increased to a high of 1,032 rigs in September, then fluctuated between 947 and 1,019 rigs until yearend (International Association of Drilling Contractors, IADC rotary rig report, accessed weekly at URL http://www.iadc.org/rigcount.htm).

U.S. consumption of tungsten scrap increased 10% in 1997. Scrap consumption by U.S. tungsten processors and consumers was 2,930 tons of contained tungsten in 1997 compared with 2,670 tons (revised) in 1996.

Prices

Prices for tungsten concentrates and ammonium paratungstate remained low in 1997. In general, prices were higher during the first half of the year and lower during the second half. The average of tungsten concentrate prices reported by Metal Bulletin in 1997 was 10% lower than the average of prices reported in 1996. The average of U.S. spot prices reported by Platt's Metals Week in 1997 was 3% lower than that of 1996. Monthly concentrate prices and annual averages are listed in table 4.

U.S. ammonium paratungstate prices decreased progressively during the year. The average of high and low prices reported by Platt's Metals Week decreased from $88 per short ton unit ($96 per metric ton unit) in January to $67 per short ton unit ($74 per metric ton unit) in December. The average of U.S. ammonium paratungstate prices reported by Metal Bulletin decreased from $76 per short ton unit ($84 per metric ton unit) in January to $64 per short ton unit ($71 per metric ton unit) by yearend.

Ammonium paratungstate prices quoted in Metal Bulletin for the European and Hong Kong markets were more variable than those for the U.S. market. The average European ammonium paratungstate price was highest during February and March at $72 per metric ton unit and lowest during August at $56 per metric ton unit. The average Hong Kong price was highest during late January through mid May at $64 per metric ton unit and lowest during August at $53 per metric ton unit.

Mine executives at the Seventh International Tungsten Symposium in September, 1996, stated that tungsten concentrate prices would need to increase to more than $80 per metric ton unit and ammonium paratungstate prices would need to increase to more than $100 per metric ton unit for it to be economic to bring back the more than 10,000 tons per year of capacity lost during the last 15 years (American Metal Market, 1996).

Foreign Trade

Total U.S. imports of all tungsten materials increased by 9% in 1997, returning to the total level of tungsten imported in 1995. China continued to be the largest supplier of tungsten to the United States, providing 34% of all tungsten imports in 1997. Imports from China increased slightly to 4,320 tons of contained tungsten compared with 4,220 tons imported in 1996. Of the imports from China, 82% was intermediate products (tungsten oxide, ammonium paratungstate, and other tungstates).

Russia was the next largest supplier of tungsten materials to the United States, providing 23% of U.S. imports. Imports from Russia increased by 24% in 1997 to 2,930 tons of contained tungsten compared with 2,360 tons in 1996. The Russian imports were mainly tungsten ores and concentrates (64%) and ferrotungsten (25%).

Imports of tungsten ores and concentrates, ammonium paratungstate, ferrotungsten, tungsten metal powders, and tungsten carbide powders increased in 1997 compared with those of 1996, while imports of tungsten oxides, other tungstates, and tungsten waste and scrap decreased. Detailed statistics of U.S. tungsten imports and exports by country are listed in tables 5 through 13.

World Review

World consumption of primary tungsten was strong in 1997 and remained well above world mine production. An estimated one-third of world supply was from tungsten materials released from stockpiles in Russia and Kazakstan. The stockpile releases have maintained an

oversupplied market and have kept the price of primary tungsten below the operating costs of most mines. As a result, many mines have closed, and world tungsten production capacity has fallen to around 75% of world consumption (Bunting, 1998).

China continued to be the dominant world producer of tungsten concentrates. In 1997, China produced an estimated three-quarters of the world's tungsten concentrates; Russia was the next largest producer at an estimated 9% of total production, followed by Austria at 4% and Portugal at 3%. World production of tungsten concentrates is listed by country in table 14 and as a total in table 1.

Australia.—Tasmania Mines Ltd. produced 41 tons of low- and high-grade scheelite concentrates from its Kara Mine at Hampshire. The concentrates were used by the specialty steel industry (Resource Information Unit, 1998).

Canada.—North American Tungsten Corp. Ltd., of Vancouver, British Columbia, signed a purchase agreement with Aur Resources Inc. for the acquisition of Aur's tungsten assets. The assets, formerly owned by Canada Tungsten Inc., consist of the CanTung Mine at Tungsten, Northwest Territories, which suspended operations in 1986 because of market conditions; the MacTung deposit, near MacMillan Pass in the Northwest Territories; the Hemerdon deposit near Plymouth, England, from which some tungsten was mined during World War II; and a 50%-50% joint venture with Strategic Minerals Corp. in the ammonium metatungstate plant at Bishop, CA (Aur Resources Inc., 1996; North American Tungsten Corp. Ltd., 1997).

H.C. Starck GmbH & Co. KG opened a new tungsten carbide plant in Sarnia, Ontario, in September. The plant will use tungsten oxide from Starck's Goslar, Germany, plant as feed and has a capacity of 1,200 tons per year of contained tungsten (Ryan's Notes, 1997).

China.—An overview of Chinese tungsten production and consumption was presented by the China National Nonferrous Metals Import and Export Co. (CNIEC) at the 10th annual general meeting of the International Tungsten Industry Association in September 1997 (Pugang, 1997). Between 1990 and 1996, about 40% of China's tungsten concentrate production was from State-owned mines and 60% was from locally operated mines. The locally operated mines included mines owned by local governments, collectively owned mines, and mines run by private individuals.

Chinese tungsten concentrate production was forecast to decrease in the future as a result of declining ore grades in State- and local government-owned mines. In addition, the Government planned to strengthen its enforcement of a ban on illegal mining by private individuals and refrain from providing financial support to reopen uneconomic mines. The decrease in production was not expected to result in a shortage of supply to domestic or foreign tungsten processors during the next 3 years. To avoid a supply deficit in later years, however, the Chinese tungsten industry will need to find the funding to develop resources to replace production lost from the anticipated closure of many State-owned mines by 2005 (International Tungsten Industry Association, 1997; Metal Bulletin, 1997; Pugang, 1997).

The Chinese tungsten-processing industry has grown in recent years. A survey of 22 major tungsten processors determined that the total capacity to produce intermediate products, such as ammonium paratungstate, was 31,500 tons per year of contained tungsten. In contrast, Chinese consumption of primary products has remained stable at about 10,000 tons of contained tungsten since 1980. Tungsten consumption by China's steel industry has decreased over the years, while consumption to make cemented carbides; tungsten products, such as wire; and tungsten chemicals has increased (Pugang, 1997).

India.—Hindustan Zinc Ltd. decided to close its tungsten-zinc mine at Nagaur in Rajasthan State. The company stated that the mine was no longer economic because of high mining costs and declining ore grades (Platt's Metals Week, 1997).

Japan.—In October, Japan New Metals Co. Ltd. (Nihon Shin Kinzoku) opened a new ammonium paratungstate plant in Akita Prefecture. The Akita plant processed Russian scheelite concentrates in 1997. Japan New Metals was considering feed materials from other countries, including Australia. In addition to concentrates, the plant can process cemented carbide scrap. Ammonium paratungstate produced at Akita will be converted to tungsten metal powder and tungsten carbide powder at Japan New Metals' main plant in Toyonaka, Osaka Prefecture. The Toyonaka plant has facilities to produce ammonium paratungstate from concentrates, but in recent years, it has been processing Chinese ammonium paratungstate and sodium tungstate. By opening the Akita plant, Japan New Metals hoped to reduce its dependence on China for its tungsten raw materials supply (Metal Mining Agency of Japan, 1998; Roskill's Letter from Japan, 1998).

Peru.—Avocet Mining PLC subsidiary Minera Malaga Santolalla S.A. reopened its Pasto Bueno Mine in January. Production had been suspended in 1996 to complete a mine development plan. Exploration and development at the mine increased ore reserves to 143,000 tons at a grade of 1.51% WO_3, which would equal 3 years' production at current rates. Exploration to expand the reserves further continued during the year (Avocet Mining PLC, 1997a).

The Palca Mine in southeastern Peru, operated by Avocet subsidiary S.A. Minera Regina, remained under care and maintenance in 1997. Production from Palca was not economically viable at the current tungsten price (Avocet Mining PLC, 1997a).

Portugal.—During the fiscal year ending March 1997, Avocet Mining PLC subsidiary Beralt Tin & Wolfram S.A. produced concentrates containing 100,070 metric ton units of tungsten trioxide, a 20% decrease from the 122,247 metric ton units of concentrates produced the previous fiscal year. The decrease was attributed to an extended summer shutdown for maintenance and completion of a new final concentration plant, which was being built near the existing preconcentration plant (Avocet Mining PLC, 1997a). Beralt planned to commission a subvertical hoisting shaft at the Panasqueria Mine in December 1997. The shaft was intended to facilitate mining higher grade reserves at greater depths and will allow two-shift operation of the mine and continuous operation of the processing plant (Avocet Mining PLC, 1997b).

Russia.—Exports of tungsten materials from Russian stockpiles continued to contribute to world supply (Bunting, 1998). In terms of tungsten mine output, most of Russia's production in 1997 was from the Lermontov Mine in Primorskiy Kray (Interfax-America, Inc., 1997c).

The Tyrnyauz tungsten and molybdenum mine and mill complex in the Republic of Kabardino-Balkaria resumed production in late 1996 but stopped producing in February 1997 because of financial constraints. The Kabardino-Balkaria State Property committee was considering a proposal to merge Tyrnyauz with the Gidrometallurg tungsten anhydride plant in Nalchik (Interfax-America, Inc., 1997a).

Gidrometallurg's planned commissioning of a new facility to

recover tungsten from tailings stockpiled at Nalchik was postponedbecause of financial constraints. The facility was intended to process more than 400,000 tons of tailings with a tungsten content of up to 1.5%. Gidrometallurg needed $1.5 million to complete the facility, which was expected to supplement output by 300 tons per year of tungsten anhydride beginning in 1998 (Interfax-America, Inc., 1996, 1997d).

The Primorsky tungsten mine and mill complex in Primorskiy Kray was idle for most of 1997 because of a lack of working capital. The complex raised funds to restart operations by selling stockpiled tungsten concentrate provided by the Government on credit. Primorsky planned to restart concentrate production in January 1998 (Interfax International Ltd., 1998).

Tajikistan.—Ikar Mineral Corp. of Vancouver, British Columbia, hired Kilborn Engineering Pacific Ltd. to evaluate the Ikar tungsten deposit in its 100%-owned Rushan concession in southeastern Tajikistan. Kilborn's onsite evaluation was intended to verify the results of a study done by Russian and Tajik mining engineers in the 1970's that estimated geological resources to be 3.1 million tons of ore with an average grade of 0.52% tungsten trioxide, 0.24% copper, 0.126% cobalt, 5.6 grams per ton gold, and 4.7 grams per ton silver (Ikar Mineral Corp., 1998).

Uzbekistan.—Early in the year, the Government of Uzbekistan was reportedly planning to incorporate the Uzbek Refractory and High-Temperature Metals Plant in Chirchik, Tashkent region. By yearend, the Uzbek Government had not approved the State Property Committee's plans to turn the Chirchik plant into a public stock company. Instead, the Government was considering converting Spetsplav, the organization that controls the plant, into a joint-stock holding company. The Chirchik plant produces tungsten powder, semifabricated products, hard alloys, and wire from domestic tungsten concentrates and concentrates imported from Russia. The plant has gradually imported an increasing portion of its feed materials as a result of decreasing ore grades in domestic mines (Interfax-America, Inc., 1997e; Interfax International Ltd., 1997).

To increase domestic reserves, the Uzbek State Committee for Geology and Mineral Resources was assisted by the Metals Mining Agency of Japan and Japan's Mitsui Mineral Development Engineering Co. (Mindeco) in the exploration of some of Uzbekistan's undeveloped tungsten deposits. Mindeco completed an exploration of the Sautbai deposit in the Bukantau Mountains and concluded that 17,000 tons of tungsten was extractable (Interfax-America, Inc., 1997b, e).

Outlook

Demand for tungsten tends to follow general economic conditions. Future consumption of tungsten in cemented carbides, the largest end-use sector, will depend on the performance of the following industries: automotive and aircraft production, oil and gas drilling, coal mining, construction, and semiconductor and other manufacturing. On the basis of trends in these and other industry sectors, total U.S. tungsten demand was expected to increase by more than 5% in 1998 (Vine, 1997). Tungsten demand was reported to be reasonably strong in most market economy countries until late May 1998, when it began to weaken (Metal Bulletin, 1998).

The amount of tungsten concentrates remaining in stockpiles in China and the Commonwealth of Independent States and how long they will continue to contribute to world supply are concerns for the tungsten industry. Past exports of tungsten materials from China, Kazakstan, and Russia have sustained an oversupply situation, kept prices low, and resulted in a significant decrease in mine production. Once the stockpiles are depleted, world mine production will have to increase to meet demand. How quickly mines can be brought back online and whether mine production can meet demand once stockpiles are depleted will influence the future tungsten supply-demand balance.

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TABLE 1
SALIENT TUNGSTEN STATISTICS 1/

(Metric tons of tungsten content unless otherwise specified)

		1993	1994	1995	1996	1997
United States:						
Concentrate:						
Mine production		W	W	W	W	W
Mine shipments		W	W	W	W	W
Value	thousands	W	W	W	W	W
Consumption		2,870 2/	3,630 2/	5,890 r/	5,260 r/	6,590
Exports		63	44	20	72	40
Imports for consumption		1,720	2,960	4,660	4,190	4,850
Stocks, December 31:						
Producer e/		44	44	44	44	44
Consumer		592	756	627 r/	569	658
Ammonium paratungstate:						
Production		4,730 3/	536 4/	2,580 5/	4,450 6/	5,380 6/
Consumption		6,970	7,080	7,920	7,790 r/	9,300
Stocks, December 31: Producer and consumer		420	82	727	558	W
Primary products:						
Net production		9,410	7,410	8,060 r/	7,810	8,300
Consumption		7,580	8,110	8,800	7,830 r/	8,390
Stocks, December 31:						
Producer 7/		1,480	1,160	1,300	1,400	1,210
Consumer		716	849	570 r/	419 r/	616
World:						
Concentrate:						
Production		34,300 r/	34,300	38,600 r/	35,100 r/	33,400 e/
Consumption 8/		31,900	31,600	31,000 e/	(9/)	(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, January 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 1997	3,410	4,890	W	W	8,300
Net production 1996	3,720	4,090	W	W	7,810
Producer stocks, December 31, 1997	710	405	W	95	1,210
Producer stocks, December 31, 1996	860 r/	406	W	131	1,400

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 total shown.

TABLE 3
REPORTED CONSUMPTION AND STOCKS OF TUNGSTEN PRODUCTS
IN THE UNITED STATES 1/ 2/ 3/

(Metric tons of tungsten content)

	1996	1997
Consumption by end use:		
Steel:		
Tool	434	361
Other	107	151
Superalloys	371	367
Other alloys 4/	177	278
Cemented carbides 5/	5,960	6,290
Mill products made from metal powder	687 r/	828
Chemical uses 6/	97 r/	124
Miscellaneous and unspecified	(7/)	--
Total	7,830 r/	8,390
Consumption by form:		
Ferrotungsten	522	473
Tungsten metal powder	926 r/	964
Tungsten carbide powder	5,740 r/	6,270
Tungsten scrap	519 r/	526
Other tungsten materials 8/	123	166
Total	7,830 r/	8,390
Consumer stocks, December 31:		
Ferrotungsten	26 r/	28
Tungsten metal powder	28 r/	30
Tungsten carbide powder	317 r/	488
Tungsten scrap	34 r/	45
Other tungsten materials 8/	14	26
Total	419 r/	616

r/ Revised.
1/ Data are rounded to three significant digits; may not add to totals shown.
2/ Does not include materials used in making primary tungsten products.
3/ Includes estimates.
4/ Includes welding and hard-facing rods and materials, wear- and corrosion-resistant alloys, and nonferrous alloys.
5/ Formerly called "Cutting and wear-resistant materials." Includes diamond bit matrices, cemented and sintered carbides, and cast carbide dies or parts.
6/ Formerly called "Chemical and ceramic uses."
7/ Revised to zero.
8/ Includes tungsten chemicals.

TABLE 4
MONTHLY PRICE QUOTATIONS OF TUNGSTEN CONCENTRATE IN 1997

	Metal Bulletin (London), European market, 65% WO_3 basis, c.i.f. 1/				Platt's Metals Week, U.S. spot quotations, 65% WO_3 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
Month	Low	High	Average	Average	Low	High	Average	Average
January	43	53	48	44	55	65	60	66
February	43	55	49	44	55	65	60	66
March	45	55	50	45	55	65	60	66
April	45	55	50	45	55	65	60	66
May	45	55	50	45	55	65	60	66
June	45	55	50	45	55	65	60	66
July	45	55	50	45	55	65	60	66
August	40	45	43	39	55	65	60	66
September	40	45	43	39	55	65	60	66
October	40	45	43	39	45	65	55	61
November	40	52	46	42	45	55	50	55
December	40	52	46	42	45	55	50	55

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 WO_3, of all semiweekly low and high prices was $47 for 1997. The average equivalent price per short ton unit of WO_3 was $43 for 1997.

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 WO_3 of all weekly low and high prices was $58 for 1997. The average equivalent price per metric ton unit of WO_3 was $64 for 1997.

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

	1996		1997	
Country of destination	Tungsten content 1/ (metric tons)	Value (thousands)	Tungsten content 2/ (metric tons)	Value (thousands)
Bolivia	--	--	3	$19
China	57	$428	13	91
Germany	1	4	1	6
Hong Kong	1	7	1	8
India	--	--	1	10
Ireland	(3/)	3	1	8
Italy	--	--	4	28
Japan	3	26	12	86
Mexico	(3/)	3	--	--
Netherlands	5	38	--	--
Qatar	--	--	(3/)	3
Singapore	1	6	--	--
United Kingdom	3	24	3	21
Vietnam	--	--	(3/)	3
Total 4/	72	539	40	282

1/ Calculated based upon an estimated value of $59 per metric ton unit WO_3.

2/ Calculated based upon an estimated value of $56 per metric ton unit WO_3.

3/ Less than 1/2 unit.

4/ Data may not add to totals shown because of independent rounding.

Source: Bureau of the Census.

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

Country of destination	1996 Tungsten content (metric tons)	1996 Value (thousands)	1997 Tungsten content (metric tons)	1997 Value (thousands)
Belgium	81	$970	42	$519
Denmark	--	--	3	33
Germany	4	33	--	--
Japan	65	303	62	464
Korea, Republic of	--	--	(2/)	6
Netherlands	--	--	11	145
Sweden	--	--	4	41
Venezuela	(2/)	3	--	--
Total	150	1,310	121	1,210

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 of destination	1996 Tungsten content (metric tons)	1996 Value (thousands)	1997 Tungsten content (metric tons)	1997 Value (thousands)
Australia	9	$546	6	$142
Austria	39	749	52	971
Belgium	4	199	2	140
Brazil	4	111	6	161
Canada	372	8,940	323	8,530
Chile	2	86	(2/)	15
China	1	15	--	--
Denmark	4	138	3	153
Finland	1	98	--	--
France	38	655	54	651
Germany	318	5,100	177	3,380
Hong Kong	1	28	1	74
India	(2/)	3	3	136
Ireland	3	227	4	271
Israel	18	678	(2/)	13
Italy	106	3,680	80	2,380
Japan	29	833	38	1,440
Korea, Republic of	9	597	24	1,020
Luxembourg	16	498	(2/)	15
Mexico	7	308	9	380
Netherlands	12	238	7	171
New Zealand	11	23	--	--
Peru	--	--	2	56
Portugal	4	97	3	15
Singapore	9	348	47	1,020
South Africa	28	426	58	878
Sweden	107	4,150	83	4,090
Switzerland	4	523	(2/)	5
Taiwan	24	994	29	840
Turkey	1	43	--	--
United Arab Emirates	1	34	(2/)	13
United Kingdom	107	1,260	31	640
Venezuela	3	122	22	465
Other	3 r/	216 r/	2	128
Total	1,290	32,000	1,070	28,200

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 METAL POWDERS 1/, BY COUNTRY 2/ 3/

Country of destination	1996 Gross weight (metric tons)	1996 Tungsten content 4/ (metric tons)	1996 Value (thousands)	1997 Gross weight (metric tons)	1997 Tungsten content 4/ (metric tons)	1997 Value (thousands)
Argentina	2	2	$54	1	1	$18
Australia	2	1	50	5	4	154
Belgium	(5/)	(5/)	5	11	8	365
Brazil	3	3	212	11	8	447
Canada	48	38	1,330	74	59	2,120
Chile	(5/)	(5/)	13	2	1	91
China	10	8	143	(5/)	(5/)	17
Colombia	--	--	--	2	2	50
France	6	5	209	13	11	295
Germany	91	72	2,350	195	156	5,880
Guatemala	--	--	--	7	5	9
Honduras	23	18	70	--	--	--
Hong Kong	2	1	54	6	5	102
India	1	1	33	(5/)	(5/)	10
Israel	36	29	159	54	43	735
Italy	2	1	112	4	3	100
Japan	5	4	184	6	5	62
Korea, Republic of	4	3	151	1	1	36
Mexico	7	5	191	6	5	145
Netherlands	2	2	11	14	11	63
Singapore	30	24	538	2	2	72
South Africa	1	1	41	(5/)	(5/)	6
Spain	1	(5/)	16	5	4	56
Sweden	8	6	475	1	1	44
Switzerland	4	3	166	47	37	1,290
Taiwan	2	1	62	1	1	58
Trinidad	--	--	--	7	6	45
Turkey	1	1	34	--	--	--
United Kingdom	8	6	502	36	29	513
Venezuela	--	--	--	1	1	29
Vietnam	3	2	87	--	--	--
Other	1	1	25 r/	2	1	69
Total	300	240	7,280	512	410	12,900

r/ Revised.
1/ Formerly called "Tungsten and tungsten alloy powder."
2/ Data are rounded to three significant digits; may not add to totals shown.
3/ May include tungsten alloy powders.
4/ Content estimated from reported gross weight.
5/ 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 of destination	1996 Tungsten content (metric tons)	1996 Value (thousands)	1997 Tungsten content (metric tons)	1997 Value (thousands)
Wrought tungsten, wire: 2/ 3/ 4/				
Belgium	(5/)	$30	1	$103
Brazil	1	116	1	96
Canada	9	409	31	1,040
France	2	305	3	422
Germany	10	435	4	409
Guatemala	1	132	--	--
Hong Kong	3	1,000	7	903
Hungary	(5/)	5	11	624
India	14	1,020	26	1,640
Italy	3	277	5	473
Japan	13	1,760	11	1,490
Korea, Republic of	1	95	1	93
Malaysia	1	306	1	338
Mexico	12	1,150	15	1,320
Singapore	(5/)	20	1	20
Spain	6	320	11	557
Sweden	1	144	3	262
Taiwan	9	905	3	223
United Kingdom	1	392	1	149
Other	1 r/	233 r/	2	334
Total	88	9,050	136	10,500
Unwrought tungsten and waste and scrap: 3/ 4/ 6/				
Australia	7	74	5	26
Brazil	5	34	11	98
Canada	7	102	43	417
Chile	6	35	--	--
Colombia	--	--	13	78
France	8	46	--	--
Germany	336	1,850	318	1,990
Hong Kong	--	--	4	21
India	--	--	3	30
Israel	15	88	1	8
Italy	19	128	1	3
Japan	9	60	3	31
Mexico	43 r/	279	17	129
Spain	--	--	1	7
Sweden	43	379	--	--
Taiwan	4	21	11	62
United Kingdom	45	412	61	348
Venezuela	--	--	12	54
Other	17	127	2	22
Total	565	3,630	507	3,320
Other tungsten metal: 3/ 4/				
Australia	2	171	2	301
Belgium	3 r/	365	1	107
Brazil	3	248	2	313
Canada	5 r/	339	9	617
Colombia	1	64	(5/)	76
France	1	142	1	218
Germany	9 r/	855	3	972
Hong Kong	2	144	3	116
India	3 r/	268	6	493
Israel	1	222	1	226
Italy	1	89	(5/)	21
Japan	5 r/	1,460	9	3,400
Korea, Republic of	2	899	7	704
Mexico	11 r/	1,240	11	1,290
Netherlands	1 r/	315	1	291

See footnotes at end of table.

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

Product and country of destination	1996 Tungsten content (metric tons)	1996 Value (thousands)	1997 Tungsten content (metric tons)	1997 Value (thousands)
Other tungsten metal-Continued:				
Singapore	2	573	1	391
South Africa	1	116	(5/)	4
Sweden	1	100	(5/)	57
Switzerland	1	136	(5/)	97
Taiwan	6 r/	902	7	840
Thailand	1	256	1	504
United Kingdom	11 r/	921	11	1,010
Other	1	329 r/	3	1,090
Total	71 r/	10,200	80	13,100
Ferrotungsten and ferrosilicon tungsten:				
Canada	2	22	1	23
China	--	--	3	42
India	--	--	(5/)	5
Mexico	--	--	7	28
Total	2	22	10	98
Wrought tungsten, excluding wire: 3/ 4/ 7/				
Australia	(5/)	36	4	180
Belgium	1	151	1	26
Brazil	(5/)	11	1	72
Canada	19	772	21	658
Chile	1	43	(5/)	34
France	22	736	3	305
Germany	36	975	154	3,540
India	2	142	4	109
Ireland	--	--	5	221
Israel	1	55	1	105
Italy	5	353	2	166
Japan	8	1,020	9	904
Korea, Republic of	2	113	1	75
Lithuania	--	--	2	41
Mexico	3	165	3	189
Netherlands	(5/)	8	1	54
Singapore	1	64	2	121
Spain	6	336	7	292
Taiwan	6	532	8	658
United Kingdom	2	219	2	238
Other	3 r/	309 r/	5	554
Total	115 r/	6,040	237	8,540
Other tungsten compounds: 8/				
Argentina	--	--	(5/)	3
Brazil	(5/)	8	--	--
Canada	2	10	5	16
Chile	--	--	(5/)	3
Hungary	--	--	(5/)	4
Netherlands	11	16	--	--
United Kingdom	--	--	1	64
Total	13	34	6	90

r/ Revised.
1/ Data are rounded to three significant digits; may not add to totals shown.
2/ Formerly called "Tungsten and tungsten alloy wire."
3/ May include alloys.
4/ Content estimated from reported gross weight.
5/ Less than 1/2 unit.
6/ Includes bars and rods obtained simply by sintering. Formerly called "Unwrought tungsten and alloy in crude form, waste and scrap."
7/ Formerly called "Wrought tungsten."
8/ 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 of origin	1996 Tungsten content (metric tons)	1996 Value (thousands)	1997 Tungsten content (metric tons)	1997 Value (thousands)
Australia	--	--	23	$127
Bolivia	782	$4,190	635	3,230
Brazil	11	69	--	--
Burma	33	190	--	--
Canada	--	--	1	5
Chile	--	--	46	255
China	--	--	71	349
Germany	--	--	52	240
Japan	--	--	11	57
Kazakstan	125	689	626	2,450
Mexico	166	644	176	652
Mongolia	--	--	22	90
Netherlands	202	1,160	3	25
Peru	385	2,450	212	1,220
Portugal	518	3,360	1,010	6,100
Russia	1,690	7,190	1,880	9,020
Rwanda	13	65	51	248
Spain	6	45	--	--
Thailand	60	361	37	221
United Kingdom	203	1,080	--	--
Total	4,190	21,500	4,850	24,300

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 of origin	1996 Tungsten content (metric tons)	1996 Value (thousands)	1997 Tungsten content (metric tons)	1997 Value (thousands)
China	1,440	$9,690	1,920	$12,100
Germany	63	524	52	649
Hong Kong	15	69	45	293
Japan	18	124	25	281
Netherlands	1	12	--	--
Russia	--	--	4	145
Sweden	38	193	52	287
Total	1,580	10,600	2,100	13,700

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

Source: Bureau of the Census.

TABLE 12
U.S. IMPORTS FOR CONSUMPTION OF FERROTUNGSTEN AND FERROSILICON TUNGSTEN 1/, BY COUNTRY 2/

Country of origin	1996 Tungsten content (metric tons)	1996 Value (thousands)	1997 Tungsten content (metric tons)	1997 Value (thousands)
China	312	$2,010	76	$410
Germany	1	16	2	30
Hong Kong	13	88	--	--
Russia	163	993	725	4,000
Sweden	(3/)	1	--	--
United Kingdom	45	302	--	--
Total	535	3,410	803	4,440

1/ Formerly called "Ferrotungsten."
2/ Data are rounded to three significant digits; may not add to totals shown.
3/ 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 of origin	1996 Tungsten content (metric tons)	1996 Value (thousands)	1997 Tungsten content (metric tons)	1997 Value (thousands)
Waste and scrap:				
Australia	16	$71	--	--
Austria	33	208	8	$51
Belgium	--	--	14	140
Canada	25	175	24	121
China	7	54	93	825
France	68	322	13	94
Germany	272	2,180	285	2,350
Hong Kong	--	--	6	51
India	--	--	48	240
Ireland	32	224	--	--
Israel	48	257	105	483
Italy	22	136	--	--
Japan	347	1,860	349	2,100
Korea, Republic of	63	279	14	95
Mexico	10	55	2	10
Netherlands	48	359	5	21
Pakistan	49	198	15	72
Peru	9	54	--	--
Russia	289	1,880	166	1,040
Singapore	57	290	29	179
South Africa	58	293	81	411
Sweden	70	432	64	433
Taiwan	7	48	18	115
United Kingdom	310	1,560	138	1,280
Uzbekistan	--	--	27	307
Other	4 r/	19 r/	3	26
Total	1,840	11,000	1,510	10,400
Tungsten metal powders: 2/ 3/				
Belgium	5	220	26	751
Canada	10	310	7	237
China	15	235	126	1,790
Czech Republic	10	176	28	456
France	23	147	9	56
Germany	37	1,450	51	1,520
Israel	1	18	22	287
Japan	27	2,340	16	1,950
Latvia	--	--	31	142
Russia	57	782	--	--
Sweden	46	1,600	18	724
United Kingdom	170	1,530	93	933
Other	4 r/	29 r/	6	150
Total	404	8,840	432	8,990
Unwrought tungsten: 2/ 4/ 5/				
Austria	3	139	1	120
Canada	--	--	3	14
Germany	(6/)	33	13	212
Korea, Republic of	6	32	--	--
Russia	14	100	--	--
Switzerland	2	198	3	334
Other	(6/) r/	40 r/	(6/)	8
Total	26	543	20	689
Wrought tungsten wire, plate, sheet, strip, foil, and other: 2/ 4/				
Austria	27	4,490	20	3,020
Belgium	(6/)	21	(6/)	20
Canada	(6/)	26	4	107
China	35	1,620	41	2,060
France	2	427	2	474
Germany	4	709	102	9,020
Hong Kong	5	369	1	56

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 of origin	1996 Tungsten content (metric tons)	1996 Value (thousands)	1997 Tungsten content (metric tons)	1997 Value (thousands)
Wrought tungsten wire, plate, sheet, strip, foil, and other 2/ 4/-Continued:				
Hungary	5	583	7	802
Israel	8	$539	19	$1,340
Japan	44	7,990	32	6,600
Mexico	6	936	8	848
Netherlands	3	346	7	675
Russia	2	143	2	119
Singapore	--	--	1	58
Switzerland	2	413	9	989
United Kingdom	5	985	2	470
Uzbekistan	--	--	17	103
Other	1	189	1	211
Total	149	19,800	277	27,000
Calcium tungstate:				
China	53	240	29	169
Ireland	10	20	--	--
Japan	1	88	2	108
Total	65	348	31	277
Tungsten oxides:				
Austria	--	--	(6/)	5
China	1,530	11,800	1,190	8,020
Germany	2	39	43	452
Hong Kong	145	1,010	117	727
Russia	152	1,130	152	929
Sweden	--	--	4	32
United Kingdom	(6/)	2	220	1,900
Uzbekistan	30	65	--	--
Total	1,860	14,000	1,720	12,100
Chlorides of tungsten:				
Canada	(6/)	2	--	--
China	2	13	--	--
Total	2	15	--	--
Other tungstates: 7/				
China	683	4,230	426	2,400
Germany	(6/)	35	(6/)	52
Hong Kong	28	170	--	--
Japan	(6/)	4	(6/)	14
Switzerland	(6/)	3	--	--
Total	711	4,440	426	2,470
Tungsten carbide powder:				
Austria	(6/)	$11	20	$352
Canada	58	1,490	38	571
China	134 8/	2,540 8/	356	5,310
France	(6/)	3	14	273
Germany	150	4,740	125	2,810
Hong Kong	13	404	7	102
India	1	13	11	198
Israel	3	50	14	266
Japan	2	274	(6/)	19
Korea, Republic of	(6/)	5	16	317
Switzerland	3	100	2	119

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 of origin	1996 Tungsten content (metric tons)	1996 Value (thousands)	1997 Tungsten content (metric tons)	1997 Value (thousands)
Ttungsten carbide powder-Continued:				
United Kingdom	40	386	43	457
Other	(6/) r/	42 r/	3	136
Total	404 8/	10,100 8/	650	10,900

r/ Revised.
1/ Data are rounded to three significant digits; may not add to totals shown.
2/ May include alloys.
3/ Formerly called "Unwrought tungsten, except alloys, in lumps, grains, and powders."
4/ Content estimated from reported gross weight.
5/ Includes bars and rods obtained simply by sintering; excludes powders, waste and scrap. Formerly called "Unwrought tungsten, ingots, shot, alloy, and other."
6/ Less than 1/2 unit.
7/ Formerly called "Sodium tungstate."
8/ 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	1993	1994	1995	1996	1997 e/
Australia	23	11 e/	--	--	--
Austria	105 r/	--	738 r/	1,413 r/	1,400
Bolivia	287	462	655	582	500
Brazil	245	270 r/	171 r/	171 r/	170
Burma 3/	524	544 r/	531	334 r/	280
Burundi e/	--	--	22	16	16
China e/ 4/	21,600	27,000	27,400	26,500 r/	25,000
India	1	2	4 r/	2	3
Japan	66	--	--	--	--
Kazakstan e/	350 r/	200	225	220	200
Korea, North e/	1,000	900	900	900	900
Korea, Republic of	-- r/	--	--	--	-- 5/
Malaysia	2	--	--	-- e/	--
Mexico	--	--	287 r/	188 r/	179 5/
Mongolia e/	250	150	200	200	100
Peru	388	259	728	332 r/	280 5/
Portugal	768	60 r/	870 r/	776 r/	1,036 5/
Russia e/	8,000	4,000	5,400	3,000	3,000
Rwanda e/	175	30	47 r/ 5/	40 r/	40
Tajikistan e/	150	100	75	50	50
Thailand e/	80	40	60	30 r/	25
Uganda	5	12	17	--	--
United States	W	W	W	W	W
Uzbekistan e/	300	300	300	300	250
Total	34,300 r/	34,300	38,600 r/	35,100 r/	33,400

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 available through June 13, 1998.
3/ Includes content of tin-tungsten concentrate.
4/ Based upon data published in the Yearbook of Nonferrous Industry of China, 1994-97.
5/ Reported figure.