Tungsten

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Tungsten is a whitish-gray metal with many unique properties and a wide variety of commercial, industrial, and military applications. The leading use is as tungsten carbide in cemented carbides, which are wear-resistant materials used by the construction, metalworking, mining, and oil and gas drilling industries. Tungsten alloy and pure tungsten metal contacts, electrodes, and wires are used in electrical, electronic, heating, lighting, and welding applications. Tungsten is also used to make heavy-metal alloys for armaments, heat sinks, radiation shielding, and weights and counterweights; superalloys for turbine blades; tool steels; and wear-resistant alloy parts and coatings. Tungsten alloys and composites are used as a substitute for lead in bullets and shot. Tungsten chemicals are used to make catalysts, corrosion-resistant coatings, dyes and pigments, fire-resistant compounds, lubricants, phosphors, and semiconductors.

U.S. apparent consumption of all tungsten materials in 2004 was 25% higher than apparent consumption in 2003. The increased demand was met through increased shipments of ores and concentrates from the National Defense Stockpile (NDS) and a drawdown in U.S. industry stocks. No U.S. tungsten mine production was reported in 2004. U.S. supply of tungsten raw materials comprised imports, tungsten-bearing scrap, releases from industry stocks, and sales of excess materials from the NDS. China continued to be the world's leading producer of tungsten concentrates and the leading supplier of U.S. imports of tungsten materials. Tight supplies of tungsten concentrates within China resulted in significant increases in the world prices of ammonium paratungstate, ferrotungsten, and tungsten ore concentrates. Salient U.S. tungsten statistics and world tungsten concentrate production for 2004 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 (WO_3). The short ton unit, which is used in the United States, is 1% (20 pounds) of a short ton, and WO_3 is 79.3% tungsten. A short ton unit of WO_3, therefore, equals 20 pounds of 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% (10 kg) of a metric ton. A metric ton unit of WO_3, therefore, equals 10 kg of WO_3 and contains 7.93 kg (17.48 pounds) of tungsten.

Legislation and Government Programs

The Defense National Stockpile Center (DNSC), U.S. Department of Defense, sold tungsten materials from the NDS under two formats—negotiated sales and a strategic supply alliance (SSA). The DNSC awarded approximately 68 metric tons (t) of tungsten in ores and concentrates as SSA sales during the first half of fiscal year 2004 (October 1, 2003, through March 31, 2004) and approximately 244 t of tungsten in ores and concentrates under a negotiated sale in March. In April, all sales of tungsten materials were suspended because a statutory revenue ceiling had been reached. Tungsten sales resumed in December, with a negotiated sale of ores and concentrates announced for December 6 and the reactivation of the SSA on December 20. No sales of ferrotungsten or tungsten metal powder occurred during the fiscal or calendar year (Defense National Stockpile Center, 2003, p. 6-13; 2004a-f; undated§[1]).

By the end of the fiscal year, 3 t of tungsten contained in ferrotungsten had been sold, but not shipped, from the stockpile. The quantities of tungsten materials remaining in the stockpile at the end of the calendar year, including those committed for sale and pending shipment, are listed in tables 1 and 2. The Annual Materials Plan (AMP) for fiscal year 2004, which represented the maximum quantities of tungsten materials that could be sold, is listed in table 2. In the revised AMP for fiscal year 2005 (October 1, 2004, through September 30, 2005), the maximum quantity of tungsten ores and concentrates available for sale was increased to 2,270 t (5 million pounds) (Defense National Stockpile Center, 2005; U.S. Department of Defense, 2005, p. 7-8, 10, 56).

In August, the U.S. Fish and Wildlife Service (FWS) granted final approval to three new tungsten shot products for hunting waterfowl and coots—tungsten-bronze, containing 51.1% tungsten; tungsten-iron, containing 22% tungsten; and tungsten-tin-bismuth, containing 49% to 71% tungsten. Approval of these products brought the number of FWS-approved tungsten-base shot products to eight. The other five products were tungsten-iron containing 40% tungsten, tungsten matrix (which was a tungsten-polymer composite), tungsten-nickel-iron, tungsten-polymer, and tungsten-tin-iron-nickel (U.S. Fish and Wildlife Service, 2004).

The Department of Health and Human Services' National Toxicology Program (NTP) announced that it intended to review cobalt-tungsten carbide hardmetals (cemented carbides) during 2004 or 2005 for possible inclusion in the 12th edition of the NTP's "Report on Carcinogens" (RoC), which was scheduled to be published in 2006. The RoC lists all substances which are either known to be human carcinogens or may reasonably be anticipated to be human carcinogens, and to which a significant number of persons residing in the United States are exposed. Hardmetals were nominated to be reviewed by the National Institute of Environmental Health Sciences (NIEHS) on the basis of human cancer studies on the hardmetal manufacturing

[1]References that include a section mark (§) are found in the Internet References Cited section.

industry that showed an association between exposure to hardmetals and lung cancer (U.S. Public Health Service, 2004a).

The NTP announced that it recommended tungsten trioxide and fibrous tungsten suboxides for toxicological studies. These compounds were nominated by the National Cancer Institute on the basis that they might form toxic fibrous whiskers and that the carcinogenic potential of tungsten versus cemented tungsten carbide was not adequately characterized (U.S. Public Health Service, 2004b).

The U.S. Environmental Protection Agency (EPA) ruled that 20 tungsten compounds be included in the Toxic Substances Control Act's Preliminary Assessment Information Reporting (PAIR) Program. The program requires producers and importers of listed materials to report production, importation, and exposure data to the EPA (U.S. Environmental Protection Agency, 2005).

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 mine output was reported for the United States in 2004.

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. Major U.S. processors of tungsten materials operating in 2004 included Allegheny Technologies Inc.'s Metalworking Products business, Huntsville, AL; Buffalo Tungsten Inc., Depew, NY; General Electric Co., Euclid, OH; Kennametal Inc., Latrobe, PA, and Fallon, NV; and Osram Sylvania, Inc., Towanda, PA.

In 2004, U.S. processors consumed less ammonium paratungstate, concentrates, and scrap than they did in 2003. Domestic production of ammonium paratungstate was lower than that of 2003. Net production of tungsten metal powder and tungsten carbide powder decreased by 22% in 2004 compared with that of 2003 (table 3).

Consumption

U.S. apparent consumption of all tungsten materials, as calculated from net imports, primary and secondary production, and changes in Government and industry stock levels, was 12,600 t in 2004, which was 25% higher than the 2003 apparent consumption of 10,100 t. The increase in demand was met from increased shipments of tungsten ores and concentrates from the NDS and a reduction of U.S. industry inventories of tungsten materials.

Statistics on consumption of tungsten in end-use applications by U.S. metal consumers were developed from the voluntary "Consolidated Consumers Survey." For this survey, approximately 65 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 end-use products in 2004 was 17% higher than that of 2003. Producers of cemented carbides, mill products for lighting and other industries, superalloys, and other alloys used more tungsten in 2004 than in 2003 and steelmakers used less. In 2004, U.S. industry consumed more tungsten carbide powder, tungsten metal powder, and tungsten scrap; less ferrotungsten and approximately the same amount of tungsten chemicals than it consumed in 2003.

Weekly reports of the number of operating drilling rigs give an indication of the demand for cemented carbide components used by industry to explore for or produce oil and natural gas. The number of rigs that operated in the United States gradually increased during 2004. The average number of operating rigs in the United States was 1,192, 16% higher than the average of 1,032 operating rigs in 2003 (Baker Hughes Inc., undated§).

In 2004, total consumption of tungsten scrap by U.S. processors and consumers was 4,000 t of contained tungsten, which was 3% less than the 4,130 t (revised) consumed in 2003.

Prices

Ammonium paratungstate is the most widely traded primary tungsten material, and as a result, its price has become a reference price for such upstream materials as tungsten ore concentrates and such downstream materials as tungsten metal powders and tungsten carbide powders. Ammonium paratungstate prices increased during the year, resulting in annual average prices that were significantly higher than those of 2003 (table 1). The U.S. ammonium paratungstate price reported by Platts Metals Week was $65 to $70 per short ton unit ($72 to $77 per metric ton unit) at the beginning of the year and $94 to $98 per short ton unit ($104 to $108 per metric ton unit) at yearend. The U.S. ammonium paratungstate price reported by Metal Bulletin began the year at $60 to $66 per short ton unit ($66 to $73 per metric ton unit) and ended the year at $94 to $97 per short ton unit ($104 to $107 per metric ton unit).

The U.S. spot tungsten ore concentrate price reported by Platts Metals Week, remained at $40 to $45 per short ton unit ($44 to $50 per metric ton unit) from January into November, when it increased to $55 to $65 per short ton unit ($61 to $72 per metric ton unit) (table 5). The Platts' ferrotungsten price began the year at $5.90 to $6.90 per kilogram of contained tungsten and ended the year at $12.00 to $13.00 per kilogram of contained tungsten.

Foreign Trade

The total tungsten content of U.S. exports was 3,770 t, 26% lower than the 5,090 t exported in 2003. Exports of tungsten carbide powders, tungsten metal powders, unwrought tungsten, waste and scrap, and wrought tungsten bars and rods, profiles, plates, sheets, strip, and foil decreased compared with those of 2003, and exports of ammonium paratungstate, ferrotungsten, ores and concentrates, other tungstates, other wrought tungsten products, and wire increased (tables 6 through 10).

The total tungsten content of U.S. imports was 10,600 t, 14% lower than the 12,300 t imported in 2003. China, which continued to be the leading supplier of imported tungsten to the United States, provided 44% of all tungsten imports in

2004. In 2004, the total tungsten content of imports from China decreased by 4% to 4,610 t from 4,790 t in 2003. The distribution of materials imported from China was as follows: ammonium paratungstate (40%); tungsten carbide powders and tungsten metal powders (16% each); tungsten oxides (12%); ferrotungsten (8%); tungsten waste and scrap, unwrought tungsten, wrought tungsten (3% each); and minor amounts of tungsten ores and other tungstates. Other significant suppliers of tungsten materials were as follows: Canada, with 14% of the total tungsten imports to the United States; Germany, 11%; Bolivia and Portugal, 5% each; and Israel, 4%.

In 2004, the tungsten contained in U.S. imports of ores and concentrates was about one-half of that imported in 2003, primarily as a result of decreased imports from Canada following the closure of the Cantung Mine (table 11). In 2004, the leading suppliers of U.S. imports of tungsten ores and concentrates were Canada (34%), Bolivia and Portugal (22% each), Thailand (10%), and Rwanda (6%).

U.S. imports of ammonium paratungstate decreased by 21% compared with those of 2003 (table 12). China continued to be the dominant supplier, providing 88% of U.S. ammonium paratungstate imports. Imports of nearly all other tungsten materials were higher in 2004 than those of 2003 (tables 13-14).

Net import reliance as a percentage of apparent consumption is used to measure the adequacy of current domestic production to meet U.S. demand. Net import reliance was defined as imports minus exports plus adjustments for Government and industry stock changes. Releases from stocks, including shipments from the NDS, were counted as part of import reliance, regardless of whether they were imported or produced in the United States. In 2004, net import reliance as a percentage of apparent consumption was 73%. Because there was no recorded U.S. mine production in 2004, about 73% of U.S. tungsten supply was from imports and stock releases and 27% was from scrap materials generated in the United States.

World Industry Structure

Estimated world tungsten mine production increased in 2004 in spite of the fact that the Cantung Mine in Canada was on care-and-maintenance status all year. Estimated production from China, which was the leading producer of tungsten concentrates, continued to increase (table 15). In addition to mine production and tungsten recovered from scrap, tungsten materials from stockpiles in China, Russia and other countries in the Commonwealth of Independent States (CIS), and the United States have contributed to supply in recent years. In 2004, releases of tungsten materials from government stockpiles in the CIS reportedly had ceased (Maby, 2004; Schiller, 2004, p. 10).

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Australia.—GTN Resources Ltd. entered into an option agreement to acquire Australian Tungsten Pty. Ltd. (owner of the King Island scheelite project). The project comprised the King Island Mine on King Island northwest of Tasmania, which operated between 1917 and 1990, possible extensions to the known ore bodies, and other tungsten exploration opportunities. As part of the option agreement, GTN was to fund a prefeasibility study to upgrade the resource information to Joint Ore Reserves Committee standard, confirm the market outlook for tungsten, and address key factors affecting project development. By early 2005, GTN had completed the study and decided to acquire Australian Tungsten. GTN planned to complete a bankable feasibility study during 2005, develop the mine, and begin production by late 2006. Production would be from an open pit for 4 to 5 years, followed by underground mining thereafter. A scoping study prepared by Australian Tungsten indicated that the mine could produce concentrates containing approximately 3 million metric ton units of WO_3 (approximately 23,800 t of tungsten) during an initial 9-year life, which could be extended to 20 years based on scheelite occurrences outside the two main ore bodies (Gibson, 2003, 2004; GTN Resources Ltd., 2004, 2005).

Tennant Creek Gold Ltd. studied the feasibility of developing the Molyhil scheelite-molybdenite deposit northeast of Alice Springs, Northern Territory. At yearend, Tennant Creek was working towards reconciling the bulk grades derived from pilot-scale metallurgical test work with drill indicated grades (Tennant Creek Gold Ltd., 2005, p. 3).

Gindalbie Metals Ltd. reviewed previous feasibility studies on its Mt. Mulgine tungsten project in the South Murchison region of Western Australia. The company planned to assess possible development options for the Hill deposit, for which it estimated probable reserves of 181,000 t grading 0.72% WO_3, or 130,000 metric ton units (1,030 t of tungsten) (Gindalbie Metals Ltd., 2005).

Austria.—Wolfram Bergbau und Hütten 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.

Canada.—North American Tungsten Corp. Ltd.'s Cantung Mine in Northwest Territories remained on care-and-maintenance status, while the company took the necessary steps to emerge from protection under the Canadian Companies' Creditors Arrangement Act. The company then focused on obtaining financing and establishing sales agreements for its concentrates, so that it could reopen the mine. In November, Kaska Minerals Corp. (a First Nations corporation based in Yukon Territory) agreed to invest $2.97 million in North American Tungsten. In addition to resuming operations at the Cantung Mine, North American Tungsten and Kaska Minerals planned to study the feasibility of establishing an ammonium paratungstate plant in southeast Yukon Territory and developing the Mactung tungsten property in the Macmillan Pass, northeast of Ross River in Yukon Territory (North American Tungsten Corp. Ltd., 2004; 2005b, p. 3-5, 18).

China.—Tight supplies of tungsten concentrates within China led to reduced production and exports of ammonium paratungstate and ferrotungsten, which resulted in increases in world tungsten prices. Various factors were cited as contributing to the shortage of tungsten concentrates and increase in prices (Metal Bulletin, 2004; Wong and Magnowski, 2004; Martin, 2005, p. 24, 27).

In recent years, the Chinese Government has had a program to make full use of its tungsten resources and to try to stabilize world tungsten prices. This program included regulating the production of tungsten concentrates through mine closures and production quotas, and regulating tungsten exports by restricting the volumes and types of tungsten materials and products that could be sent out of the country. For 2004, the Ministry of Land and Natural Resources established a tungsten concentrate production quota of 52,000 t (65% WO_3), which was an increase from the 43,380 t (65% WO_3) established for 2003. Four percent of the quota was to be from concentrates recovered from gangue, and the remaining production, by province or autonomous region, was distributed as follows: Jiangxi (57%), Hunan (19%), Yunnan (7%), Guangdong (6%), Fujian, Guangxi, and Inner Mongolia (2% each), Zhejiang (1%), and Anhui and Qinghai (0.1% each). The Ministry of Foreign Trade and Economic Cooperation (MOFTEC) reportedly reduced the 2004 export quota for tungsten materials by 300 t to 16,000 t of contained tungsten (Beijing Antaike Information Development Co., Ltd., 2004b, p. 10; Platts Metals Week, 2004).

Early in the year, drought conditions in the tungsten mining regions of southern China resulted in severe shortages of electrical power, which affected the production of tungsten concentrates. In addition, major producer Jiangxi Tungsten Group Co. Ltd. announced that it planned to cease operations at 4 of its 11 mines for a period of 6 months as part of a reorganization. Other factors cited as contributing to the tightness in concentrate supply included the following: mines being closed for environmental reasons, the realization by mining companies that they controlled the market, the need for mining companies to make money, the lack of new resource development, and speculation (Metal Bulletin, 2004; Wong, 2004; Wong and Magnowski, 2004; Martin, 2005, p. 24, 27).

Increasing demand for tungsten products within China added to the tightness in supply of concentrates and other raw materials. The growth in China's economy during the past decade resulted in a significant increase in Chinese consumption of tungsten raw materials to produce downstream products for its domestic market. One analyst estimated that by 2003, China's consumption of tungsten had increased to 20,850 t. To meet its need for raw materials, China imported concentrates and was developing increased capacity for processing tungsten-bearing scrap. This led to an evolving infrastructure of scrap collection within China and an increase in demand for foreign scrap (Guang, 2004; Maby, 2004; Schiller, 2004, p. 11).

In July, the Chinese State Reserves Bureau released 2,000 t of tungsten concentrate to the Chinese market. This was followed by the sale of inventories by traders and a temporary decrease in the domestic price of concentrates (Beijing Antaike Information Development Co., Ltd., 2004a, p. 10-11).

Portugal.—Early in the year, Beralt Tin & Wolfram S.A. considered bankruptcy protection and was close to suspending operations at its Panasqueira tungsten mine, when the Government of Portugal provided assistance in the form of a 6-month loan. In April, Beralt signed a 2-year contract for the sale of substantially all of the tungsten concentrates produced from the mine. Mine production was restricted to sections with below-average ore grades owing to lack of development underground. To achieve stable and profitable operations, Beralt continued to investigate financing options for its development plan, which focused on replacing existing mining equipment with low-profile units (Primary Metals Inc., 2005).

Russia.—In recent years, tungsten concentrates have been produced from Primorsky GOK's Vostok-2 Mine and the Lermontovskaya Mining Co. operation, both of which are in Primorskiy Kray, and from Tyrnyauzsky GOK's operation in the Republic of Kabardino-Balkaria. Primorsky GOK was Russia's leading tungsten concentrate producer. Lermontovskaya Mining Co. ceased operations in November 2003 as a result of bankruptcy but planned to resume production in August 2004. The Tyrnyauz Mine was assumed to be inactive in 2004 (Interfax-CNA, 2004; Interfax International Ltd., 2004a, b, 2005).

In the past few years, Russia had increased its capacity to process tungsten-bearing scrap. The country is also a producer of ferrotungsten for domestic use and export (Visser, 2002, p. 7; Schiller, 2004, p. 11).

Thailand.—SC Mining Co. Ltd. produced high-grade ferberite concentrates from an open pit mine southwest of Chiang Mai in northern Thailand (Black, 2003).

Uganda.—M/S Krone Uganda Ltd. mined tungsten ores from the Nyamuliro deposit near Kabale. During the year, the company brought an excavator into the mine. Prior to that, all mining was done by artisanal methods (Olaki, 2004§).

Vietnam.—Tiberon Minerals Ltd. of Calgary, Alberta, Canada, studied the feasibility of developing the Nui Phao deposit 80 kilometers north-northwest of Hanoi in Thai Nguyen Province. The deposit is a polymetallic skarn and greisen containing tungsten, primarily in the form of scheelite. Interim results from the study indicated that open pit mining of the deposit could produce an average of 3,425 metric tons per year (t/yr) of tungsten (4,319 t/yr of WO_3) during a mine life of 16 years. Bismuth, copper, fluorspar, and gold would also be produced. In February, the Government of Vietnam granted an investment license for the project. This provided the legal basis for Tiberon Minerals Ltd., Thai Nguyen Mineral Co., and Export-Import Investment Co. Thai Nguyen to form the Nui Phao Mining Joint Venture Company Ltd. and gave the joint venture the right to explore, mine, and process minerals from a defined area containing the deposit. Tiberon planned to complete the final feasibility study by the end of June 2005 and then take the necessary financial, regulatory, and technical steps prior to beginning mine construction. Tiberon hoped to begin commercial production in early 2008 (Tiberon Minerals Ltd., 2005, p. 6-9, 15-16).

Outlook

Demand for tungsten tends to follow general economic conditions. Future consumption of tungsten in cemented carbides, which is the leading end-use sector, will depend on the performance of the following industries: automotive and aircraft production; construction; electronics manufacturing, where cemented carbide microdrills are used on circuit boards; general manufacturing; large equipment manufacturing; mining; and oil and gas drilling. Demand for tungsten is also influenced by changes in government spending for defense applications. In 2002, the consumption of tungsten to produce 5.56-millimeter "green ammunition" for the military was forecast to reach 2,200 to 2,700 t by the year 2006, depending on which ammunition was produced. Since that forecast was made, a significant increase in ammunition requirements and the higher cost of producing the tungsten-base ammunition compared with conventional lead-base ammunition resulted in a restructuring of the green ammunition program to identify a "total cartridge solution" that would lessen environmental impact, perform at least as well as or better than the current cartridge, and be cost effective. Future demand for tungsten in green ammunition will depend on the outcome of this research (Payne, 2002, p. 10-11; Metal-Pages, 2005§; U.S. Army Armament Research, Development & Engineering Center, 2005a§, b§).

World tungsten supply will continue to be dominated by Chinese production and exports. Chinese export licenses for 2005 reportedly were limited to a total of 16,300 t of all tungsten products, approximately equal to the total quota in 2004. During the first half of 2005, inadequate supplies of tungsten concentrates within China combined with increased demand for tungsten materials in China and elsewhere resulted in steep increases in the prices of tungsten concentrates, ammonium paratungstate, and ferrotungsten. The Cantung Mine in Canada was expected to resume production of tungsten concentrates by August 2005. Other new, non-Chinese tungsten mine production was not expected before late 2006 or early 2007 (Beijing Antaike Information Development Co., Ltd., 2005, p. 6; GTN Resources Ltd., 2005; North American Tungsten Corp. Ltd., 2005a).

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TABLE 1
SALIENT TUNGSTEN STATISTICS[1]

(Metric tons of tungsten content and dollars per metric ton unit)

	2000	2001	2002	2003	2004
United States:					
Concentrates:					
Consumption	W	W	W	W	W
Exports	70	220	94	20	43
Imports for consumption	2,370	2,680	4,090	4,690	2,310
Stocks, December 31:					
Consumer	W	W	W	W	W
U.S. Government[2]	33,400	31,200 e	30,100	29,400	28,400
Price:					
U.S. spot quotation[3]	47	64	55	50	49
European[4]	45	65	38	45	55
Ammonium paratungstate:					
Production	W	W	W	W	W
Consumption[5]	8,980	9,240	8,860	9,450 r	8,790
Stocks, December 31, producer and consumer	W	W	68	W	W

See footnotes at end of table.

TABLE 1—Continued

SALIENT TUNGSTEN STATISTICS[1]

(Metric tons of tungsten content and dollars per metric ton unit)

	2000	2001	2002	2003	2004
United States—Continued:					
Ammonium paratungstate—Continued:					
Price:					
U.S. free market[6]	66	99	72	69	92
U.S. market[3]	64	97	73	72	91
European free market[6]	60	89	54	62	84
Primary products:					
Net production[7]	10,100 r	10,100 r	12,400 r	9,420 r	7,400
Consumption[8]	9,280	9,090	9,490	9,600 r	11,200
Stocks, December 31:					
Producer[9]	1,160	698 r	666	793 r	787
Consumer[8]	522	729	394	423	406
U.S. Government[2]	2,110	1,120 e	947	765	685
World, production of concentrate	44,000	48,900 r	64,200 r	66,700 r	73,700 e

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

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

[2]Defense National Stockpile Center. Includes material committed for sale pending shipment.

[3]Annual average calculated from weekly prices reported by Platts Metals Week.

[4]Annual average calculated from semiweekly prices reported by Metal Bulletin.

[5]Reported by tungsten processors.

[6]Annual average calculated from annual average high and low prices reported by Metal Bulletin.

[7]Includes only tungsten metal powder and tungsten carbide powder.

[8]Includes ammonium paratungstate and other tungsten chemicals, ferrotungsten, tungsten metal powder, tungsten carbide powder, and tungsten scrap.

[9]Data exclude cast and crystalline tungsten carbide powder and chemicals.

TABLE 2

U.S. GOVERNMENT NATIONAL DEFENSE STOCKPILE TUNGSTEN STATISTICS IN 2004[1, 2]

(Metric tons of tungsten content)

	Inventory, yearend[3]		Annual	Sales		Inventory decrease[4]	
Material	Fiscal year[5]	Calendar year	Materials Plan[5]	Fiscal year[5]	Calendar year	Fiscal year[5]	Calendar year
Ores and concentrates	28,400	28,400	1,810	312	312	1,100	979
Ferrotungsten	262	262	136	--	--	43	41
Tungsten metal powder	463	424	136	--	--	--	39
Total	29,100	29,100	2,090	312	312	1,140	1,060

-- 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, 2004.

Source: Defense National Stockpile Center.

TABLE 3
U.S. NET PRODUCTION AND STOCKS OF TUNGSTEN PRODUCTS[1, 2, 3]

(Metric tons of tungsten content)

	Tungsten metal powder	Tungsten carbide powder	Total
Net production:			
2003[r]	5,520	3,900	9,420
2004	3,020	4,370	7,400
Producer stocks:			
December 31, 2003[r]	536	258	793
December 31, 2004	438	349	787

[r]Revised.
[1]Net production equals receipts plus 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.
[3]Data for cast and crystalline tungsten carbide powder and tungsten chemicals are withheld to avoid disclosing company proprietary data; not included in "Total."

TABLE 4
U.S. REPORTED CONSUMPTION AND STOCKS OF TUNGSTEN PRODUCTS[1, 2, 3]

(Metric tons of tungsten content)

	2003	2004
Consumption by end use:		
Steels	312	259
Superalloys	W	W
Other alloys[4]	W	W
Cemented carbides[5]	5,210	6,020
Mill products made from metal powder	W	W
Chemical uses	129	130
Total	9,600 [r]	11,200
Consumption by form:		
Ferrotungsten	288	248
Tungsten metal powder	W	W
Tungsten carbide powder	5,300	6,120
Tungsten scrap	W	W
Other tungsten materials[6]	129	130
Total	9,600 [r]	11,200
Consumer stocks, December 31:		
Ferrotungsten	32	21
Tungsten metal powder	33	28
Tungsten carbide powder	301	308
Tungsten scrap	25	19
Other tungsten materials[6]	32	30
Total	423	406

[r]Revised. W Withheld to avoid disclosing company proprietary data, included in "Total."
[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 tool matrices, cemented and sintered carbides, and cast carbide dies or parts.
[6]Includes tungsten chemicals.

TABLE 5
MONTHLY PRICE QUOTATIONS OF TUNGSTEN CONCENTRATES IN 2004

Month	Metal Bulletin, European market, 65% WO_3 basis, c.i.f.[1, 2] Dollars per metric ton unit Low	High	Average	Dollars per short ton unit, average	Platts Metals Week, U.S. spot quotations, 65% WO_3 basis, c.i.f. U.S. ports, including duty[3] Dollars per short ton unit Low	High	Average	Dollars per metric ton unit, average
January	42	50	46	42	40	45	43	47
February	42	50	46	42	40	45	43	47
March	43	52	48	43	40	45	43	47
April	46	56	51	46	40	45	43	47
May	52	58	55	50	40	45	43	47
June	55	58	57	51	40	45	43	47
July	57	60	59	53	40	45	43	47
August	57	60	59	53	40	45	43	47
September	57	60	59	53	40	45	43	47
October	59	61	60	54	40	45	43	47
November	59	64	62	56	40	65	53	58
December	62	64	63	57	55	65	60	66

[1]C.i.f., cost, insurance, and freight.

[2]Combined wolframite and scheelite quotations. Low and high prices are reported semiweekly. Monthly averages are arithmetic averages of semiweekly low and high prices. The annual average price per metric ton unit of WO_3 of all semiweekly low and high prices was $55 in 2004. The average equivalent price per short ton unit of WO_3 was $50 in 2004.

[3]Low and high prices are reported weekly. Monthly averages are arithmetic averages of weekly low and high prices. The annual average price per short ton unit of WO_3 of all weekly low and high prices was $45 in 2004. The average equivalent price per metric ton unit of WO_3 was $49 in 2004.

TABLE 6

U.S. EXPORTS OF TUNGSTEN ORES AND CONCENTRATES, BY COUNTRY[1]

	2003			2004		
	Quantity			Quantity		
Country of destination	Gross weight (metric tons)	Tungsten content[2] (metric tons)	Value (thousands)	Gross weight (metric tons)	Tungsten content[2] (metric tons)	Value (thousands)
Argentina	(3)	(3)	$3	(3)	(3)	$5
Australia	--	--	--	2	1	32
Canada	1	1	15	4	2	28
China	--	--	--	17	9	259
Estonia	22	11	335	--	--	--
France	2	1	32	(3)	(3)	7
Germany	1	(3)	24	19	10	159
India	(3)	(3)	4	(3)	(3)	7
Indonesia	1	(3)	9	--	--	--
Ireland	2	1	32	--	--	--
Italy	1	(3)	11	1	(3)	13
Japan	1	(3)	17	(3)	(3)	5
Mexico	(3)	(3)	10	(3)	(3)	5
Netherlands	4	2	62	2	1	35
Philippines	--	--	--	(3)	(3)	3
Singapore	(3)	(3)	3	(3)	(3)	3
South Africa	--	--	--	1	1	9
Sweden	(3)	(3)	7	18	9	156
Taiwan	2	1	25	(3)	(3)	4
Turkey	(3)	(3)	7	--	--	--
United Kingdom	1	1	25	18	9	229
Vietnam	1	(3)	10	--	--	--
Total	39	20	630	83	43	959

-- Zero.

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

[2]Content estimated from reported gross weight.

[3]Less than ½ unit.

Source: U.S. Census Bureau.

TABLE 7

U.S. EXPORTS OF AMMONIUM PARATUNGSTATE, BY COUNTRY[1]

	2003		2004	
Country of destination	Quantity, tungsten content (metric tons)	Value (thousands)	Quantity, tungsten content (metric tons)	Value (thousands)
France	--	--	(2)	$3
Germany	63	$344	124	719
Netherlands	34	182	--	--
Spain	2	17	--	--
Total	99	543	125	722

-- Zero.

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

[2]Less than ½ unit.

Source: U.S. Census Bureau.

TABLE 8

U.S. EXPORTS OF TUNGSTEN METAL POWDERS, BY COUNTRY[1, 2]

	2003			2004		
	Quantity			Quantity		
Country of destination	Gross weight (metric tons)	Tungsten content[3] (metric tons)	Value (thousands)	Gross weight (metric tons)	Tungsten content[3] (metric tons)	Value (thousands)
Australia	6	5	$229	23	19	$643
Belgium	20	16	103	(4)	(4)	24
Brazil	12	10	455	11	9	647
Canada	36	29	1,160	65	52	1,880
Chile	2	1	52	1	1	37
China	1	1	62	19	15	804
Czech Republic	21	17	226	4	3	47
France	24	19	1,040	16	13	871
Germany	243	195	6,540	169	135	4,670
Hong Kong	2	1	92	3	2	308
India	493	395	4,020	2	2	53
Israel	123	99	1,100	20	16	218
Italy	36	29	1,520	31	25	1,770
Japan	18	14	804	17	13	832
Korea, Republic of	2	2	112	12	9	328
Mexico	17	13	432	6	5	111
Netherlands	4	3	104	1	1	53
Norway	(4)	(4)	14	4	3	104
Peru	1	1	23	1	1	23
Singapore	13	10	669	6	5	333
South Africa	1	1	21	1	1	61
Spain	4	3	167	3	3	163
Sweden	193	155	1,530	13	10	251
Switzerland	3	2	206	13	10	658
Taiwan	44	35	1,060	45	36	1,460
Thailand	(4)	(4)	8	2	2	87
Turkey	3	3	69	2	2	115
United Kingdom	90	72	2,180	40	32	1,840
Venezuela	(4)	(4)	5	8	7	181
Other	3	2	97 r	3	2	104
Total	1,420	1,130	24,100	542	433	18,700

rRevised.

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

2May include tungsten alloy powders.

3Content estimated from reported gross weight.

4Less than ½ unit.

Source: U.S. Census Bureau.

TABLE 9

U.S. EXPORTS OF TUNGSTEN CARBIDE POWDER, BY COUNTRY[1]

	2003		2004	
Country of destination	Quantity, tungsten content (metric tons)	Value (thousands)	Quantity, tungsten content (metric tons)	Value (thousands)
Australia	5	$67	12	$274
Austria	--	--	7	203
Belgium	11	332	12	243
Brazil	4	80	4	108
Canada	60	1,540	102	2,550
Chile	2	41	2	36
China	1	20	10	173
Czech Republic	11	122	(2)	14
France	59	1,800	152	2,320
Germany	862	4,520	224	3,120
India	5	146	19	309
Ireland	9	420	9	457
Italy	7	165	6	138
Japan	20	484	20	574
Korea, Republic of	24	505	23	578
Luxembourg	9	172	35	552
Mexico	2	82	4	91
Netherlands	2	83	1	24
Norway	(2)	4	2	90
Peru	(2)	9	2	67
Singapore	1	101	4	221
South Africa	56	625	30	472
Spain	1	36	5	61
Sweden	64	989	167	2,040
Switzerland	6	141	3	106
Taiwan	1	21	7	285
Thailand	2	75	2	87
United Kingdom	465	7,010	568	8,800
Other	3 r	94 r	3	161
Total	1,690	19,700	1,440	24,200

[r]Revised. -- Zero.

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

[2]Less than ½ unit.

Source: U.S. Census Bureau.

TABLE 10

U.S. EXPORTS OF MISCELLANEOUS TUNGSTEN-BEARING MATERIALS, BY COUNTRY[1]

	2003		2004	
Product and country of destination	Quantity, tungsten content (metric tons)	Value (thousands)	Quantity, tungsten content (metric tons)	Value (thousands)
Ferrotungsten and ferrosilicon tungsten:				
Canada	--	--	1	$17
Chile	--	--	(2)	6
Mexico	40	$95	98	238
Netherlands	18	110	--	--
United Kingdom	(2)	8	--	--
Total	59	214	99	261
Unwrought tungsten:[3, 4, 5]				
Australia	48	205	1	4
Belgium	17	76	--	--
Brazil	29	134	20	101
Canada	32	349	14	280
China	9	40	6	27
France	120	384	23	98
Germany	29	182	78	332
Hong Kong	5	22	--	--
Hungary	15	73	69	328
Ireland	4	15	--	--
Israel	25	107	2	10
Italy	36	153	34	143
Japan	95	866	7	30
Malaysia	18	82	15	68
Mexico	190	843	127	637
Netherlands	56	240	19	164
New Zealand	2	21	--	--
Philippines	15	63	--	--
Singapore	4	23	3	13
Slovakia	4	18	--	--
Spain	7	30	--	--
Sweden	4	28	5	43
Switzerland	3	14	11	99
Taiwan	261	1,200	262	1,170
Turkey	--	--	16	67
United Kingdom	24	133	37	189
Other	3	20	2	7
Total	1,060	5,330	754	3,810
Waste and scrap:[4]				
Armenia	16	94	7	40
Belgium	29	165	74	452
Brazil	7	112	3	24
Canada	9	63	22	174
China	288	1,660	60	463
Germany	81	396	119	911
Hong Kong	12	148	--	--
India	109	593	110	616
Ireland	2	9	--	--
Italy	2	10	--	--
Japan	--	--	13	136
Mexico	--	--	2	11
Netherlands	36	160	43	223
Singapore	8	57	2	11
Sweden	--	--	11	132

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	2003 Quantity, tungsten content (metric tons)	2003 Value (thousands)	2004 Quantity, tungsten content (metric tons)	2004 Value (thousands)
Waste and scrap—Continued:[4]				
Taiwan	99	$446	7	$39
Thailand	1	7	--	--
United Arab Emirates	--	--	3	48
United Kingdom	2	9	50	390
Total	702	3,930	525	3,670
Wrought tungsten:[3, 4, 6]				
Brazil	3	356	3	675
Canada	53	2,390	44	2,590
China	12	1,110	5	1,050
Colombia	1	327	6	2,090
Czech Republic	2	237	10	977
France	6	898	6	1,210
Germany	88	3,610	36	3,390
Hong Kong	3	527	2	319
Hungary	(2)	233	8	1,130
India	20	885	13	642
Israel	1	511	3	276
Italy	5	488	4	390
Japan	38	3,520	97	7,720
Korea, Republic of	5	1,090	5	1,460
Mexico	22	2,440	36	5,590
Philippines	6	274	3	157
Poland	2	540	1	207
Singapore	1	312	2	260
Slovakia	1	267	2	362
Spain	18	806	19	895
Sweden	4	319	2	238
Taiwan	2	416	2	585
United Arab Emirates	1	162	2	188
United Kingdom	11	1,600	17	1,530
Other	9	1,920 r	8	1,940
Total	314	25,200	334	35,900
Tungsten compounds:[7]				
Belgium	(2)	8	--	--
Canada	8	18	7	17
Czech Republic	1	11	--	--
France	--	--	1	23
Germany	--	--	(2)	8
Mexico	2	16	12	74
Total	12	53	20	122

[r]Revised. -- Zero.

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

[2]Less than ½ unit.

[3]May include alloys.

[4]Content estimated from reported gross weight.

[5]Includes bars and rods produced simply by sintering; excludes powders and waste and scrap.

[6]Includes bars and rods other than those produced simply by sintering; profiles, plates, sheets, strip, and foil; wire; and other wrought products.

[7]Includes only other tungstates.

Source: U.S. Census Bureau.

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

	2003		2004	
Country of origin	Quantity, tungsten content (metric tons)	Value (thousands)	Quantity, tungsten content (metric tons)	Value (thousands)
Bolivia	350	$1,770	504	$3,620
Canada	3,340	17,500	778	3,710
China	59	289	(2)	21
Congo (Kinshasa)	28	96	28	97
Czech Republic	(2)	7	--	--
Kenya	37	193	38	177
Mexico	--	--	3	10
Mongolia	10	46	30	85
Peru	22	140	--	--
Portugal	589	5,010	514	4,710
Rwanda	127	595	138	657
Tanzania	11	55	--	--
Thailand	68	275	228	1,230
Uganda	8	43	8	50
United Kingdom	(2)	3	23	180
Vietnam	33	175	19	71
Total	4,690	26,200	2,310	14,600

-- Zero.

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

[2]Less than ½ unit.

Source: U.S. Census Bureau.

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

	2003		2004	
Country of origin	Quantity, tungsten content (metric tons)	Value (thousands)	Quantity, tungsten content (metric tons)	Value (thousands)
China	2,380	$14,300	1,830	$14,000
Germany	134	915	198	2,010
Hong Kong	--	--	48	368
Japan	77	658	15	156
Russia	36	207	--	--
United Kingdom	21	219	--	--
Total	2,640	16,300	2,090	16,500

-- Zero.

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

Source: U.S. Census Bureau.

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

Country of origin	2003 Quantity, tungsten content (metric tons)	2003 Value (thousands)	2004 Quantity, tungsten content (metric tons)	2004 Value (thousands)
Brazil	--	--	43	$412
China	362	$2,310	349	3,100
Taiwan	15	77	--	--
Total	377	2,380	392	3,510

-- 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	2003 Quantity, tungsten content (metric tons)	2003 Value (thousands)	2004 Quantity, tungsten content (metric tons)	2004 Value (thousands)
Tungsten metal powders:[2]				
Australia	10	$31	--	--
Austria	3	40	18	$314
Belgium	4	152	4	96
Canada	69	616	97	1,520
China	539	5,140	714	8,370
Germany	198	2,960	392	6,590
Israel	140	2,080	81	1,450
Japan	12	935	25	1,620
Korea, Republic of	94	1,600	131	2,320
Mexico	(3)	7	25	156
Sweden	5	12	--	--
United Kingdom	21	212	(3)	7
Other	1	15 r	--	--
Total	1,090	13,800	1,490	22,400
Tungsten carbide powder:				
Austria	23	436	(3)	19
Canada	460	6,820	520	8,680
China	432	4,400	759	9,660
Czech Republic	1	14	6	176
France	3	369	8	695
Germany	64	1,240	51	976
Hong Kong	--	--	28	341
Israel	319	4,370	322	4,840
Italy	--	--	33	27
Japan	12	215	1	98
Korea, Republic of	46	647	24	377
Luxembourg	7	96	--	--
Other	1 r	48 r	1	65
Total	1,370	18,700	1,750	26,000

See footnotes at end of table.

TABLE 14—Continued

U.S. IMPORTS FOR CONSUMPTION OF MISCELLANEOUS TUNGSTEN-BEARING MATERIALS, BY COUNTRY[1]

	2003		2004	
Product and country of origin	Quantity, tungsten content (metric tons)	Value (thousands)	Quantity, tungsten content (metric tons)	Value (thousands)
Unwrought tungsten:[2, 4, 5]				
Austria	--	--	2	$32
Canada	2	$8	--	--
China	6	68	150	1,320
Germany	16	950	2	89
Singapore	8	50	12	193
Other	1	51 r	2	158
Total	33	1,130	166	1,790
Waste and scrap:				
Belgium	8	53	17	394
Brazil	16	80	--	--
Canada	34	184	63	357
China	201	1,560	126	1,260
Estonia	10	42	--	--
Germany	79	513	489	3,440
Hong Kong	58	278	121	946
India	115	508	16	111
Israel	121	413	17	154
Japan	94	435	160	1,070
Korea, Republic of	123	189	23	52
Mexico	5	21	8	88
Pakistan	16	77	--	--
Russia	16	83	19	112
South Africa	60	358	18	121
Sweden	21	217	11	89
Switzerland	(3)	4	16	111
United Kingdom	132	641	43	394
Other	10	61 r	7	35
Total	1,120	5,720	1,150	8,730
Wrought tungsten:[2, 4, 6]				
Austria	25	2,300	28	3,220
Belgium	1	53	2	268
China	68	3,810	117	5,380
Czech Republic	(3)	210	5	1,150
Germany	43	3,840	25	2,770
Hong Kong	7	486	7	508
Hungary	4	348	6	527
India	3	396	4	456
Israel	15	1,200	3	300
Japan	45	4,270	47	5,160
Mexico	(3)	12	3	22
Netherlands	3	286	1	141
Russia	5	389	4	283
Singapore	(3)	18	1	83
Taiwan	1	55	11	148
United Kingdom	1	280	4	652
Other	4	658 r	2	667
Total	227	18,600	270	21,700

See footnotes at end of table.

TABLE 14—Continued

U.S. IMPORTS FOR CONSUMPTION OF MISCELLANEOUS TUNGSTEN-BEARING MATERIALS, BY COUNTRY[1]

	2003		2004	
Product and country of origin	Quantity, tungsten content (metric tons)	Value (thousands)	Quantity, tungsten content (metric tons)	Value (thousands)
Tungsten oxides:				
China	743	$5,050	558	$6,880
Germany	7	174	7	136
Hong Kong	--	--	14	151
Liechtenstein	--	--	41	701
Netherlands	--	--	50	360
Russia	--	--	193	1,740
United Kingdom	10	124	41	749
Total	760	5,350	905	10,700
Calcium tungstate, Japan	(3)	25	--	--
Other tungstates:				
Australia	(3)	2	(3)	4
China	(3)	126	(3)	4
Germany	(3)	21	5	89
India	--	--	(3)	11
Japan	--	--	(3)	9
United Kingdom	--	--	(3)	26
Total	(3)	149	6	142
Other tungsten compounds:[7]				
Germany	(3)	126	1	226
Japan	2	398	4	656
Ukraine	(3)	52	--	--
United Kingdom	(3)	6	(3)	3
Total	3	582	4	885

[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 ½ unit.

[4]Content estimated from reported gross weight.

[5]Includes bars and rods produced simply by sintering; excludes powders and waste and scrap.

[6]Includes bars and rods other than those produced simply by sintering; profiles, plates, sheets, strip, and foil; wire; and other wrought products.

[7]Includes tungsten chlorides.

Source: U.S. Census Bureau.