CHROMIUM

By John F. Papp

In the United States, chromium apparent consumption was about 488,000 metric tons-contained chromium, a 1.7% increase over that of 1996. U.S. supply (measured in contained chromium) was 120,000 tons from recycled stainless steel scrap, 350,000 tons from imports, and 1.14 million tons from government and industry stocks. Supply distribution was 30,300 tons to exports and 1.09 million tons to government and industry stocks. The reported consumption of chromite ore, chromium ferroalloys, and chromium metal measured in contained chromium increased by 25%.

The United States exported about 73,500 tons-gross weight of chromium-containing materials valued at about $107 million. Both the quantity and value of chromium material exports decreased; quantity by 46%, value by 3.8%. The United States imported about 765,000 tons-gross weight of chromium-containing materials valued at about $450 million. Compared with those of 1996, the quantity of chromium material imports increased by 1.7% while their value decreased by 2.9%.

Chromium has a wide range of uses in metals, chemicals, and refractories. Chromium use in iron, steel, and nonferrous alloys enhances hardenability and resistance to corrosion and oxidation; production of stainless steel and nonferrous alloys are two of its more important applications. Other applications are in alloy steel, plating of metals, pigments, leather processing, catalysts, surface treatments, and refractories.

Because the United States has no 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 resources, mining capacity, and ferrochromium production capacity are concentrated in the Eastern Hemisphere. World chromite ore reserves are more than adequate to meet anticipated world demand. In recognition of the vulnerability of long supply routes during a military emergency, chromium is held in the National Defense Stockpile (NDS) in various forms, including chromite ore, chromium ferroalloys, and chromium metal. As a result of improved national security, stockpile goals have been reduced and inventory is being sold. Recycling is the only domestic supply source of chromium.

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, and the U.S. Department of Energy conduct alternative materials research.

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 regulates workplace exposure.

Legislation and Government Programs

The Defense Logistics Agency (DLA) disposed of chromium materials under its fiscal year (FY) 1997 (October 1, 1996 through September 30, 1997) Annual Materials Plan. DLA's FY 1997 AMP (as revised in April) set maximum disposal goals of 90,700 tons of chemical grade chromite ore; 227,000 tons of metallurgical grade chromite ore; 90,700 tons of refractory grade chromite ore; and 31,700 tons of chromium ferroalloys. DLA also developed its FY 1998 AMP, which set maximum disposal goals of 90,700 tons of chemical grade chromite ore; 227,000 tons of metallurgical grade chromite ore; 90,700 tons of refractory grade chromite ore; and 45,400 tons of chromium ferroalloy. At the end of 1997, the NDS held 2.12 million tons of chromium material comprising 1.09 million tons of chromite ore, 1.02 million tons of chromium ferroalloys, and 7,720 tons of chromium metal. *(See table 6.)*

The EPA extended Toxic Release Inventory reporting requirements to seven industry groups including metal mining, coal mining, electric utilities, and commercial hazardous waste treatment facilities under authority of the Emergency Planning and Community Right-to-Know Act of 1986. These industries were to start reporting for calendar year 1998 (U.S. Environmental Protection Agency, 1997a).

The EPA regulated solid waste disposal of wood treatment waste by setting treatment standards and excluded printed circuit boards and scrap metal from Resource Conservation and Recovery Act regulation (U.S. Environmental Protection Agency, 1997b).

Production

The major marketplace chromium materials are chromite ore and chromium ferroalloys, metal, and chemicals. In 1997, the United States produced chromium ferroalloys, metal, and chemicals, but no chromite ore.

Domestic data for chromium materials are developed by the USGS by means of two separate surveys—"Chromite Ores and Chromium Products" (consumers, monthly) and "Ferroalloys" (producers, annual).

Consumption

Domestic consumption of chromite ore and concentrate was 350,000 tons in 1997. Chromium has a wide range of uses in the chemical, metallurgical, and refractory industries. In the metallurgical industry, its principal use in 1997 was in stainless

steel. Of the 388,000 tons of chromium ferroalloys, metal, and other chromium-containing materials reported consumed, stainless steel accounted for 76%; full-alloy steel, 8%; carbon steel, 4%; high-strength, low-alloy, and electric, 3%; superalloys, 2%; cast irons, 1%; and other end uses, 6%. The primary use of chromium in the refractory industry was in the form of chromite to make refractory bricks to line metallurgical furnaces.

The chemical industry consumed chromite for manufacturing sodium dichromate, chromic acid, and other chromium chemicals and pigments. Sodium dichromate is the material from which a wide range of chromium chemicals is made. *(See tables 1 and 4.)*

Domestic data coverage of the primary consuming industries—chemical, metallurgical, and refractory—are developed by the USGS by means of the voluntary monthly "Chromite Ores and Chromium Products" survey. The companies listed in table 2 account for 100% of the chromite consumption listed in table 1.

Stocks

Reported domestic consumer stocks of chromite ore at consumers' plants were 175,000 tons in 1997. At the 1997 annual rate of chromite ore consumption, consumer stocks represented 6 months of supply. Producer stocks of chromium ferroalloys, metal, and other chromium materials were 10,900 tons in 1997. Consumer stocks of chromium ferroalloys, metal, and other chromium materials were 16,700 tons in 1997. At the 1997 annual rate of chromium ferroalloy, chromium metal, and other chromium material consumption, producer plus consumer stocks represented 0.9 month of supply. The Government maintained the National Defense Stockpile. *(See tables 3, 4, and 5.)* Government inventories are declining as the Defense Logistics Agency disposes of stocks.

Prices

Chromium materials are not openly traded. Purchase contracts are confidential information between buyer and seller. However, trade journals report composite prices based on interviews with buyers and sellers, and importers declare the value of materials they trade. Thus industry publications and U.S. import data are a source of chromium material prices and values, respectively. *(See tables 1, 7, 8, and figures 1 and 2.)*

Foreign Trade

Chromium material exports from and imports to the United States included chromite ore and chromium chemicals, ferroalloys, metal, and pigments. *(See tables 9 through 12.)* The amount of foreign trade in 1997 of these chromium materials measured in dollars was $343 million for exports and $450 million for imports.

World Review

The major world chromite-ore-producing countries are India, Kazakstan, South Africa, and Turkey. Brazil, Finland, and Zimbabwe are smaller but significant chromite-ore-producing countries. Most chromite ore is smelted in electric arc furnaces to produce ferrochromium for use by the metallurgical industry. Stainless steel manufacture is the major end use of ferrochromium. A small amount of chromite is kiln roasted to produce sodium dichromate, a chemical industry product. A very small amount of chromite ore is used, without chemical modification, as a refractory material. The major ferrochromium-producing country is South Africa. China, Finland, India, Japan, Kazakstan, Russia, and Zimbabwe are smaller but significant ferrochromium-producing countries. The major stainless-steel-producing areas of the world—Europe (including Western Europe and Scandinavia), Japan, and the United States—account for about 70% of world stainless steel production. Among eight producers in Europe, Germany has the largest share at 29%. Among four producers in Asia, Japan has the largest share at about 65%. Among three producers in the Americas, the United States has the largest share at about 80%. South Africa has 100% of African production. The major world chromium-chemical-producing countries are Kazakstan, Russia, the United Kingdom, and the United States. *(See tables 13 through 17.)*

The ferrochromium industry originally developed in close proximity to the stainless steel industry. In recent years, ferrochromium production capacity has moved to chromite-producing areas. The world chromium industry in 1997 operated with supply capacity in excess of demand. The last time demand exceeded supply was in the 1989-90 time period, causing prices to increase appreciably. The industry used its profits from the price increase to expand capacity by about 15% in the 1991-92 time period. Capacity expansions took place primarily in chromite-producing countries, with South Africa the country where most capacity was added. The dissolution of the former U.S.S.R. in 1991 and subsequent reorganization resulted in declining chromium demand in the former U.S.S.R. without loss of chromium-material production capacity. As a result, significant quantities of chromium raw materials, including chromite ore, ferrochromium, chromium chemicals, and chromium containing scrap, entered Western markets from the former U.S.S.R. The integration of the former Eastern bloc with the West exacerbated the already excess production capacity in the West. During this same time period, China increased utilization of its ferroalloy production capacity for ferrochromium production.

In 1992 and 1993, significant rationalizations took place in Western chromite mining and ferrochromium industries. Not all added capacity from the 1991-92 time period could be brought into production or fully utilized. The South African chromite ore and ferrochromium industry operated at 50% to 60% of design capacity to reduce supply in excess of world demand. Several ferrochromium producers idled furnaces or converted furnaces to ferromanganese production. The ferrochromium industry in Japan continued to be rationalized.

As 1994 drew to a close, chromium material supply from Kazakstan and Russia diminished. Western world stainless steel demand for chromium materials strengthened appreciably. Chromium demand moved closer to balance with demand, and ferrochromium price started to recover. Furnaces were planned to restart ferrochromium production. Even before all of existing

ferrochromium production capacity could be brought back into production, some new furnaces were planned in South Africa, and chromium recovery from slag processes was planned or implemented.

Further vertical integration of the chromium industry was taking place as Finland and South Africa increased their stainless steel production capacities. Two industry process trends evolved—chromium recovery from slag in the ferrochromium industry and supply of molten ferrochromium to stainless steel production. Both of these trends improve chromium recovery efficiency.

In 1995, chromite ore and ferrochromium prices strengthened. Ferrochromium production capacity was increased in South Africa through the renovation of idle equipment and the startup of new furnaces. Construction of more capacity was started. Chromite mine capacity was increased or planned to meet demand from current and planned ferrochromium consumers. The chromium industries of Finland and South Africa were vertically integrated, resulting in increased stainless steel production capacity in those countries, especially in South Africa. By yearend, world demand for stainless steel weakened as did ferrochromium prices.

In 1996, new furnaces were brought into production in South Africa and new processes that recover ferrochromium from slag were brought into production in South Africa and Zimbabwe. Southern African ferrochromium producers continued to enter into joint ventures with Asian stainless-steel-producing companies. Chromium ferroalloy prices ended the year lower than they began.

In 1997, South Africa consolidated its position as the leading chromite ore and ferrochromium producer. Some new mining capacity was developed, and previously negotiated joint ventures were implemented with concomitant reductions in ferrochromium production in Japan and elsewhere. The price of high-carbon ferrochromium increased over the year while that of low-carbon ferrochromium declined.

Industry Structure.—The chromium industry is composed primarily of chromite ore, ferrochromium, and stainless steel producers. Other industry components are chromium chemical and chromite refractory producers. There is a trend to vertical integration within the industry manifest both within and across national boundaries. Brazil, Finland, India, South Africa, and Turkey are countries that have vertically integrated chromium industries. They mine chromite ore, produce ferrochromium, and produce stainless steel. In Finland, Outokumpu Oy, a major share of which is state-owned, owns and operates the only chromite mining, ferrochromium production, and stainless steel production facilities, making it completely vertically integrated. In South Africa, chromium-related companies are privately owned. Typically, major shares of a company are owned by other companies and the remainder, if any, are openly traded. Samancor owns and operates chromite mining and ferrochromium production, and co-owns major stainless steel production facilities. Other chromite operations in South Africa are also vertically integrated. Bayer AG (Germany) owns a chromite mine and is constructing a chromium chemical plant to produce chemicals from ore. In Brazil, the mining and smelting of chromium is vertically integrated, but stainless steel production is independent of the mining and smelting operations. The major mining companies are subsidiaries of Cia. de Ferro Ligas da Bahia S.A. Stainless steel is produced primarily by Companhia Acos Especiais Itabira. Other chromite operations in Brazil are also vertically integrated. Bayer AG (Germany) owns a chromite mine and chromium chemical plant. Refractory chromite operations are also vertically integrated from chromite production through refractory material production. Chromite mining and ferrochromium production in India is mostly vertically integrated. Ferro Alloys Corp. is the only stainless steel producer in India that is integrated from chromite ore mining through ferrochromium and stainless steel production. In India, the chromium industry is composed of large and small producers. About 20 chromite mines produced ore. Major ferrochromium plants are licensed, and small plants are independent. There are many small ferrochromium and chromium chemical plants in India. In Japan, chromite ore production is minor and primarily for refractory industry use. Also in Japan, some ferrochromium producers are associated with stainless steel plants by location, ownership, or both. Russia produces large quantities of ferrochromium and chromium metal and moderate quantities of chromite ore. In Kazakstan, chromite ore mining and ferrochromium production are vertically integrated. In Turkey, the chromium industry is composed of large and small chromite ore producers, with one major producer, Etibank, integrated from mining through ferrochromium production. The chromium industry of Zimbabwe is composed of large companies vertically integrated from chromite mine production through ferrochromium production, small independent chromite mines, and chromite mines operated independently on behalf of the large vertically integrated companies. In China, the chromium industry is concentrated on ferrochromium production from imported ore. Only minor amounts of chromite ore and stainless steel are produced in China. In China, a few major plants produce ferrochromium or chromium chemicals while many small producers also operate. Elkem integrated its high-carbon ferrochromium production across international boundaries utilizing chromite ore of Brazilian origin to feed its Norwegian smelter.

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 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 production capacity information available, historical chromium trade data have been used to estimate production capacity. Estimates of production capacity change as a result of changes in facilities and of changes in knowledge about facilities. Capacities have been rated for the chromite ore, ferrochromium, chromium chemical, and chromium metal industries. *(See table 17.)*

Reserves.—The United States has no chromite ore reserves. However, the United States has a reserve base and resources that

could be exploited. The U.S. reserve base is estimated to be about 10 million tons of chromium. World reserves are about 3.6 billion tons of chromium and the reserve base is about 7.5 billion tons. Over 80% of world reserves and over 70% of the world reserve base are in South Africa. The USGS reports reserves and reserve base information annually in Mineral Commodity Summaries.

Production.—World chromite ore production in 1997 was estimated at about 12.5 million tons, a 9% increase over that of 1996. World ferrochromium production in 1997 was estimated at about 4.42 million tons, a 13% increase over that of 1996. *(See tables 15 and 16.)* World production of ferrochromium-silicon is small compared with that of ferrochromium.

Albania.—Albania licensed Royal Rod (Canada) and Karma Mining (Canada) to explore for chromite in the Tropojë region for 4 years. Albania generates hydroelectric power and sells excess power to its neighbors Greece, Macedonia, and the former Yugoslavia. KESH, the state energy corporation, reported that the system was threatened by debt and property loss. KESH reported that about 46% of electricity supplied went unpaid for and that physical property was stolen or destroyed. Albania has been entertaining offers to privatize its chromium industry since 1991. Preussag (Germany) made an offer at the end of 1996, which was under consideration when unscheduled political change took place. Civil unrest resulted in elections that resulted in a change of government. The new government declined the Preussag offer and called for new offers. The Government accepted an offer from Kinglor (Italy) and Reconstruction & Development International (United Kingdom) to renovate the chromium industry. The consortium proposed to modernize the Kalimash and Buluqiza Mines, develop the ferrochromium smelters, and develop hydroelectric power. Financing had yet to be arranged at yearend.

Australia.—Danelagh Resources Pty. Ltd. is producing chromite ore in trial mining operations from Valiant Consolidated Limited's Coobina Chromite Deposit and has an option to buy a 70% interest in the property. Danelagh shipped chromite ore graded at 40% to 42% Cr_2O_3 with chromium-to-iron ratio of 1.6. The mine is in the Mount Newman area of Western Australia and exports through Port Hedland, Western Australia.

Brazil.—Brazil reported 1996 chromite ore production of 408,495 tons graded at 42.6% Cr_2O_3, exports of 121,000 tons and imports of about 5,700 tons. Brazil also reported ferrochromium production of 72,609 tons, exports of 11,101 tons, and imports of 6,885 tons. Based on these statistics, Brazil's 1996 chromium apparent consumption was 119,000 tons, contained chromium. Brazil reported measured resources of chromite ore of 19.9 million tons of average grade 31.3% Cr_2O_3, indicated resources of 3.94 million tons, and inferred resources of 2.14 million tons.

Associação Brasileira Dos Produtores de Ferroligas, the Brazilian ferroalloy producers association, reported ferrochromium production of 77,231 tons in 1996, down 23.5% from that of 1995. Cia. de Ferro Ligas da Bahia (Ferbasa), Brazil's sole ferrochromium producer, reported domestic chromite consumption of about 68,000 tons and estimated its production in 1997 at 65,000 tons. Brazil imposed antidumping duties on ferrochromium that were due to expire in 1998. Those duties were being reviewed. Elkem ASA (Norway) purchased the Vila Nova Mine and mineral rights from Companhia Ferro-Ligas do Amapá, a subsidiary of Industria e Comércio de Minérios S.A. The mine was idled in 1996 after producing about 150,000 tons in 1995 out of an annual capacity of 200,000 to 300,000 tons with potential to go to 500,000 tons. Proven reserves were about 6 million tons. Elkem ASA owns a ferrochromium smelter in Rana (Norway) which will process the ore. The Rana smelter has a production capacity of about 150,000 tons, a good match in terms of volume of production.

Canada.—Dow Corning Silicon Energy Systems negotiated with Chrome Corp. of America to sell its East Selkirk, Manitoba, smelter. Dow made silicon metal at the smelter; however, Chrome Corp. planned to use it for ferrochromium production.

Atlas Specialty Steel, the major stainless steel producer in Canada, reported reducing chromium losses. Chromium oxidation occurs during steelmaking when chromium reacts with oxygen or oxides dissolved in the steel or with gaseous oxygen. Oxidation was found to occur during melting, blowing, and pouring. By controlling ambient conditions during the production process, Atlas was able to reduce chromium loss from about 1.9% to about 1.2%.

China.—Zunyi Ferroalloy Works, Guizhou Province, converted a furnace from ferrosilicon to ferrochromium production. Zunyi has three furnaces, two rated at 38-megavolt-amperes and one at 55 megavolt-amperes. One of the 38 megavolt-ampere furnaces was converted to high-carbon ferrochromium production with an annual capacity of 60,000 tons. Chinese trade in 1996, as reported in 1996 China Customs Statistics Yearbook published by China's General Customs Administration, was chromite ore imports, 764,377 tons; high-carbon ferrochromium imports, 221 tons; low-carbon ferrochromium imports, 32 tons; ferrochromium-silicon imports, 820 tons; and chromium metal imports, 1,327 tons; high-carbon ferrochromium exports, 81,198 tons; low-carbon ferrochromium exports, 49,649 tons; ferrochromium-silicon exports, 31,079 tons; and chromium metal exports, 2,952 tons. Based on these trade data and chromite ore production of 130,000 tons estimated from China Iron and Steel Yearbook, China's chromium apparent consumption in 1996 was 169,000 tons of contained chromium.

Cuba.—Cromo-Moa reported proven reserves of 310,600 tons and resources of 1 million tons at the Mercedita Mine at Baracoa Peak. Production was reported to have been 37,300 tons in 1996. Production was anticipated to increase as new technology is applied to new resources between Punta Gorda de Moa and Baracoa.

Finland.—Outokumpu Oy replaced two wet grinding mills and two high-pressure dry grinding mills with a single wet grinding mill. Outokumpu planned underground mine development at its Kemi Mine.

France.—Delachaux reported completion of its chromium metal plant in Valenciennes.

India.—A dispute over licensing rights to chromite ore in Sukinda was resolved in 1996 when the courts mandated the distribution of chromite resources among ferrochromium producers. Orissa State government recommended distributing 418 hectares of land containing 43 million tons of chromite resources to the national government and that mineral rights be distributed as follows: International Charge Chrome Ltd. and

Indian Metals and Ferro Alloys, 190 hectares, 20 million tons of reserves; Ispat, 100 hectares, 10 million tons; Jindal Strips, 89 hectares, 9 million tons; and Ferro Alloys Corp., 39 hectares, 4 million tons. Nav Bharat Ferro Alloy Ltd. merged with Nav Chrome, Raipur. Nava Bharat installed a 30-megawatt captive thermal powerplant at its Paloncha smelter. Nav Bharat extended its contract with Tata Iron and Steel Co. to produce ferrochromium on a conversion basis by adding a second furnace to the contract.

Iran.—Faryab Mine reported developing a new face. Upon completion, production was expected to increase.

Japan.—Japan imported 577,858 tons of chromite ore, 811,353 tons of ferrochromium, and 66 tons of chromium metal. Domestically, the ferroalloy industry produced 199,734 tons of ferrochromium, a decrease of 5% compared with that of 1996. Hot rolled stainless steel production was reported to be 3.256 million tons, an increase of 1% compared with that of 1996. Ferrochromium imports represented 74% of market share. Japan exported 915 tons of ferrochromium, 6,785 tons of stainless steel scrap, and 1.152 million tons of stainless steel. The latter represented 35% of production. On the basis of chromite ore, ferrochromium, and chromium metal trade, chromium apparent consumption in Japan was 620,000 tons of contained chromium.

Showa Denko ceased low-carbon ferrochromium production at its Chichibu plant. Showa Denko entered into a joint venture with Samancor (South Africa) in 1995 to produce low-carbon ferrochromium under the name Middelburg Technochrome Ltd., in South Africa. Japan Metals & Chemicals stopped production of low-carbon ferrochromium in 1996 after establishing a joint venture in 1995 with Zimbabwe Alloys to produce low-carbon ferrochromium under the name JM Alloys, in Zimbabwe. The closure of these two plants left Nippon Kokan as the sole domestic low-carbon ferrochromium producer at its Toyama plant.

Japan Metals & Chemicals Co. Ltd. planned a joint-venture agreement with Hernic Ferrochrome (Pty.) Ltd. (South Africa) to produce high-carbon ferrochromium in South Africa. As a result of the transfer of high-carbon ferrochromium production to South Africa, Japan Metals & Chemicals will close its Kyushu plant. The production transfer was attributed to the high cost of production in Japan, especially for energy.

Kazakstan.—Donskoy Mine continued production at the annual rate of about 1 million tons. Donskoy planned to open a new open pit face. Chromite ore production was channeled to Aktyubinsk and Aksu ferroalloy plants. Kaz Chrome is the management organization for Donskoy, Aktyubinsk, and Aksu. The ferrochromium plants planned to add new furnaces. Kaz Chrome converted one furnace to chromium metal production. Annual production was planned to be about 1,200 tons. Kaz Chrome is co-owned by Trans World (Alloys) Inc. and the Government of Kazakstan. A dispute arose between Trans World and local company officials over who would control and manage the mine and ferrochromium smelters. The dispute remained unsettled at yearend.

Korea, Republic of.—The Republic of Korea reported imports of ferrochromium to have been 276,483 tons, and imports of stainless steel scrap, 164,678 tons. Ferrochromium consumption was reported to have been 223,760 tons and ending stocks were 28,977 tons. Ferrochromium imports increased by 53%, while consumption increased by 21% over that of 1996.

Madagascar.—Kraomita Malagasy reported its chromite ore market distribution to have been about as follows: Europe, 67%; Japan, 17%; and China, 16%.

Norway.—Elkem purchased the idle Vila Nova chromite mine in Brazil to supply its ferrochromium smelter at Rana. (*See Brazil.*)

Oman.—Oman Chromite Co. and Trans-Gulf Industrial Development Co. planned a ferrochromium plant in the Sohar industrial area about 250 kilometers south of Muscat. The plant was planned to comprise a gas-fired electrical power station, a smelter with annual ferrochromium production capacity of 50,000 tons, and dust-handling equipment. The project was expected to cost about $80 million and would take 18 to 20 months to construct, suggesting that it would come on-stream in 2000 or 2001. Omani chromite ore production has grown from about 1,000 tons to about 10,000 tons over the past 5 years. To feed a smelter of this size, chromite ore production would have to increase to about 100,000 tons per year.

Philippines.—Ferrochromium production was suspended owing to high electrical energy cost despite abundant water supply at Lake Ranao which feeds a hydropower plant.

Russia.—Elkem (Norway) and B&D Industrial Group B.V. (the Netherlands) surveyed chromite ore deposits in the Kola Peninsula. It was reported that low-carbon ferrochromium and chromium metal were sold from the Russian raw materials strategic stockpile. The value of stocks and transactions are held as national secrets by the Russian ministry of industry. The chromium metal sold was reported at 1,960 tons. B&D Group partially completed construction of a ferrochromium plant at Tikhvin near St. Petersburg. The plant was planned to comprise four furnaces and have an annual production capacity of 140,000 tons. It was reported that owing to a financing shortfall of about $20 million, construction was suspended, with the first two furnaces near completion. Serovsk Ferroalloy Works produced both high- and low-carbon ferrochromium for the domestic and export market. Chelyabinsk Electrometallurgical Works produced high- and low-carbon ferrochromium from local, Kazakstani, and Turkish ore. Chelyabinsk planned to develop its own source of chromite ore. Klyuchevsk Ferroalloy Works reported annual production of chromium metal in the range of 4,000 to 5,000 tons. Domestic annual demand was about 1,000 tons, down from a peak demand of 12,000 tons.

South Africa.—The South Africa Department of Minerals and Energy reported mineral production as follows: in 1996, South Africa produced 4,970,945 tons of chromite ore, of which it exported 1,339,567 tons. In the same year, chromium ferroalloy production was 1,480,000 tons, of which 1,413,300 tons were exported. In 1997, South Africa produced 5,779,424 tons of chromite ore, of which it exported 1,295,370 tons. In the same year, chromium ferroalloy production was 1,925,000 tons, of which 1,603,800 tons were exported. Based on these data, South African chromium apparent consumption was 358,000 tons in 1996 and 596,000 tons in 1997.

Chromite Ore.—Samancor operated chromite ore mines in the eastern and western chromite ore belts. Samancor reported an

annual marketable chromite ore production capacity of 4.16 million tons, 2.38 million from nine eastern mines and 1.78 million tons from four western mines. Samancor exploited chromite ore reserves from the LG6, MG1, and MG2 seams.

It was reported that chromite ore from the UG2 seam is finding greater commercial acceptance. Amplats, a platinum producer, has been producing chromite for the chemical and metallurgical industries as a byproduct of its Union Section operation. UG2 chromite typically has a lower chromium-to-iron ratio than that of LG6 chromite (UG2, 1.33-1.35; LG6, 1.5). Amplats recovers chromite at its Mortimer concentrator plant using spiral circuits and, when necessary, uses a hydroseparator to wash out excess siliceous minerals. The UG2 product from Union Section is 40.5% to 42.0% Cr_2O_3 and from less than 1% to 3% SiO_2.

Chrome Resources (Pty.) Ltd. reported mining chromite ore at the annual rate of 2.4 million tons per year for part of the year distributed among its mines as follows: Kroondal, 960,000 tons; and Waterval and Wonderkop, 720,000 tons each. Chrome Resources reported annual production exceeded 1.2 million tons in 1997.

Consolidated Metallurgical Industries (CMI) developed underground operations at Thorncliff Mine, near Steelpoort, Mpumalanga Province. They reported open pit mine annual production at 250,000 tons with an annual production capacity of 500,000 tons and reserves available to sustain that level of operation for 4 years: 80 million tons of resources and proven reserves of 27 million tons to a depth of 300 meters. Exploration work on the adjacent Helena site was expected to double resources. The chromite ore is in the LG6 seam, which dips at 12 to 13 degrees, is 1.75 meters thick, has 44% to 45% Cr_2O_3 and a chromium-to-iron ratio of 1.5. CMI built a high wall and inclined shafts that would permit underground mining at an annual run-of-mine rate of 1 million tons, which could be converted into 800,000 tons of chromite ore product. CMI also built a heavy media separation plant to improve the quality of chromite ore products delivered to the smelter. These improvements cost about $15 to $18 million and the mine was expected to employ 300 to 350 workers when producing at full capacity. Chromite ore from Thorncliff feeds CMI's Lydenburg smelter, replacing ore from Winterveld Mine. Development of the underground operations at Thorncliff completes the backward integration of the Lydenburg smelter making it independent of external ore supplies in 1998.

Ferrochromium.—Typical costs of South African ferrochromium production were reported as follows. Ferrochromium production requires about 3,800 to 4,200 kilowatt hours per ton. South African electrical energy cost was reported as about 3.1 cents per kilowatt hour. South African producers use coal and coke as a reductant during the smelting process. About 0.7 ton of reductant is required per ton of product, typically 0.4 ton of coal and 0.3 ton of coke or char. ISCOR, Suprachem, and Zisco (Zimbabwe) supplied metallurgical coke. Coke demand exceeded supply, which was met by imports from China. Transportation cost, including rail and sea freight, was estimated to be in the range of 4 to 4.5 cents per pound of contained chromium.

Samancor is the world's largest ferrochromium producer with an annual ferrochromium production capacity of 1.249 million tons from five plants: Batlhako Ferrochrome, Ferrometals, Middelburg Ferrochrome, Palmiet Ferrochrome, and Tubatse. Samancor's strategy appears to be to meet increasing demand by improving the efficiency of currently operating plants, instead of constructing new plants, and to finance improvements through joint-venture partnerships with traders and consumers, thereby achieving the larger goals of steady demand and improved capacity utilization. Samancor has installed ferrochromium-from-slag recovery plants at its major plants and is proceeding to make production more efficient. This approach delays the need to build new plants; however, new plants are inevitable if world stainless steel production continues to grow. Ferrometals constructed a pelletizing plant to feed three furnaces and preheating lines for two of those furnaces. These facilities were developed by Outokumpu Oy (Finland), cost about $88 million, and were expected to start operation in 1998. Pelletizing permits use of fine ore, improves chromium recovery in the smelting process (from 80% to 85%), increases furnace annual production capacity (from 85,000 tons to 100,000 tons for preheated and from 70,000 tons to 80,000 tons for cold feed), decreases unit consumption of energy by 500 kilowatts per ton, and more closely matches chromite ore production capacity to smelter material requirements. The plant was planned to produce 520,000 tons of pellets annually, which would result in a 60,000-ton-per-year ferrochromium production capacity increase owing to more efficient smelting. Ferrometals upgrading was based on a joint-venture agreement with Japan Metals and Chemicals (JMC) (Japan) and Mitsui (Japan) in which JMC would displace domestic ferrochromium production with that from Ferrometals.

Tubatse brought its ferrochromium-from-slag recovery plant production capacity up to 30,000 tons per year. The plant was started up near the end of 1996 and expanded in 1997 at a cost of about $6 million. Tubatse improved its materials handling by introducing larger slagpot carriers. The pots are used to carry slag the 1.5 kilometers from the furnaces to the slag tip. Larger pots result in fewer trips, which result in lower maintenance.

Palmiet Ferrochrome restarted its renovated direct current plasma arc furnace.

Middelburg Ferrochrome operated a direct current plasma arc furnace with electrical transformer capacity of 62 megavolt-amperes that was commissioned at the end of 1996 and commissioned the Chrome Direct Reduction Kiln. The kiln output was to be fed to the plasma arc furnace to produce ferrochromium from chromite ore fines with an energy usage of 4,900 kilowatt hours per ton. Together they cost about $18 million and permit Middelburg to produce 100,000 tons of ferrochromium per year from fines. Middelburg commissioned crushing and milling facilities for its low-carbon ferrochromium product.

ISCOR reported that it would no longer produce low-phosphorus coke now used by the ferrochromium industry to produce low-phosphorus grade ferrochromium. Standard grades were not expected to be affected.

The owners of the Ilitha chromite ore deposit proposed development of a ferrochromium smelter to exploit the deposit. The deposit comprises 10 million tons of chromite ore reserves in the LG6 seam. The proposed smelter was to comprise two furnaces and have an annual ferrochromium production capacity

of 100,000 tons. The smelter would take about 11 months to complete and would be near Rustenburg.

ASA Metals, a joint venture between Northern Province Development Co. and East Asian Metal Investment Corp., began operations. The principal asset of the joint venture is the Dilokong chromite mine at Sekhukhune in the eastern chromite ore belt. ASA plans to improve productivity at the mine and build a ferrochromium smelter to exploit its chromite ore assets. The mine has an annual production capacity of about 350,000 tons; however, it has just been reopened after having been closed for 18 months. The planned smelter was to consist of two furnaces and have an annual production capacity of 115,000 tons. Construction on the first furnace with annual production capacity of 50,000 tons was planned to start in 1998. East Asian Metal Investment Corp. is a parastatal organization whose major shareholders are China Iron & Steel Industry & Trade Group Corp. and Jilin Ferroalloys.

Chrome Resources started a ferrochromium smelter at Wonderkop. The Wonderkop smelter was comprised of a pelletizing plant and two furnaces capable of using UG2 chromite, a finely ground ore byproduct of platinum production in the area that requires agglomeration before use in an electric-arc furnace. Chrome Resources planned to produce ferrochromium containing 49% to 50% chromium from a mixture of byproduct UG2 chromite from Eastern Platinum Mine and LG6 chromite ore from Wonderkop Mine. Chrome Resources constructed a second pelletizing plant and two additional furnaces, which were to reach full production in 1998. Annual production capacity at Wonderkop smelter, with four furnaces with electrical rating of 39 megavolt-amperes, was expected to be 320,000 tons. Chrome Resources constructed a rail siding connecting the Wonderkop plant to the main rail lines. Chrome Resources annual production capacity, including all six furnaces at the Rustenburg and Wonderkop plants and recovery from slag, was to be about 615,000 tons. At this capacity, Chrome Resources would become South Africa's second largest ferrochromium-producing company. Chrome Resources is owned by Chrome Corp. Holding Company, which is owned by Südelectra Holding Company (Switzerland), 40% of which is owned by Glencor (Switzerland), the trading company that sells Chrome Resources' products.

Hernic Ferroalloys (Pty.) Ltd. operated a ferrochromium smelter at Brits, North West Province, comprising two electric furnaces each of 37 megavolt-ampere electrical capacity and 60,000- to 70,000-tons-per-year production capacity. Hernic planned to expand its operation by adding a pelletizing plant and a new furnace. Hernic planned to acquire Outokumpu technology for pelletizing and preheating. The pelletizing plant's annual production capacity of 350,000 tons was planned to be in excess of the new furnace's demand in order that pellets could be used in the existing furnaces to enhance their production capacity by from 10% to 15%. The new furnace was planned to have an electrical transformer capacity of about 50 megavolt-amperes and an annual production capacity of about 130,000 tons. The addition was expected to cost about $40 million and to increase employment from the current 250 employees to 350 employees. Construction was planned to start in 1998 and be completed in 1999. Hernic is owned 16.5% by ELG Haniel (Germany), 11.0% by Nittetsu Shoji (Japan), and 72.5% by management.

Consolidated Metallurgical Industries operated two smelters, one at Lydenburg (supplied by Thorncliff Mine), and the other at Rustenburg (supplied by Purity Chrome Mine). JCI Limited owned 56.6% of CMI. JCI planned to restructure itself making CMI available for sale. By yearend, no sale had taken place.

Chromium Chemicals.—Chrome International, a joint venture between Bayer AG and Karbotherm, a division of Sentrachem, started construction of a chromium chemical plant at Newcastle, KwaZulu-Natal Province. Production was planned to start late in 1998 or early in 1999. The plant was expected to require about 100,000 tons of chromite ore annually from Bayer's chromite mine near Rustenburg. Bayer planned to expand production at its chromium-containing tanning chemical plant at Merebank from 6,000 tons per year to 45,000 tons per year.

Sweden.—Vargön Alloys AB started commercial production from a fourth furnace. Vargön has had three of four furnaces available for production since the fourth furnace was idled in 1974. The idled furnace was renovated in 1996. The newly operational furnace has an electrical power capacity of 25 megawatts and an annual high-carbon ferrochromium production capacity of about 35,000 tons. The addition of the renovated furnace increases Vargön's annual ferrochromium production capacity to about 185,000 tons.

Turkey.—Entes, a company that recovers ferrochromium from slag, tendered 3,000 tons of ferrochromium for spot market sale and planned to recover at the rate of 2,000 tons per month. Kromsan, a sodium dichromate producer located at Mersin, started construction of a chromic acid production plant at the same location. Chromic acid is produced from sodium dichromate. The plant was planned to have an annual chromic acid production capacity of 6,000 tons.

United Kingdom.—London & Scandinavian Metal Co. Limited's Special Metals Division started up a new chromium metal manufacturing plant at Rotherham. The new plant incorporates control technology and data recording systems into Special Metals' production process and increases production capacity.

Zimbabwe.—The price of electricity, a major cost constituent for ferrochromium, has been rising as a result of World Bank demands that electricity fees reflect production cost. Zimbabwe Electricity Supply Authority raised power rates by 35% in July. Rates were planned to rise by 129% to 136% over the next few years. Power cost for ferroalloy producers was about $0.03 per kilowatt hour at yearend. A political dispute over the ownership of Zimasco (Private) Ltd. remained unresolved at yearend. The Government sought to transfer ownership of 50% of the company through negotiation to black Zimbabweans as part of an indigenisation program. However, when Nyika Enterprises, a black-owned investment company headed by a former army commander, sought to take a 27% share in the company, the president found that action to be contrary to the goals of the program. At yearend, redistribution of ownership was not settled.

Zimasco made an agreement with Japan Metals & Chemicals to take an idle shaking ladle furnace and use it to produce low-sulfur, high-carbon ferrochromium at Kwe Kwe plant. The new furnace was planned to begin production in 1998 working in

conjunction with Zimasco's currently active six furnaces. Zimasco's newly installed metal-from-slag recovery plant was planned to process about 170 tons per hour of slag to produce 23,000 tons per year of ferrochromium. Actual production from the plant had been brought up to 15,000 tons per year. The plant produces a marketable ferrochromium product containing over 63% chromium and under 2% slag while recovering over 96% of liberated metal in slag. Zimasco held about 4.5 million tons of ferrochromium slag.

Zimbabwe Alloys Limited (Zimalloys) reported production of 159,735 tons of chromite ore, which it supplemented with 48,656 tons of purchased chromite ore, to produce 34,356 tons of low-carbon ferrochromium and 41,054 tons of ferrochromium-silicon. Chromite production came from Great Dyke Mine, Great Dyke Outcrop, Inyala Mine, Inyala Airstrip Block, and North Dyke co-operatives. Zimalloys suspended mining North Dyke operations, including Great Dyke and Outcrop, and closed the Inyala Open Pit.

A new ferrochromium plant and a new stainless steel plant were being planned. Maranatha Holdings planned a 20,000-ton-per-year high-carbon ferrochromium plant at Eiffel Flats. It planned to acquire a 7-megavolt-ampere furnace currently idle in the country and a second similar furnace from outside the country. Redcliff Municipality, Ziscosteel, and Steelmakers Ltd. (Kenya) planned a 45,000-ton-per-year stainless steel plant. The plant, including a 12-ton induction furnace, a ladle refining furnace, and an argon-oxygen decarburising station was estimated to cost $70 million and to be completed in 1998.

Current Research and Technology

Mineral Processing and Industrial Applications.—Industry conducts research to develop new, more efficient processes and to improve the efficiency of currently used processes.

The Council for Mineral Technology (Mintek) of South Africa conducts government-sponsored, commercially sponsored, and cosponsored research and development on chromite ore and ferrochromium.

Environmental.—Environmental concerns about chromium have resulted in a wide variety of studies to determine chemical characteristics, natural background levels, sources of environmental emissions, movement of chromium in the environment, interaction of chromium with plants and animals, effect of chromium on plants and animals, measurement methods, and recovery technology.

Outlook

In 1997, two estimates of the distribution of chromium production were made. One reported that the metallurgical industry accounted for 85% of chromium consumption, with the chemical industry accounting for 8% and the refractory industry 7% (Toerien, 1997). Another estimate put metallurgical use at 82% of consumption with chemical and refractory demand accounting for the remaining 18% (Probert, 1997). A comparison of world production of chromite ore, ferrochromium, and stainless steel (*see table 1*), shows that on average over the 1993 through 1997 time period, chromium contained in ferrochromium was about 59% of chromium contained in chromite ore production and about 78% of chromium contained in stainless steel production.

The outlook for chromium consumption in the United States and internationally is about the same as that for stainless steel. Stainless steel is the major end use for chromium worldwide. Thus, stainless steel industry performance largely determines chromium industry demand worldwide. (See following section on stainless steel.)

The trend to supply chromium in the form of ferrochromium by chromite-mining countries is expected to continue. With new, efficient ferrochromium production facilities and excess capacity in chromite-producing countries, production and capacity are expected to diminish in traditional nonore but ferrochromium-producing countries and in countries with small, less efficient producers, except where domestic industries are protected by quotas and tariffs. Further upward integration of the chromium industry is expected as chromite-producing countries expand ferrochromium or stainless steel production capacity.

Chromite Ore.—Chromite ore production capacity is in balance with average demand; however, consumption capacity by ferrochromium plants exceeds production capacity. This leads to short supply when demand surges. This condition prevents ferrochromium producers from meeting surge demand. In order to improve chromite ore availability and stabilize feed material price, ferrochromium producers invest in chromite-ore-producing mines.

Ferrochromium.—Ferrochromium production is electrical energy intensive. Charge-grade ferrochromium requires 3,800 to 4,100 kilowatt hours per ton of product, with efficiency varying with ore grade, operating conditions, and production process. Thus, ferrochromium plant location reflects a cost balance between raw materials and electrical energy supply. The South African share of ferrochromium production moved from about 35% in 1992 to 48% in 1996. It was expected to exceed 50% in 1997. A situation similar to that between chromite ore producers and ferrochromium producers exists between ferrochromium producers and stainless steel producers. Stainless steel producers have been investing in ferrochromium production plants.

Stainless Steel.—Western world stainless steel production experienced double-digit percent growth for two consecutive years, 1994 and 1995. Strong demand for stainless steel in 1995 resulted in excessive production. This excess production resulted in large stocks of stainless steel in 1996. At the same time, capacity expansion projects already under way continued to come into production. It was estimated that 3.865 million tons of stainless steel production capacity was added in 1994 through 1996. World stainless steel production capacity expansion exceeds production expansion. As a result, capacity utilization has been declining.

Stainless steel demand is price sensitive, and an important part of stainless steel cost is nickel cost (about 70% of stainless steel requires nickel). Nickel availability and cost have been viewed as potential limitations to increased stainless steel production. The discovery and development of new nickel deposits projected to produce at near one-half the cost of current producers mitigates this potential limitation to stainless steel production growth.

World stainless steel consumption increased at an annual rate of about 5% (based on historical production increase from 1986 to 1995) and that rise was expected to continue in the near future at an average annual rate of from 5% to 7%; however, stainless steel production capacity was anticipated to increase even faster. This situation was expected to result in market pressure to keep prices low. Anticipating the effect of stainless steel market growth on chromium demand is complicated by use of stainless steel scrap. Stainless steel scrap use displaces demand for ferrochromium and the chromite ore needed to make ferrochromium. Ferrochromium was estimated to supply 60% to 65% of chromium units in stainless steel, with scrap supplying the remaining 30% to 35% (Probert, 1997). The origin of that scrap was reported to have been 50% reclaimed, 35% revert, and 15% industrial (Ward, 1997).

Chromium Chemicals.—Chromium chemical production is geographically concentrated in developed economy countries. Major producing countries where large plants (capacity in excess of 100,000 tons of sodium dichromate per year) operate include Kazakstan, Russia, the United Kingdom, and the United States. Moderate size production facilities are in Brazil, China, Germany, Japan, Romania, and Turkey. Moderate scale plant development to displace German production is under way in South Africa. Small-scale local producers operate in China and India.

Sodium dichromate consumption in the United States was reported at 150,000 tons in 1996 and 155,000 tons in 1997, while domestic production capacity was reported at 156,000 tons. Distribution of this consumption was 66% for chromic acid; 13%, leather tanning; 9%, chromic oxide; 6%, pigments; and 6%, miscellaneous (including wood preservation and metal finishing) (Chemical Marketing Reporter, 1997).

Chromium Metal.—Tosoh, the Japanese electrolytic chromium metal producer, ceased production in 1995, leading to anticipated restructuring of the chromium metal industry. It was not until December 1996 that Tosoh finally sold off its stocks. Restructuring of the chromium metal supply market put the remaining electrolytic producers (Russia and the United States) in competition with the major aluminothermic producers (France and the United Kingdom) for the Japanese market. Both aluminothermic producers expanded their production capacity. The price of chromium metal was expected to increase as raw material (chromic oxide) price increases are passed on to metal consumers.

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TABLE 1
SALIENT CHROMIUM STATISTICS 1/

(Metric tons, contained chromium unless otherwise specified)

		1993	1994	1995	1996	1997
World production:						
Chromite ore (mine) 2/		2,800,000 r/	3,040,000 r/	4,360,000 r/	3,460,000 r/	3,770,000 e/
Ferrochromium (smelter) 3/		1,800,000	1,390,000 r/	2,510,000 r/	2,130,000 r/	2,520,000 e/
Stainless steel 4/		2,160,000 r/	2,350,000	2,650,000 r/	2,910,000 r/	3,200,000 e/
U.S. supply:						
Components of U.S. supply:						
Domestic mines		--	--	--	--	--
Secondary		92,000	99,000	112,000	98,400	120,000
Imports:						
Chromite ore		84,300	59,600	81,400	79,200	96,600
Chromium chemicals		6,210	9,210	8,360	7,060	6,430
Chromium ferroalloys		233,000	198,000	319,000	267,000	237,000
Chromium metal		6,170	6,520	7,040	8,730	9,800
Stocks, Jan. 1:						
Government		1,280,000	1,210,000	1,170,000	1,120,000	1,070,000
Industry		118,000	103,000	101,000	80,100	72,800
Total U.S. supply		1,820,000	1,690,000	1,790,000	1,660,000	1,610,000
Distribution of U.S. supply:						
Exports:						
Chromite ore		3,310	14,000	5,740	21,900	5,890
Chromium chemicals		8,170	11,700	14,700	18,200	16,700
Chromium ferroalloys and metal		9,420	7,600	6,260	10,800	7,710
Stocks, Dec. 31:						
Government		1,210,000	1,170,000	1,120,000	1,060,000	1,020,000
Industry		103,000	101,000	80,400	74,300	71,900
Total U.S. distribution		1,340,000	1,300,000	1,230,000	1,180,000	1,120,000
Apparent industry demand		484,000	390,000	566,000	480,000	488,000
Reported consumption						
Chromite ore (gross weight)		337,000	322,000	351,000	282,000	350,000
Chromite ore average Cr_2O_3 (percentage)		47.2	47.3	43.8	45.2	45.1
Chromium ferroalloys (gross weight)		357,000	346,000	334,000	328,000	383,000
Chromium metal (gross weight)		4,060	3,960	4,600	4,620	4,990
Stocks, Dec. 31 (gross weight):						
Government						
Chromite ore		1,640,000	1,470,000	1,320,000	1,170,000	1,090,000
Chromium ferroalloys		1,080,000	1,080,000	1,070,000	1,040,000	1,020,000
Chromium metal		7,060	7,690	7,690	7,720	7,720
Industry, producer		5,610	8,070	8,430	6,450	10,900
Industry, consumer:						
Chromite ore		275,000	266,000	205,000	173,000	175,000
Chromium ferroalloys		16,000	14,700	22,500	27,300	16,500
Chromium metal		481	292	264	211	233
Prices, average annual:						
Chromite ore, 5/ dollar per ton gross weight		55	55	60	75	73
Ferrochromium, 6/ dollar per pound chromium content		.37	.37	.70	.51	.48
Chromium metal, 7/ dollar per pound gross weight		3.70	3.70	3.97	4.15	4.15
Value of trade:						
Exports	thousands	$64,900	$69,900	$83,200	$111,000	107,000
Imports	do.	$279,000	$254,000	$545,000	$463,000	450,000
Net trade 8/	do.	($213,961)	($184,567) r/	($461,480)	($352,266)	(342,807)

e/ Estimated. r/ Revised.

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

2/ Calculated assuming chromite ore to average 44% Cr_2O_3 that is 68.42% chromium.

3/ Calculated assuming chromium content of ferrochromium to average 57%.

4/ Calculated assuming chromium content of stainless steel to average 17%.

5/ Time average price of South African chromite ore as reported by Platt's Metals Week.

6/ Time average price of imported high-carbon chromium containing 50% to 55% chromium as reported by Platt's Metals Week.

7/ Time average price of electrolytic chromium metal as reported by Platt's Metals Week.

8/ Number in parentheses indicates that imports are greater than exports.

TABLE 2
PRINCIPAL U.S. PRODUCERS OF CHROMIUM PRODUCTS IN 1997, BY INDUSTRY

Industry and company	Plant
Metallurgical:	
Elkem A/S, Elkem Metals Co.	Marietta, OH.
JMC (USA), Inc.	Research Triangle Park, NC.
Macalloy Corp.	Charleston, SC.
Refractory:	
A.P. Green Industries Inc.	Lehi, UT.
Harbison-Walker Refractories, a subsidiary of Global Industrial Technologies	Hammond, IN.
National Refractories & Minerals Corp.	Moss Landing, CA, and Columbiana, OH.
North American Refractories Co. Ltd.	Womelsdorf, PA.
Chemical:	
Elementis Chromium LP 1/	Corpus Christi, TX.
Occidental Chemical Corp.	Castle Hayne, NC.

1/ Name changed from American Chrome & Chemical in January 1998.

TABLE 3
PRODUCTION, SHIPMENTS, AND STOCKS OF CHROMIUM FERROALLOYS AND METAL,
AND OTHER CHROMIUM MATERIALS IN THE UNITED STATES 1/

(Metric tons)

	Net production			
Year	Gross weight	Chromium content	Net shipments	Producer stocks, Dec. 31
1996	36,800	26,400	38,800	6,450
1997	60,700	40,900	56,300	10,900

1/ Data are rounded to three significant digits.

TABLE 4
U.S. CONSUMPTION OF CHROMIUM FERROALLOYS AND METAL, BY END USE 1/

(Metric tons, gross weight unless noted)

End use	Ferrochromium		Ferro-chromium-silicon	Other	Total
	Low-carbon 2/	High-carbon 3/			
1996:					
Steel:					
Carbon	3,960 r/	9,220 r/	154 r/	557 r/	13,900 r/
Stainless and heat-resisting	8,020 r/	203,000 r/	32,300 r/	W	243,000
Full-alloy	3,750	25,600	1,620	52 r/	31,000
High-strength, low-alloy, and electric	2,100 r/	2,120 r/	7,240	--	11,500 r/
Tool	W	5,040	W	W	5,040
Cast irons	W	2,780 r/	W	314 r/	3,090 r/
Superalloys	2,010 r/	4,400 r/	276 r/	3,890 r/	10,600 r/
Welding materials 4/	83	76 r/	1	279 r/	439 r/
Other alloys 5/	319 r/	270 r/	--	1,330	1,920 r/
Miscellaneous and unspecified	2,920 r/	555 r/	8,900	183 r/	12,600 r/
Total 6/	23,200	253,000	50,500 r/	6,600 r/ 7/	333,000
Chromium content	15,600	151,000	17,900 r/	5,510 r/	190,000
Stocks, Dec. 31, 1996	1,820 r/	24,000 r/	1,440 r/	383 r/ 8/	27,600
1997:					
Steel:					
Carbon	4,120	9,580	146	369	14,200
Stainless and heat-resisting	8,620	251,000	35,900	159	296,000
Full-alloy	4,380	26,800	1,580	46	32,800
High-strength, low-alloy, and electric	2,290	2,310	7,490	W	12,100
Tool	W	3,840	W	W	3,840
Cast irons	724	3,620	W	330	4,670
Superalloys	2,340	W	W	4,370	6,720
Welding materials 4/	176	167	6	179	528
Other alloys 5/	478	434	--	1,610	2,520
Miscellaneous and unspecified	1,450	5,680	7,710	44	14,900
Total 6/	24,600	304,000	52,800	7,110 9/	388,000
Chromium content	16,700	195,000	18,900	5,630	237,000
Stocks, Dec. 31, 1997	1,760	13,800	698	448 10/	16,700

r/ Revised. W Withheld to avoid disclosing company proprietary data; included with "Miscellaneous and unspecified."

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

2/ Low-carbon ferrochromium contains less than 3% carbon.

3/ High-carbon ferrochromium contains 3% or more carbon.

4/ Includes structural and hard-facing welding material.

5/ Includes cutting materials and magnetic, aluminum, copper, nickel, and other alloys.

6/ Includes estimates.

7/ Includes 4,520 tons of chromium metal.

8/ Includes 215 tons of chromium metal.

9/ Includes 4,990 tons of chromium metal.

10/ Includes 233 tons of chromium metal.

TABLE 5
U.S. CONSUMER STOCKS OF CHROMITE, CHROMIUM FERROALLOYS, AND METAL, DECEMBER 31 1/

(Metric tons, gross weight)

Industry	1996	1997
Chromite:		
Chemical and metallurgical	165,000	167,000
Refractory	7,890	7,520
Total	173,000	175,000
Chromium ferroalloy and metal:		
Low-carbon ferrochromium	1,820 r/	1,760
High-carbon ferrochromium	24,000 r/	13,800
Ferrochromium-silicon	1,440 r/	698
Other 2/	383 r/	448
Total	27,600	16,700

r/ Revised.
1/ Data are rounded to three significant digits; may not add to totals shown.
2/ Incudes chromium metals stocks of 233 tons in 1997 and 215 tons in 1996.

TABLE 6
U.S. GOVERNMENT STOCKPILE YEAREND INVENTORIES 1/ AND CHANGE FOR CHROMIUM 2/

(Metric tons, gross weight)

Material	1996	1997	Change 3/	
			Quantity	Percent 4/
Chromite:				
Chemical	220,000	217,000	(2,800)	(1)
Metallurgical	645,000	565,000	(80,200)	(12)
Refractory	322,000	309,000	(12,600)	(4)
Chromium ferroalloys:				
Ferrochromium-silicon	52,700	52,700	--	--
High-carbon ferrochromium	718,000	689,000	(28,400)	(4)
Low-carbon ferrochromium	283,000	283,000	--	--
Chromium metal:				
Aluminothermic	2,670	2,670	--	--
Electrolytic	5,050	5,050	--	--

1/ Includes specification- and nonspecification-grade materials.
2/ Data are rounded to three significant digits.
3/ Number in parentheses indicates decrease.
4/ Quantity change as a percent of stocks before sale.

Source: Defense Logistics Agency.

TABLE 7
TIME-VALUE 1/ RELATIONS FOR CHROMITE ORE, FERROCHROMIUM, AND CHROMIUM METAL 2/

(Average annual value, dollars per metric ton)

Material	1995		1996		1997	
	Contained chromium	Gross weight	Contained chromium	Gross weight	Contained chromium	Gross weight
Chromite ore:						
Not more than 40% chromic oxide	629 r/	153	594	135	777	160
More than 40% but less 46% chromic oxide	262	74	327	98	239	75
46% or more chromic oxide	232	76	282	91	223	72
Average	247	80	293	93	232	74
Ferrochromium:						
High-carbon 3/	1,220	731	976	564	1,020	562
Medium-carbon 4/	1,430	932	2,010	1,300	1,010	542
Low-carbon 5/	1,940 r/	1,260 r/	2,270	1,440	2,120	1,400
Average	1,320	805	1,180	690	1,210	687
Chromium metal	XX	6,500 r/	XX	7,030 r/	XX	7,420

r/ Revised. XX Not applicable.
1/ Customs value per ton of chromium contained in imported material.
2/ Data are rounded to three significant digits; may not add to totals shown.
3/ More than 4% carbon.
4/ Carbon more than 3% but not more than 4%.
5/ Carbon not more than 3%.

TABLE 8
PRICE QUOTATIONS FOR CHROMIUM MATERIALS AT BEGINNING AND END OF 1997

Material	January	December	Year average
Dollars per metric ton of product:			
Chromite ore:			
South Africa	70 - 80	65 - 75	73
Turkey	220 - 230	140 - 150	180
Cents per pound of chromium:			
High-carbon ferrochromium:			
Imported:			
50% to 55% chromium	40 - 43	48 - 50	48
60% to 65% chromium	41.5 - 43	44.2 - 44.5	49
Low-carbon ferrochromium:			
Domestic:			
0.05% carbon	Discontinued	Discontinued	Discontinued
0.015% carbon (Simplex)	Discontinued	Discontinued	Discontinued
Imported:			
0.05% carbon	112 - 120	82 - 88	103
0.10% carbon	97 - 103	80 - 85	90
Cents per pound of product:			
Chromium metal (domestic):			
Electrolytic	415.0	415.0	415.0
Elchrome	530.0	575.0	557.0

Source: Platt's Metals Week.

TABLE 9
U.S. EXPORTS OF CHROMIUM MATERIALS, BY TYPE 1/

HTSUSA 2/	Type	1995 Quantity (metric tons)	1995 Value (thousands)	1996 Quantity (metric tons)	1996 Value (thousands)	1997 Quantity (metric tons)	1997 Value (thousands)	Principal destinations, 1997
2610.00.0000	Chromite ore and concentrate, gross weight	17,800	$3,430	69,400	$11,100	18,500	$4,200	Canada (69%); Japan (19%); Mexico (10%).
	Metal and alloys:							
8112.20.0000	Chromium metal, gross weight 3/	714	7,820	1,330	12,800	2,340	17,400	Germany (57%); Japan (28%); Canada (10%).
	Chromium ferroalloys:							
7202.41.0000	High-carbon ferrochromium, gross weight 4/	6,610	8,120	12,800	9,650	7,220	6,980	Mexico (63%); Canada (34%).
7202.41.0000	High-carbon ferrochromium, contained weight 4/	4,060	--	7,800	--	4,330	--	
7202.49.0000	Low-carbon ferrochromium, gross weight 5/	2,010	3,490	2,780	4,020	1,740	3,010	Mexico (34%); Canada (20%); Netherlands (14%); Brazil (12%).
7202.49.0000	Low-carbon ferrochromium, contained weight 5/	1,220	--	1,630	--	963	--	
7202.50.0000	Ferrochromium-silicon, gross weight	741	860	252	286	214	238	Canada (62%); Mexico (22%); United Kingdom (8%);
7202.50.0000	Ferrochromium-silicon, contained weight	259	--	88	--	75	--	Venezuela (8%).
	Total ferroalloys, gross weight	9,360	12,500	15,800	14,000	9,180	10,200	
	Total ferroalloys, contained weight	5,540	--	9,520	--	5,360	--	
	Chemicals, gross weight:							
	Chromium oxides:							
2819.10.0000	Chromium trioxide	7,590	14,500	11,000	21,000	12,700	24,400	Canada (28%); Brazil (25%); Australia (9%); New Zealand (8%); Mexico (6%); Korea, Republic of (5%); South Africa (4%).
2819.90.0000	Other	2,460	14,600	2,110	11,100	2,870	14,200	Canada (29%); Netherlands (22%); Germany (12%); China (7%); United Kingdom (5%); Mexico (4%).
2833.23.0000	Chromium sulfates	187	412	1,060	3,330	532	1,540	Canada (49%); Germany (23%); Netherlands (14%).
	Salts of oxometallic or peroxometallic acids:							
2841.20.0000	Zinc and lead chromate	969	3,280	928	2,620	156	640	Canada (64%); Panama (13%); Mexico (12%).
2841.30.0000	Sodium dichromate	25,800	18,900	31,500	26,300	23,100	19,600	Mexico (46%); Thailand (11%); Uruguay (11%).
2841.40.0000	Potassium dichromate	35	102	66	122	101	204	Brazil (41%); Canada (31%); Japan (15%); Venezuela (9%).
2841.50.0000	Other chromates, dichromates, and peroxochromates	410	1,620	385	1,640	313	1,160	Canada (75%); Mexico (9%); Germany (7%); United Kingdom (7%).
3206.20.0000	Pigments and preparations, gross weight	1,260	6,020	2,100	6,920	3,790	13,100	Canada (79%); Mexico (3%); Jamaica (3%).

1/ Data are rounded to three significant digits; may not add to totals shown.
2/ Harmonized Tariff Schedule of the United States of America code.
3/ Articles thereof and waste and scrap.
4/ More than 4% carbon.
5/ Not more than 4% carbon.

Source: Bureau of the Census.

TABLE 10
U.S. IMPORTS FOR CONSUMPTION OF CHROMITE ORE, BY COUNTRY 1/

Country	Not more than 40% Cr_2O_3 (HTSUSA 2/ 2610.00.0060)			More than 40% but less than 46% Cr_2O_3 (HTSUSA 2/ 2610.00.0040)			46% or more Cr_2O_3 (HTSUSA 2/ 2610.00.0020)			Total		
	Gross weight (metric tons)	Cr_2O_3 content (metric tons)	Value (thou-sands)	Gross weight (metric tons)	Cr_2O_3 content (metric tons)	Value (thou-sands)	Gross weight (metric tons)	Cr_2O_3 content (metric tons)	Value (thou-sands)	Gross weight (metric tons)	Cr_2O_3 content (metric tons)	Value (thou-sands)
1995:												
Canada	--	--	--	--	--	--	39	24	$9	39	24	$9
India	--	--	--	--	--	--	25,400	12,400	4,090	25,400	12,400	4,090
Philippines	11,100	4,000	$1,700	--	--	--	--	--	--	11,100	4,000	1,700
South Africa	171	39	27	14,800	6,110	$1,100	201,000	96,400	13,200	216,000	103,000	14,300
Venezuela	304 r/	74 r/	43 r/	--	--	--	--	--	--	304 r/	74 r/	43 r/
Total	11,600	4,110 r/	1,770 r/	14,800	6,110	1,100	226,000	109,000	17,200	253,000	119,000	20,100
1996:												
Canada	20	8	3	--	--	--	--	--	--	20	8	3
Philippines	7,940	2,620	1,060	--	--	--	--	--	--	7,940	2,620	1,060
South Africa	--	--	--	25,400	11,100	2,480	217,000	102,000	19,700	242,000	113,000	22,100
Venezuela	46	18	16	--	--	--	--	--	--	46	18	16
Zimbabwe	23	9	3	--	--	--	--	--	--	23	9	3
Total	8,030	2,650	1,080	25,400	11,100	2,480	217,000	102,000	19,700	250,000	116,000	23,200
1997:												
Canada	--	--	--	--	--	--	13	6	5	13	6	5
China	20	7	6	--	--	--	--	--	--	20	7	6
Japan	657	67	3	--	--	--	--	--	--	657	67	3
Philippines	5,780	1,910	1,050	--	--	--	--	--	--	5,780	1,910	1,050
Russia	--	--	--	--	--	--	22	261	117	22	261	117
South Africa	645	154	70	19,500	8,970	1,460	277,000	130,000	19,700	297,000	139,000	21,300
Venezuela	20	7	6	--	--	--	--	--	--	20	7	6
Total	7,120	2,140	1,140	19,500	8,970	1,460	277,000	130,000	19,900	303,000	141,000	22,500

r/ Revised.

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

2/ Harmonized Tariff Schedule of the United States of America code.

Source: Bureau of the Census.

TABLE 11
U.S. IMPORTS FOR CONSUMPTION OF FERROCHROMIUM, BY COUNTRY 1/

Country	Low-carbon (not more than 3% carbon) (HTSUSA 2/ 7202.49.5000)			Medium-carbon (more than 3% carbon but not more than 4% carbon) (HTSUSA 2/ 7202.49.1000)			High-carbon (more than 4% carbon) (HTSUSA 2/ 7202.41.0000)			Total (all grades)		
	Gross weight (metric tons)	Chromium content (metric tons)	Value (thousands)	Gross weight (metric tons)	Chromium content (metric tons)	Value (thousands)	Gross weight (metric tons)	Chromium content (metric tons)	Value (thousands)	Gross weight (metric tons)	Chromium content (metric tons)	Value (thousands)
1995:												
Albania	--	--	--	--	--	--	8,700	5,240	$5,170	8,700	5,240	$5,170
Argentina	(3/)	(3/)	(3/)	--	--	--	--	--	--	(3/)	(3/)	(3/)
Brazil	70 r/	51 r/	$107 r/	--	--	--	7,000	3,690	4,660	7,070 r/	3,740 r/	4,760 r/
Canada	--	--	--	--	--	--	19	11	22	19	11	22
China	5,240	3,350	6,830	227	151	$127	12,400	8,020	11,000	17,800	11,500	17,900
Croatia	--	--	--	6	4	9	14,300	8,820	10,800	14,300	8,820	10,800
Estonia	(3/)	(3/)	(3/)	--	--	--	--	--	--	(3/)	(3/)	(3/)
Finland	--	--	--	--	--	--	8,610	4,850	5,270	8,610	4,850	5,270
France	--	--	--	--	--	--	7	5	9	7	5	9
Germany	6,830	4,770	14,600	--	--	--	7	5	15	6,840	4,780	14,600
India	--	--	--	--	--	--	11,600	6,970	10,300	11,600	6,970	10,300
Japan	525	348	1,350	--	--	--	269	169	309	793	517	1,660
Kazakstan	7,040	4,370	7,730	5,840	3,840	5,750	34,300	22,800	28,000	47,200	31,000	41,500
Latvia	(3/)	(3/)	(3/)	--	--	--	15,500	10,700	13,300	15,500 r/	10,700 r/	13,300 r/
Norway	--	--	--	--	--	--	6,170	3,850	5,200	6,170	3,850	5,200
Philippines	--	--	--	--	--	--	2,580	1,530	2,390	2,580	1,530	2,390
Poland	--	--	--	--	--	--	1,410	801	1,020	1,410	801	1,020
Russia	29,300 r/	20,300 r/	38,500 r/	--	--	--	68,300	45,800	57,800	97,600 r/	66,100 r/	96,300 r/
Slovenia	--	--	--	--	--	--	1,250	750	1,140	1,250	750	1,140
South Africa	14,300	8,050	10,900	--	--	--	118,000	60,000	58,900	132,000	68,000	69,800
Sweden	--	--	--	--	--	--	38	26	49	38	26	49
Turkey	956	699	1,240	1,500	930	1,170	82,400	51,000	69,000	84,800	52,600	71,400
Ukraine	185	131	237	--	--	--	--	--	--	185	131	237
United Kingdom	61	46	132	--	--	--	162	107	201	224	153	332
Zimbabwe	1,340	716	1,320	--	--	--	29,000	18,400	24,000	30,300	19,100	25,300
Total	65,800	42,800	82,900	7,570	4,930	7,060	422,000	254,000	309,000	495,000	301,000	399,000
1996:												
Albania	--	--	--	--	--	--	8,170	4,730	5,170	8,170	4,730	5,170
China	8,180	5,370	12,600	--	--	--	9,860	6,280	6,540	18,000	11,600	19,100
Croatia	20	13	17	--	--	--	9,430	5,880	6,110	9,450	5,900	6,130
Estonia	--	--	--	--	--	--	8,310	5,400	5,360	8,310	5,400	5,360
Finland	--	--	--	--	--	--	9,020	4,790	4,820	9,020	4,790	4,820
Germany	9,200	6,410	21,100	--	--	--	19	14	38	9,220	6,430	21,100
India	1,360	933	2,220	--	--	--	6,150	3,810	3,860	7,500	4,750	6,080
Japan	533	345	1,380	--	--	--	18	12	25	551	357	1,400
Kazakstan	152	106	257	--	--	--	77,600	46,800	45,600	77,700	46,900	45,800
Namibia	--	--	--	--	--	--	17	11	28	17	11	28

See footnotes at end of table.

TABLE 11--Continued
U.S. IMPORTS FOR CONSUMPTION OF FERROCHROMIUM, BY COUNTRY 1/

Country	Low-carbon (not more than 3% carbon) (HTSUSA 2/ 7202.49.5000)			Medium-carbon (more than 3% carbon but not more than 4% carbon) (HTSUSA 2/ 7202.49.1000)			High-carbon (more than 4% carbon) (HTSUSA 2/ 7202.41.0000)			Total (all grades)		
	Gross weight (metric tons)	Chromium content (metric tons)	Value (thousands)	Gross weight (metric tons)	Chromium content (metric tons)	Value (thousands)	Gross weight (metric tons)	Chromium content (metric tons)	Value (thousands)	Gross weight (metric tons)	Chromium content (metric tons)	Value (thousands)
1996--Continued:												
Philippines	--	--	--	36	23	$47	--	--	--	36	23	$47
Russia	18,000	11,900	$27,200	--	--	--	21,600	11,300	$16,200	39,700	23,100	43,400
South Africa	18,900	10,600	16,800	--	--	--	107,000 r/	54,100 r/	45,600 r/	125,000 r/	64,700 r/	62,300 r/
Turkey	902	652	1,890	--	--	--	43,800	27,100	27,400	44,700	27,800	29,200
United Kingdom	313	201	575	--	--	--	513 r/	324 r/	421 r/	826 r/	524 r/	996 r/
Zimbabwe	3,140	1,930	3,240	--	--	--	58,200	36,700	35,300	61,400	38,700	38,600
Total	60,700	38,400	87,200	36	23	47	359,000	207,000	202,000	420,000	246,000	290,000
1997:												
Albania	--	--	--	--	--	--	2,510	1,520	1,350	2,510	1,520	1,350
Canada	--	--	--	--	--	--	28	14	21	28	14	21
China	2,900	1,910	3,300	17	11	16	15,100	9,530	9,630	18,100	11,400	12,900
Croatia	--	--	--	--	--	--	12,200	7,880	6,540	12,200	7,880	6,540
Germany	10,500	7,320	26,700	--	--	--	--	--	--	10,500	7,320	26,700
India	--	--	--	--	--	--	11,200	7,010	6,880	11,200	7,010	6,880
Japan	281	110	520	--	--	--	--	--	--	281	110	520
Kazakstan	1,300	845	1,560	--	--	--	268	197	456	1,570	1,040	2,010
Macedonia	21	15	15	--	--	--	--	--	--	21	15	15
Russia	30,700	20,900	38,800	214	139	248	76,100	34,800	50,100	107,000	55,800	89,100
South Africa	10,200	5,780	7,880	1,300	671	568	112,000	55,300	48,600	124,000	61,700	57,100
Sweden	20	14	34	--	--	--	--	--	--	20	14	34
Turkey	100	73	164	--	--	--	52,700	35,700	32,900	52,800	35,800	33,100
United Kingdom	(4/)	(4/)	2	22	12	9	82	56	63	104	68	74
Zimbabwe	3,020	2,030	3,510	--	--	--	48,500	30,400	29,500	51,500	32,500	33,000
Total	59,100	39,000	82,500	1,550	834	842	331,000	182,000	186,000	392,000	222,000	269,000

r/ Revised.
1/ Data are rounded to three significant digits; may not add to totals shown.
2/ Harmonized Tariff Schedule of the United States of America code.
3/ Revised to zero.
4/ Less than 1/2 unit.

Source: Bureau of the Census.

TABLE 12
U.S. IMPORTS FOR CONSUMPTION OF CHROMIUM MATERIALS, BY TYPE 1/

HTSUSA 2/	Type	1995 Quantity (metric tons)	1995 Value (thousands)	1996 Quantity (metric tons)	1996 Value (thousands)	1997 Quantity (metric tons)	1997 Value (thousands)	Principal sources, 1997
	Metals and alloys:							
	Chromium metal:							
8112.20.3000	Waste and scrap, gross weight	110 r/	$549 r/	67	$311 r/	25	$221	United Kingdom (87%); Singapore (7%); Germany (5%).
8112.20.6000	Other than waste and scrap, gross weight	6,890 r/	44,800 r/	8,670	60,900	9,770	72,500	Russia (34%); China (26%); France (19%); United Kingdom (16%).
7202.50.0000	Ferrochromium-silicon, gross weight	49,600	32,500	49,400	33,200	36,500	23,700	Russia (81%); Zimbabwe (15%); China (4%).
7202.50.0000	Ferrochromium-silicon, contained weight	17,300	--	21,100	--	14,700	--	
	Chemicals, gross weight:							
	Chromium oxides and hydroxides:							
2819.10.0000	Chromium trioxide	4,060	7,270	3,800	7,060	2,980	5,930	Kazakstan (74%); Germany (11%); Italy (8%); Japan (5%).
2819.90.0000	Other	5,030	14,500	4,350	13,100	3,550	13,800	Germany (30%); Japan (29%); China (18%); Canada (8%); Brazil (5%).
2833.23.0000	Sulfates of chromium	170	127	192	159	216	212	United Kingdom (48%); Mexico (24%); Germany (17%); South Africa (9%).
	Salts of oxometallic or peroxometallic acids:							
2471.20.0000	Chromates of lead and zinc	396	925	114	260	295	686	Poland (27%); Korea, Republic of (25%); Canada (20%); Norway (20%); United Kingdom (5%).
2841.30.0000	Sodium dichromate	7,000	4,660	5,100	4,040	6,140	5,740	United Kingdom (80%); Canada (9%); Argentina (6%); Turkey (5%).
2841.40.0000	Potassium dichromate	377	661	381	718	350	688	United Kingdom (52%); Poland (31%); Mexico (9%); India (6%).
2841.50.0000	Other chromates and dichromates; peroxochromates	919	2,040	573	1,260	788	1,720	United Kingdom (96%); Canada (3%); Austria (1%).
2849.90.2000	Chromium carbide	200	1,970	190	2,270	159	2,110	United Kingdom (36%); Germany (35%); Japan (29%).
	Pigments and preparations based on chromium, gross weight:							
3206.20.0010	Chrome yellow	4,700	10,400	7,020	17,600	6,820	19,500	Canada (77%); Hungary (9%); Mexico (8%); Philippines (3%).
3206.20.0020	Molybdenum orange	673	2,250	1,840	5,670	1,760	6,420	Canada (98%); Japan (2%).
3206.20.0030	Zinc yellow	136	314	127	283	--	--	
3206.20.0050	Other	805	3,060	929	3,530	1,090	4,560	France (58%); China (8%); Germany (7%); South Africa (7%)%; Japan (6%).

r/ Revised.
1/ Data are rounded to three significant digits; may not add to totals shown.
2/ Harmonized Tariff Schedule of the United States of America code.

Source: Bureau of the Census.

TABLE 13
PRINCIPAL WORLD CHROMITE PRODUCERS, 1997

Country 1/	Company
Albania	Albchrome Ltd. (Government owned).
Brazil	Bayer AG (Germany).
	Coitizeiro Mineração S.A. (COMISA).
	Cia. de Ferro-Ligas da Bahia S.A. (FERBASA).
	Cia. de Mineração Serra de Jacobina S.A.
	Mineração Vale do Jacurici S.A.
	Elkem ASA (Norway).
	Vila Nova Mine.
	Magnesita S.A.
Finland	Outokumpu Oy.
	Outokumpu Steel Oy.
	Outokumpu Chrome Oy.
India	Ferro Alloys Corp. Ltd.
	Mysore Mineral Ltd.
	Orissa Mining Corp. Ltd. (Government owned).
	Tata Iron and Steel Co. Ltd.
Indonesia	PT. Palabim Mining-PT. Bituminusa.
Iran	Faryab Mining Company.
Japan	Japan Chrome Industry Co. Ltd.
Kazakstan	Donskoy Ore Dressing Complex.
Madagascar	Kraomita Malagasy.
Philippines	Acoje Mining Co. Inc.
	Benguet Corp.
	Krominco Inc.
	Philchrome Mining Corp.
	Velore Mining Corp.
Russia	Saranov Complex.
South Africa	African Mining and Trust Co. Ltd.
	Rustenburg Minerals Development Co. (Pty.) Ltd.
	Zeerust Chrome Mine Ltd.
	Bayer AG (Germany).
	Bayer (Pty.) Ltd.
	Canadian Gold S.A. (Pty.) Ltd.
	Goudini Chrome (Pty.) Ltd.
	Chromecorp Holdings (Pty.) Ltd.
	Chrome Resources (Pty.) Ltd.
	Consolidated Metallurgical Industries Ltd.
	Hernic Chrome.
	Hernic Mining (Pty.) Ltd.
	Northern Province Development Corp. Ltd.
	Dilokong Chrome Mine (Pty.) Ltd.
	Pilanesberg Chrome (Pty.) Ltd.
	Rooderand Chrome Mine (Pty.) Ltd.
	Rustenburg Minerals Development Company.
	Samancor Limited.
	Eastern Chrome Mines.
	Western Chrome Mines.
	Vereeniging Refractories Ltd.
	Bophuthatswana Chrome Co. (Pty.) Ltd.
	Marico Chrome Corp. (Pty.) Ltd.
Sudan	Advanced Mining Works Ltd.
Turkey	Aycan Madencilik Ltd. Sti.
	Bilfer Madencilik A.S.
	Birlik Madencilik Sanayi ve Ticaret A.S.
	Cevher Madencilik ve Ticaret A.S.
	Dedeman Madencilik ,Turzim, Sanayi ve Ticaret A.S.
	Ege Metal Endüstri A.S.
	Etibank General Management (Government owned).
	Hayri Ögelman Madencilik Ltd. Sti.
	Tekfen Dis. Ticaret A.S.
	Tevfik Refik Bayoglu Madencilik.
	Tut. Gen. Ticaret Ltd. Sti.
	Turk Maadin Sti. A.S.

See footnote at end of table.

TABLE 13--Continued
PRINCIPAL WORLD CHROMITE PRODUCERS, 1997

Country 1/	Company
Zimbabwe	Zimbabwe Alloys Ltd.
	Zimasco (Pvt.) Ltd.

1/ Other chromite-producing countries included Burma, China, Cuba, Egypt, Macedonia, Morocco, Oman, and Pakistan.

TABLE 14
PRINCIPAL WORLD FERROCHROMIUM PRODUCERS, 1997

Country 1/	Company
Albania	Albchrome Ltd. (Government owned).
Brazil	Cia. de Ferro-Ligas da Bahia S.A.
China	Chongqing Ferroalloy Works (Government owned).
	Emei Ferroalloy Works (Government owned).
	Hanzhong Ferroalloy Works (Government owned).
	Hengshan Iron and Steel Works (Government owned).
	Hunan Ferroalloy Works (Government owned).
	Jiangyin Ferroalloy Factory (Government owned).
	Jilin Ferroalloy Works (Government owned).
	Jinzhou Ferroalloy Works.
	Liaoyang Ferroalloy Works (Government owned).
	Nanjing Ferroalloy Plant (Government owned).
	Shanghai Ferroalloy Works (Government owned).
	Xibei Ferroalloy Works (Government owned).
Croatia	Dalmacija Ferro-Alloys Works.
Finland	Outokumpu Oy.
	Outokumpu Steel Oy.
	Outokumpu Chrome Oy.
Germany	Elektrowerk Weisweiler GmbH.
India	Deepak Ferro-Alloys Ltd.
	Eastern Metals & Ferro-Alloys Ltd.
	Ferro Alloys Corp. Ltd.
	Charge Chrome Works.
	Ferroalloys Works.
	GMR Vasavi Industries Ltd.
	Hi-Tech Electrothermics (Pvt.) Ltd.
	Indian Metals & Ferro Alloys Ltd.
	Indian Charge Chrome Ltd.
	Industrial Development Corp.
	Ispat Alloys Ltd.
	Jindal Ferro Alloys Ltd.
	Mandsaur Ferro Alloys Ltd.
	Monnet Industries Ltd.
	Nav Chrome Ltd.
	Nava Bharat Ferro Alloys Ltd.
	Shri Girija Smelters Ltd.
	Srinivasa Ferro Alloys Ltd.
	Standard Chrome Ltd.
	Tata Iron and Steel Co. Ltd.
	Bamnipal Plant.
	Joda Plant.
	VBC Ferro-Alloys Ltd.
	Visvesvaraya Iron & Steel Ltd. (State owned).
	V.K. Ferroalloys (Pvt.) Ltd.
Iran	Faryab Mining Co. - Abadan Ferroalloys Refinery.
Italy	Acciaierie e Ferriere Lombarde Falck SpA.
	Darfo s.r.l.
	Ferroleghe SpA.
Japan	Japan Metals and Chemicals Co. Ltd.
	Nippon Denko Co. Ltd.
	NKK Corp.
	Pacific Metals Co. Ltd.
	Showa Denko K.K.
Kazakstan	Aktubinsk Ferroalloy Works.
	Aksu Ferroalloy Plant.

See footnotes at end of table.

TABLE 14 - Continued
PRINCIPAL WORLD FERROCHROMIUM PRODUCERS, 1997

Country 1/	Company
Norway	Elkem A/S.
Philippines	Ferrochrome Philippines Inc.
	Integrated Chrome Corp.
	Philippine Mineral & Alloy Corp.
Poland	Huta "Laziska" Ferroalloy Plant.
Romania	S.C. Ferom S.A.
Russia	Chelyabinsk Electrometallurgical Intergrated Plant.
	Klutchevsk Ferroalloy Plant.
	Serov Ferroalloys Plant.
Slovakia	Oravske Ferozliatinarske Zavody.
Slovenia	Tovarna Dusika Ruse-Metalurgija d.o.o.
South Africa	Assoc. Manganese Mines of South Africa Ltd.
	Feralloys Ltd.
	Chromecorp Holdings Ltd.
	Chrome Resources (Pty.) Ltd.
	Ferrochrome Division.
	Hernic Ferrochrome (Pty.) Ltd.
	Johannesburg Consolidated Investment Co. Ltd.
	Consolidated Metallurgical Industries Ltd.
	Lydenburg Works.
	Rustenburg Works.
	Purity Ferrochrome (Pty.) Ltd.
	Samancor Limited.
	Batlhako Ferrochrome Ltd.
	Ferrometals Division.
	Middelburg Ferrochrome Division.
	Palmiet Ferrochrome Division.
	Tubatse Ferrochrome Division.
Sweden	Vargön Alloy AB.
Turkey	Etibank General Management (Government owned).
	Antalya Electrometallurgical Works.
	Elazig Sarkkromlari Ferrochromium Works.
United States	Elkem Metals Co.
	Macalloy Corp.
Zimbabwe	Zimbabwe Alloys Ltd.
	Zimasco (Pvt.) Ltd.

1/ Other ferrochromium-producing countries include Chile, Spain, and Taiwan.

TABLE 15
CHROMITE: WORLD PRODUCTION, BY COUNTRY 1/ 2/

(Metric tons, gross weight)

Country 3/	1993	1994	1995	1996	1997 e/
Albania	115,000 r/	118,000 r/	160,000 r/	143,000 r/	106,000
Brazil 4/	307,577	359,788	447,963	408,495 r/	330,000
Burma e/	1,000	1,000	1,000	1,000	1,000
China e/	54,000	62,000	94,000	130,000 r/	120,000
Cuba	15,000 r/	20,000 r/	30,693 r/	37,300 r/	44,000
Egypt	-- r/	-- r/	-- r/	-- r/	--
Finland	511,000	572,747	597,605	573,904 r/	611,000
Greece e/	10,000 r/	5,000 r/	5,000 r/	5,000 r/	5,000
India	1,000,073 r/	909,076	1,536,386	1,363,205	1,363,049 5/
Indonesia e/	2,500	2,500	10,000	13,300	2,156
Iran	124,300 r/	354,100 r/	371,100 r/	250,000 r/	200,000
Japan e/	7,000	7,000	7,000	7,000	7,000
Kazakstan	2,900,000 e/	2,020,000	2,871,000	1,190,000	1,000,000
Macedonia e/	5,000	5,000	5,000	5,000 r/	5,000
Madagascar	144,200	90,200	106,107 r/	137,210	139,700
Oman	10,236	6,166	5,300	15,000	15,000
Pakistan	22,154	6,240	17,000 e/	27,987	30,000
Philippines	61,732	76,003	111,035	78,345	87,500 5/
Russia	120,800	143,000	151,400	96,700	150,000
South Africa	2,838,000	3,599,000	5,085,000	4,970,945 r/	5,779,424 5/
Sudan e/	11,500	25,000	44,988 5/	12,000	43,000
Turkey	767,313	1,270,431	2,080,043	1,279,032 r/	1,750,000
United Arab Emirates	19,000 r/	55,000	37,000	56,000	61,000
Zimbabwe	252,033	516,801	707,433	697,311	680,000
Total	9,300,000 r/	10,200,000 r/	14,500,000 r/	11,500,000 r/	12,500,000

e/ Estimated. r/ Revised.

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

2/ Table includes data available through June 25, 1998.

3/ Figures for all countries represent marketable output unless otherwise noted.

4/ Average Cr_2O_3 content was as follows: 1993--41.0%; 1994--41.3%; 1995--42.2% (revised); 1996--42.2%; and 1997--42.6%.

5/ Reported figure.

TABLE 16
FERROCHROMIUM: WORLD PRODUCTION, BY COUNTRY 1/ 2/

(Metric tons)

Country	1993	1994	1995	1996	1997
Albania	35,600	33,764	42,986	31,189	31,445
Brazil 3/	83,892	77,165 r/	95,840	72,609	73,000 e/
Chile	680	1,579	2,730	2,079 r/	2,000 e/
China e/	372,000	370,000	500,000 r/	423,000 r/	387,000
Croatia	27,336	31,704	26,081	10,559	24,231
Finland	218,370	253,501	246,805	227,811 r/	237,000 e/
Germany	16,400	17,283	21,665 r/	25,303 r/	25,856
India 4/	228,000 r/	247,000 r/	307,537 r/	261,666 r/	286,973
Iran 5/	--	7,150	11,900	10,500 r/	11,450
Italy	53,504	22,650	51,017	29,915	11,295
Japan 3/	211,102	204,181	221,425	200,365	191,005
Kazakstan	327,896	200,000 e/	486,000	352,000 e/	300,000 e/
Macedonia	4,376	3,164	3,765	3,780	460
Norway	80,000	120,000	148,000	108,800	145,000 e/
Philippines	11,908	16,186	50,450	6,736 r/	--
Poland	38,449	7,353	18,334	3,785 r/	5,900
Romania	3,907	3,885	15,053	9,650	950
Russia	255,900	265,525	290,000 r/ e/	135,000 r/ e/	247,000
Slovakia 3/	50,600	48,555	65,260	19,900 r/	11,394
Slovenia	8,812 r/	13,412 r/	23,247 r/	22,819 r/	9,232
South Africa 6/	833,600	1,103,612	1,386,400	1,478,000 r/	1,925,000
Spain	2,390	2,300	1,320	805	490
Sweden	127,543	134,076	130,170	138,110	101,842
Turkey	90,030	97,585	94,251	101,450	100,000 e/
United States 7/	63,000	67,400	72,500	36,800 8/	60,700
Zimbabwe 3/	124,000	182,852	254,142	261,918 r/	230,000 e/
Total	3,270,000 r/	3,530,000 r/	4,570,000 r/	3,970,000 r/	4,420,000

e/ Estimated. r/ Revised.

1/ World totals, U.S. data, and estimated data are rounded to three significant digits; may not add to totals shown.

2/ Table includes data available through June 25, 1998.

3/ Includes high- and low-carbon ferrochromium.

4/ Includes ferrochrome and charge chrome.

5/ Production began in 1994.

6/ Includes high- and low-carbon ferrochromium and ferrochromium-silicon.

7/ Includes high- and low-carbon ferrochromium, ferrochromium-silicon, chromium metal, and other chromium materials.

8/ Reported figure.

TABLE 17
WORLD CHROMIUM ANNUAL PRODUCTION CAPACITY OF CHROMITE ORE,
FERROCHROMIUM, CHROMIUM METAL, CHROMIUM CHEMICALS, AND STAINLESS STEEL IN 1997 1/

(Thousand metric tons, contained chromium)

	Ore	Ferro-chromium	Metal	Chemicals	Stainless steel
Albania	60	25	--	--	--
Argentina	--	--	--	6	--
Austria	--	--	--	--	8
Bangladesh	--	--	--	--	3
Belgium	--	--	--	--	107
Brazil	135	73	(2/)	--	37
Burma	1	--	--	--	--
Canada	--	--	--	--	32
Chile	--	2	--	--	--
China	30	325	4	21	68
Croatia	--	67	--	--	--
Cuba	14	--	--	--	7
Egypt	--	--	--	--	--
Finland	211	134	--	--	89
France	--	--	7	--	163
Germany	--	22	1	24	255
Greece	2	--	--	--	--
India	480	295	(2/)	8	100
Indonesia	20	--	--	--	--
Iran	130	11	--	2	--
Italy	--	34	--	--	182
Japan	2	115	1	17	660
Kazakstan	900	567	1	42	--
Korea, North	--	32	--	--	--
Korea, Republic of	--	--	--	--	150
Macedonia	2	7	--	5	--
Madagascar	45	--	--	--	--
Mexico	--	--	--	--	--
Norway	--	94	--	--	--
Oman	6	--	--	--	--
Pakistan	10	--	--	3	--
Philippines	45	66	--	--	--
Poland	--	16	--	5	--
Romania	--	33	--	9	--
Russia	40	239	13	60	330
Slovakia	--	63	--	--	--
Slovenia	--	13	--	--	--
South Africa	1,700	1,250	--	(3/)	95
Spain	--	--	--	--	140
Sudan	14	--	--	--	--
Sweden	--	113	--	--	110
Taiwan	--	1	--	--	123
Thailand	--	--	--	--	--
Turkey	580	100	--	10	54
Ukraine	--	--	--	--	33
United Arab Emirates	21	--	--	--	--
United Kingdom	--	--	5	52	92
United States	--	116	3	56	390
Zimbabwe	214	154	--	--	--
Total	4,660	3,960	34	320	3,230

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

2/ Less than 1/2 unit.

3/ Twenty-four-thousand-ton plant under construction in 1997.