TUNGSTEN

By Earle B. Amey

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, and 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 increased by about 47% in 1995 compared with that of 1994. Demand generally increased in the cemented carbide end-use sectors that included the combined cutting tool, mining tool, oil drilling equipment, and wear-resistant component industries. Counter to these increases was a decrease in the demand for directly reusable tungsten scrap. Demand for mill products made from metal powder remained the same in 1995. A gradual strengthening of the U.S. economy influenced the overall increase in demand for tungsten products during 1995.

During 1995, prices for tungsten concentrates, which had built up in the second half of 1994, strengthened reaching the highest levels in the last 11 years (1995 from 1985). Major liquidation of both Russian and Chinese stockpiles occurred as the supply of tungsten ore tightened and a large amount of tungsten ore was put into production. Because of the uncertainty of the tungsten market, however, 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 1995 showed a shift towards tungsten concentrate, tungsten oxide, and ammonium paratungstate. Competition was apparently coming from the Russians. However, China continued to be the dominant supplier of tungsten materials to the United States in 1995, providing about 31% of all imported tungsten materials.

A summary of the important U.S. and international statistics for 1995 and the previous 4 years are shown in table 1.

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 proposed legislation that calls for new proposals to Congress on April 16, 1996. DLA would conduct sales on a specified amount per year which would be subject to a Congressional mandate not to disrupt markets. No timetable was set for Congress to act on this proposal. Forms of tungsten in the U.S. National Defense Stockpile Center included: tungsten ore and concentrates, metal, carbides, and ferrotungsten.

The Office of the United States Trade Representative (USTR) investigated, under the Trade Act of 1974, acts, policies, and practices of the Government of China concerning the enforcement of intellectual property rights and the provision of property protection. If these acts, policies, and practices were judged to be unreasonable and to constitute a burden or restriction on U.S. Commerce, USTR would propose raising tariffs on a list of Chinese import articles. The antidumping tariffs on imports of tungsten ore concentrates and products from China, initially imposed on October 28, 1991, were extended throughout 1995. These import duties are currently 37% on tungsten concentrates, 35% on tungsten oxide and acid, and 33% on tungsten carbide and fused carbide. The extent to which the tariffs might affect the European market is uncertain, primarily because ammonium paratungstate (APT), the major tungsten material being processed in Europe, is not included under these tariffs.

Production

Domestic production data for tungsten were developed by the U.S. Geological Survey by means of two separate, voluntary surveys. These surveys are “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 33% and 36%, respectively, of those operations surveyed. Production and stock totals for the survey respondents are shown in table 1.

The already low tungsten mining activity in the United States remained the same in 1995 as the uncertainties in the tungsten market continued. Only limited quantities of tungsten concentrate were produced by U.S. Tungsten Corp., a division of Strategic Minerals Corp. (Stratcor), at its Pine Creek Mine and conversion facility in Bishop, CA.

Avocet Ventures Inc., British Columbia, Canada, parent company of Waller Metals Ltd., London, United Kingdom, bought inventories and fixed assets of Stratcor’s tungsten processing and APT operations at Bishop, CA. This facility has an APT designed capacity of 4,100 metric tons of contained tungsten annually. Feed for the processing facility was shipped from Avocet's Latin American (Peru) and European (Portugal) mines. In addition, Stratcor formed a 50-50 joint venture with Avocet to mine and process tungsten at the Pine Creek deposit near Bishop. The Pine Creek Mine, with 1.4 million metric tons of tungsten ore reserves grading 0.51% tungsten oxide, had been closed since 1991.

In the first quarter of 1995, the Bishop plant produced 600 metric tons of APT containing 540 metric tons of tungsten oxide. Material other than the company’s own mined

production, particularly scheelite, was brought in as feed. Plans were made to begin yellow oxide production, a product that eliminated the intermediate APT.

Major processors of tungsten materials in 1995 were 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; Teledyne Firth Sterling, LaVergne, TN; 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) increased by almost 47% in 1995 compared with that of 1994. Demand generally increased in the cemented carbide end-use sectors that included the combined cutting tool, mining tool, oil drilling equipment, and wear-resistant component industries. Demand for ferrotungsten used in steels that included the tool, alloy, and stainless steel sectors, as well as demand for tungsten chemicals and directly reusable tungsten scrap, decreased in 1995. Demand for mill products made from powders was relatively constant.

Reported consumption of obsolete tungsten scrap, reprocessed either chemically or physically for reuse, increased to 4,300 metric tons of contained tungsten in 1995 from 2,100 tons in 1994. 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.

Further strengthening of the U.S. economy influenced the overall increase in demand for tungsten products during 1995. Economic recovery in the major industrial sectors of auto, aerospace, and construction, where a significant quantity of tungsten was consumed as cemented carbide components, continued from 1993. Demand for cemented carbide components in the oil drilling industry fluctuated during 1995. The number of operating oil drilling rigs in the United States rapidly declined from a high of 791 in early January to a yearly low of 664 rigs in early May, then gradually increased to a yearly high of 775 rigs by September, and remained level until yearend 1995, according to figures reported 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, increased about 51% in 1995 compared with that of 1994. The concentrate price increased to an average of $63.80 per metric ton unit (mtu) tungsten oxide from an average of $42.35 per mtu in 1994. This trend for 1995 continued the upward trend that started last year.

World market prices for APT decreased during 1995, inconsistent with the increasing 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 by 7% from an average of $81.67 per mtu in January to an average of $75.75 per mtu by yearend. Similarly, quotations for Chinese No. 1 Grade APT in Hong Kong decreased by 12% during the year from an average price of $86 per mtu to an average of $76 per mtu. The average price of APT on the European free market decreased by 11%, from $87.50 per mtu to $78 per mtu, according to quotations published in Metal Bulletin (London).

Foreign Trade

Comprehensive lists of U.S. export and import trade statistics by material quantity and 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 1995 showed a shift toward tungsten concentrate and the intermediates ammonium paratungstate and tungsten oxide. Concentrate prices increased during this period with an increase in demand and the appearance of a depletion of Chinese inventories. In 1995, concentrate represented a 49% share of the combined imports of concentrate and intermediates from all sources, compared with 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 35% in 1995 or slightly down from 37% in 1994.

Total U.S. imports of all tungsten materials increased by 14% in 1995 compared with those of 1994. While China continued to be the dominant supplier, providing about 31% of all imported 1995 tungsten materials, China's 1995 share of the total quantity of tungsten materials imported by the United States was down about 2 percentage points compared with that of 1994. However, the total quantity of tungsten materials imported from China increased from 3,500 tons of contained tungsten in 1994 to 3,814 tons in 1995. Of the total tungsten imports from China, the percentage imported as intermediate products was 63% in 1995, less than 66% in 1994, and 74% in 1993 and 1992. Russia continued to be competitive with China as one of the dominant suppliers, providing about 29% of all imported tungsten materials. Major suppliers of concentrates to the United States in 1995 included Russia (61%), Peru (11%), and Bolivia (9%).

World Review

Capacity **.—**Rated world capacity for mines and mills as of December 31, 1995, was approximately 40,000 tons of contained tungsten. Estimated annual mine production capacity declined by about 5% in 1995 compared with that of 1994. Some of this decline was attributed to the apparent closure of additional smaller, inefficient mines in China, as well as the production declines at some larger mines, following the

discontinuation of Government subsidies to tungsten mines during the last quarter of 1992.

Annual concentrate world production is shown by country in table 14 and as a total in table 1; annual world concentrate consumption statistics are also shown in table 1.

Austria.—Metall Mining Corp. (Metall) of Toronto bought the Wolfram Bergbau und Huettengesellschaft (WBH) tungsten operations in Austria. The mine and powder facility have an annual capacity rated at 2,500 metric tons of tungsten powder and tungsten carbide. WBH's mine is in Mittersill, close to the Austrian town of Salzbrug, and their smelter is in Bergla. The latter uses tungsten scrap as well as ore feed and produced 2,100 metric tons of tungsten powder and 1,500 metric tons of tungsten carbide in 1993-94. If tungsten prices strengthen, the Mittersill Mine could be reopened. This mine had been placed on care-and-maintenance status since the end of February 1993.

China.—China temporarily closed its tungsten mines for 2 months during the summer of 1995. The China National Production and Marketing Union for Tungsten Ores and Concentrates confirmed the temporary closure of 21 mines it controls and producers in Jiangxi, Hunan, Guangdong, and Guangxi Provinces. An official of the China National Nonferrous Metals Import Export Corp. (CNNC) said that China was waiting until the international price of tungsten concentrate reached $70 per mtu of tungsten before resuming production. China, subsequently, reopened most of the tungsten mines at a price below $70. However, CNNC restricted monthly wolframite output of the reopened mines to about 1,000-2,000 metric ton units.

Later in the year, China cut its tungsten exports by 5% because of their reduced reserves and weak prices in the international markets. This reduction prompted a 1-month annual maintenance shutdown of China's major tungsten mines and APT plants. CNNC Nanchang, which operates the converter and major tungsten mines in the Jiangxi Province, planned to produce a larger portion of value-added products rather than sell wolframite to plants in other provinces. Wolframite concentrates were diverted to its own APT converter at Ganzhou and could affect some production plants.

Commonwealth of Independent States (CIS).—A new tungsten mine was being developed in Kazakstan according to the general director of Kairakti Mining-Metal Complex. Although a concentrator needed to be built at the site, construction of the Kattpar tungsten mine has begun. The mine would produce an estimated 3,000 to 6,000 metric tons per year of wolframite. However, as with so many ventures in the country, the state-owned mining company was cash-strapped and was searching for investments to complete the development of the facilities at the mine site.

One of Kyrgyzstan's biggest mining complexes, Kara Balta, was forming a joint venture with Onyx, a Russian investment company, to develop the Sary Dzhaz tungsten deposit in the Issyk Kul region. The deposit contains more than 100,000 metric tons of tungsten and was expected to produce 600 metric tons of tungsten per year when the second stage of an on-site mill was completed in mid-1996. The first stage of the mill already was producing 200 metric tons of tungsten per year.

No U.S. imports of tungsten materials have been received from Romania, Kazakstan, and Ukraine following their receipt of Generalized System of Preference status.

European Union (EU).—Eurometaux, acting on behalf of the EU tungsten industry, requested an expiry review from the European Commission (EC) of the antidumping measures in force against imports of tungsten ores, concentrates, tungsten carbide, and tungstic acid originating from China. This request was lodged citing that a lapse of duties would possibly lead to a continuation or recurrence of dumping and injury. Later in 1995, the EC upheld this request.

India.—Tungsten resources in India were either scarce or uneconomical to exploit due to lack of viable extraction technology. For this reason, bank loans for mining projects were difficult to obtain in 1995, and demand was met by imports.

International Tungsten Industry Association (ITIA).—ITIA held its eighth International Tungsten Symposium in Stockholm, Sweden, September 20, 1995. Speakers from five countries presented a wide range of papers that focused on contradictory stories about the supply/demand balance in 1995 as well as technological papers that detailed developments in the Russian tungsten industry, modern tools for developing cemented carbides, the role of potassium bubbles in tungsten lamp wire, and product attributes of tungsten blue oxides. One of the highlights was the presence for the first time at an ITIA meeting of a Russian delegation (from Moscow). ITIA's Secretary-General's presentation on various aspects of the tungsten market stated that, it was clear that real production from China had been supplemented by stocks, and noted the increasing trend of exports from the CIS.

Korea, Republic of.—The Government of the Republic of Korea, consistent with its ongoing privatization process, sold its majority ownership in Korea Tungsten Mining Co. Ltd. (KTMC). The new owner, Keopyung Group, a Korean conglomerate, continued to maintain KTMC's Sangdong tungsten mine on care and maintenance status.

Japan.—Japanese shipments of tungsten powder rose to 1,800 metric tons in 1994, mainly for use in the electronics sector. Demand for tungsten carbide rose to 1,500 metric tons and for other tungsten-related products rose to 318 metric tons. The strength of the yen was making several Japanese companies look at transferring operations overseas. Since most APT was imported from China, the tungsten industry was drawn away from Japan towards China. The Japanese were concerned that Chinese manufacturers may not be able to refine the high-grade metals needed to produce high-quality metals required for high-technology materials.

Peru.—Avocet Ventures Inc., British Columbia, Canada, produced in its Regina and Malaga Mines a combined 49,406 metric ton units of tungsten trioxide concentrate, up 31% from 1994. Avocet completed its acquisition of shares in Minera Regina to bring its interest from 22.4% to 80%, by converting loans to equity and purchasing shares from the previous majority owner, the Arias family, for $2.5 million. Likewise, Avocet

acquired a further 3% of Minera Malaga Santolalla to bring its interest to 75%.

Portugal.—Avocet Ventures Inc. reopened the Panasquiera tungsten mine near Fundao (in the Serra da Estrela region of Portugal) in January 1995. Minorco SA, Luxembourg, the company from whom Avocet purchased the mine in early 1994, had placed it on care and maintenance status at the end of 1993 after the market had become saturated with Chinese tungsten concentrate. According to a spokesperson for the new ownership of the Panasquiera Mine, a strengthening of the tungsten market was foreseen. The Panasqueira Mine resumed production at a rate of 110 metric tons of high grade tungsten concentrate per month. Later in the year, Avocet Ventures Inc. consolidated its interest in the Panasqueria Mine. Through an agreement between Minorco and Avocet, Minorco relinquished its entitlement to a 20% net interest in the free cashflow of Beralt Tin & Wolfram Ltd. in Portugal. In return, Minorco sold Avocet 450 tons of Panasqueria's high-grade tungsten concentrates and obtain a 5.2% interest in Avocet.

Russia.—Principal Russian mines resumed intermittent production of tungsten during 1995 after being at a standstill for most of 1994. Lermontov (in Primorsky Kray) operated for most of the year; Primorsky-GOK (in Primorsky Kray) operated for about half of the year; and Tyrny-Auz (in Caucasus) operated intermittently. Tyrny-Auz has abandoned its open pit operations and would produce from underground mines. Some resumption in tungsten production has also taken place at Dzida.

Avocet Ventures Inc. agreed to purchase about a 20% interest in the Lermontovsky Mining Co. with an option to purchase an additional 4.3% later. This Russian mining company owned and operated the Lermontov tungsten mine situated in the Primorsky Kray region of Russia's Far East. The mine has 1.5 metric million tons of ore grading 2% WO_3, which makes it one of the richest open pit tungsten mines in the world. Current production was approximately 300 metric tons per month of medium-grade concentrate that can be processed by only a few processing facilities, one of which is Avocet's facility in Bishop, CA.

Current Research and Technology

Powder metallurgy tool steels contained significant amounts of tungsten offered the following advantages over conventional cast/wrought tool steels:

- Micro-Melt M-4 alloy (5.5% tungsten) provided very high wear resistance along with high strength.
- Micro-Melt M-3 Class 2 alloy (6.25% tungsten) had superior wear resistance for difficult cutting operations.
- Micro-Melt T-15 alloy (13% tungsten) had excellent abrasion resistance and red hardness.
- Micro-Melt HS-30 alloy (6.25% tungsten) had excellent hot hardness combined with good wear resistance and toughness.
- Micro-Melt HS-76 alloy (10% tungsten) had excellent abrasion resistance and superior red hardness, and would be considered where other high-speed steels may be inadequate.[1]

A process that used technology developed at the Georgia Institute of Technology (Atlanta, GA) made titanium boride a contender for cutting. Advanced Engineering Materials LLC, Woodstock, GA, used this process to produce a new generation of cutting tools, dies, and electrodes that have a Knoop hardness of 3,400, cuts both ferrous and nonferrous metals, lasts five to six times longer than tungsten carbide, and costs only two to three times as much.[2]

Mechanical properties were measured for tungsten alloys in order to compare their fracture behavior and identify the connection between fracture and ballistic performance. Differences were detected in crack initiation and propagation energies at higher loading rates. Fracture was found to occur by cleavage in the tungsten grains and shear in the matrix. Alloys with more cobalt were tougher than the iron alloys.[3]

Normet Technologies developed a microwelding process in which a depositing electrode vaporizes and rapidly solidifies into a hard, amorphous coating. The process generated very little heat, was applied at ambient temperature, and did not alter the substrate microstructure. It required no masking, toxic chemicals, or vacuum chamber. Using an electrode composed of tungsten carbide particles in a cobalt matrix, coatings were produced that were reported to increase tool life 2 to 15 times normal and sharpness life by up to 5 times. Applications included surgical instruments, gripping pliers, ski edges, and automotive valves.[4]

Thorium and thoria additions have been used in tungsten-based materials for a variety of performance-enhancing reasons, including better electron emissivity of electrodes, higher strength and hardness, finer grain size, and better machinability. However, the resulting material's radioactive potential made it subject to stringent legislation that made handling, use, recycling, and disposal more difficult. Therefore, research was done on alternative additives that exhibit the same advantages as thoriated tungsten without the drawbacks. In this respect, lanthanum and cerium-oxide doping represent competitive alternatives.[5]

A low-cost chemical method for producing tungsten carbide needle-shaped crystals of sodium tungsten bronze was developed at Oak Ridge National Laboratory. Experiments showed that, by a simple reaction with a common gas, an expensive material could be converted into an industrial product of high value. This product could be used as reinforcements in metal- and ceramic-matrix composites that then could be used in automobile engine cylinders and other applications required high strength and toughness at high temperatures.[6]

Outlook

Based on the first quarter reported consumption of all tungsten products, the total annual demand for tungsten materials in the United States in 1996 was estimated to be about 12,000 tons of contained tungsten. This would represent about the same consumption as the 11,900 tons reported for 1995.

The economic recovery rate in 1996 was expected to exceed slightly the modest gains the economy experienced in 1995. 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 was expected to increase moderately in 1996. In particular, the consumption of cemented carbide tool bit inserts was expected to continue to increase 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 was 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 less certain by the end of 1995 as observers indicated that clearing of inventories by traders had taken place.

China remained the principal supplier of tungsten products to the world market during 1995, and many observers believed that stocks of Chinese concentrate have nearly been depleted. A number of Chinese mines were reported as almost exhausted,low in grade, and high in cost to operate. As a result, 12 of these mines have recently closed, and another 10 mines were 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. However, 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, by yearend 1995 claims were made that no further releases of materials from stockpiles would be made from either Russia or China. If this claim holds true and demand remains strong, industry analysts believe supply and demand would be more balanced, but the future is very much dependent upon the Chinese.

Specifically, the future supply of APT from China, the predominant world provider, remained questionable in view of the continued low mine production that was limiting the quantity of concentrate production. In addition, China was believed to have exhausted its supply of concentrate stocks. Consequently, a more balanced tungsten supply-demand condition emerged by the end of 1995. In the short term, the tungsten market was expected 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.

---

[1]Garner, H. and G. DelCorso. Powder Metallurgy Tool Steels. Advanced Materials & Processes. V. 149, No. 4, Apr. 1996, p. 25-26.

[2]Materials Alert. Advanced Materials & Processing. V. 149, No. 3, Mar. 1996, p. 15.

[3]Gray, G. T. Evaluation of Crack Initiation and Propagation Energies of Tungsten Alloys. Los Alamos National Laboratory, USA, Jan. 1995.

[4]Hard Amorphous Coating Applied at Room Temperature. Advanced Materials & Processing. V. 148, No. 2, Aug. 1996, p. 13.

[5]Paschen, P. Alternatives to Thorium Additions to Tungsten-Based Materials. J. Met. V. 48, No. 1, Jan. 1996, pp. 45-46.

[6]Bamberger, C. Low-Cost WC Needles Made From Sodium Tungsten Bronze. Advanced Materials & Processing. V. 148, No. 2, Aug. 1996, p. 9.

OTHER SOURCES OF INFORMATION

U.S. Geological Survey Publications

Tungsten. Reported monthly in Mineral Industry Surveys.

Tungsten Chapter in Mineral Commodity Summaries.

Hobbs, S. W., and Elliott, J. E. Tungsten, in Brobst, D. A., and Pratt, W. P., United States Mineral Resources: U.S. Geological Survey Professional Paper 820, 1973, pp. 667-678.

Other Sources

American Metal Market (daily paper).

Federal Register.

ITIA Newsletters.

Metal Bulletin (London).

Platt's Metals Week.

Private correspondence.

TABLE 1
SALIENT TUNGSTEN STATISTICS 1/

(Metric tons of tungsten content unless otherwise specified)

		1991	1992	1993	1994	1995
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		5,310 2/	4,310	2,870 3/	3,630 3/	6,320
Shipments from Government stocks		--	--	--	--	--
Exports		21	38	63	44	10
Imports for consumption		7,840	2,480	1,720	2,960	4,180
Stocks, Dec. 31:						
Producer		26	44	44	44	44
Consumer		1,780	702	592	756	631
Ammonium paratungstate:						
Production		5,860 2/	5,760	4,730 2/	536 4/	2,580 5/
Consumption		8,900 6/	7,010	6,970	7,080	7,690
Stocks, Dec. 31: Producer and consumer		578	333	420	82	338
Primary products:						
Net production		8,980	8,450	9,410	7,410	8,190
Consumption		7,980	6,910	7,580	8,110	11,900
Stocks, Dec. 31:						
Producer		1,670 7/	1,510 7/	1,480 7/	1,160 7/	1,290
Consumer		796	601	716	849	547
World:						
Concentrate:						
Production		48,200	43,900 r/	35,100 r/	35,400 r/	30,600 e/
Consumption 8/		41,600 r/	36,500 r/	31,900 r/	31,600 r/	31,000 e/

e/ Estimated. r/ Revised. W Withheld to avoid disclosing company proprietary data.
1/ Data are rounded to three significant digits.
2/ Excludes 2 months of "Withheld" data.
3/ Excludes 3 months of "Withheld" data.
4/ Excludes 11 months of "Withheld" data.
5/ Excludes 7 months of "Withheld" data.
6/ Excludes 1 month of "Withheld" data.
7/ Excludes tungsten carbide-cast and crystalline.
8/ Based on data received from United Nations Conference on Trade and Development, Jan. 1996.

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 1995	2,910	5,280	W	W	8,190
Net production 1994	3,190	4,220	W	W	7,410
Producer stocks, Dec. 31, 1995	818	348	W	126	1,290
Producer stocks, Dec. 31, 1994	648	390	W	120	1,160

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.

TABLE 3
REPORTED CONSUMPTION AND STOCKS OF TUNGSTEN PRODUCTS
IN THE UNITED STATES IN 1995, BY END USE 1/

(Metric tons of tungsten content)

End use	Ferro-tungsten 2/	Tungsten metal powder	Tungsten carbide powder	Tungsten scrap 3/	Other tungsten materials 4/	Total
Steel:						
Stainless and heat-resisting	W	--	--	W	--	W
Alloy	18	--	--	--	--	18
Tool	265	--	--	--	--	265
Superalloys	W	W	24	166	25	215
Alloys (excludes steels and superalloys):						
Cutting and wear-resistant materials	--	80	6,510	W	W	6,590
Other alloys 5/	W	1	--	W	--	1
Mill products made from metal powder	--	1,170	29	--	W	1,200
Chemical and ceramic uses	--	W	(6/)	--	W	W
Miscellaneous and unspecified	51	68	3,300	82	100	3,600
Total	334	1,320	9,860 7/	248	125	11,900
Consumer stocks, Dec. 31, 1995	57	40	380 7/	59	11	547

W Withheld to avoid disclosing company proprietary data; included in "Miscellaneous and unspecified."
1/ Data are rounded to three significant digits; may not add to totals shown.
2/ Includes scheelite, natural and synthetic.
3/ Does not include that used in making primary tungsten products.
4/ Includes tungsten chemicals and others.
5/ Includes welding and hard-facing rods and materials and nonferrous alloys.
6/ Included in "Tungsten carbide powder: Cutting and wear-resistant materials."
7/ Based on reported consumption plus information from secondary sources on companies not canvassed; includes estimates.

TABLE 4
MONTHLY PRICE QUOTATIONS OF TUNGSTEN CONCENTRATE IN 1995

	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
Month	Low	High	Average	Average	Low	High	Average	Average
January	47.00	65.00	56.00	50.80	40.00	48.00	44.00	48.50
February	50.00	70.00	60.00	54.45	40.00	48.00	44.00	48.50
March	58.00	70.00	64.00	58.06	40.00	48.00	44.00	48.50
April	58.00	70.00	64.00	58.06	40.00	48.00	44.00	48.50
May	58.00	72.00	65.00	58.97	40.00	70.00	55.00	60.63
June	60.00	72.00	66.00	59.87	60.00	70.00	65.00	71.65
July	62.00	72.00	67.00	60.78	60.00	70.00	65.00	71.65
August	62.00	70.00	66.00	59.87	55.00	70.00	62.50	68.89
September	62.00	70.00	66.00	59.87	55.00	65.00	60.00	66.14
October	62.00	70.00	66.00	59.87	55.00	65.00	60.00	66.14
November	62.00	70.00	66.00	59.87	55.00	65.00	60.00	66.14
December	55.00	70.00	62.50	56.70	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 $63.80 for 1995. The average equivalent price per short ton unit of WO3 was $57.88 for 1995.
2/ Low and high prices are reported weekly. Monthly averages are arithmetic averages of weekly low and high prices. The average equivalent price per metric ton unit of WO3 was $61.14 for 1995.

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

Country	1994		1995	
	Tungsten content 1/ (metric tons)	Value (thou-sands)	Tungsten content 2/ (metric tons)	Value (thou-sands)
Germany	--	--	10	$230
Japan	41	$195	--	--
Mexico	3	14	(3/)	8
Singapore	--	--	--	--
United Kingdom	--	--	(3/)	4
Total	44	209	10	242

1/ Calculated based upon an estimated value of $38 per metric ton unit WO3.
2/ Calculated based upon an estimated value of $58 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	1994		1995	
	Tungsten content (metric tons)	Value (thou-sands)	Tungsten content (metric tons)	Value (thou-sands)
Belgium	54	$1,110	52	$659
Germany	91	303	--	--
Japan	35	175	129	1,710
Korea, Republic of	--	--	7	58
Netherlands	70	614	50	331
Total	250	2,200	238	2,760

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

Source: Bureau of the Census.

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

Country	1994		1995	
	Tungsten content (metric tons)	Value (thou-sands)	Tungsten content (metric tons)	Value (thou-sands)
Argentina	(2/)	$22	(2/)	$20
Australia	7	229	12	616
Austria	55	920	99	1,590
Belgium	3	132	4	209
Brazil	16	197	12	271
Canada	411	9,550	387	9,990
Chile	(2/)	22	(2/)	3
China	6	38	--	--
Denmark	65	442	53	716
Finland	2	48	(2/)	5
France	92	1,250	53	1,370
Germany	135	2,570	288	5,330
India	(2/)	13	1	90
Ireland	--	--	14	153
Israel	10	673	11	734
Italy	89	2,930	128	4,230
Japan	42	973	52	1,280
Korea, Republic of	2	235	4	432
Luxembourg	3	102	5	136
Mexico	1	112	2	76
Netherlands	99	1,340	97	1,500
Portugal	5	44	4	182
Singapore	3	185	2	138
South Africa	13	212	63	931
Spain	1	16	--	--
Sweden	106	2,120	84	1,880
Switzerland	22	853	7	608
Taiwan	18	496	25	883
Thailand	--	--	11	89
United Kingdom	108	1,690	237	3,100
Venezuela	4	131	5	199
Other	1	95	3	224
Total	1,320	27,600	1,660	37,000

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	1994 Gross weight (metric tons)	1994 Tungsten content 2/ (metric tons)	1994 Value (thou-sands)	1995 Gross weight (metric tons)	1995 Tungsten content 2/ (metric tons)	1995 Value (thou-sands)
Australia	4	3	$66	4	3	$70
Austria	1	1	29	7	5	136
Belgium	3	2	93	2	1	80
Brazil	7	6	222	11	9	334
Canada	43	34	930	49	39	1,210
Finland	2	2	54	5	4	47
France	11	9	344	18	14	421
Germany	207	166	5,910	245	196	6,070
Hong Kong	1	1	30	--	--	--
Israel	152	122	1,380	17	13	113
Italy	3	2	111	44	36	219
Japan	4	3	122	19	15	96
Korea, Republic of	1	1	64	4	3	113
Mexico	18	14	216	9	7	255
Netherlands	2	2	38	42	33	524
Singapore	53	42	806	46	37	821
South Africa	2	2	56	1	1	22
Spain	--	--	--	18	14	52
Sweden	21	17	314	2	1	10
Switzerland	17	14	271	5	4	316
Taiwan	15	12	389	18	14	442
Turkey	(3/)	(3/)	4	--	--	--
United Kingdom	25	20	1,010	40	32	389
Other	2	2	87	3	5	41
Total	595	477	12,500	609	486	11,800

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 1/

Product and country	1994 Tungsten content (metric tons)	1994 Value (thousands)	1995 Tungsten content (metric tons)	1995 Value (thousands)
Tungsten and tungsten alloy wire:				
Argentina	--	--	1	$23
Belgium	1	$59	2	195
Brazil	(2/)	60	2	202
Canada	4	201	4	228
China	4	518	--	--
France	(2/)	54	1	120
Germany	(2/)	70	(2/)	68
Hong Kong	2	158	7	235
India	10	626	9	557
Italy	(2/)	26	1	86
Japan	3	421	6	903
Korea, Republic of	1	67	2	140
Malaysia	--	--	2	399
Mexico	4	330	18	1,340
Netherlands	(2/)	28	1	62
Poland	(2/)	3	--	--
Switzerland	(2/)	3	(2/)	13
Taiwan	5	395	2	233
United Kingdom	2	197	(2/)	167
Other	4	316	7	502
Total	40	3,530	64	5,480
Unwrought tungsten and alloy in crude form, waste and scrap:				
Australia	106	527	101	378
Canada	70	546	53	308
Chile	1	6	--	--
France	2	11	2	16
Germany	256	1,170	510	2,320
Israel	1	10	6	31
Italy	23	182	40	161
Japan	7	37	76	303
Mexico	63	354	15	97
Spain	15	83	34	135
Sweden	12	100	--	--
Taiwan	3	42	--	--
United Kingdom	25	154	55	289
Other	49	252	108	388
Total	633	3,470	996	4,420
Other tungsten metal:				
Australia	1	61	1	63
Belgium	(2/)	68	(2/)	5
Brazil	2	238	3	294
Canada	4	256	6	326
Colombia	(2/)	31	(2/)	21
France	2	330	1	114
Germany	2	213	3	1,260
Hong Kong	4	783	4	416
India	2	92	4	226
Ireland	(2/)	103	7	780
Italy	1	645	1	85
Japan	8	1,360	3	858
Korea, Republic of	3	258	3	237
Mexico	4	455	12	665
Netherlands	(2/)	192	1	366
Singapore	2	601	3	714
South Africa	1	102	1	62
Sweden	(2/)	39	(2/)	47
Switzerland	(2/)	98	1	184
Taiwan	3	236	10	847
Thailand	(2/)	31	1	69
United Kingdom	14	859	12	861
Venezuela	(2/)	61	(2/)	47
Other	4	833	7	1,240
Total	55	7,950	81	9,780

See footnotes at end of table.

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

Product and country	1994 Tungsten content (metric tons)	1994 Value (thousands)	1995 Tungsten content (metric tons)	1995 Value (thousands)
Ferrotungsten and ferrosilicon tungsten:				
Canada	1	$13	--	--
Germany	31	50	--	--
Korea, Republic of	--	--	(2/)	$7
Mexico	7	8	52	62
Netherlands	--	--	1	3
Total	39	71	53	72
Wrought tungsten:				
Canada	58	1,820	33	1,130
France	9	693	4	545
Germany	24	680	96	2,650
India	11	569	10	595
Israel	1	124	4	263
Italy	8	566	4	370
Japan	8	977	10	1,420
Korea, Republic of	18	881	9	453
Mexico	4	181	(2/)	24
Netherlands	(2/)	136	(2/)	40
Singapore	1	50	1	71
Spain	7	319	9	447
Taiwan	3	382	9	725
United Kingdom	3	328	8	508
Other	6	531	9	861
Total	161	8,230	204	10,100
Other tungsten compounds: 3/				
Argentina	(2/)	7	--	--
Brazil	37	292	5	81
Canada	3	9	2	7
Colombia	1	8	--	--
Japan	17	56	--	--
Netherlands	49	236	10	15
Sweden	36	100	--	--
United Kingdom	6	54	1	24
Other	1	43	5	367
Total	150	804	23	494

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	1994 Tungsten content (metric tons)	1994 Value (thousands)	1995 Tungsten content (metric tons)	1995 Value (thousands)
Australia	74	$507	191	$1,250
Bolivia	542	2,090	355	2,280
Brazil	76	342	11	77
Burma	11	64	39	280
Chile	27	107	--	--
China	--	--	1	15
Kazakstan	--	--	53	272
Korea, Republic of	14	68	--	--
Mexico	58	269	28	161
Mongolia	--	--	35	166
Netherlands	--	--	126	934
Peru	306	1,280	478	3,290
Portugal	--	--	152	990
Russia	1,660	3,600	2,530	11,300
Thailand	126	587	98	512
Uganda	57	130	85	522
Vietnam	11	63	--	--
Total	2,960	9,110	4,180	22,100

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	1994		1995	
	Tungsten content (metric tons)	Value (thou-sands)	Tungsten content (metric tons)	Value (thou-sands)
Austria	--	--	16	$140
China	625	$3,240	987	8,550
Germany	160	1,590	85	1,250
Hong Kong	45	249	113	797
Russia	18	140	42	347
Sweden	--	--	50	103
Switzerland	--	--	(2/)	1
Total	848	5,220	1,290	11,200

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	1994		1995	
	Tungsten content (metric tons)	Value (thou-sands)	Tungsten content (metric tons)	Value (thou-sands)
Austria	--	--	27	$130
China	484	$1,720	362	2,160
Germany	--	--	43	213
Latvia	--	--	88	305
Mexico	31	161	21	123
Russia	--	--	82	379
United Kingdom	--	--	29	160
Total	515	1,880	652	3,470

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

Source: Bureau of the Census.

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

Product and country	1994 Tungsten content (metric tons)	1994 Value (thousands)	1995 Tungsten content (metric tons)	1995 Value (thousands)
Waste and scrap:				
Australia	--	--	7	$31
Austria	--	--	41	283
Belgium	115	$511	21	107
Brazil	18	75	--	--
Canada	20	80	35	214
China	159	1,000	16	101
France	102	367	63	431
Germany	531	2,580	635	3,890
Ireland	32	168	20	133
Israel	80	211	101	516
Italy	129	401	43	242
Japan	401	1,600	408	2,480
Korea, Republic of	20	47	--	--
Mexico	5	22	15	110
Netherlands	31	220	22	158
Pakistan	18	34	25	78
Portugal	6	28	--	--
Russia	132	858	23	86
Singapore	36	142	25	133
South Africa	76	334	75	432
United Kingdom	561	1,910	492	1,780
Other	127	474	40	316
Total	2,600	11,100	2,110	11,500
Unwrought tungsten, except alloys, in lumps, grains, and powders:				
Belgium	3	110	4	175
Canada	11	389	17	437
China	61	691	196	2,520
Germany	24	871	28	1,200
Japan	12	1,280	36	1,690
Russia	--	--	11	227
South Africa	27	108	8	33
Uganda	13	20	--	--
United Kingdom	34	207	(2/)	5
Other	14	142	11	181
Total	199	3,820	311	6,460
Unwrought tungsten, ingots, shot, alloy, and other:				
Austria	2	164	3	118
South Africa	10	15	--	--
Other	(2/)	12	(2/)	11
Total	12	190	3	129
Wrought tungsten-wire, plate, sheet, strip, foil, and other: 3/				
Austria	(2/)	52	48	3,650
Belgium	1	156	1	100
Canada	5	379	1	68
China	6	369	48	1,660
France	(2/)	106	1	166
Germany	4	680	10	1,560
Israel	14	671	12	538
Japan	54	7,370	40	7,170
Mexico	(2/)	236	7	751
Netherlands	(2/)	375	2	386
Russia	(2/)	4	1	32
United Kingdom	5	466	6	664
Other	14	1,210	21	2,220
Total	104	12,100	199	19,000

See footnotes at end of table.

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

Product and country	1994 Tungsten content (metric tons)	1994 Value (thou-sands)	1995 Tungsten content (metric tons)	1995 Value (thou-sands)
Calcium tungstate:				
Australia	--	--	24	$135
Bolivia	10	$45	10	43
China	254	927	52	314
Germany	2	106	--	--
Japan	(2/)	28	1	40
Total	267	1,110	86	532
Tungsten oxides:				
Austria	59	338	19	170
China	890	4,470	1,240	12,300
Germany	2	43	3	69
Hong Kong	52	368	36	272
Russia	929	5,140	822	6,660
Switzerland	43	164	--	--
United Kingdom	5	34	1	27
Other	1	6	1	20
Total	1,980	10,600	2,120	19,600
Other metal-bearing materials in chief value of tungsten:				
China	--	--	2	32
Germany	(2/)	5	1	55
Italy	--	--	7	168
Mexico	--	--	(2/)	13
Total	(2/)	5	10	268
Chlorides of tungsten:				
Russia	--	--	(2/)	2
Sodium tungstate:				
Australia	--	--	18	108
Bolivia	3	12	28	145
China	991	4,330	761	5,260
Germany	(2/)	39	10	266
Hong Kong	--	--	26	133
Japan	(2/)	14	(2/)	17
Zambia	--	--	17	118
Total	994	4,390	858	6,040
Tungsten carbide:				
Austria	(2/)	12	(2/)	31
Canada	10	369	52	1,670
China	30	919	149	3,090
France	24	349	(2/)	2
Germany	159	2,790	165	4,550
Hong Kong	5	73	--	--
Israel	8	107	13	188
Japan	2	91	13	129
Korea, Republic of	17	252	3	72
United Kingdom	(2/)	2	79	541
Other	4	119	2	47
Total	258	5,080	476	10,300

1/ Data are rounded to three significant digits; may not add to totals shown.
2/ Less than 1/2 unit.
3/ Quantity estimated from reported gross weight.

Source: Bureau of the Census.

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

(Metric tons of tungsten content)

Country	1991	1992	1993	1994	1995 e/
Argentina	5	--	--	--	--
Australia	237	159	23	11 e/	10
Austria	1,314	1,489	104	--	190
Bolivia	1,070	851	287 r/	462 r/ e/	780
Brazil	223	205	245	155 r/ e/	115
Burma 3/	356	531	524	548 r/ e/	531 4/
China e/ 5/	31,800	25,000	21,600	27,000 r/	21,000
Czechoslovakia e/ 6/	13	XX	XX	XX	XX
India	11	2 r/	1	2 r/ e/	2
Japan	279	347	66	--	--
Kazakstan e/	XX	200	150	100	100
Korea, North e/	1,000	1,000	1,000	900	900
Korea, Republic of	780	247	200	--	--
Malaysia	2	3 e/	2	--	--
Mexico	194	162	160 e/	150 e/	145
Mongolia e/	300	260	250	150 r/	200
Peru	1,232	802	398	256 r/	260
Portugal e/	971	1,870	1,280	1,000	500
Russia e/	XX	10,000 r/	8,000 r/	4,000	5,400
Rwanda e/	175	175	175	30	--
Tajikistan e/	XX	200	150	100	75
Thailand	230	70	80 r/	156 r/	64
Uganda e/	4	66 4/	60	60	60
U.S.S.R. e/ 7/	8,000	XX	XX	XX	XX
United Kingdom	9	--	--	--	--
United States	W	W	W	W	W
Uzbekistan e/	XX	300	300	300	300
Zaire e/	15	--	--	--	--
Zimbabwe e/	1	--	--	--	--
Total	48,200	43,900 r/	35,100 r/	35,400 r/	30,600

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

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

2/ Table includes data through July 5, 1996.

3/ Includes content of tin-tungsten concentrate.

4/ Reported figure.

5/ Based upon data published in the Yearbook of Nonferrous Industry of China, 1992, 1993, and 1994.

6/ Dissolved in Dec. 31, 1992.

7/ Dissolved in Dec. 1991.