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# 2006 Minerals Yearbook

## CHROMIUM

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# CHROMIUM

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In 2006, the U.S. chromium supply (measured in contained chromium) was 179,000 metric tons (t) from recycled stainless steel scrap, 520,000 t from imports, and 384,000 t from Government and industry stocks. Supply distribution was 212,000 t to exports, 281,000 t to Government and industry stocks, and 589,000 t to apparent consumption. Chromium apparent consumption increased by 7.5% compared with that of 2005. Historically, chromium ferroalloys have replaced chromite ore as the leading source of chromium to the U.S. economy. Stainless steel mill products have been accounting for an increasing share of chromium supply to the domestic economy, now rivaling that of ferrochromium. Because stainless steel mill products contribute a significant amount of chromium to the domestic economy, trade in these products has been incorporated into chromium trade statistics and their contribution accounted for in chromium apparent consumption.

Chromium has a wide range of uses in chemicals, metals, and refractory materials. Its use in iron, nonferrous alloys, and steel is for the purpose of enhancing hardenability or resistance to corrosion and oxidation. Production of stainless steel and nonferrous alloys are two of its more critical applications. Other applications are in alloy steel, catalysts, leather processing, pigments, plating of metals, refractories, and surface treatments.

Chromium is an essential trace element for human health. Some chromium compounds, however, are acutely toxic, chronically toxic, and/or carcinogenic. The U.S. Environmental Protection Agency (EPA) regulates chromium releases into the environment. The Occupational Safety and Health Administration (OSHA) regulates workplace exposure.

Because the United States has small chromite ore reserves and a small reserve base, domestic supply has been a concern during every national military emergency since World War I. World chromite ore resources, mining capacity, and ferrochromium production capacity are concentrated in the Eastern Hemisphere. In recognition of the vulnerability of long supply routes during a military emergency, chromium (in various forms, including chromite ore, chromium ferroalloys, and chromium metal) was held in the National Defense Stockpile (NDS) since before World War II. As a result of changed national security considerations since 1991, stockpile goals have been reduced, and inventory is being sold. Material for recycling is the only domestic commercial chromium supply source.

The U.S. Geological Survey (USGS) has conducted mineral resource surveys of the United States to assess the potential for occurrences of chromium and other mineral resources. The National Aeronautics and Space Administration, the National Institute of Standards and Technology, the U.S. Department of Defense (DOD), and the U.S. Department of Energy conduct alternative materials research.

## Domestic Data Coverage

Domestic data for chromium materials were developed by the USGS by means of the monthly "Chromite Ores and Chromium Products" and "Consolidated Consumers" consumer surveys. Stainless and heat-resisting steel producers are the leading chromium consumers, and high-carbon ferrochromium is the leading chromium-containing material consumed.

## Legislation and Government Programs

The Defense National Stockpile Center (DNSC) disposed of chromium materials under its fiscal year 2006 (October 1, 2005, through September 30, 2006) Annual Materials Plan (AMP) and announced the fiscal year 2007 plan. The DNSC's fiscal year 2007 AMP set maximum disposal goals for chromium materials at 136,000 t of chromium ferroalloys, 84,400 t of refractory-grade chromite ore, 4,540 t of chemical-grade chromite ore, and 907 t of chromium metal (Defense National Stockpile Center, 2006).

The DNSC reported 2006 fiscal year sales of 905 t of chromium metal for $5.6 million and 104,000 t of chromium ferroalloys for $98.2 million (Holder, 2006).

## Production

The major marketplace chromium-containing materials are chromite ore and foundry sand; chromium chemicals, ferroalloys, and metal; and stainless steel. In 2006, the United States produced chromium ferroalloys, metal, chemicals, and stainless steel. The United States is a major world producer of chromium chemicals, chromium metal, and stainless steel (the major end use of chromium).

Eramet Marietta Inc. produced chromium metal using the electrolytic process at the rate of about 3,000 metric tons per year (t/yr). About 1,200 t/yr of that chromium metal was vacuum degassed. Vacuum degassed is the chromium metal grade used for superalloy production (Ryan's Notes, 2006a).

Oregon Resources Corporation (ORC) [a subsidiary of Industrial Minerals Corporation (Australia)] extracted bulk samples of chromite ore at its surface mine in Coos County, OR. ORC developed its material beneficiation process to recover chromite, garnet, and zircon minerals with production expected to start in 2008 (Industrial Minerals Corporation, 2007). ORC reported proven reserves of 1.27 million metric tons (Mt) of mineral sands (proven plus probable reserves of 1.9 Mt; geologic resources of 6.4 Mt) that contained an average of 13% chromite. The company estimated that it would produce about 41,000 t/yr of foundry-grade chromite (Industrial Minerals, 2005). ORC determined that its product was best suited for the foundry market (Resource Finance & Investment, 2006).

The U.S. stainless steel industry produces more than 2 million metric tons per year (Mt/yr) of stainless steel and imports and exports stainless steel mill products and scrap. The stainless steel industry is the leading consumer of chromium materials. A significant amount of chromium is imported and exported in stainless steel mill products and scrap.

North American Stainless (NAS) produced stainless steel in Ghent, Kentucky. NAS reported melt shop production to have been 849,504 t in 2006 compared with 767,624 t in 2005, and 690,882 t in 2004. NAS brought electric furnace no. 2 into production and planned to acquire a second AOD converter and a ladle furnace to come into operation in 2008, at which time NAS melting production capacity will be about 1.415 million Mt/yr (Acerinox, 2006, p. 12, p. 105-107; 2007, p. 12-13, p. 104-107).

## Environment

Under court order to do so, OSHA lowered the 8-hour time-weighted average hexavalent chromium workplace permissible exposure (PEL) limit to 5 micrograms per cubic meter of air. OSHA had previously set the hexavalent chromium PEL at 52 micrograms per cubic meter of air (Occupational Safety and Health Administration, 2006; U.S. Department of Labor, 2006). The EPA regulates and reports on chromium releases to the environment (U.S. Environmental Protection Agency, 2006).

## Prices

Chromium materials are not openly traded. Purchase contracts are confidential between buyer and seller; however, trade journals report composite prices based on interviews with buyers and sellers, and traders declare the value of materials they import or export. Thus, industry publications and U.S. trade statistics are sources of chromium material prices and unit values, respectively.

The average South African Rand exchange rate increased to 6.767 Rand per U.S. dollar in 2006 from 6.366 Rand per U.S. dollar in 2005 (Pacific Exchange Rate, 2007). There is strong correlation between the unit value of U.S. high-carbon ferrochromium and the U.S. dollar value of the South African Rand. When the exchange rate provides fewer Rand per dollar, the unit value of U.S. high-carbon ferrochromium increases. Compared with that of 2005, the Rand exchange rate increased 6.3% and the unit value of U.S. high-carbon ferrochromium imports decreased by 8.9%.

## Foreign Trade

Chromium-containing material exports from and imports to the United States included chromite ore; chromium chemicals, ferroalloys, metal, and pigments; and stainless steel. Based on foreign trade statistics collected by the U.S. Department of the Treasury and reported by the U.S. Department of Commerce, the value of foreign trade of these chromium materials excluding stainless steel was $121 million for exports and $529 million for imports in 2006. A significant amount of chromium enters the U.S. economy as stainless steel mill product and scrap trade. The value of foreign trade of chromium materials including stainless steel mill products and scrap was $2,410 million for exports and $3,950 million for imports.

## World Industry Structure

The chromium industry comprises chromite ore, chromium chemicals and metal, ferrochromium, stainless steel, and chromite refractory producers. Several trends are simultaneously taking place in the chromium industry. The chromium chemical industry has eliminated excess production capacity, concentrating on production growth in surviving plants. Chromite refractory use has been declining; however, foundry use has been increasing slowly. Environmental concerns have reduced the use of chromium chemicals and chromite refractories. The amount of chromite ore from independent producers is declining, while that from vertically integrated producers is increasing. In other words, chromite ore mines tend now to be owned and operated by chromite refractory, chromium chemical, or ferrochromium producers. This trend is associated with the migration of ferrochromium production capacity from stainless steel producing countries to chromite ore producing countries, a trend that has been interrupted with the emergence of China as a significant ferrochromium and leading stainless steel producer. While ferrochromium production capacity was closed in historically producing countries, which usually have been stainless steel producing countries, new furnaces or plants were constructed in chromite ore producing areas. The electrical power and submerged-arc electric furnace production capacities used to produce ferrochromium have been increasing. Furnaces built recently have an electrical capacity in the tens of megavolt-amperes (MVA); whereas when ferrochromium plants were first built, furnaces rated in the low kilovoltampere range were common.

Production process improvements, such as agglomeration of chromite ore, preheating and prereduction of furnace feed, and closed-furnace technology, have been retrofitted at the plants of major producers and are being incorporated in newly constructed plants. Since the introduction of post-melting refining processes in the steel industry after 1960, there has been a shift in production to high-carbon ferrochromium from low-carbon ferrochromium. After years of ferrochromium production, slag stockpiles have built up. Recently developed processes have efficiently recovered ferrochromium from that slag, and processes have been or are being installed at existing plant sites. In South Africa, the leading chromite-ore- and ferrochromium-producing country, three trends are emerging—ferrochromium plants are being developed in the western belt of the Bushveld Complex, ferrochromium plants are being built in association with chromite ore mines, and ferrochromium production processes are being designed to accommodate chromite ore byproduct recovered from platinum operations.

***Capacity.***—Rated capacity is defined as the maximum quantity of product that can be produced in a period of time at a normally sustainable long-term operating rate, based on the physical equipment of the plant and given acceptable routine operating procedures involving labor, energy, materials, and maintenance. Capacity includes both operating plants and plants temporarily closed that can be brought into production

within a short period of time with minimum capital expenditure. Because not all countries or producers make information about production capacity available, historical chromium trade data have been used to estimate national production capacities. Reported production capacity changes result from both facility changes and increased knowledge about facilities. New information about a facility may result in the reevaluation of production capacity for that facility. Production capacities have been rated for the chromite ore, chromium chemical, chromium metal, ferrochromium, and stainless steel industries (table 7).

***Production.***—In 2006, world chromite ore production was about 19.2 Mt gross weight, of which about 95.2% was produced for the metallurgical industry; 2.2%, for the chemical industry; 1.2%, for the foundry industry; and 0.8%, for the refractory industry (International Chromium Development Association, 2007, p. 1).

**Chromium Metal.**—Major chromium metal producers included Russia and the United States (by the electrolytic process) and China, France, Russia, and the United Kingdom (by the aluminothermic process).

**Stainless Steel.**—In 2006, world stainless steel production was 28.3 Mt, an increase of 17% compared with that of 2005 (International Stainless Steel Forum, 2007).

**Stainless Steel Scrap.**—Stainless steel scrap is an important source of chromium to the stainless steel industry. Recycling of stainless steel scrap accounts for a significant but undocumented fraction of world stainless steel production.

## World Review

***Albania.***—Darfo S.p.A (Italy) produced chromite ore and ferrochromium. Darfo planned to double ferrochromium production capacity by 2008.

***Australia.***—Pilbara Chromite Pty. Ltd. (a subsidiary of Consolidated Minerals Limited) produced 252,867 t of chromite ore in financial year 2006 (July 1, 2005, through June 30, 2006) compared with 241,756 t in financial year 2005. Pilbara's chromite ore grade was 42% chromic oxide ($Cr_2O_3$); production capacity was 250,000 t/yr (Consolidated Minerals Limited, 2006, p. 14).

***Brazil.***—Brazil produced chromite ore, ferrochromium, and stainless steel. Brazil reported 2005 chromite ore production of 616,534 t (253,082 t $Cr_2O_3$-content), exported 139,326 t of chromite ore (64,000 t $Cr_2O_3$-content), and imported 17,590 t (7,916 $Cr_2O_3$-content). Brazil produced from a chromite ore reserve containing about 5.362 Mt $Cr_2O_3$-content. In 2005, Brazil produced 197,653 t of chromium ferroalloys. Brazil imported 11,259 t of ferrochromium and exported 149 t (Gonçalves, 2006). Based on production of chromite ore and trade of chromite ore and chromium ferroalloys, Brazilian chromium apparent consumption was 270,000 t in 2005. Expansion of Brazilian stainless steel production capacity was expected to increase domestic demand for domestically produced ferrochromium.

***Canada.***—Canada reported chromium mineral imports of 60,589 t in 2005; 55,853 t in 2004; and 68,571 t in 2003; exports of 2,991 t in 2005; 3,685 t in 2004; and 3,830 t in 2003 (Natural Resources Canada, 2006).

***China.***—China produced chromite ore, ferrochromium, chromium chemicals and metal, and stainless steel. China's chromite ore production is small, so China imports most of its chromite ore needs. China's ferrochromium production capacity was about 1.5 Mt (0.4 Mt of low-carbon ferrochromium and 1.1 Mt of high-carbon ferrochromium) (Li, 2006). In order to improve the environment, China sought to reduce the number of small ferrochromium producers in favor of larger, more efficient, and less polluting ferrochromium producers by identifying environmentally acceptable operations, increasing electrical power cost to unapproved producers, and reducing tax rebates on chromium-containing exports.

Ferrochromium production rose to an estimated 900,000 t from 330,000 t in 2002. Production capacity by province was Hunan, 20,000 t; Inner Mongolia, 100,000 t; Jilin, 50,000 t; Liaoning, 50,000 t; Shanghai, 30,000 t; Shanxi, 305,000 t; Sichuan, 300,000 t; and Xinjiang, 50,000 t. Ferrochromium production was supported by imports of 4.1 Mt of chromite ore, up from 1.14 Mt in 2002, most of which was supplied by India, the Republic of South Africa, and Turkey in 2006. Ferrochromium production in China supported stainless steel production that has increased to an estimated 4.5 Mt from 2.3 Mt in 2004 and is expected to continue increasing. As a result of this increase, China has accounted for the main world growth in chromium consumption (Mirakhmedov, 2006).

Sinosteel Corporation acquired Shanghai Shenjia Ferroalloy Works and Tuoli Taihang Ferroalloy Company. Shanghai Shenjia operated three electric furnaces with a total production capacity of 150,000 t/yr of ferrochromium. Sinosteel planned to move the furnaces to Xuzhou City, Jiangsu Province, where it will be integrated with two furnaces under construction and be operated as Jinxiang Metallurgical with a production capacity of 200,000 t/yr of ferrochromium. Tuoli Taihang, Xinjiang Uygur Autonomous Region, operated with production capacity of 70,000 t/yr of ferrochromium and planned to expand to 140,000 t/yr in 2007 with the commissioning of two new 12,500 kilovoltampere electric arc furnaces. Tuoli Taihang planned to increase production capacity to 300,000 t/yr after 2007. Sinosteel also acquired 70% of Tuoli Guoyuan's chromite mine and electrical power generation facilities in the area. Tuoli Guoyuan supplied about 20% of Tuoli Taihang chromite ore needs with the remainder imported from Kazakhstan (Metal Bulletin, 2006; TEX Report, 2006c). Sinosteel also planned a joint venture with Samancor (South Africa) to take a 50% interest in 5 of 6 furnaces at Tubatse Ferrochrome. The sixth furnace was jointly owned by Samancor and Nippon Steel Corporation (Japan) (Piasecka, 2006). Sinosteel's agreement with Samancor included ferrochromium production capacity at 300,000 t/yr and chromite ore production capacity at 1.6 Mt/yr, and chromite ore resources of 74 Mt.

***Finland.***—Finland produced chromite ore at Kemi Mine, ferrochromium at Tornio Works, and stainless steel at Tornio Works. Outokumpu produced 549,000 t of marketable chromite ore from 1.2 Mt of run-of-mine ore and 243,000 t of ferrochromium in 2006 compared with 572,000 t of chromite ore from 1.1 Mt of run-of-mine ore and 235,000 t of ferrochromium in 2005. Outokumpu reported 2006 chromite ore proven reserves of 39 Mt graded at 26% $Cr_2O_3$, indicated resources of 13 Mt at 29% $Cr_2O_3$, and inferred resources 72 Mt

at 29% $Cr_2O_3$. Outokumpu reported stainless steel production in 2006 from 1.65 Mt/yr melting, 1.6 Mt/yr hot rolling, and 1.2 Mt/yr finished products stainless steel production capacities at its Tornio Works. Outokumpu also had stainless steel-producing plants in Sweden and the United Kingdom. Outokumpu planned to add ferritic grades of stainless steel to its Tornio product line, anticipated to reach 60,000 t/yr of ferritic stainless steel (Outokumpu, 2007, p. 21).

Outokumpu studied the ferrochromium production processes to improve the sustainability of its operations by accounting for the increased cost and reduced quality of raw materials, increased energy cost, stricter environmental regulations, and demand for better working conditions (Daavittila, 2004). Outokumpu found the cost of ferrochromium production in Europe was distributed as follows: chromite ore, 30%; electricity, 30%; reducing agent, 20%; and other, 20%. Physical laws set the minimum amounts of chromite ore, reducing agent, and energy required to produce ferrochromium; however, real process inefficiencies result in material and energy use over these minima. Changes in production technology have improved production efficiency and profitability of ferrochromium operations. In particular, the historical movement from lump ore to pelletized ore feed, from open to semiclosed to closed furnaces, and from low-power to high-power furnaces, along with the introduction of air and water cleaning processes has improved sustainability. Outokumpu identified furnace and other production equipment availability as the major profitability issue facing the ferrochromium industry, especially for larger furnaces. In addition, profitability can be improve by increased use of lower-cost raw materials, increased furnace size, more efficient energy use and recovery, greater automation, and stricter environmental control.

Kaitue (2005) reported that the 21 European stainless steel producers in 1976 had consolidated to 4 producers in 2001, that from 1980 through 2002 stainless steel compound annual demand growth rate was 5.5%, and that Outokumpu was Europe's third largest stainless steel producer (as measured by slab capacity).

***France.***—France produced chromium metal and stainless steel. ArcelorMittal, a multinational company, reported that 11,550 employees produced 2.6 Mt of stainless steel and shipped 2.2 Mt in 2006 (Arcelor, 2007, p. 96).

***Germany.***—Elektrowerke Weisweiler GmbH produced low-carbon ferrochromium, and ThyssenKrupp, a multinational corporation, produced stainless steel. Elektrowerke Weisweiler was owned by Kermas Group (United Kingdom). Kermas also owned Serov Ferroalloys Plant (Russia) and Samancor (South Africa), other low-carbon ferrochromium producers.

***India.***—India produced chromite ore, chromium chemicals, ferrochromium, and stainless steel.

Harman (2007) reported the development of the Indian ferrochromium industry. India started ferrochromium production in 1967 when Ferro Alloys Corporation commissioned a 12 MVA submerged arc furnace to produce high-carbon and ferrochromiumsilicon which were, in turn, mixed with materials preheated in a rotary kiln furnace in an 8 MVA tilting furnace to produce low-carbon ferrochromium. Indian producers favored low-power furnaces for their flexibility to shift among ferroalloys. Larger, export-oriented high-carbon ferrochromium production capacity that took advantage of Indian raw materials and the opportunity to earn foreign currency was added in the 1980s. In 2006, India had 26 plants with 47 furnaces with electric power capacity of 705 MVA that were capable of producing 1.164 Mt/yr of high-carbon ferrochromium. India may improve its ferrochromium productivity by moving to higher electrical capacity furnaces, employing automated furnace control, changing from open to closed furnaces, better controlling moisture in feed materials, and increasing use of agglomerated feed materials.

India reported that 17 mines collectively produced 3,422,880 t of chromite ore in fiscal year 2005-06 (April 1, 2005, through March 31, 2006) compared with 3,621,394 t from 19 mines in fiscal year 2004-05, from a chromite ore recoverable reserve of 97.076 Mt (Indian Bureau of Mines, 2006). India reported chromite ore exports of 692,673 t in fiscal year 2005-06; 1,116,644 t in fiscal year 2004-05, and 745,119 t in fiscal year 2003-04.

India reported chromite ore imports of 5,100 t in fiscal year 2005-06; 2,521 t in fiscal year 2004-05. India reported ferrochromium production of 662,297 t in fiscal year 2005-06; 594,994 t in fiscal year 2004-05; and 525,824 t in 2003-04; and consumption of 38,300 t in fiscal year 2004-05. India reported ferrochromium exports of 255,997 t in fiscal year 2005-06; 167,066 t in fiscal year 2004-05. India reported ferrochromium imports of 11,182 t in fiscal year 2005-06; 11,677 t in fiscal year 2004-05 (Indian Bureau of Mines, 2007a, b). Based on the chromite ore production and chromite ore and ferrochromium trade reported above, Indian chromium apparent consumption in fiscal year 2005-06 was 689,000 t; as compared with 669,000 t in fiscal year 2004-05.

Jindal Stainless Ltd., a stainless steel and ferrochromium producer, expanded its annual stainless steel and ferrochromium production capacity. Jindal produced ferrochromium at Vizag and developed a greenfield operation in Orissa State to produce ferrochromium and stainless steel. The Vizag plant had a high-carbon ferrochromium production capacity of 40,000 t/yr. The Orissa plant started operation with an annual ferrochromium production capacity of 80,000 t/yr, and planned to start a second 80,000-t/yr furnace in 2006. A new 500-megawatt (MW)-captive powerplant was planned for the Orissa plant to accommodate high-carbon ferrochromium production of 250,000 t/yr and stainless steel production of 1.6 Mt/yr.

IMFA Group (comprising Indian Charge Chrome Ltd., an export-oriented producer, and Indian Metals and Ferroalloys) a domestic-oriented producer, is integrated from chromite ore mining through ferrochromium production, including thermoelectric power generation. IMFA completed installation of a 27-MVA furnace with ferrochromium production capacity of 35,000 t/yr at its Choudwar, Orissa State, plant at a cost of about $11 million bringing its installed electrical capacity to 157 MVA. IMFA planned to add two more furnaces, one with electrical capacity of 27 MVA and one with 48 MVA, and a 120-MW powerplant. IMFA reported fiscal year 2004-05 chromite ore production of 252,189 t. To supply its export-oriented ferrochromium production, IMFA planned to open captive chromite mines in Mahagiri, Orissa State, when environmental permits are issued (Metal-Pages, 2006b).

Karthik Alloys Limited produced high-carbon ferrochromium from a plant with capacity of 10,700 t/yr at Durgapur, West Bengal State, as feed to local steel plants (Harman, 2007).

Rawmet Ferrous Industries Pvt. Ltd. operated a ferrochromium plant near Cuttack, Orissa State, comprised of two semiclosed furnaces with electrical power capacity of 16.5 MVA each. Rawmet had a ferrochromium production capacity of 50,000 t/yr (Harman, 2007).

Rohit Ferro-Tech Limited produced high-carbon ferrochromium from four submerged arc furnaces with electrical power rating of 9 MVA each. The Bishnupur, West Bengal State, plant had a production capacity of 55,000 t/yr. Rohit also produced high-carbon ferrochromium at Kalinganagar Industrial Complex, Jajpur District, Orissa State, with a production capacity of 110,000 t/yr. Rohit operated four furnaces at Kalinganagar rated at 16.5 MVA each and produced other ferroalloys (Harman, 2007).

Nava Bharat Ferro Alloys Limited produced ferrochromium from two electric arc furnaces with electrical capacity of 22.5 MVA at Kharagprasad village, Dhenkanal District, Orissa State. Nava Bharat's ferrochromium production capacity was 75,000 t/yr. Nava Bharat planned to build a 64-MW, coal-fired, powerplant in Orissa (Harman, 2007).

Tata Steel Ltd. operated two ferrochromium plants in Orissa State, one at Bamnipal and the other at Joda. Tata planned to increase production at Bamnipal to 110,000 t/yr of ferrochromium. Tata also planned to build a captive powerplant and a ferroalloy plant in South Africa, where it could smelt Indian chromite ore.

***Japan.***—Japan produced chromium chemicals and metal, ferrochromium, and stainless steel. Japan had the world's leading national stainless steel production capacity.

***Kazakhstan.***—Kazakhstan, the world's second ranked chromite ore producer, produced chromite ore, chromium chemicals, chromium metal, and ferrochromium. Chromite ore was produced at Donskoy Mine, Aqtobe Oblysy; ferrochromium at Aksu, Pavlodar Oblysy, and Aktobe, Aqtobe Oblysy; and chromium metal at Aktobe.

TNC Kazchrome JSC made a long-term agreement to supply ferrochromium to Taiyuan Iron and Steel Co. (China) (Ryan's Notes, 2006b).

Oriel Resources plc (United Kingdom) started to develop the Voskhod chromite deposit (50°18′N, 58°30′E), Khromtau District, Aqtobe Oblysy. Oriel estimated mine development cost at $131 million. Oriel upgraded road, rail, and power supply to the Voskhod deposit while starting construction of an access ramp. Oriel planned to start chromite ore production in 2008 with a production capacity of 900,000 t/yr (1.3 Mt/yr run-of-mine). Oriel planned to mine ore grading 48% $Cr_2O_3$ and to beneficiate it at the mine site to a marketable product grading 57% $Cr_2O_3$. Oriel acquired a license to mine the Karaagash deposit adjacent to Voskhod. Karaagash held 7.8 Mt of chromite ore classified C2 and P1 in the Russian resource classification system. The Voskhod deposit is one of about 80 deposits in the Kempirsai Massif discovered since 1936 and is adjacent to Donskoi GOK, an established chromite mining operation owned by JSC Kazchrome. Voskhod is one large lens of massive to disseminated chromite that lies at a depth of from 98 meters (m) to 450 m with a northeasterly dip of about 28 degrees in the eastern zone of the main Kempirsai Massif. Run-of-mine production will be beneficiated at the mine site by crushing and gravity separation using spiral circuits for fine material and dense media separation for coarser material. In accordance with Canadian Institute of Mining, Metallurgy and Petroleum (CIM) standards on mineral resources and reserves, Oriel estimated the Voskhod deposit resources at 19.5 Mt of indicated resources at 48.5% $Cr_2O_3$; 1.6 Mt of inferred resources at 41% $Cr_2O_3$; and probable reserves of 18.3 Mt at 40.3% $Cr_2O_3$ where the cutoff grade was 20% $Cr_2O_3$ (Oriel Resources plc, 2006a, b).

***Oman.***—Gulf Mining and Materials Company (GMM) started production of refractory grade chromite ore in Wadi Mahram after which GMM added several more chromite mines. GMM's ore contains from 34% to 42% $Cr_2O_3$. GMM entered into a joint-venture agreement with a Saudi Arabian company under which GMM would operate mines owned by the Saudi company. The Saudi ore grade was 50% $Cr_2O_3$ (Gulf Mining and Materials Company, 2007).

***Russia.***—Russia produced chromite ore, chromium chemical, ferroalloys, and metal.

Oriel Resources plc was constructing ferrochromium smelter at Tikhvin (59°38′N, 33°31′E), Tikhvinsky District, Leningrad Oblast. Production was expected to start in 2007 using chromite ore from Turkey and then from Oriel's planned mine in Kazakhastan. The plant was to house four 15.8-MW furnaces installed in two phases. Upon completion, the plant was to have a production capacity of 148,000 t/yr of high-carbon ferrochromium containing 70.8% chromium, which was to be increased to 180,000 t/yr by 2011. Chromium recovery was estimated to be 87% (Oriel Resources plc, 2006b).

Kongor-Khrom OJSC purchased exploration and mining rights to chromite ore in the Yengaiskoye field, Priuralsky District, Yamalo-Nenets Autonomous Region. Kongor-Khrom is owned primarily by Chelyabinsk Metallurgical Combine Joint Stock Co., a ferrochromium producer. Kongor-Khrom mined 1.4 Mt of chromite ore from the Tsentralnoye deposit, Rayiz Mountains, Yamalo-Nenets Autonomous Region, an increase from 800,000 t in 2005. The chromite ore graded about 40% $Cr_2O_3$ with chromium-to-iron ratio of 3:1. Proven reserves were estimated to be 6 Mt; resources, about 100 Mt (Lundman, 2006). Chelyabinsk Electrometallurgical Combine produced high-, medium-, and low-carbon ferrochromium and ferrosilicon chromium from chromite ore obtained from Kharp, Yamalo-Nenets Autonomous Region (Interfax, 2006; Metals Place, 2006).

Russian Chrome 1915 JSC, formerly Khrompik Company, Ekaterinburg, Sverdlovsk Oblast, was Russia's leading chromium chemical producer. Russian Chrome could produce about 30,000 t/yr of chromium chemicals. Russian Chrome was owned one-half by Kermas Group (United Kingdom) and one-half by Luigi Stoppani Company (Italy). Klyuchevsky Ferroalloy Plant became the new majority owner of Russian Chrome, which supplies chromic oxide to Klyuchevsky. Kluchevsky Ferroalloy Plant, Sverdlovsk Oblast, produced chromium ferroalloys and aluminothermic chromium metal. Russian Chrome provided about 4,800 t/yr of chromium oxide to Klyuchevsk (Kommersant Daily, 2006; Metal-Pages, 2006a).

***South Africa.***—South Africa produces chromite ore, chromium chemicals, ferrochromium, and stainless steel.

The ferrochromium industry has been increasing at about 5% per year. That is equivalent to between two and three new furnaces per year. National issues currently facing South Africa include environmental concerns over chromium emissions and dust generation, adequacy of electrical power supply, shipping facilities, and transportation facilities. Black empowerment legislation requires 26% ownership by formerly underrepresented groups by 2014. Black empowerment and the sale of Samancor resulted in ownership realignments among chromite ore and ferrochromium producers while anticipated demand increases resulted in new chromite ore mines, ferrochromium furnace renovation, and new furnaces that increased production capacity and decreased pollution.

The Minerals Bureau reported that in 2005 South Africa produced 7.494 Mt of chromite ore from which it produced 2.812 Mt of chromium ferroalloys. South Africa exported 0.657 Mt of chromite ore and 2.460 Mt of ferrochromium (Masetlana, 2006). Based on chromite ore production and chromite ore and ferrochromium trade, South African chromium apparent consumption was 705,000 t. South African domestic utilization of chromite ore increased from about 75% in 1994 to 93% in 2003 and 2004; however, utilization decreased to 91% in 2005 as a result of chromite ore export to China.

Samancor Chrome [a wholly owned subsidiary of Kermas South Africa (Pty.) Ltd. (Kermas SA)], which is owned by Kermas Ltd. (British Virgin Islands), operated chromite ore mines and ferrochromium smelters. Kermas was a vertically and horizontally integrated chromium materials producer. Kermas owned Serov Ferroalloys and Chrome 1915, a chromium chemical producer in Russia, Electrowerk Weisweiller (EWW) in Germany, and chromite mines in Turkey. EWW and Serov produced low-carbon ferrochromium. Samancor Chrome comprised five business units—Eastern Chrome Mines and Western Chrome Mines, producing chromite ore; and Ferrometals, Middelburg Ferrochrome, and Tubatse Ferrochrome, producing ferrochromium. Samancor had joint-venture s with stainless steel producers Nippon Denko (Japan), Nishin (Japan), and POSCO (Korea). International Mineral Resources AG (Switzerland) (IMR) purchased 32.5% of Kermas SA. IMR controls Eurasian Natural Resources Corporation (ENRC), which owns Kazchrome, a chromite ore mining and ferrochromium producing company in Kazakhstan. Samancor and Sinosteel agreed to form Tubatse Chrome joint-venture in which Sinosteel purchased 50% interest in the five Tubatse Ferrochrome furnaces owned by Samancor for $200 million and the Tweefontein chromite ore mine for $250 million. The agreement enhances Sinosteel's vertical integration from chromite ore production through ferrochromium production (in South Africa) through stainless steel production (in China). Sinosteel owned a 70% interest in ASA Metals, a South African chromite ore and ferrochromium producer (Competition Tribunal of South Africa, 2006; TEX Report, 2006b).

International Ferro Metals Ltd. (IFM), an Australian company formerly known as Transvaal Ferroalloys operated the Lesedi chromite mine near Buffelsfontein, North West Province, on the western limb of the Bushveld Complex and acquired an 80% interest in the Skychrome deposit (Turner, 2006). IFM extracted chromite ore from the MG1 and MG2 seams by underground mining and planned to start ferrochromium production in 2007. IFM began construction on a 267,400-t/yr-capacity ferrochromium plant comprised of two 66-MVA furnaces that were to be operated on about one-third lumpy chromite and two-thirds pelletized chromite. The ferrochromium would supply a growing world stainless steel demand. IFM estimated its capital expenditure at $1,360 per metric ton of chromium contained in production capacity ($/t-Cr in FeCr) compared with a range of $830 to $1,700 $/t-Cr in FeCr for operations currently being constructed. IFM estimated that China accounted for 16% of ferrochromium consumption in 2005 and projected that China would account for 27% in 2015. IFM holds shares in Jiuquan Iron & Steel (Group) Co., Ltd. (JISCO), a Chinese stainless steel producer; and JISCO guaranteed to take about 120,000 t/yr of ferrochromium from IFM.

IFM designed its plant to accommodate doubling of production capacity after 2009. IFM contracted Pyromet Technologies (Pty.) Ltd. (Johannesburg) to design and construct the smelter and beneficiation plant, Outokumpu (Finland) and Bateman Engineering N.V. (South Africa) to design and construct the pelletising and sintering plant, and SEDGMAN Limited (Australia) to do mine development and operation.

ASA Metals (Pty.) Ltd. (ASA), 70% owned by Sinosteel, produced chromite ore and ferrochromium at Burgersfort, North West Province. ASA's chromite ore run-of-mine production capacity was 420,000 t/yr and ferrochromium production capacity was 120,000 t/yr. ASA planned to build two closed furnaces and a pelletizing plant by 2009 that would add 240,000 t/yr ferrochromium production capacity and to recover another 40,000 t/yr yielding a total ferrochromium production capacity of 400,000 t/yr. ASA also planned to increase its chromite ore production capacity to 650,000 t/yr in 2007 and, by adding new mines, another 600,000 to 700,000 t/yr of chromite ore production capacity by 2011 (TEX Report, 2006a).

Columbus Stainless (Pty.) Ltd. produced stainless steel in Middelburg, Mpumalanga Province. Columbus reported melt-shop production was 727,132 t in 2006 compared with 564,877 t in 2005, and 718,094 t in 2004. Columbus melting capacity exceeded 1 Mt in 2006 (Acerinox, 2006, p. 12, p. 105-107; 2007, p. 12-13, p. 104-107).

Feralloys Limited (owned by Assmang Ltd.) produced chromite ore at the Dwarsrivier Mine and ferrochromium at the Machadodorp plant. Assmang reported selling 210,000 t of ferrochromium in fiscal year 2006 (July 1, 2005, through June 30, 2006) compared with 262,000 t in fiscal year 2005 and 178,000 t of chromite ore in fiscal year 2006 compared with 35,000 t in fiscal year 2005 (Assmang Limited, 2006, p. 5).

Tata Iron and Steel Co., Ltd. (India) started construction of a ferrochromium plant at Richards Bay, Kwazulu-Natal, a port city removed from the South Africa's chromite mines. Tata planned to use Outokumpo pelletizing and preheating technology to produce ferrochromium from chromite ore imported from its mines in India. Tata's plant was planned to have an annual ferrochromium production capacity of 270,000 t from two furnaces (TEX Report, 2006d).

Hernic (Pty.) Ltd. produced chromite ore and ferrochromium at Brits, North West Province, with a ferrochromium production

capacity of 420,000 t/yr and a chromite ore production capacity of 500,000 t/yr at its Bokfontein Mine. Hernic planned to add an underground mineshaft at Bokfontein to increase its production capacity to 1 Mt/yr. Hernic acquired Black Economic Empowerment (BEE) partners, as required by law, by selling 15% of Hernic to BEE partners.

Xstrata S.A. (Pty.) Ltd. reported operating seven chromite ore mines and four ferrochromium plants. Xstrata's chromite ore mines and capacities were—Boshoek opencast mine, Boshoek, North West Province, 360,000 t/yr; Chrome Eden Mine, Pilansberg, North West Province, 96,000 t/yr; Horizon Mine, Pilansberg, North West Province, 180,000 t/yr; Kroondal Mine, Rustenburg, North West Province, 1,920,000 t/yr; Kroondal opencast mine, Rustenburg, North West Province, 96,000 t/yr; Thorncliffe Mine, Steelpoort, Mpumalanga Province, 1,440,000 t/yr; and Waterval Mine, Rustenburg, North West Province, 480,000 t/yr. Xstrata's ferrochromium plants and capacities were—Boshoek Plant, Boshoek, North West Province, 240,000 t/yr; Lydenburg Plant, Lydenburg, Mpumalanga Province, 396,000 t/yr; Rustenburg Plant, Rustenburg, North West Province, 430,000 t/yr; and Wonderkop Plant, Marikana, North West Province, 553,000 t/yr. Xstrata completed the prereduction kilns at its new smelter, the Lion Project, and planned to start ferrochromium production in 2007 with production capacity of 360,000 t/yr from two 63-MVA furnaces based on Premus technology developed by Xstrata at its Lydenburg Plant. The Helena Mine, which will supply the new smelter, started production. Xstrata continued a joint-venture agreement with Anglo American Platinum Corp Ltd., the Mototolo project, to produce byproduct chromite tailings from the Bushweld UG2 seam, which the agglomeration plant at Wonderkop would pelletize (Xstrata, 2006, p. 41-2.).

Chromex Mining Plc undertook the Mecklenburg project to mine chromite ore from the LG-6 and LG-6a reefs on the western limb of the Bushveld Complex, Mecklenburg Farm, Limpopo Province. Chromex reported chromite ore resources compliant with South African Mineral Reserve and Resource Estimating Code (SAMREC) to be 9.42 Mt in situ resources of which 7.15 Mt are indicated and 2.27 Mt are inferred (Chromex Mining Plc, 2006, p. 12-15, 24-64).

Chrome International South Africa (CISA) is a vertically integrated company from chromite ore mining at the Rustenburg Mine through sodium dichromate production at Newcastle, and chromium sulfate leather tanning chemicals at Merebank. Lanxess Corporation (Germany) purchased the remaining 50% of CISA that it did not already hold from Sentrachem, which is a subsidiary of Dow Chemical Company (United States) (Lanxess Corporation, 2006).

African Rainbow Minerals Ltd. (ARM) reported that Nkomati Mine, Mpumalanga Province, which hosts cobalt, copper, nickel, and platinum group metals (PGM), started production of chromite ore. ARM planned to produce about 720,000 t/yr of chromite ore for smelting at Assmang's Machadodorp smelter for export. ARM planned to crush and screen the ore to get a salable product of 38% $Cr_2O_3$ with a chromium iron ratio of 1.65:1. ARM reported chromite ore production from the Dwarsrivier Mine by fiscal year (July 1 to June 30) to have been—0.7 Mt, 2001-02; 0.85 Mt, 2002-03; 0.96 Mt, 2003-04; 0.92 Mt, 2004-05; and 0.82 Mt, 2005-06 (African Rainbow Minerals, 2006a, p. 67-69; 2006b).

RHI Group (Austria), an international refractory manufacturing group, planned to add magnesia- and chromite-containing refractory production facilities at Isithebe, Kwazulu-Natal. RHI planned to use chromite from Samancor and magnesite from China to produce refractories for China's steel industry (Creamer, 2006).

Sylvania Resources Limited contracted with Samancor to build chrome washing plants and PGM extraction plants to produce chromite and PGMs from 7 Mt of tailings from 13 mines on the western limb of the Bushveld complex. The first chrome washing plant was completed at Millsell. Plants were planned to be built next at Steelpoort and Elandsdrift. The chrome washing plants were expected to produce between 90,000 t/yr and 120,000 t/yr of chromite ore from 360,000 t/yr of tailings. Sylvania also produced PGMs from tailings at its Chrome Tailings Retreatment Project, making PGMs a byproduct of chromite ore mining (Sylvania Resources Limited, 2006).

***Spain.***—Acerinox produced stainless steel in the Campo de Gibraltar plant, Cadiz Province. Acerinox reported melt shop production to have been about 1,011,642 t in 2006 compared with 909,101 t in 2005, and 920,736 t in 2004 (Acerinox, 2006, p. 12, p. 105-107; 2007, p. 12-13, p. 104-107).

***Turkey.***—Turkey produced chromite ore, chromium chemicals, and ferrochromium.

The Istanbul Mineral Exporters' Association (IMEA) reported that the Turkey and Mediterranean Alpine ophiolitic belts coincided. There are more than 1,000 chromite deposits and outcrops, typically of high chromium-to-iron ratio and appropriate for metallurgical and refractory industry use. Refractory grade chromite chemical composition was 50% to 54% $Cr_2O_3$, 12% to 15% $Al_2O_3$ with a chromium-to-iron ratio of 3.1:1 to 3.3:1, while metallurgical chromite contained 36% to 54% $Cr_2O_3$ and 11% to 14% $Al_2O_3$ with a chromium-to-iron ratio of 2.2:1 to 3.2:1. IMEA estimated Turkish chromite ore resources at 30 Mt of proven reserves (excluding 145 Mt of material graded at 5% to 6% $Cr_2O_3$), 60 Mt of probable reserves, and 120 Mt of possible reserves (no specified grade). Since chromite was discovered in northwestern Turkey by Lawrence Smith in1848, Turkey has produced 50 Mt of chromite ore (Çağlayan, 2006). Current production capacity was about 1.5 Mt with the expectation of expanding to 1.8 to 2.0 Mt by 2010 to meet demand from China and Russia.

## Outlook

The outlook for chromium consumption in the United States and the rest of the world is about the same as that for stainless steel, which is the leading end use for chromium worldwide. Thus, stainless steel industry performance largely determines the performance of the chromium industry in the United States and worldwide. In 2006, China and India were in the process of economic expansion that resulted in demand growth for chromium for the production of stainless steel needed to support those economic expansions.

The practice of supplying chromium in the form of ferrochromium by countries that mine chromite ore was somewhat interrupted as China became a major consumer of chromite ore; however, the practice was expected to continue eventually. The rising cost of ferrochromium sustained independent ferrochromium producers; however, other factors being equal, ferrochromium production is most cost effective when the ferrochromium plant is close to the chromite mine. With new efficient and reliable ferrochromium production facilities in chromite-ore-producing countries, ferrochromium capacity and production are expected to diminish in countries with market-driven economies that produce ferrochromium without nearby chromite ore resources. Other factors of production, such as electrical energy or labor costs may offset chromite ore transportation costs. Further vertical integration of the chromium industry is expected as countries that produce chromite ore expand ferrochromium or stainless steel production capacity.

***Chromite Ore.***—Chromite ore production capacity is in balance with average consumption. To improve chromite ore availability and to stabilize feed material price, ferrochromium producers invest in mines that produce chromite ore. Indeed, most chromite ore is produced under vertically integrated mine-smelter or mine-plant ownership. As platinum mining moves to chromite-bearing seams, a greater portion of chromite is likely to be supplied as byproduct from such operations. In addition, platinum may become a byproduct of some chromite operations.

***Ferrochromium.***—Ferrochromium production is electrical energy intensive. Charge-grade ferrochromium requires between 2,900 and 4,100 kilowatthours of electrical energy per metric ton of product, with efficiency varying by ore grade, operating conditions, and production process. Thus, ferrochromium plant location will reflect a cost balance between raw materials and electrical energy supply.

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TABLE 1
SALIENT CHROMIUM STATISTICS[1]

| | | 2002 | 2003 | 2004 | 2005 | 2006 |
|---|---|---|---|---|---|---|
| World, production, contained chromium: | | | | | | |
| Chromite ore (mine)[2] | metric tons | 4,510,000 r | 4,740,000 r | 5,460,000 r | 5,940,000 r | 5,850,000 |
| Ferrochromium (smelter)[3] | do. | 2,880,000 | 3,460,000 | 3,760,000 r | 3,740,000 | 3,990,000 |
| Stainless steel[4] | do. | 3,480,000 | 3,860,000 | 4,180,000 | 4,130,000 | 4,080,000 |
| U.S. supply: | | | | | | |
| Components of U.S. supply, contained chromium: | | | | | | |
| Domestic mines | do. | -- | -- | -- | -- | -- |
| Secondary | do. | 174,000 r | 180,000 r | 177,000 r | 174,000 r | 179,000 |
| Imports: | | | | | | |
| Chromite ore | do. | 35,300 | 55,300 | 49,500 | 52,900 | 53,800 |
| Chromium chemicals | do. | 17,400 | 10,300 | 6,040 | 11,400 | 12,100 |
| Chromium ferroalloys | do. | 203,000 | 243,000 | 261,000 | 278,000 | 265,000 |
| Chromium metal | do. | 7,430 | 8,570 | 9,630 | 11,000 | 10,900 |
| Stainless steel mill products & scrap | do. | 142,000 | 124,000 | 163,000 | 150,000 | 179,000 |
| Stocks, January 1: | | | | | | |
| Government | do. | 706,000 | 643,000 | 560,000 | 466,000 | 375,000 |
| Industry[5] | do. | 16,700 | 8,390 | 9,870 | 7,900 | 8,600 |
| Total | do. | 1,300,000 | 1,270,000 | 1,240,000 r | 1,150,000 r | 1,080,000 |
| Distribution of U.S. supply, contained chromium: | | | | | | |
| Exports: | | | | | | |
| Chromite ore | do. | 7,680 | 32,800 | 14,000 | 13,700 | 17,400 |
| Chromium chemicals | do. | 10,500 | 9,710 | 14,500 | 18,900 | 16,700 |
| Chromium ferroalloys and metal | do. | 10,800 | 3,770 | 6,250 | 24,700 | 22,300 |
| Stainless steel mill products & scrap | do. | 105,000 | 141,000 | 136,000 | 162,000 | 156,000 |
| Stocks, December 31: | | | | | | |
| Government | do. | 643,000 | 560,000 | 466,000 | 375,000 | 272,000 |
| Industry[5] | do. | 8,390 | 9,870 | 7,900 | 8,600 | 9,640 |
| Total | do. | 785,000 | 758,000 | 645,000 | 603,000 | 494,000 |
| Production, reported:[6] | | | | | | |
| Chromium ferroalloy and metal net production: | | | | | | |
| Gross weight | do. | W | W | W | W | W |
| Chromium content | do. | W | W | W | W | W |
| Net shipments, contained chromium | do. | W | W | W | W | W |
| Consumption: | | | | | | |
| Apparent, contained chromium | do. | 516,000 r | 514,000 r | 591,000 r | 548,000 r | 589,000 |
| Reported: | | | | | | |
| Chromite ore and concentrates, gross weight | do. | W | W | W | W | W |
| Chromite ore, average $Cr_2O_3$ | percent | 45.4 | 45.0 | 45.0 | 45.0 | 45.0 |
| Chromium ferroalloys:[7] | | | | | | |
| Gross weight | metric tons | 407,000 | 411,000 | 449,000 | 431,000 | 429,000 |
| Contained chromium | do. | 236,000 | 240,000 | 262,000 | 250,000 | 252,000 |
| Chromium metal, gross weight | do. | 5,080 | 5,140 | 5,690 | 7,280 | 6,210 |
| Stocks, December 31, gross weight: | | | | | | |
| Government: | | | | | | |
| Chromite ore | do. | 339,000 | 235,000 | 135,000 | 73,400 | 1,160 |
| Chromium ferroalloys | do. | 767,000 | 691,000 | 595,000 | 492,000 | 373,000 |
| Chromium metal | do. | 7,220 | 7,120 | 6,670 | 6,190 | 5,290 |
| Industry: | | | | | | |
| Producer[8] | do. | W | W | W | W | W |
| Consumer: | | | | | | |
| Chromite ore[9] | do. | W | W | W | W | W |
| Chromium ferroalloys[10] | do. | 13,700 | 16,300 | 13,000 | 14,200 | 15,900 |
| Chromium metal | do. | 230 | 242 | 182 | 228 | 194 |
| Prices, average annual: | | | | | | |
| Ferrochromium, chromium content[11] | dollars per pound | $0.317 | $0.433 | $0.690 | $0.684 | $0.695 |
| Electrolytic chromium metal, gross weight[12] | dollars per pound | $4.50 | $4.50 | $4.50 | $4.50 | $4.50 |
| Aluminothermic chromium metal, gross weight[13] | do. | $2.08 | $1.84 | $2.27 | $2.72 | $2.94 |
| Value of trade:[14] | | | | | | |
| Exports, contained chromium | thousands | $67,600 | $58,400 | $80,700 | $116,000 | $121,000 |
| Imports, contained chromium | do. | $256,000 | $322,000 | $477,000 | $583,000 | $529,000 |
| Net exports, contained chromium[15] | do. | -$188,000 | -$264,000 | -$397,000 | -$468,000 | -$408,000 |

See footnotes at end of table.

TABLE 1—Conitnued
SALIENT CHROMIUM STATISTICS[1]

| | | 2002 | 2003 | 2004 | 2005 | 2006 |
|---|---|---|---|---|---|---|
| Stainless steel: | | | | | | |
| Production: | | | | | | |
| Gross weight[16] | metric tons | 2,190,000 | 2,220,000 | 2,400,000 | 2,240,000 | 2,460,000 |
| Contained chromium[17] | do. | 369,000 | 373,000 | 407,000 | 373,000 | 419,000 |
| Average grade, dimensionless[18] | | 0.1687 | 0.1683 | 0.1697 | 0.1667 | 0.1705 |
| Shipments, gross weight[19] | metric tons | 1,720,000 | 1,790,000 | 1,880,000 | 1,730,000 | 1,890,000 |
| Exports, gross weight | do. | 273,000 | 327,000 | 323,000 | 371,000 | 410,000 |
| Imports, gross weight | do. | 752,000 | 639,000 | 811,000 | 770,000 | 872,000 |
| Scrap, gross weight: | | | | | | |
| Receipts | do. | 1,020,000 | 1,060,000 | 1,040,000 r | 1,030,000 r | 1,050,000 |
| Consumption | do. | 1,380,000 | 1,430,000 | 1,480,000 r | 1,480,000 r | 1,500,000 |
| Exports | do. | 342,000 | 505,000 | 478,000 | 585,000 | 506,000 |
| Imports | do. | 81,000 | 89,200 | 146,000 | 111,000 | 180,000 |
| Value of trade: | | | | | | |
| Exports | thousands | $742,000 | $895,000 | $1,030,000 | $1,340,000 | $1,580,000 |
| Imports | do. | $1,350,000 | $1,320,000 | $2,230,000 | $2,630,000 | $3,210,000 |
| Scrap exports | do. | $252,000 | $382,000 | $548,000 | $670,000 | $716,000 |
| Scrap imports | do. | $49,400 | $70,200 | $160,000 | $124,000 | $209,000 |
| Net exports[15, 20] | do. | -$405,000 | -$115,000 | -$809,000 | -$744,000 | -$1,130,000 |

[r]Revised. W Withheld to avoid disclosing company proprietary data. -- Zero.
[1]Data are rounded to no more than three significant digits; may not add to totals shown.
[2]Calculated assuming chromite ore to average 44% $Cr_2O_3$, which is 68.42% chromium.
[3]Calculated assuming chromium content of ferrochromium to average 57% chromium.
[4]Calculated assuming chromium content of stainless steel to average 16.7% chromium.
[5]Includes consumer stocks of chromium ferroalloys and metal and other chromium-containing materials.
[6]Includes chromium ferroalloys and metal and other chromium materials in the United States.
[7]Chromium ferroalloy, chromite ore, and other chromium-containing materials excluding chromium metal.
[8]Chromium ferroalloy and metal producer stocks of chromium ferroalloys and metal.
[9]Chemical, chromium ferroalloy and metal, and refractory producer stocks of chromite ore.
[10]Consumer stocks of chromium ferroalloys, chromite ore, and other chromium-containing materials excluding chromium metal.
[11]Time-weighted average U.S. price of imported high-carbon chromium that contains 50% to 55% chromium as reported in Platts Metals Week.
[12]Time-weighted average U.S. price of domestically produced electrolytic chromium metal as reported by Ryan's Notes.
[13]Time-weighted average U.S. price of imported aluminothermic chromium metal as reported by Ryan's Notes.
[14]Includes chromite ore and chromium ferroalloys, metal, and chemicals.
[15]Negative data indicate that imports are greater than exports.
[16]Source: American Iron and Steel Institute annual report of stainless and heat-resisting raw steel production and shipments.
[17]Estimated mass-weighted average of the mean chromium content of stainless steel production by grade. Uncertainty is approximatly ± 0.01 owing to the range of chromium chemical specification limits by stainless steel grade.
[18]Ratio of estimated mass-weighted average chromium content of stainless steel production by grade to production. Expressed as a fraction.
Source: American Iron and Steel Institute quarterly reports of stainless and heat-resisting raw steel production by grade.
[19]Source: American Iron and Steel Institute annual report of stainless and heat-resisting raw steel shipments.
[20]Includes stainless steel and stainless steel scrap.

TABLE 2
U.S. REPORTED CONSUMPTION AND STOCKS OF CHROMIUM PRODUCTS[1]

(Metric tons)

| | 2005 | | 2006 | | Change[2] | |
|---|---|---|---|---|---|---|
| | Gross weight | Chromium content | Gross weight | Chromium content | Quantity | Percentage |
| Consumption by end use: | | | | | | |
| Alloy uses: | | | | | | |
| Iron alloys, steel: | | | | | | |
| Carbon steel | 6,460 | 3,870 | 6,060 | 3,660 | -397 | -6 |
| High-strength low-alloy steel | 9,370 | 5,000 | 9,610 | 5,220 | 239 | 3 |
| Stainless and heat-resisting steel | 355,000 | 205,000 | 351,000 | 205,000 | -3,770 | -1 |
| Full alloy steel | 20,900 | 12,000 | 21,400 | 12,800 | 452 | 2 |
| Tool steel | 5,360 | 3,250 | 5,020 | 3,030 | -340 | -6 |
| Superalloys | 16,200 | 12,600 | 16,400 | 12,600 | 187 | 1 |
| Other alloys[3] | 21,700 | 12,600 | 21,400 | 12,600 | -270 | -1 |
| Other uses not reported above | 3,400 | 2,240 | 4,400 | 2,800 | 1,010 | 30 |
| Total | 439,000 | 257,000 | 436,000 | 258,000 | -2,890 | -1 |
| Consumption by material: | | | | | | |
| Low-carbon ferrochromium | 36,200 | 24,500 | 36,600 | 25,000 | 431 | 1 |
| High-carbon ferrochromium | 354,000 | 209,000 | 351,000 | 210,000 | -2,720 | -1 |
| Ferrochromium silicon | 35,700 | 13,900 | 36,500 | 14,300 | 818 | 2 |
| Chromium metal | 7,280 | 7,630 r | 6,210 | 6,200 | -1,070 | -15 |
| Chromite ore | 4,010 | 1,280 | 3,960 | 1,290 | -48 | -1 |
| Chromium-aluminum alloy | 549 | 380 | 484 | 372 | -65 | -12 |
| Other chromium materials | 659 | 267 | 421 | 212 | -240 | -36 |
| Total | 439,000 | 257,000 | 436,000 | 258,000 | -2,900 | -1 |
| Consumer stocks: | | | | | | |
| Low-carbon ferrochromium | 2,170 | 1,470 | 2,140 | 1,460 | -29 | -1 |
| High-carbon ferrochromium | 10,700 | 6,300 | 12,400 | 7,440 | 1,760 | 17 |
| Ferrochromium silicon | 1,170 | 456 | 1,150 | 451 | -21 | -2 |
| Chromium metal | 228 | 228 | 194 | 194 | -34 | -15 |
| Chromite ore | 110 | 35 | 69 | 22 | -41 | -37 |
| Chromium-aluminum alloy | 120 | 83 | 102 | 78 | -18 | -15 |
| Other chromium materials | 75 | 31 | 66 | -- | -9 | -12 |
| Total | 14,500 | 8,600 | 16,100 | 9,640 | 1,610 | 11 |
| National Defense Stockpile stocks:[4] | | | | | | |
| Chromite ore:[5] | | | | | | |
| Chemical[6] | 3,590 | 1,030 | -- | -- | -3,590 | -100 |
| Refractory[7] | 69,800 | 16,700 | 1,160 | 276 | -68,700 | -98 |
| Chromium ferroalloys:[8] | | | | | | |
| High-carbon ferrochromium[9] | 319,000 | 228,000 | 247,000 | 176,000 | -72,200 | -23 |
| Low-carbon ferrochromium[9] | 173,000 | 123,000 | 126,000 | 89,800 | -46,700 | -27 |
| Chromium metal[10] | 6,190 | 6,190 | 5,290 | 5,290 | -910 | -15 |

rRevised. -- Zero.
[1]Data are rounded to no more than three significant digits; may not add to totals shown.
[2]Change based on gross weight quantity of current year compared with that of previous year.
[3]Includes cast irons, welding and alloy hard-facing rods and materials, wear- and corrosion-resistant alloys, and aluminum, copper, magnetic, nickel, and other alloys.
[4]The source for stockpile materials is the Defense Logistics Agency, Defense National Stockpile Center.
[5]Metallurgical grade chromite ore was used up in 2002.
[6]Chromium content estimated using 28.6% chromium.
[7]Chromium content estimated using 23.9% chromium.
[8]Ferrochromium silicon was used up in 2002.
[9]Chromium content estimated using 71.4% chromium.
[10]Chromium content estimated using 100% chromium.

TABLE 3
VALUE OF IMPORTS AND U.S. PRICE QUOTATIONS FOR CHROMIUM MATERIALS[1]

| Material | | 2005 Contained chromium | 2005 Gross weight | 2006 Contained chromium | 2006 Gross weight |
|---|---|---|---|---|---|
| Value:[2, 3] | | | | | |
| Chromite ore: | | | | | |
| Not more than 40% chromic oxide | dollars per metric ton | 2,270 | 475 | 624 | 158 |
| More than 40% but less than 46% chromic oxide | do. | 257 | 81 | 564 | 177 |
| 46% or more chromic oxide | do. | 476 | 153 | 434 | 141 |
| Average | do. | 437 | 140 | 437 | 141 |
| Ferrochromium: | | | | | |
| Not more than 3% carbon: | | | | | |
| Not more than 0.5% carbon | do. | 2,340 | 1,590 | 2,490 | 1,710 |
| More than 0.5% but not more than 3% carbon | do. | 1,890 | 1,230 | 1,570 | 1,220 |
| Average (less than 0.5% but not more than 3%) | do. | 2,310 | 1,560 | 2,490 | 1,710 |
| More than 3% but not more than 4% carbon | do. | (4) | (4) | (5) | (5) |
| More than 4% carbon | do. | 1,310 | 762 | 1,190 | 694 |
| Average (all grades) | do. | 1,430 | 846 | 1,290 | 762 |
| Chromium metal | do. | XX | 8,010 | XX | 8,180 |
| Price:[6] | | | | | |
| High-carbon ferrochromium:[7] | | | | | |
| 50% to 55% chromium | cents per pound | 68.40 | XX | 69.54 | XX |
| 60% to 65% chromium | do. | 67.32 | XX | 63.32 | XX |
| Low-carbon ferrochromium:[7] | | | | | |
| 0.05% carbon | do. | 118 | XX | 116 | XX |
| 0.10% carbon | do. | 104 | XX | 100 | XX |
| 0.15% carbon | do. | 100 | XX | 99 | XX |
| Chromium metal: | | | | | |
| Domestic, electrolytic[8] | do. | XX | 450 | XX | 450 |
| Imported: | | | | | |
| Aluminothermic[8] | do. | XX | 272 | XX | 294 |

XX Not applicable.
[1]Data are rounded to no more than three significant digits; may not add to totals shown.
[2]Mass-weighted average based on customs value and weight of imported material.
[3]Reported by the U.S. Census Bureau.
[4]No imports of more that 3% but not more than 4% carbon ferrochromium were reported in 2005.
[5]No imports of more that 3% but not more than 4% carbon ferrochromium were reported in 2006.
[6]Time-weighted average based on prices reported by material in trade journals.
[7]Source: Platts Metals Week.
[8]Source: Ryan's Notes.

TABLE 4
U.S. EXPORTS OF CHROMIUM MATERIALS, BY TYPE[1]

| HTS[2] code | Type | 2005 Quantity (kilograms) | 2005 Value (thousands) | 2006 Quantity (kilograms) | 2006 Value (thousands) | Principal destinations in 2006 |
|---|---|---|---|---|---|---|
| 2610.00.0000 | Chromite ore and concentrate, gross weight | 42,600,000 | $9,940 | 53,900,000 | $10,200 | China (47.7%); Sweden (40.8%); Canada (9.7%); Mexico (1.6%). |
| | Metal and alloys, gross weight: | | | | | |
| 8112.21.0000 | Unwrought chromium powders | 169,000 | 2,940 | 262,000 | 4,200 | Mexico (26.3%); Canada (21.3%); Japan (17.4%); Germany (11.2%); United Kingdom (7.0%); China (6.3%); Brazil (3.9%); Singapore (1.2%). |
| 8112.22.0000 | Chromium metal waste and scrap | 227,000 | 4,260 | 208,000 | 3,730 | Japan (89%); Germany (6.8%); Singapore (1.7%); Taiwan (1.5%). |
| 8112.29.0000 | Chromium metal other than unwrought powders and waste and scrap | 628,000 | 9,680 | 545,000 | 13,300 | Japan (76.5%); Taiwan (5.0%); Singapore (4.6%); Germany (2.0%); United Kingdom (1.7%); Columbia (1.6%); Peru (1.2%); Israel (1.1%); China (1.0%). |
| | Total chromium metal | 1,020,000 | 16,900 | 1,020,000 | 21,300 | |
| | Chromium ferroalloys: | | | | | |
| 7202.41.0000 | High-carbon ferrochromium:[3] | | | | | |
| | Gross weight | 30,700,000 | 31,100 | 18,800,000 | 15,600 | Netherlands (63.5%); Canada (18.1%); Mexico (15.7%). |
| | Contained weight | 20,100,000 | XX | 11,200,000 | XX | |
| 7202.49.0000 | Low-carbon ferrochromium:[4] | | | | | |
| | Gross weight | 5,460,000 | 7,560 | 16,600,000 | 22,000 | Netherlands (71.3%); Mexico (11.2%); Canada (5.5%); Taiwan (3.2%); Brazil (1.9%); Republic of Korea (1.7%); United Kingdom (1.4%); Romania (1.2%). |
| | Contained weight | 3,540,000 | XX | 9,960,000 | XX | |
| 7202.50.0000 | Ferrochromium-silicon: | | | | | |
| | Gross weight | 147,000 | 186 | 248,000 | 480 | Mexico (51.6%); Canada (38.3%); Australia (7.6%); Chile (1.5%); Turkey (1.0%). |
| | Contained weight | 51,400 | XX | 96,500 | XX | |
| | Total chromium ferroalloys: | | | | | |
| | Gross weight | 36,300,000 | 38,900 | 35,700,000 | 38,100 | |
| | Contained weight | 23,700,000 | XX | 21,300,000 | XX | |
| | Chemicals, gross weight: | | | | | |
| | Chromium oxides: | | | | | |
| 2819.10.0000 | Chromium trioxide | 9,000,000 | 11,000 | 9,560,000 | 11,800 | United Kingdom (20.2%); India (16.6%); Brazil (15.4%); Republic of Korea (7.7%); Taiwan (5.5%); Belgium (3.7%); Chile (3.6%); China (3.3%); Mexico (3.0%); South Africa (2.8%); France (2.7%); Thailand (2.1%); Columbia (1.7%); Indonesia (1.7%); Japan (1.7%); Pakistan (1.3%); Germany (1.1%); Canada (1.0%). |
| 2819.90.0000 | Other | 1,660,000 | 7,300 | 2,180,000 | 8,730 | Canada (27.9%); France (15.8%); Brazil (11.2%); Republic of Korea (5.7%); Australia (4.4%); Thailand (3.8%); Chile (3.5%); China (3.0%); Malaysia (3.0%); Philippines (2.6%); Germany (2.4%); Mexico (2.3%); Taiwan (2.1%); Japan (1.8%); Argentina (1.7%); United Kingdom (1.7%). |
| | Total chromium oxides | 10,700,000 | 18,300 | 11,700,000 | 20,500 | |
| 2833.23.0000 | Chromium sulfates | 78,900 | 376 | 34,600 | 145 | Canada (26.3%); Republic of Korea (24.8%); Singapore (17.2%); Hong Kong (16.2%); Dominican Republic (8.1%); United Kingdom (3.4%); Taiwan (2.5%); India (1.6%). |
| | Salts of oxometallic or peroxometallic acids: | | | | | |
| 2841.20.0000 | Zinc and lead chromate | 65,500 | $269 | 73,800 | $703 | Canada (44.8%); Trinidad and Tobago (24.2%); Mexico (11.4%); Netherlands Antilles (6.2%); Guatemala (3.4%); Antigua (3.3%); Singapore (1.9%); Jamaica (1.4%); Hungary (1.1%). |
| 2841.30.0000 | Sodium dichromate | 37,200,000 | 25,000 | 28,900,000 | 20,700 | Japan (70.8%); Canada (9.2%); Germany (5.0%); Mexico (3.7%); Peru (2.4%) Taiwan (1.6%); Republic of Korea (1.3%); Philippines (1.2%); Brazil (1.1%). |
| 2841.50.0000 | Other chromates, dichromates, and peroxochromates: | | | | | |
| 2841.50.1000 | Potassium dichromate | 127,000 | 285 | 181,000 | 497 | Canada (99.4%). |

TABLE 4—Continued
U.S. EXPORTS OF CHROMIUM MATERIALS, BY TYPE[1]

| HTS[2] code | Type | 2005 Quantity (kilograms) | 2005 Value (thousands) | 2006 Quantity (kilograms) | 2006 Value (thousands) | Principal destinations in 2006 |
|---|---|---|---|---|---|---|
| | Chemicals, gross weight—Continued: | | | | | |
| | Salts of oxometallic or peroxometallic acids—Continued: | | | | | |
| 2841.50.0000 | Other chromates, dichromates, and peroxochromates—Continued: | | | | | |
| 2841.50.9000 | Other | 529,000 | 1,650 | 667,000 | 2,570 | Hong Kong (35.6%); China (16.5%); Canada (10.7%); Taiwan (7.6%); Mexico (6.7%); Republic of Korea (5.3%); Indonesia (3.2%); Belgium (2.8%); United Kingdom (2.5%); Thailand (1.6%); India (1.3%); Argentina (1.2%). |
| | Total salts | 37,900,000 | 27,200 | 29,900,000 | 24,400 | |
| 3206.20.0000 | Pigments and preparations, gross weight | 767,000 | 4,090 | 1,330,000 | 6,620 | Canada (27.9%); Australia (22.7%); Mexico (19.2%); Colombia (5.1%); Germany (2.3%); Brazil (2.2%); Guatemala (2.2%); Jamaica (1.9%); Italy (1.6%); Barbados (1.5%); Republic of Korea (1.5%); Taiwan (1.5%); China (1.1%); Peru(1.0%). |

XX Not applicable.
[1]Data are rounded to no more than three significant digits; may not add to totals shown.
[2]Harmonized Tariff Schedule of the United States of America.
[3]More than 4% carbon.
[4]Not more than 4% carbon.

TABLE 5
U.S. IMPORTS FOR CONSUMPTION OF FERROCHROMIUM, BY COUNTRY[1]

| Country | Not more than 0.5% carbon (HTS[2] code 7202.49.5090) | | | More than 0.5% but not more than 3% carbon (HTS[2] code 7202.49.5010) | | | More than 3% but not more than 4% carbon (HTS[2] code 7202.49.1000) | | |
|---|---|---|---|---|---|---|---|---|---|
| | Quantity | | | Quantity | | | Quantity | | |
| | Gross weight (metric tons) | Cr content (metric tons) | Value (thousands) | Gross weight (metric tons) | Cr content (metric tons) | Value (thousands) | Gross weight (metric tons) | Cr content (metric tons) | Value (thousands) |
| 2005: | | | | | | | | | |
| Australia | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| China | 94 | 66 | 212 | -- | -- | -- | -- | -- | -- |
| France | 4 | 3 | 8 | -- | -- | -- | -- | -- | -- |
| Germany | 5,810 | 4,070 | 11,700 | -- | -- | -- | -- | -- | -- |
| India | -- | -- | -- | 20 | 13 | 17 | -- | -- | -- |
| Japan | 2,870 | 2,010 | 8,130 | -- | -- | -- | -- | -- | -- |
| Kazakhstan | 3,910 | 2,680 | 5,880 | 870 | 601 | 1,370 | -- | -- | -- |
| Mexico | 41 | 34 | 72 | -- | -- | -- | -- | -- | -- |
| Russia | 27,300 | 18,800 | 39,600 | 1,830 | 1,240 | 2,030 | -- | -- | -- |
| South Africa | 2,950 | 1,630 | 2,760 | 810 | 446 | 905 | -- | -- | -- |
| Sweden | 38 | 27 | 136 | -- | -- | -- | -- | -- | -- |
| Turkey | 5 | 3 | 12 | -- | -- | -- | -- | -- | -- |
| Zimbabwe | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| Total | 43,000 | 29,300 | 68,500 | 3,530 | 2,300 | 4,330 | -- | -- | -- |
| 2006: | | | | | | | | | |
| Brazil | 19 | 14 | 47 | -- | -- | -- | -- | -- | -- |
| China | 710 | 475 | 1,220 | 10 | 7 | 16 | -- | -- | -- |
| Germany | 5,910 | 4,140 | 12,700 | -- | -- | -- | -- | -- | -- |
| India | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| Japan | 2,770 | 1,920 | 8,800 | -- | -- | -- | -- | -- | -- |
| Kazakhstan | 3,330 | 2,310 | 4,730 | -- | -- | -- | -- | -- | -- |
| Mexico | 20 | 13 | 65 | -- | -- | -- | -- | -- | -- |
| Russia | 13,400 | 9,300 | 18,700 | -- | -- | -- | -- | -- | -- |
| South Africa | 1,800 | 1,060 | 1,410 | 19 | 16 | 20 | -- | -- | -- |
| Sweden | 35 | 25 | 121 | -- | -- | -- | -- | -- | -- |
| Tajikistan | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| Turkey | 102 | 65 | 276 | -- | -- | -- | -- | -- | -- |
| Zimbabwe | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| Total | 28,100 | 19,300 | 48,000 | 29 | 23 | 35 | -- | -- | -- |

See footnotes at end of table.

TABLE 5—Continued
U.S. IMPORTS FOR CONSUMPTION OF FERROCHROMIUM, BY COUNTRY[1]

| Country | More than 4% carbon (HTS[2] code 7202.41.0000) Quantity: Gross weight (metric tons) | Cr content (metric tons) | Value (thousands) | Total all grades Quantity: Gross weight (metric tons) | Cr content (metric tons) | Value (thousands) |
|---|---|---|---|---|---|---|
| 2005: | | | | | | |
| Australia | 13 | 9 | 11 | 13 | 9 | 11 |
| China | 13 | 8 | 11 | 107 | 74 | 223 |
| France | -- | -- | -- | 4 | 3 | 8 |
| Germany | -- | -- | -- | 5,810 | 4,070 | 11,700 |
| India | 20 | 12 | 16 | 40 | 24 | 33 |
| Japan | -- | -- | -- | 2,870 | 2,010 | 8,130 |
| Kazakhstan | 115,000 | 79,400 | 112,000 | 119,000 | 82,700 | 119,000 |
| Mexico | -- | -- | -- | 41 | 34 | 72 |
| Russia | 35,100 | 23,000 | 28,900 | 64,300 | 43,000 | 70,500 |
| South Africa | 187,000 | 93,600 | 115,000 | 190,000 | 95,600 | 119,000 |
| Sweden | 260 | 173 | 293 | 298 | 201 | 428 |
| Turkey | -- | -- | -- | 5 | 3 | 12 |
| Zimbabwe | 61,200 | 36,200 | 47,500 | 61,200 | 36,200 | 47,500 |
| Total | 398,000 | 232,000 | 303,000 | 444,000 | 264,000 | 376,000 |
| 2006: | | | | | | |
| Brazil | -- | -- | -- | 19 | 14 | 47 |
| China | -- | -- | -- | 720 | 481 | 1,240 |
| Germany | -- | -- | -- | 5,910 | 4,140 | 12,700 |
| India | 70 | 51 | 51 | 70 | 51 | 51 |
| Japan | -- | -- | -- | 2,770 | 1,920 | 8,800 |
| Kazakhstan | 98,800 | 68,800 | 85,300 | 102,000 | 71,100 | 90,000 |
| Mexico | -- | -- | -- | 20 | 13 | 65 |
| Russia | 44,400 | 28,600 | 30,000 | 57,700 | 37,900 | 48,600 |
| South Africa | 190,000 | 97,000 | 114,000 | 192,000 | 98,100 | 115,000 |
| Sweden | 557 | 374 | 633 | 592 | 399 | 754 |
| Tajikistan | 101 | 69 | 140 | 101 | 69 | 140 |
| Turkey | -- | -- | -- | 102 | 65 | 276 |
| Zimbabwe | 59,000 | 34,600 | 43,000 | 59,000 | 34,600 | 43,000 |
| Total | 393,000 | 230,000 | 273,000 | 421,000 | 249,000 | 321,000 |

-- Zero.
[1]Data are rounded to no more than three significant digits; may not add to totals shown.
[2]Harmonized Tariff Schedule of the United States of America.

Source: U.S. Census Bureau.

TABLE 6
U.S. IMPORTS FOR CONSUMPTION OF CHROMIUM MATERIALS, BY TYPE[1]

| HTS[2] code | Type | 2005 Quantity (kilograms) | 2005 Value[3] (thousands) | 2006 Quantity (kilograms) | 2006 Value[3] (thousands) | Principal sources in 2006 |
|---|---|---|---|---|---|---|
| | Chromite ore: | | | | | |
| 2610.00.0020 | Not more than 40% $Cr_2O_3$: | | | | | |
| | Gross weight | 36,000 | $17 | 117,000 | $9 | China (93.2%); Canada (6.8%). |
| | $Cr_2O_3$ content | 11,000 | XX | 45,000 | XX | |
| 2610.00.0040 | More than 40%, but less than 46% $Cr_2O_3$: | | | | | |
| | Gross weight | 29,700,000 | 2,400 | 3,810,000 | 674 | South Africa (100%). |
| | $Cr_2O_3$ content | 13,700,000 | XX | 1,750,000 | XX | |
| 2610.00.0060 | 46% or more $Cr_2O_3$: | | | | | |
| | Gross weight | 135,000,000 | 20,700 | 146,000,000 | 22,800 | South Africa (100%). |
| | $Cr_2O_3$ content | 63,600,000 | XX | 76,300,000 | XX | |
| | Total chromite ore: | | | | | |
| | Gross weight | 165,000,000 | 23,100 | 150,000,000 | 23,500 | |
| | $Cr_2O_3$ content | 77,300,000 | XX | 78,100,000 | XX | |
| | Chromium ferroalloys: | | | | | |
| 7202.49.5090 | Not more than 0.5% carbon: | | | | | |
| | Gross weight | 43,000,000 | 68,500 | 28,100,000 | 48,000 | Russia (47.6%); Germany (21.1%); Kazakhstan (11.9%); Japan (9.9%); |
| | Cr content | 29,300,000 | XX | 19,300,000 | XX | South Africa (6.4%); China (2.5%). |
| 7202.49.5010 | More than 0.5%, but less than 3% carbon: | | | | | |
| | Gross weight | 3,530,000 | 4,330 | 29,000 | 35,500 | South Africa (65.5%); China (34.5%). |
| | Cr content | 2,300,000 | XX | 22,700 | XX | |
| 7202.49.1000 | More than 3%, but less than 4% carbon: | | | | | |
| | Gross weight | -- | -- | -- | -- | |
| | Cr content | -- | XX | -- | XX | |
| 7202.41.0000 | More than 4% carbon: | | | | | |
| | Gross weight | 398,000,000 | 303,000 | 393,000,000 | 273,000 | South Africa (48.4%); Kazakhstan (25.1%); Zimbabwe (15.0%); Russia (11.3%). |
| | Cr content | 232,000,000 | XX | 230,000,000 | XX | |
| 7202.50.0000 | Ferrochromium-silicon: | | | | | |
| | Gross weight | 33,700,000 | 31,600 | 38,300,000 | 32,200 | Kazakhstan (65.3%); Russia (22.8%); South Africa (11.7%). |
| | Cr content | 14,100,000 | XX | 15,900,000 | | |
| | Total chromium ferroalloys: | | | | | |
| | Gross weight | 478,000,000 | 408,000 | 459,000,000 | 389,000 | |
| | Cr content | 278,000,000 | XX | 265,000,000 | XX | |
| | Chromium metal, gross weight: | | | | | |
| 8112.21.1000 | Unwrought chromium powders | 1,050,000 | 15,000 | 1,250,000 | 17,000 | Russia (51.6%); China (17.7%); United Kingdom (14.5%); Japan (11.2%); Germany (2.3%); Spain (1.5%). |
| 8112.22.0000 | Waste and scrap | 57,500 | 564 | 90,400 | 864 | Singapore (47.9%); Japan (26.6%); Germany (12.0%); United Kingdom (11.2%); Taiwan (1.3%); France (0.9%). |
| 8112.29.0000 | Other than waste and scrap | 9,850,000 | 72,100 | 9,540,000 | 71,100 | Russia (28.9%); France (26.5%); China (26.1%); United Kingdom (14.9%); Spain (2.5%); Germany (0.6%). |
| | Total chromium metal | 11,000,000 | 87,700 | 10,900,000 | 89,000 | |
| | Chemicals, gross weight: | | | | | |
| | Chromium oxides and hydroxides: | | | | | |
| 2819.10.0000 | Chromium trioxide | 11,400,000 | 21,600 | 9,090,000 | 17,900 | Turkey (50.4%); Kazakhstan (30.2%); United Kingdom (6.6%); South Africa (5.7%); China (4.4%); Colombia (1.5%); Germany (0.8%). |
| 2819.90.0000 | Other | 3,200,000 | 11,000 | 2,300,000 | 8,080 | China (66.0%); Germany (15.5%); Japan (9.4%); United Kingdom (5.2%); Russia (1.3%); Israel (0.8%); Poland (.8%). |
| | Total oxides | 14,600,000 | 32,600 | 11,400,000 | 26,000 | |
| 2833.23.0000 | Sulfates of chromium | 288,000 | 438 | 422,000 | 823 | United Kingdom (86.3%); China (8.1%); India (5.6%). |

See footnotes at end of table.

TABLE 6—Continued
U.S. IMPORTS FOR CONSUMPTION OF CHROMIUM MATERIALS, BY TYPE[1]

| HTS[2] code | Type | 2005 Quantity (kilograms) | 2005 Value[3] (thousands) | 2006 Quantity (kilograms) | 2006 Value[3] (thousands) | Principal sources in 2006 |
|---|---|---|---|---|---|---|
| | Salts of oxometallic or peroxometallic acids: | | | | | |
| 2841.20.0000 | Chromates of lead and zinc | 614,000 | 1,440 | 416,000 | 1,060 | Republic of Korea (73.7%); Colombia (20.1%); Austria (2.4%); Japan (2.4%); China (1.5%). |
| 2841.30.0000 | Sodium dichromate | 8,980,000 | 5,360 | 16,100,000 | 11,000 | United Kingdom (98.4%); China (1.0%). |
| 2841.50.0000 | Other chromates and dichromates; Peroxochromates: | | | | | |
| 2841.50.1000 | Potassium dichromate | 84,000 | 156 | 4,450 | 32 | India (44.9%); Mexico (37.1%); Japan (18.0%). |
| 2841.50.9000 | Other | 212,000 | 507 | 299,000 | 676 | Austria (76.5%); China (23.1%). |
| | Total salts: | 9,890,000 | 7,460 | 16,800,000 | 12,700 | |
| 2849.90.2000 | Chromium carbide | 131,000 | $2,150 | 126,000 | $2,000 | Japan (46.2%); Canada (18.0%); Germany (13.5%); Austria (12.0%); United Kingdom (9.9%). |
| | Pigments and preparations based on chromium, gross weight: | | | | | |
| 3206.20.0010 | Chrome yellow | 4,770,000 | 13,600 | 4,080,000 | 12,600 | Canada (39.2%); Republic of Korea (28.1%); China (12.7%); Mexico (12.3%); Czech Republic (2.2%); Germany (1.6%); Colombia (1.2%); Japan (1.2%); Venezuela (1.2%). |
| 3206.20.0020 | Molybdenum orange | 983,000 | 4,780 | 822,000 | 5,110 | Canada (87.3%); Mexico (8.5%); India (1.7%); Germany (1.5%). |
| 3206.20.0030 | Zinc yellow | 11,000 | 28 | 31,000 | 78 | Germany (54.9%); China (25.8%); Mexico (19.3%). |
| 3206.20.0050 | Other | 1,750,000 | 3,700 | 1,620,000 | 3,880 | France (60.0%); Canada (23.0%); China (6.5%); Poland (3.5%); Japan (2.8%); |
| | Total pigments: | 7,510,000 | 22,100 | 6,550,000 | 21,600 | |

XX Not applicable. -- Zero.
[1]Data are rounded to no more than three significant digits; may not add to totals shown.
[2]Harmonized Tariff Schedule of the United States of America code.
[3]Customs import value generally represents a value in the foreign country and therefore excludes U.S. import duties, freight, insurance, and other charges incurred in bringing the merchandise into the United States.

TABLE 7
WORLD PRODUCTION CAPACITY OF CHROMITE ORE, FERROCHROMIUM, CHROMIUM METAL, CHROMIUM CHEMICALS, AND STAINLESS STEEL, AND APPARENT CONSUMPTION IN 2005[1]

(Thousand metric tons of contained chromium)

| | Production capacity | | | | | |
|---|---|---|---|---|---|---|
| Country | Ore | Ferrochromium | Metal | Chemicals | Stainless steel | Apparent consumption[2] |
| Afghanistan | 2 | -- | -- | -- | -- | -- |
| Albania | 48 | 24 | -- | -- | -- | 28 |
| Argentina | -- | -- | -- | 13 | -- | 21 |
| Australia | 78 | -- | -- | -- | -- | -52 |
| Austria | -- | -- | -- | -- | 8 | 100 |
| Belgium | -- | -- | -- | -- | 120 | 104 |
| Brazil | 197 | 113 | -- | -- | 96 | 180 |
| Canada | -- | -- | -- | -- | -- | 24 |
| China | 69 | 468 | 6 | 70 | 595 | 1,070 |
| Cuba | 13 | -- | -- | -- | -- | 4 |
| Czech Republic | -- | -- | -- | -- | 2 | -- |
| Finland | 174 | 138 | -- | -- | 221 | 164 |
| France | -- | -- | 7 | -- | 112 | 97 |
| Germany | -- | 18 | 1 | -- | 298 | 261 |
| Greece | 1 | -- | -- | -- | -- | (3) |
| India | 980 | 318 | (3) | 4 | 306 | 530 |
| Indonesia | -- | -- | -- | -- | -- | -31 |
| Iran | 67 | 12 | -- | 2 | -- | (3) |
| Italy | -- | -- | -- | -- | 272 | 235 |
| Japan | 1 | 8 | 1 | 17 | 714 | 563 |
| Kazakhstan | 1,080 | 637 | 2 | 37 | -- | 395 |
| Korea, Republic of | -- | -- | -- | -- | 425 | 266 |
| Madagascar | 42 | -- | -- | -- | -- | 35 |
| Oman | 9 | -- | -- | -- | -- | -13 |
| Pakistan | 45 | -- | -- | 3 | -- | -6 |
| Philippines | 21 | -- | -- | -- | -- | -4 |
| Poland | -- | -- | -- | -- | -- | 3 |
| Russia | 232 | 333 | 16 | 31 | 17 | 313 |
| Slovakia | -- | 1 | -- | -- | -- | (3) |
| Slovenia | -- | -- | -- | -- | 13 | -1 |
| South Africa | 2,300 | 1,540 | -- | 23 | 122 | 616 |
| Spain | -- | -- | -- | -- | 204 | 107 |
| Sudan | 11 | -- | -- | -- | -- | -- |
| Sweden | -- | 81 | -- | -- | 119 | 77 |
| Taiwan | -- | -- | -- | -- | 272 | 212 |
| Turkey | 259 | 23 | -- | 17 | -- | 35 |
| Ukraine | -- | -- | -- | -- | 19 | (3) |
| United Arab Emirates | 2 | -- | -- | -- | -- | (3) |
| United Kingdom | -- | -- | 7 | 17 | 85 | 66 |
| United States | -- | 20 | 3 | 38 | 425 | 266 |
| Vietnam | 59 | -- | -- | -- | -- | -- |
| Yugoslavia | -- | -- | -- | -- | 91 | -- |
| Zimbabwe | 247 | 165 | -- | -- | -- | 127 |
| Total | 5,930 | 3,900 | 43 | 272 | 4,540 | XX |

XX Not applicable. -- Zero.

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

[2]Apparent consumption is chromite ore production plus chromite ore, ferrochromium, and chromium metal net imports. Net imports are imports minus exports. Based on data reported by the International Chromium Development Association. A negative apparent consumption indicates that exports are greater than production plus imports.

[3]Less than ½ unit.

TABLE 8
CHROMITE: WORLD PRODUCTION, BY COUNTRY[1, 2]

(Metric tons, gross weight)

| Country[3] | 2002 | 2003 | 2004 | 2005 | 2006 |
|---|---|---|---|---|---|
| Afghanistan[4] | 6,136 | 6,364 | 6,591 | 6,818 r | NA |
| Albania[5] | 72,600 | 98,000 | 54,430 | 66,270 | 65,000 |
| Australia | 132,665 | 248,969 r | 265,987 | 241,865 | 252,867 |
| Brazil[6] | 283,991 | 376,862 r | 593,476 | 615,904 r | 615,900 p |
| Burma | 318 r | 341 r | 364 r | 409 r | NA |
| China[e] | 180,000 | 200,000 | 200,000 | 200,000 | 200,000 |
| Cuba | 20,400 | 33,300 | 40,300 | 34,000 r | 34,000 e |
| Finland | 566,090 | 549,040 | 579,780 | 572,000 r | 548,713 |
| India | 2,698,577 | 2,210,000 | 2,948,944 | 3,255,162 | 3,600,400 |
| Iran | 512,640 | 97,238 | 138,775 | 223,563 | 225,000 e |
| Kazakhstan | 2,369,400 | 2,927,500 | 3,267,000 | 3,579,000 | 3,600,000 e |
| Madagascar | 11,000 | 45,040 | 77,386 | 140,847 | 132,335 |
| Oman | 27,444 | 13,000 | 18,585 | 18,386 | 70,500 |
| Pakistan | 62,005 | 98,235 | 129,500 | 148,432 | 199,000 |
| Philippines | 22,000 r | 33,780 r | 42,140 r | 38,081 r | 46,728 |
| Russia | 74,300 | 116,455 | 320,200 | 772,000 | 966,065 |
| South Africa | 6,435,746 | 7,405,391 | 7,645,000 r | 7,493,000 r | 7,418,326 p |
| Sudan | 14,000 | 37,000 | 26,000 | 21,654 | 22,000 e |
| Turkey | 313,637 | 229,294 | 506,421 | 858,729 | 1,059,901 |
| United Arab Emirates | -- | -- | 7,089 | -- | -- |
| Vietnam | 66,300 r | 91,000 r | 82,000 r | 89,000 r | 90,000 e |
| Zimbabwe | 749,339 | 637,099 | 668,391 | 614,720 r | 600,000 e |
| Total | 14,600,000 r | 15,500,000 r | 17,600,000 r | 19,000,000 r | 19,700,000 |

eEstimated. pPreliminary. rRevised. NA Not available. -- Zero.
[1]World totals and estimated data are rounded to no more than three significant digits; may not add to totals shown.
[2]Table includes data available through August 10, 2007.
[3]Figures for all countries represent marketable output unless otherwise noted.
[4]Gross weight estimated assuming an average grade of 44% chromic oxide ($Cr_2O_3$).
[5]Direct shipping plus concentrate production.
[6]Average chromic oxide ($Cr_2O_3$) content was as follows: 2002–40.1%; 2003–41.1%; and 2004-06–42.6%.

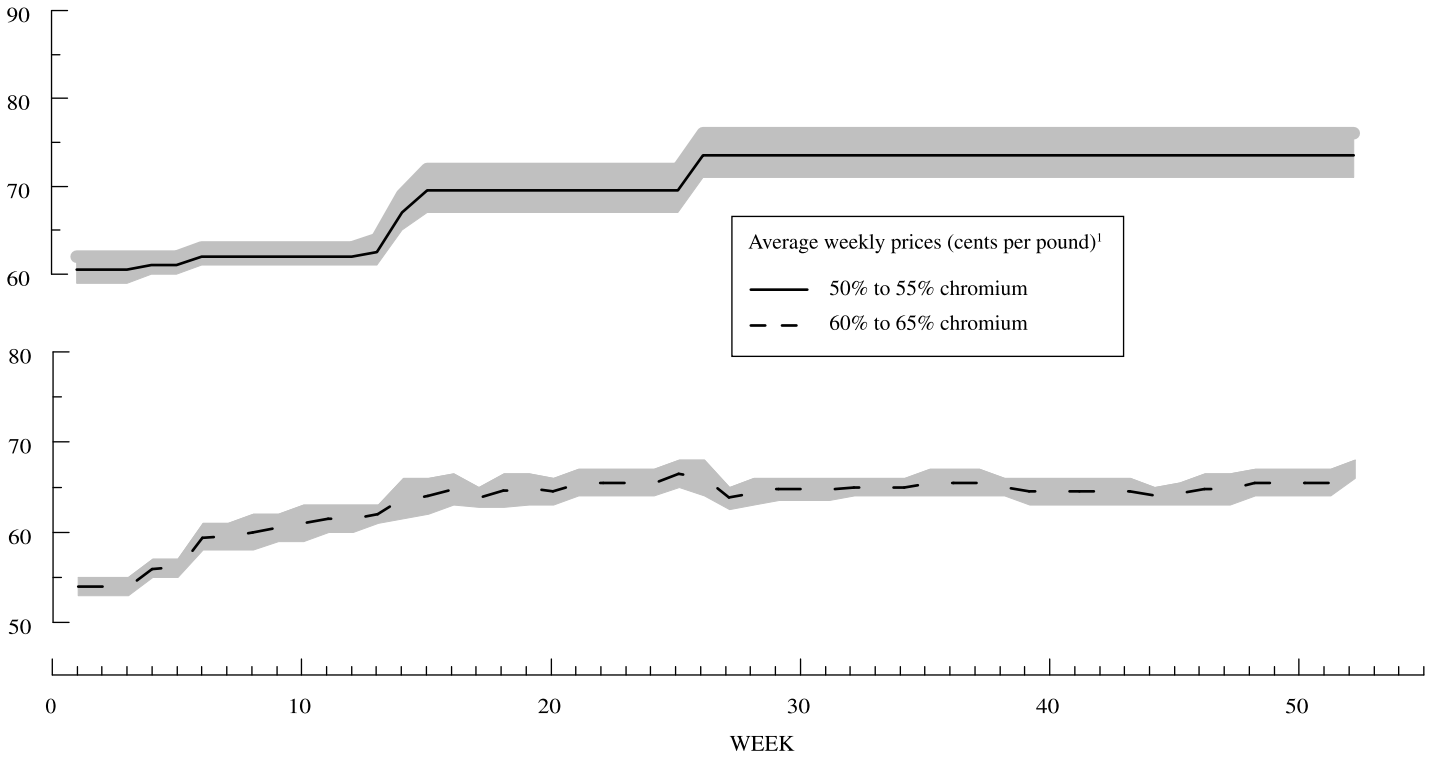
TABLE 9
FERROCHROMIUM: WORLD PRODUCTION, BY COUNTRY[1, 2]

(Metric tons, gross weight)

| Country | 2002 | 2003 | 2004 | 2005 | 2006 |
|---|---|---|---|---|---|
| Albania | 22,100 | 37,800 | 47,700 | 35,780 | 35,000 e |
| Brazil[3] | 164,140 | 204,339 | 216,277 | 197,653 r | 200,000 p |
| China[e] | 330,000 | 500,000 | 640,000 | 850,000 r | 1,000,000 |
| Finland | 248,181 | 250,490 | 264,492 | 234,881 | 243,350 |
| Germany | 20,018 | 18,318 | 24,857 | 22,672 | 26,710 |
| India[4] | 311,927 | 468,677 | 527,100 | 611,373 | 634,200 |
| Iran[e] | 8,000 | 10,000 | 7,750 [5] | 8,000 | 8,000 |
| Japan[3] | 91,937 | 19,427 | 13,472 | 12,367 | 13,056 |
| Kazakhstan | 835,800 | 993,000 | 1,080,993 | 1,156,168 | 1,200,000 e |
| Norway | 61,100 | -- | -- | -- | -- |
| Russia | 210,000 | 357,000 | 454,000 e | 578,000 | 600,000 e |
| Slovakia | 5,695 | 1,924 | 1,784 | 867 | 19 |
| South Africa[6] | 2,351,122 | 2,813,000 | 2,965,000 | 2,812,000 r | 3,030,000 |
| Sweden | 118,823 | 110,529 | 128,191 | 127,451 | 136,374 |
| Turkey | 11,200 | 35,393 | 33,686 r | 26,043 | 67,975 |
| United States[7] | W | W | W | W | W |
| Zimbabwe | 258,164 | 245,200 | 193,077 | 235,000 | 200,000 e |
| Total | 5,050,000 | 6,070,000 | 6,600,000 r | 6,910,000 r | 7,390,000 |

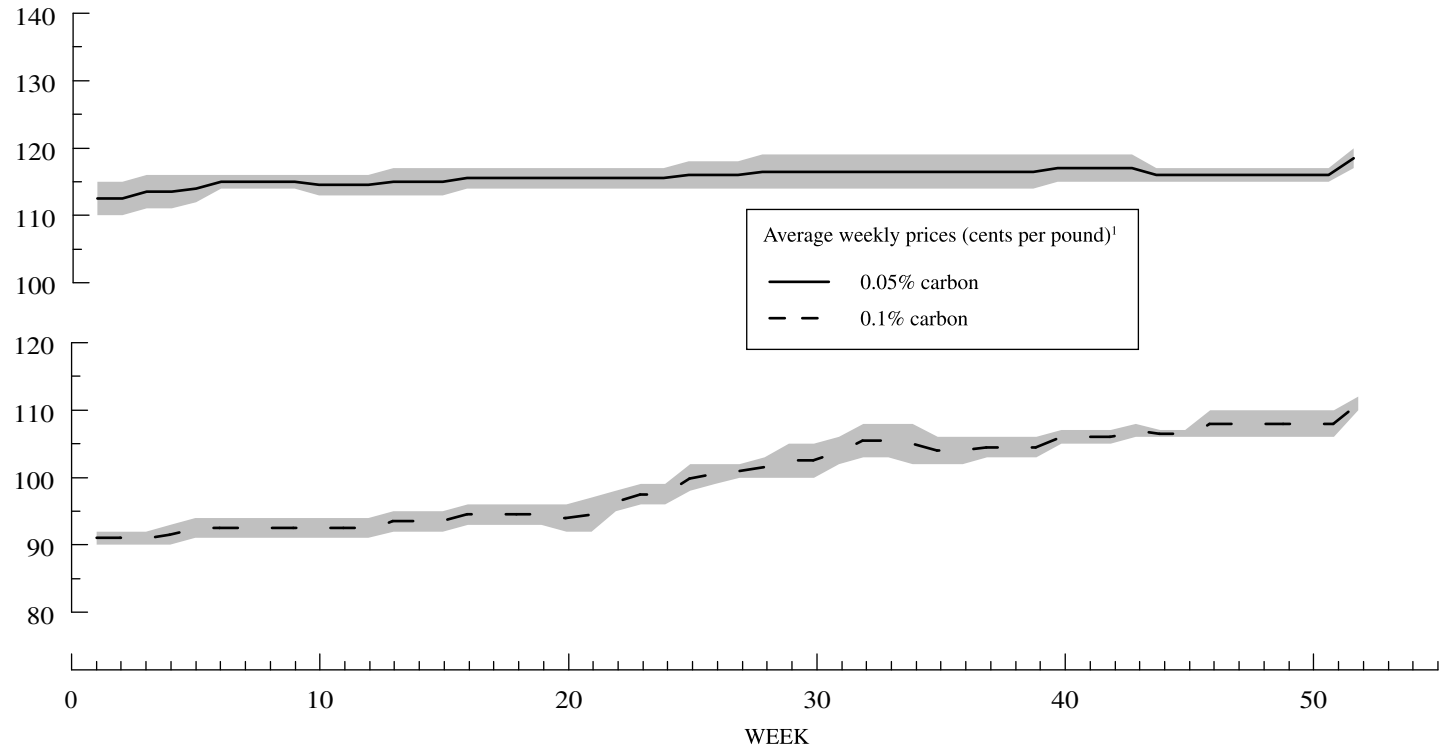
eEstimated. pPreliminary. rRevised. W Withheld to avoid disclosing company proprietary data; not included in "Total." -- Zero.
[1]World totals, U.S. data, and estimated data are rounded to no more than three significant digits; may not add to totals shown.
[2]Table inculdes data available through August 10, 2007.
[3]Includes high- and low-carbon ferrochromium.
[4]Includes ferrochrome and charge chrome.
[5]Reported figure.
[6]Includes high- and low-carbon ferrochromium and ferrochromiumsilicon.
[7]Includes chromium metal, high- and low-carbon ferrochromium, ferrochromiumsilicon, and other chromium materials.

FIGURE 1
U.S. IMPORTED HIGH-CARBON FERROCHROMIUM IN 2006




[1]Average weekly price shown against price range background.
Source: Platts Metals Week.

FIGURE 2
U.S. IMPORTED LOW-CARBON FERROCHROMIUM IN 2006




[1]Average weekly price shown against price range background.
Source: Platts Metals Week.