

# TUNGSTEN

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Tungsten has a wide range of industrial uses, the largest of which 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 heavy metal alloys for armaments, heat sinks, and high-density applications, such as weights and counterweights; superalloys for turbine blades; tool steels; and wear-resistant alloy parts and coatings. Chemical uses of tungsten include catalysts, inorganic pigments, and high-temperature lubricants.

U.S. tungsten mines remained closed in 1999. China continued to be the largest supplier of tungsten imports to the United States. Russia was also a significant supplier. In 1999, 66% of all tungsten imports to the United States was from these two countries.

In June, the Defense National Stockpile Center (DNSC), U.S. Department of Defense (DOD), began selling tungsten materials from the National Defense Stockpile (NDS). The last releases of tungsten from the NDS were during the ferroalloy upgrading program, which was completed in 1989. Tungsten ores and concentrates were released as payment during and in support of that program.

The important U.S. and world tungsten statistics for 1999 and the previous 4 years are listed in table 1. Most data in this report have been rounded to three significant digits. Totals and percentages were calculated from unrounded numbers. Unless otherwise specified, all statistics in this report are in metric tons of contained tungsten.

Tungsten prices and many tungsten statistics from other sources are quoted in units of tungsten trioxide ( $\text{WO}_3$ ). The short ton unit, which is used in the United States, is 1% of a short ton (20 pounds), and  $\text{WO}_3$  is 79.3% tungsten. A short ton unit of  $\text{WO}_3$ , therefore, equals 20 pounds of  $\text{WO}_3$  and contains 7.19 kilograms (kg) (15.86 pounds) of tungsten. The metric ton unit, which is used in most other countries, is 1% of a metric ton (10 kg). A metric ton unit of  $\text{WO}_3$ , therefore, equals 10 kg of  $\text{WO}_3$  and contains 7.93 kg (17.48 pounds) of tungsten.

## Legislation and Government Programs

In August, the International Trade Administration, U.S. Department of Commerce, and the U.S. International Trade Commission announced that they were each conducting a review of the antidumping duty order on U.S. imports of tungsten ore concentrates from China. The reviews were intended to determine whether revoking the antidumping duty

would be likely to lead to a continuation or recurrence of dumping or material injury to the domestic industry. As a result of the reviews, the 151% duty on imports of tungsten ore concentrates from China was revoked effective January 1, 2000 (International Trade Administration, 1999a, b; U.S. International Trade Commission, 1999a, b).

In late June, the DNSC began selling tungsten materials. Five negotiated sales were held during calendar year 1999—three for tungsten ores and concentrates and two for ferrotungsten, tungsten carbide powder, and tungsten metal powder. As shown in table 2, 1,890 metric tons (t) of tungsten contained in ores and concentrates, ferrotungsten, tungsten metal powder, and tungsten carbide powder was sold during the calendar year. During fiscal year 1999 (October 1, 1998, through September 30, 1999), 1,590 t of contained tungsten was sold; this represented 79% of the maximum amount available for sale in the Annual Materials Plan (AMP). Of the tungsten sold, however, 98% had not been shipped by the end of the fiscal year (U.S. Department of Defense, 2000, p. 16, 44). The AMP for fiscal year 2000 (October 1, 1999, through September 30, 2000) set the maximum quantities of tungsten materials that could be sold, in metric tons of contained tungsten, as follows: tungsten ores and concentrates, 1,810; tungsten carbide powder, 454; ferrotungsten, 136; and tungsten metal powder, 68 (Defense National Stockpile Center, 2000). The quantities of tungsten materials remaining in the stockpile at yearend, including those committed for sale and pending shipment, are listed in tables 1 and 2.

The U.S. Fish and Wildlife Service (FWS) granted final approval of two tungsten-based shot products for hunting waterfowl and coots—tungsten-iron shot and tungsten-polymer shot. In addition, the FWS granted temporary approval of tungsten-matrix shot for hunting waterfowl and coots during the 1999-2000 hunting season (U.S. Fish and Wildlife Service, 1999).

As part of a DOD initiative to eliminate the use of hazardous materials in the production of small caliber ammunition, the U.S. Army Armament Research, Development and Engineering Center at Picatinny Arsenal, NJ, established a joint working group comprised of various DOD entities and three U.S. Department of Energy laboratories in 1995. One component of the “Green Bullet” program was to find an alternative for the lead-antimony cores in small-caliber ammunition projectiles. Seven composite materials, each of which contained tungsten as the high-density component, were evaluated for ease of production and ballistics performance. Tungsten-nylon and tungsten-tin composites were identified as potential substitutes for lead-antimony in the cores of 5.56-millimeter (mm)

projectiles. Continued efforts during 1999 included finalizing the 5.56-mm projectile configuration and qualifying the new bullet as an alternate for the M855 service round (U.S. Army Armament Research, Development and Engineering Center, March 31, 1999, Green ammunition projects—Projectile core replacement, accessed March 30, 2000, at URL <http://www.pica.army.mil/greenammo/projects.htm>; U.S. Army Environmental Center, January 14, 2000, Green small caliber ammunition, accessed April 12, 2000, at URL <http://aec.army.mil/prod/usaec/et/xxi/nontox.htm>). Samples of the lead-free ammunition were tested by the Alaska Army National Guard and the Massachusetts National Guard. In December, the first production lot of tungsten-based bullets was manufactured at the Lake City Army Ammunition Plant near Independence, MO (U.S. Army Materiel Command, December 1999, Green bullet first production lot manufactured, AMC Technology Snapshots, accessed April 12, 2000, via URL <http://www.pica.army.mil/greenammo/press/pressindex.htm>; Bill Vagt, Alaska Army National Guard, January 14, 2000, Guard unit tests “green” ammo—Alaska soldiers fire lead-free service rounds on range, Environmental Update, v. 11, no. 1, accessed April 12, 2000, at URL <http://aec.army.mil/prod/usaec/op/update/win99/w9901.htm>).

## Production

Domestic production statistics for tungsten are based on data collected by the U.S. Geological Survey (USGS) by means of two separate voluntary surveys. Statistics that result from these surveys are listed in tables 1 and 3.

The annual Tungsten Ore and Concentrate Survey covered the production, purchases, disposition, and stocks of tungsten ores and concentrates. No tungsten was mined in the United States in 1999. The Pine Creek Mine in Bishop, CA, which was owned equally by Avocet Mining PLC (Avocet) and Strategic Minerals Corp., remained under care and maintenance.

The monthly Tungsten Concentrate and Tungsten Products Survey canvassed companies that produced tungsten carbide powder, tungsten chemicals, and/or tungsten metal powder from ammonium paratungstate, tungsten-bearing scrap, and tungsten concentrate. The USGS received responses from 12 of the 13 processing operations on the survey; estimates were made for the nonresponding operation.

Major U.S. processors of tungsten materials in 1999 included Avocet Tungsten Inc., Bishop, CA; Buffalo Tungsten Inc., Depew, NY; General Electric Co., Euclid, OH; Kennametal Inc., Latrobe, PA, and Fallon, NV; OM Group, Inc., Midland, MI, and St. George, UT; Osram Sylvania, Inc., Towanda, PA; and Teledyne Metalworking Products, Huntsville, AL.

In 1999, U.S. processors consumed 18% less tungsten concentrate but significantly more tungsten-bearing scrap than in 1998. Domestic production of ammonium paratungstate was higher than that of 1998 but remained less than that of 1997. Reported consumption of ammonium paratungstate was 26% less in 1999 compared with that of 1998. Total net production of all primary tungsten products (hydrogen-reduced metal powder, tungsten carbide powder, and tungsten chemicals)

decreased by 16% in 1999 compared with that of 1998.

Avocet Tungsten produced ammonium paratungstate and ammonium metatungstate from ore concentrates and tungsten-bearing scrap at its tungsten-processing plant in Bishop. Early in the year, North American Tungsten Corp. Ltd. of Vancouver, British Columbia, sold its interest in the ammonium metatungstate (AMT) equipment at the Bishop plant. The equipment had been leased to Avocet in return for a 50% interest in the operating profits from the AMT (North American Tungsten Corp. Ltd., 1998, 1999). The narrowing differential in prices for the Bishop plant’s products, particularly ammonium paratungstate, in relation to the price of its feedstocks caused Avocet to question the continued economic viability of the plant. The company reduced the number of employees working at the plant, decreased production levels, and drew down feedstock inventories. In spite of a reduction in operating losses, Avocet was considering various options for the future of the plant; these options included forming a strategic partnership, selling the plant, or closing it. No decision on the plant’s future had been made by yearend (Avocet Mining PLC, September 29, 1999, Chairman’s statement—Tungsten, Annual Report and Accounts 1999, accessed June 26, 2000, at URL <http://www.avocet.co.uk/accounts/1999AR/chairman.htm>).

Startup of Nanodyne Inc.’s nanocrystalline powder plant in Laurinburg, NC, was delayed by technical problems. The plant will have the capacity to produce 500 metric tons per year (t/yr) of composite metal powders by using the company’s proprietary spray-conversion process. In addition to tungsten carbide-cobalt powders, Nanodyne was also developing tungsten-silver and tungsten-copper powders to be used as electrical contacts by the semiconductor industry. Nanodyne was a wholly owned subsidiary of N.V. Union Minière S.A. of Brussels, Belgium. The Nanodyne plant is adjacent to Union Minière’s Carolmet Cobalt Products plant, which produced cobalt metal powder and salts (American Metal Market, 1998; N.V. Union Minière S.A., 2000, p. 26).

## Consumption

Statistics on consumption of tungsten in end-use categories by U.S. metal consumers were developed from the voluntary Consolidated Consumers Survey. For this survey, nearly 75 tungsten consumers were canvassed on a monthly or annual basis. Reported consumption and stocks data in tables 1 and 4 include estimates to account for nonrespondents. Total U.S. reported consumption of tungsten materials to make alloys, catalysts, cemented carbides, mill products, and pigments decreased by 8% in 1999 compared with that of 1998. In 1999, U.S. industry consumed less ferrotungsten, tungsten carbide powder, tungsten chemicals, and tungsten scrap but more tungsten metal powder than in 1998. Producers of cemented carbides, pigments, steels, superalloys, and other alloys reported decreased tungsten consumption in 1999, and producers of catalysts and mill products for lighting and other industries reported increased tungsten consumption.

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 number of rigs that operated in the United States decreased from 600 in early January to a low of 488 on April 23. This was the lowest U.S. rig count since recording began in 1940. During the remainder of the year, the number of operating rigs increased to a high of 815 in mid-December. During 1999, the average number of operating rigs in the United States was 625, which was 26% lower than the 843 operating rigs in 1998 (Baker Hughes Inc., 2000, North American rig counts, accessed April 3, 2000, at URL [http://www.bakerhughes.com/investor/rig/rig\\_na.htm](http://www.bakerhughes.com/investor/rig/rig_na.htm)).

In 1999, total consumption of tungsten scrap by U.S. processors and consumers was 5,250 t of contained tungsten, which was a 57% increase from the 3,350 t consumed in 1998.

## Prices

Prices of tungsten materials, as published in Metal Bulletin and Platt's Metals Week, remained at relatively low levels in 1999, in spite of increases during the second half of the year. Monthly and annual average prices of tungsten concentrates are listed in table 5. The average of tungsten concentrate prices reported by Metal Bulletin in 1999 was \$40 per metric ton unit, which was 9% lower than that of 1998. The average of U.S. spot tungsten ore concentrate prices reported by Platt's Metals Week in 1999 was \$47 per metric ton unit (\$43 per short ton unit), which was 10% lower than that of 1998.

Ammonium paratungstate prices were also lower than those of 1998. The average of high and low prices of ammonium paratungstate in the U.S. market reported by Platt's Metals Week remained stable at \$57 per metric ton unit (\$52 per short ton unit) throughout the year. The average of high and low prices of ammonium paratungstate in the U.S. market reported by Metal Bulletin was stable at \$55 per metric ton unit (\$50 per short ton unit) from January until mid-May, when it decreased to \$53 per metric ton unit (\$48 per short ton unit). Between late May and mid-October, the average price increased, and then remained at \$60 per metric ton unit (\$55 per short ton unit) until yearend. Ammonium paratungstate prices quoted by Platt's Metals Week and Metal Bulletin for the European and the Hong Kong markets followed similar trends.

The increase in tungsten prices during the second half of 1999 was attributed to efforts by China, the world's largest tungsten supplier, to reform its industry and to ensure a fair return to its domestic producers of concentrates and intermediate products (Maby, 1999, p. 8-9; Ross, 1999, p. 4). These efforts are discussed in more detail in the China section of this report.

In 1996, mine executives at the Seventh International Tungsten Symposium had 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 economical to bring back the more-than 10,000 t/yr of capacity lost during the previous 15 years (American Metal Market, 1996).

## Foreign Trade

The United States exported 21% less tungsten in 1999 than in 1998. As shown in tables 6 through 10, exports of all tungsten materials except ores and concentrates, waste and scrap, and wrought tungsten were lower in 1999 compared with those of 1998.

In 1999, total U.S. imports of tungsten materials were 16% lower compared with those of 1998. China, which continued to be the largest supplier of tungsten to the United States, provided 45% of all tungsten imports in 1999. Imports from China decreased by 7% to 5,000 t of contained tungsten compared with 5,360 t imported in 1998. Of the imports from China, 35% was ammonium paratungstate; 30%, tungsten oxides; 15%, other tungstates; 10%, ferrotungsten; 3%, tungsten metal powders; 3%, tungsten waste and scrap; 2%, tungsten carbide powder; and the remainder, wrought tungsten.

Russia, which was the next largest supplier of tungsten materials to the United States, provided 21% of U.S. imports. In 1999, Russian imports were mainly tungsten ores and concentrates (52%), tungsten oxide (24%), tungsten waste and scrap (15%), and ferrotungsten (7%). Total imports from Russia decreased by 18% to 2,300 t of contained tungsten in 1999 compared with 2,790 t in 1998.

As shown in table 11, U.S. imports of tungsten ores and concentrates decreased by 39% in 1999 compared with those of 1998. In 1999, 83% of these imports were from Russia (42%), Kazakhstan (16%), Bolivia (13%), and Portugal (12%).

The United States imported approximately the same amount of ammonium paratungstate during the past 2 years (table 12). China continued to be the leading supplier of imported ammonium paratungstate to the United States, although imports of Chinese ammonium paratungstate to the United States decreased by 7% in 1999 compared with those of 1998. Imports of ammonium paratungstate from Germany, the Netherlands, and Sweden increased significantly in 1999 compared with those of 1998.

In 1999, imports of tungsten carbide powder, tungsten metal powders, and unwrought tungsten decreased compared with those of 1998, but imports of ferrotungsten, other tungstates, other tungsten compounds, and wrought tungsten increased. Imports of tungsten oxides and tungsten waste and scrap were at similar levels during the past 2 years (tables 13, 14).

## World Review

In 1999, low tungsten prices resulted in a continued decrease in production of tungsten concentrates (table 15). Tungsten materials from stockpiles in Russia and other countries in the Commonwealth of Independent States (CIS) have been a significant component of world supply in recent years. Between 1992, when exports of tungsten from CIS countries first entered western markets, and mid-1999, an estimated 37,000 t of tungsten was exported. Information on the amount of tungsten that remained in CIS stockpiles and whether these

materials would be released for export continued to be unavailable, however (Maby, 1999, p. 2).

**Austria.**—Wolfram Bergbau und Hutten GmbH Nfg KG produced tungsten concentrates from the Mittersill scheelite mine in the Province of Salzburg. All these concentrates were converted to primary tungsten products at Wolfram Bergbau's Bergla tungsten processing plant in the Province of Steiermark.

**China.**—As part of the reformation and reorganization of China's nonferrous metals industry, the Chinese State Council approved the establishment of three corporations to operate as holding companies under supervision of the central government. All the mines, plants, and research institutes formerly under China National Nonferrous Metals Corp. were reorganized under China Aluminum Corp., China Copper Lead Zinc Corp., and China Rare Metals and Rare Earth Group Corp. China Rare Metals and Rare Earth Group Corp., which included tungsten mines and plants, was to be subdivided into several smaller groups. One of these subgroups, China Tungsten & Cemented Carbide Industry Corp., which consisted of Zhuzhou Cemented Carbide Works, Zigong Cemented Carbide Co., and Jinhai Industry Co., was established in February. Another subgroup, China Tungsten Mining & Smelting Group, was to include 10 State-owned tungsten mines in 3 provinces when established (Zhaoqing and Pugang, 1999).

In 1999, the Chinese Government took several steps to control the release of tungsten to the world market to increase prices to a level which would enable China's large State-owned producers to increase revenues without altering China's dominant position in the market. Early in the year, the Ministry of Land and Natural Resources ordered a halt to the operation of illegal mines and mines that were causing environmental damage or resource destruction and announced that it would not issue mining permits for new tungsten projects between April 23, 1999, and December 31, 2000. In June, following a meeting of Chinese Government agencies and several tungsten producers, the Government reduced the number of export licences for tungsten materials (American Metal Market, 1999; Kerr, 1999, p. 1-3; Metal Bulletin, 1999b).

In an effort to bring the prices of tungsten materials closer to the costs of production, the China Tungsten Industry Association set minimum prices for ammonium paratungstate, tungsten concentrates, and tungsten oxide in July. The prices were to be raised incrementally during a 3-year period (Metal Bulletin, 1999a).

**Portugal.**—During the fiscal year ending March 1999, Beralt Tin & Wolfram S.A., an Avocet subsidiary, reduced production from the Panasqueira Mine to match a decrease in sales. As a result, concentrate production decreased to 93,000 metric ton units (mtu) of  $WO_3$  compared with the 131,700 mtu produced during the previous fiscal year. In April, the Portugese Government agreed to provide financial support in the form of a training subsidy that allowed Beralt to operate the mine 3 days per week without reducing its workforce. To return to full single shift production in January 2000, Beralt established sales contracts with two large tungsten consumers that guaranteed minimum sales volumes and prices (Avocet Mining PLC, September 29, 1999, Review of operations—Tungsten, Annual

Report and Accounts 1999, accessed June 26, 2000, at URL <http://www.avocet.co.uk/accounts/1999AR/operations.htm>).

**Russia.**—In October, the Russian Government recommended that the Government of the Republic of Kabardino-Balkaria consider investment projects at the Tyrnyauz tungsten and molybdenum mine and mill complex and the Gidrometallurg tungsten anhydride plant in Nalchik (Interfax International Ltd., 1999).

**Thailand.**—Scheelite was mined in Chiang Mai Province and wolframite was mined in Kanchaburi Province.

## Outlook

Demand for tungsten tends to follow general economic conditions. Future consumption of tungsten in cemented carbides, which is the largest end-use sector, will depend on the performance of the following industries: automotive and aircraft production, construction, mining, oil and gas drilling, and semiconductor and other manufacturing. An increase in demand could help reduce the oversupply situation for tungsten. Some recent developments in uses for tungsten include the shift from lead to tungsten for military and recreational ammunition and the use of tungsten by the sporting goods industry to make golf clubs and golf ball cores. One analyst estimated that world tungsten demand would increase by 625 t, or approximately 1%, in 2000 for these and other new applications (Ross, 1999, p. 15).

World tungsten supply will continue to be dominated by Chinese production and exports. In 1999, the Chinese Government took several steps to control the release of tungsten to the market, which resulted in an increase in prices of tungsten concentrates and ammonium paratungstate during the second half of the year. Tungsten concentrate and ammonium paratungstate prices, however, leveled off by yearend. During the first half of 2000, prices for ammonium paratungstate decreased, and the price of tungsten concentrate increased slightly. This resulted in a narrowing of the price differential between concentrates and ammonium paratungstate, which would decrease the profitability of converting concentrates to ammonium paratungstate.

In 1999, a "new" source of supply became available to the tungsten market when the U.S. Government began selling tungsten materials from the NDS. Most of the tungsten in the stockpile is in the form of tungsten ores and concentrates. At yearend 1999, the NDS contained 33,300 t of tungsten in uncommitted ores and concentrates, all of which was authorized for eventual disposal. If future sales were to continue at the current AMP level (1,810 t in fiscal year 2000), then tungsten concentrates would be available from the NDS for many years to come. The amount of tungsten materials released from stockpiles has been an ongoing concern for the tungsten producing industry. In the middle to late 1990's, releases of stockpiled tungsten from Kazakhstan and Russia sustained the oversupply situation, kept prices low, and resulted in further hardship for the remaining tungsten mining industry. In recent years, approximately one-quarter of the world's tungsten supply has been from Government stockpile releases (Bunting, 1999). At some point, stockpiles will be depleted,

and world mine production will have to increase to meet demand. World mine capacity in 1998 was estimated to be less than world demand (Bunting, 1999). How quickly mines can be brought back online and whether mine production can meet demand once stockpiles are depleted will determine the future tungsten supply-demand balance.

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## GENERAL SOURCES OF INFORMATION

### U.S. Geological Survey Publications

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<sup>1</sup>Prior to January 1996, published by the U.S. Bureau of Mines.

TABLE 1  
SALIENT TUNGSTEN STATISTICS 1/

(Metric tons tungsten content, unless otherwise specified)

	1995	1996	1997	1998	1999
<b>United States:</b>					
<b>Concentrates:</b>					
Consumption	5,890	5,260	6,590	3,210 2/	2,100 2/
Exports	5 r/	18 r/	12 r/	10 r/	26
Imports for consumption	4,660	4,190	4,850	4,750	2,870
<b>Stocks, December 31:</b>					
Consumer	627	569	658	514	W
U.S. Government 3/	34,600	34,600	34,600	34,600	34,600
<b>Ammonium paratungstate:</b>					
Production	2,580 4/	4,450 5/	5,380 5/	838 6/	7,330
Consumption	7,920	7,790	9,300	10,000 r/	7,490
Stocks, December 31, producer and consumer	727	558	W	603	376
<b>Primary products:</b>					
Net production	8,060	7,810	8,300	9,630	8,500
Consumption 7/	8,800	7,830	8,390	9,100	8,390
<b>Stocks, December 31:</b>					
Producer 8/	1,300	1,400	1,210	1,340	1,070
Consumer 7/	564 r/	413	610	524 r/	565
U.S. Government 3/	2,380	2,700	2,700	2,700	2,700
World, production of concentrate	38,500	34,800 r/	33,200	32,000 r/	31,000

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

1/ Data are rounded to no more than three significant digits.

2/ Excludes 6 months of "Withheld" data.

3/ Defense National Stockpile Center. Includes material committed for sale pending shipment.

4/ Excludes 7 months of "Withheld" data.

5/ Excludes 4 months of "Withheld" data.

6/ Excludes 11 months of "Withheld" data.

7/ Includes scrap.

8/ Excludes cast and crystalline tungsten carbide powder.

TABLE 2  
U.S. GOVERNMENT NATIONAL DEFENSE STOCKPILE TUNGSTEN STATISTICS IN 1999 1/ 2/

(Metric tons tungsten content)

Material	Inventory, yearend 3/		Annual Materials Plan	Sales		Inventory decrease 4/	
	Fiscal year 5/	Calendar year	Fiscal year 5/	Fiscal year 5/	Calendar year	Fiscal year 5/	Calendar year
Ores and concentrates	34,600	34,600	1,360	1,350	1,350	(6/)	(6/)
Ferrotungsten	918	918	136	91	148	--	--
Tungsten metal powder	861	861	68	36	104	(6/)	(6/)
Tungsten carbide powder	922	922	454	111	284	(6/)	(6/)
Total	37,300	37,300	2,020	1,590	1,890	(6/)	(6/)

-- Zero.

1/ Data are rounded to no more than three significant digits; may not add to totals shown.

2/ Includes stockpile- and nonstockpile-grade materials.

3/ Includes material committed for sale pending shipment.

4/ From previous year.

5/ Twelve-month period ending September 30, 1999.

6/ Less than 1/2 unit.

Source: Defense National Stockpile Center.

TABLE 3  
NET PRODUCTION AND STOCKS OF TUNGSTEN PRODUCTS IN THE UNITED STATES 1/ 2/

(Metric tons tungsten content)

	Hydrogen reduced metal powder	Tungsten carbide powder		Chemicals	Total
		Made from metal powder	Cast and crystalline		
Net production:					
1998	4,600	5,040	W	W	9,630
1999	4,540	3,960	W	W	8,500
Producer stocks:					
December 31, 1998	719	576	W	46	1,340
December 31, 1999	626	441	W	W	1,070

W Withheld to avoid disclosing company proprietary data.

1/ Net production equals gross production less quantity used to make other products in table.

2/ Data are rounded to no more than three significant digits; may not add to totals shown.

TABLE 4  
REPORTED CONSUMPTION AND STOCKS OF TUNGSTEN PRODUCTS  
IN THE UNITED STATES 1/ 2/ 3/

(Metric tons tungsten content)

	1998	1999
Consumption by end use:		
Steels	532	486
Superalloys	333	306
Other alloys 4/	219	189
Cemented carbides 5/	6,640	5,910
Mill products made from metal powder	1,270	1,410
Chemical uses	97	93
Total	9,100	8,390
Consumption by form:		
Ferrotungsten	527	484
Tungsten metal powder	1,370	1,500
Tungsten carbide powder	6,560	5,930
Tungsten scrap	516	356
Other tungsten materials 6/	121	125
Total	9,100	8,390
Consumer stocks, December 31:		
Ferrotungsten	26	33
Tungsten metal powder	17	15
Tungsten carbide powder	420 r/	475
Tungsten scrap	38	23
Other tungsten materials 6/	24	19
Total	524 r/	565

r/ Revised.

1/ Data are rounded to no more than 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/ Includes diamond bit matrices, cemented and sintered carbides, and cast carbide dies or parts.

6/ Includes tungsten chemicals.

TABLE 5  
MONTHLY PRICE QUOTATIONS OF TUNGSTEN CONCENTRATES IN 1999

Month	Metal Bulletin (London), European market, 65% WO <sub>3</sub> basis, c.i.f. 1/			Platt's Metals Week, U.S. spot quotations, 65% WO <sub>3</sub> 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	32	44	38	34	40	45	43	47
February	33	44	39	35	40	45	43	47
March	33	44	39	35	40	45	43	47
April	33	44	39	35	40	45	43	47
May	33	44	39	35	40	45	43	47
June	33	44	39	35	40	45	43	47
July	33	44	39	35	40	45	43	47
August	33	48	41	37	40	45	43	47
September	38	48	43	39	40	45	43	47
October	38	48	43	39	40	45	43	47
November	38	48	43	39	40	45	43	47
December	38	48	43	39	40	45	43	47

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<sub>3</sub> of all semiweekly low and high prices was \$40 in 1999. The average equivalent price per short ton unit of WO<sub>3</sub> was \$36 in 1999.

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<sub>3</sub> of all weekly low and high prices was \$43 in 1999. The average equivalent price per metric ton unit of WO<sub>3</sub> was \$47 in 1999.

TABLE 6  
U.S. EXPORTS OF TUNGSTEN ORES AND CONCENTRATES, BY COUNTRY

Country of destination	1998			1999		
	Gross weight (metric tons)	Tungsten content 1/ (metric tons)	Value (thousands)	Gross weight (metric tons)	Tungsten content 1/ (metric tons)	Value (thousands)
Afghanistan	--	--	--	(2/)	(2/)	\$4
Belgium	(2/)	(3/)	\$6	--	--	--
Brazil	(2/)	(3/)	4	1	(2/)	9
Colombia	(2/)	(3/)	5	--	--	--
Ecuador	--	--	--	1	(2/)	11
Germany	2	1 r/	36	2	1	23
Ireland	6	3 r/	89	5	3	83
Italy	2	1 r/	37	--	--	--
Japan	(2/)	(2/)	3	1	(2/)	17
Korea, Republic of	--	--	--	1	1	20
Mexico	(2/)	(2/)	3	(2/)	(2/)	4
Netherlands	--	--	--	27	14	462
Singapore	--	--	--	(2/)	(2/)	6
Thailand	--	--	--	1	1	21
United Kingdom	8	4 r/	117	11	6	166
Total 4/	19	10 r/	300	51	26	826

r/ Revised. -- Zero.

1/ Content estimated from reported gross weight.

2/ Less than 1/2 unit.

3/ Revised to less than 1/2 unit.

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

Source: U.S. Census Bureau.



TABLE 7  
U.S. EXPORTS OF AMMONIUM PARATUNGSTATE, BY COUNTRY 1/

Country of destination	1998		1999	
	Tungsten content (metric tons)	Value (thousands)	Tungsten content (metric tons)	Value (thousands)
Belgium	72	\$744	79	\$673
Denmark	--	--	7	71
France	1	8	--	--
Germany	37	194	9	80
Hungary	1	9	--	--
Japan	--	--	6	56
Korea, Republic of	--	--	(2/)	4
Mexico	--	--	(2/)	23
Spain	--	--	(2/)	4
Sweden	95	708	--	--
United Kingdom	82	535	--	--
Total	287	2,200	103	911

-- Zero.

1/ Data are rounded to no more than three significant digits; may not add to totals shown.

2/ Less than 1/2 unit.

Source: U.S. Census Bureau.

TABLE 8  
U.S. EXPORTS OF TUNGSTEN METAL POWDERS, BY COUNTRY 1/ 2/

Country of destination	1998			1999		
	Gross weight (metric tons)	Tungsten content 3/ (metric tons)	Value (thousands)	Gross weight (metric tons)	Tungsten content 3/ (metric tons)	Value (thousands)
Australia	5	4	\$139	12	9	\$163
Austria	(4/)	(4/)	6	2	2	50
Belgium	12	10	124	45	36	392
Brazil	17	14	415	7	6	212
Canada	59	47	1,930	57	46	1,500
Chile	(4/)	(4/)	12	4	3	161
China	5	4	114	(4/)	(4/)	19
Congo (Kinshasa)	--	--	--	10	8	51
France	15	12	513	31	25	673
Germany	408	326	12,900	236	188	6,570
Hong Kong	3	2	84	19	15	29
India	83	66	1,160	90	72	1,570
Israel	38	30	466	41	33	494
Italy	14	12	700	21	17	813
Japan	75	60	565	48	38	624
Korea, Republic of	5	4	197	8	6	132
Mexico	9	7	224	34	27	338
Netherlands	19	15	421	25	20	733
Panama	11	9	13	2	1	33
Poland	--	--	--	3	2	100
Singapore	4	3	273	6	5	325
South Africa	3	2	111	4	3	61
Spain	1	1	40	1	1	60
Sweden	3	2	50	76	61	395
Switzerland	59	48	2,420	30	24	947
Taiwan	16	13	482	22	17	587
United Kingdom	193	154	2,140	51	41	1,810
Other	7	6 r/	207 r/	5	4	157
Total	1,060	851	25,700	889	711	19,000

r/ Revised. -- Zero.

1/ Data are rounded to no more than three significant digits; may not add to totals shown.

2/ May include tungsten alloy powders.

3/ Content estimated from reported gross weight.

4/ Less than 1/2 unit.

Source: U.S. Census Bureau.

TABLE 9  
U.S. EXPORTS OF TUNGSTEN CARBIDE POWDER, BY COUNTRY 1/

Country of destination	1998		1999	
	Tungsten content (metric tons)	Value (thousands)	Tungsten content (metric tons)	Value (thousands)
Argentina	1	\$46	2	\$12
Australia	7	157	7	182
Austria	22	463	20	362
Belgium	8	291	20	413
Brazil	7	264	6	195
Canada	224	5,680	177	4,490
Czech Republic	--	--	5	65
France	10	234	25	241
Germany	272	4,620	163	4,800
Hong Kong	(2/)	3	11	165
India	2	72	5	107
Ireland	2	170	8	282
Israel	106	1,370	26	313
Italy	96	2,490	62	1,630
Japan	28	1,040	15	808
Korea, Republic of	6	256	6	228
Luxembourg	2	38	13	158
Malaysia	1	40	(2/)	22
Mexico	13	491	3	61
Netherlands	240	3,780	53	736
Portugal	17	254	--	--
Singapore	4	272	1	91
South Africa	35	459	21	314
Spain	1	49	(2/)	10
Sweden	25	338	20	287
Switzerland	3	126	2	122
Taiwan	15	455	(2/)	19
United Arab Emirates	1	22	--	--
United Kingdom	80	1,310	27	622
Venezuela	13	292	1	53
Other	2 r/	68 r/	2	71
Total	1,240	25,200	701	16,900

r/ Revised. -- Zero.

1/ Data are rounded to no more than three significant digits; may not add to totals shown.

2/ Less than 1/2 unit.

Source: U.S. Census Bureau.

TABLE 10  
U.S. EXPORTS OF MISCELLANEOUS TUNGSTEN-BEARING MATERIALS, BY COUNTRY 1/

Product and country of destination	1998		1999	
	Tungsten content (metric tons)	Value (thousands)	Tungsten content (metric tons)	Value (thousands)
<b>Ferrotungsten and ferrosilicon tungsten:</b>				
Canada	4	\$62	2	\$26
Israel	(2/)	4	--	--
Korea, Republic of	9	394	--	--
Mexico	14	407	2	20
Netherlands	5	222	--	--
Venezuela	9	367	--	--
Total	40	1,460	4	46
<b>Unwrought tungsten and waste and scrap: 3/ 4/ 5/</b>				
Australia	6	33	22	143
Belgium	1	14	76	436
Brazil	(2/)	12	1	11
Canada	49	422	5	77
China	2	11	2	7
Colombia	2	13	--	--
Denmark	12	68	--	--
France	31	177	1	10
Germany	319	1,650	226	1,230
Hong Kong	1	12	6	35
Hungary	3	15	--	--
India	10	169	72	1,160
Ireland	3	17	(2/)	9
Israel	19	106	29	151
Italy	18	82	20	122
Japan	39	222	24	136
Korea, Republic of	4	25	12	71
Malaysia	10	75	9	60
Mexico	27	169	42	252
Netherlands	22	159	27	168
Norway	3	18	--	--
Philippines	13	74	14	80
Portugal	--	--	4	23
Singapore	3	34	1	6
Sweden	19	160	4	23
Taiwan	95	757	58	464
United Kingdom	82	475	186	1,140
Other	-- r/	-- r/	2	15
Total	794	4,970	843	5,820
<b>Wrought tungsten--wire: 3/ 4/</b>				
Belgium	10	653	1	131
Brazil	10	741	11	695
Canada	21	749	10	458
China	1	117	3	290
France	8	576	9	924
Germany	3	480	1	179
Hong Kong	1	64	5	72
Hungary	5	223	16	868
India	19	1,360	22	1,400
Indonesia	3	207	2	117
Italy	6	366	2	249
Japan	7	897	14	935
Mexico	17	1,250	9	888
Netherlands	(2/)	59	3	105
Spain	3	130	6	386
Sweden	3	249	2	201
Taiwan	4	232	(2/)	38
United Kingdom	2	340	3	1,160
Other	2 r/	450 r/	4	549
Total	125	9,140	122	9,650

See footnotes at end of table.

TABLE 10--Continued  
U.S. EXPORTS OF MISCELLANEOUS TUNGSTEN-BEARING MATERIALS, BY COUNTRY 1/

Product and country of destination	1998		1999	
	Tungsten content (metric tons)	Value (thousands)	Tungsten content (metric tons)	Value (thousands)
<b>Wrought tungsten, excluding wire: 3/ 4/</b>				
Argentina	1	\$27	--	--
Brazil	5	246	17	483
Canada	22	822	19	810
Chile	1	47	(2/)	5
China	1	162	(2/)	104
France	2	203	1	145
Germany	112	2,780	205	4,400
India	28	590	22	505
Ireland	1	24	--	--
Israel	(2/)	173	1	134
Italy	1	122	1	84
Japan	12	1,360	14	1,290
Malaysia	(2/)	3	1	25
Mexico	5	299	4	295
Netherlands	1	53	1	23
Poland	--	--	1	28
Singapore	1	108	(2/)	108
Sweden	1	128	(2/)	43
Spain	4	151	--	--
Taiwan	7	453	1	119
United Kingdom	2	213	6	376
Venezuela	(2/)	33	1	21
Other	1	181 r/	2	213
<b>Total</b>	<b>207</b>	<b>8,180</b>	<b>297</b>	<b>9,210</b>
<b>Other tungsten metal: 3/ 4/</b>				
Australia	1	147	6	527
Brazil	1	111	1	130
Canada	12	760	10	634
Finland	--	--	1	95
France	1	75	1	162
Germany	3	706	2	520
Hong Kong	4	174	(2/)	53
India	2	137	1	52
Israel	7	1,170	5	1,100
Japan	5	2,280	5	1,940
Korea, Republic of	4	285	2	167
Mexico	5	707	8	846
Netherlands	2	288	1	88
Singapore	1	362	1	431
Taiwan	8	714	3	487
Turkey	(2/)	17	1	34
United Kingdom	6	495	7	977
Other	4	739 r/	3	637
<b>Total</b>	<b>64</b>	<b>9,170</b>	<b>57</b>	<b>8,880</b>
<b>Tungsten compounds: 6/</b>				
Belgium	--	--	16	291
Canada	11	28	1	3
El Salvador	19	27	--	--
Mexico	(2/)	7	--	--
United Kingdom	--	--	1	23
<b>Total</b>	<b>31</b>	<b>62</b>	<b>18</b>	<b>317</b>

r/ Revised. -- Zero.

1/ Data are rounded to no more than three significant digits; may not add to totals shown.

2/ Less than 1/2 unit.

3/ May include alloys.

4/ Content estimated from reported gross weight.

5/ Includes bars and rods obtained by sintering.

6/ Includes only other tungstates.

Source: U.S. Census Bureau.

TABLE 11  
U.S. IMPORTS FOR CONSUMPTION OF TUNGSTEN ORES AND CONCENTRATES, BY COUNTRY 1/

Country of origin	1998		1999	
	Tungsten content (metric tons)	Value (thousands)	Tungsten content (metric tons)	Value (thousands)
Australia	72	\$308	167	\$601
Bolivia	619	3,000	361	1,670
Burma	--	--	91	283
Chile	12	57	--	--
Germany	52	238	--	--
Japan	10	54	--	--
Kazakhstan	782	3,570	461	1,610
Mexico	132	490	27	75
Mongolia	24	74	55	138
Netherlands	33	152	--	--
Peru	85	451	22	136
Portugal	643	3,770	353	1,960
Russia	2,140	9,070	1,200	5,440
Rwanda	82	302	55	154
Thailand	12	70	11	45
United Kingdom	49	270	72	274
Total	4,750	21,900	2,870	12,400

-- Zero.

1/ Data are rounded to no more than three significant digits; may not add to totals shown.

Source: U.S. Census Bureau.

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

Country of origin	1998		1999	
	Tungsten content (metric tons)	Value (thousands)	Tungsten content (metric tons)	Value (thousands)
China	1,900	\$10,900	1,760	\$9,070
Germany	3	137	103	968
Japan	(2/)	1	--	--
Netherlands	--	--	17	77
Sweden	18	91	34	115
Total	1,920	11,100	1,920	10,200

-- Zero.

1/ Data are rounded to no more than three significant digits; may not add to totals shown.

2/ Less than 1/2 unit.

Source: U.S. Census Bureau.

TABLE 13  
U.S. IMPORTS FOR CONSUMPTION OF FERROTUNGSTEN AND FERROSILICON TUNGSTEN, BY COUNTRY 1/

Country of origin	1998		1999	
	Tungsten content (metric tons)	Value (thousands)	Tungsten content (metric tons)	Value (thousands)
China	261	\$1,770	498	\$2,930
Germany	1	13	3	38
Russia	324	2,000	168	793
United Kingdom	14	100	--	--
Total	599	3,890	669	3,760

-- Zero.

1/ Data are rounded to no more than three significant digits; may not add to totals shown.

Source: U.S. Census Bureau.

TABLE 14  
U.S. IMPORTS FOR CONSUMPTION OF MISCELLANEOUS TUNGSTEN-BEARING MATERIALS, BY COUNTRY 1/

Product and country of origin	1998		1999	
	Tungsten content (metric tons)	Value (thousands)	Tungsten content (metric tons)	Value (thousands)
<b>Tungsten metal powders: 2/</b>				
Belgium	4	\$132	3	\$122
Canada	6	164	4	117
China	122	1,850	145	2,000
Czech Republic	17	277	--	--
France	10	95	--	--
Germany	79	1,780	32	865
Israel	20	201	7	125
Japan	24	1,760	15	1,400
Netherlands	17	277	--	--
Russia	--	--	3	24
United Kingdom	145	1,330	100	927
South Africa	15	79	(3/)	2
Other	(3/)	8	(3/)	8
<b>Total</b>	<b>459</b>	<b>7,950</b>	<b>310</b>	<b>5,590</b>
<b>Tungsten carbide powder:</b>				
Austria	62	1,030	43	639
Canada	432	7,510	412	6,590
China	286	4,410	113	1,740
France	2	84	(3/)	23
Germany	43	1,150	79	1,680
Hong Kong	3	49	--	--
India	16	245	--	--
Israel	84	1,420	77	1,700
Japan	(3/)	33	2	77
Korea, Republic of	4	77	10	44
Luxembourg	8	122	34	577
Russia	1	10	20	78
United Kingdom	2	41	(3/)	7
Other	1 r/	109 r/	1	93
<b>Total</b>	<b>944</b>	<b>16,300</b>	<b>790</b>	<b>13,200</b>
<b>Unwrought tungsten: 2/ 4/ 5/</b>				
Austria	4	319	2	170
Canada	3	35	3	11
Germany	4	190	2	234
Russia	10	111	--	--
United Kingdom	4	67	(3/)	12
Other	(3/)	9	(3/)	20
<b>Total</b>	<b>24</b>	<b>730</b>	<b>8</b>	<b>447</b>
<b>Waste and scrap:</b>				
Austria	15	148	17	147
Bermuda	12	59	12	65
Canada	23	167	19	102
China	98	887	169	1,380
Estonia	11	69	--	--
France	21	154	--	--
Germany	241	1,810	151	779
Hong Kong	9	83	13	120
India	48	272	16	64
Indonesia	1	4	13	101
Ireland	--	--	13	114
Israel	74	370	21	71
Japan	240	1,670	314	1,530
Korea, Republic of	15	112	60	212
Mexico	9	44	--	--
Netherlands	53	395	13	110
Russia	280	1,500	343	1,810
Singapore	33	168	11	59
South Africa	69	543	72	462
Sweden	--	--	11	66

See footnotes at end of table.

TABLE 14--Continued  
U.S. IMPORTS FOR CONSUMPTION OF MISCELLANEOUS TUNGSTEN-BEARING MATERIALS, BY COUNTRY 1/

Product and country of origin	1998		1999	
	Tungsten content (metric tons)	Value (thousands)	Tungsten content (metric tons)	Value (thousands)
<b>Waste and scrap--Continued:</b>				
Taiwan	2	\$25	--	--
Ukraine	--	--	16	\$154
United Kingdom	155	1,080	93	545
Uzbekistan	36	361	59	437
Other	11 r/	77 r/	2	12
Total	1,450	10,000	1,440	8,340
<b>Wrought tungsten wire, plate, sheet, strip, foil, other: 2/ 4/</b>				
Austria	16	3,260	17	2,490
Canada	2	62	21	649
China	31	1,360	24	1,330
France	4	234	2	302
Germany	26	3,410	78	6,270
Hungary	6	558	11	809
India	12	138	(3/)	30
Israel	28	2,060	11	1,010
Japan	30	5,950	28	5,600
Mexico	3	840	1	601
Netherlands	(3/)	184	1	245
Russia	25	191	15	121
Switzerland	16	1,450	3	416
United Kingdom	3	392	3	518
Other	5	303	2	239
Total	206	20,400	217	20,600
<b>Tungsten oxides:</b>				
China	1,940	12,600	1,530	7,940
Germany	3	63	1	28
Japan	39	298	--	--
Netherlands	(3/)	4	19	102
Russia	14	69	555	2,350
United Kingdom	140	866	4	29
Other	1	11 r/	(3/)	5
Total	2,130	13,900	2,110	10,500
Calcium tungstate, Japan	1	127	1	24
<b>Other tungstates:</b>				
China	723	3,290	763	3,240
Germany	2	75	8	143
India	(3/)	6	--	--
Japan	(3/)	2	--	--
Mongolia	11	45	--	--
Total	736	3,420	770	3,380
<b>Other tungsten compounds: 6/</b>				
China	(3/)	10	--	--
France	--	--	(3/)	3
Germany	1	81	1	143
Japan	1	257	2	513
Total	2	348	3	659

r/ Revised. -- Zero.

1/ Data are rounded to no more than three significant digits; may not add to totals shown.

2/ May include alloys.

3/ Less than 1/2 unit.

4/ Content estimated from reported gross weight.

5/ Includes bars and rods obtained by sintering; excludes powders, waste and scrap.

6/ Includes tungsten chlorides.

Source: U.S. Census Bureau.

TABLE 15  
TUNGSTEN: WORLD CONCENTRATE PRODUCTION, BY COUNTRY 1/ 2/

(Metric tons, tungsten content)

Country	1995	1996	1997	1998	1999
Austria	738	1,413	1,400 e/	1,423 r/	1,610
Bolivia	655	582	513	497	334
Brazil	98	99 r/	40 r/	-- r/	--
Burma 3/	531	334	272	178 r/	87
Burundi e/	22	16	16	10	10
China e/ 4/	27,400	26,500	25,000	24,700	24,000
India	4	2	1 r/	-- r/	--
Kazakhstan	249	--	--	--	--
Korea, North e/	900	900	900	800 r/	700
Mexico	287	188	179	130	43
Mongolia e/	34	17	26	35 r/	16
Peru	728	332	280 r/	76	--
Portugal	875	776	1,036	831 e/	450 e/
Russia e/	5,400	3,000	3,000	3,000	3,500
Rwanda	47	104 r/	78 r/	80 r/ e/	60 e/
Tajikistan e/	75	50	--	--	--
Thailand e/	52 r/	37 r/	30 r/	35 r/	29
Uganda	17	--	--	--	--
Uzbekistan e/	300	300	250	200	200
Vietnam	50	130	210	-- r/	--
Total	38,500	34,800 r/	33,200	32,000 r/	31,000

e/ Estimated. r/ Revised. -- Zero.

1/ World totals and estimated data are rounded to no more than three significant digits; may not add to totals shown.

2/ Tungsten concentrates are believed to be produced in Kyrgyzstan, but information is inadequate for making production estimates. Table includes data available through June 2, 2000.

3/ Includes content of tin-tungsten concentrate.

4/ Based upon data published in the Yearbook of Nonferrous Industry of China.