SILICON

By Larry D. Cunningham

Silicon (Si) is a light chemical element with metallic and nonmetallic characteristics. In nature, silicon combines with oxygen and other elements to form silicates. Silicon in the form of silicates constitutes more than 25% of the Earth's crust. Silica is a silicate consisting entirely of silicon and oxygen. Silica (SiO_2) as quartz or quartzite is used to produce silicon-base products for the aluminum, chemical, iron, and steel industries.

Silicon metal and ferrosilicon are referred to by the approximate percentage of silicon contained in the material and by the maximum amount of trace impurities present. There are two standard grades of ferrosilicon, with one grade approximately 50% silicon and the other 75% silicon by weight. Almost all ferrosilicon products are consumed by the iron and steel industry.

Metallurgical-grade silicon metal is used by the primary aluminum, secondary aluminum, and chemical industries. The products sold to these industries vary considerably in their specifications. The chemical and primary aluminum industries generally require more stringent specifications than those of the secondary aluminum industry. In addition, the chemical industry requires that the metal be ground into a fine powder rather than the lump form used by the aluminum industry.

The average annual dealer import price for ferrosilicon increased from that of 1993, while that for silicon metal decreased. Based on contained silicon, overall domestic silicon production increased to about 390,000 metric tons and consumption of silicon increased to about 610,000 tons.

Overall U.S. trade volume, gross weight, of silicon exports was virtually unchanged, while overall trade volume of silicon imports increased by more than 10%. The President of the United States granted General System of Preferences (GSP) status to Kazakhstan, Romania, Ukraine, and the Republic of South Africa.

Legislation and Government Programs

In October, it was reported that Sematech, an 11 member company consortium of semiconductor manufacturers, planned to relinquish government funding by late 1996. Sematech was founded in 1987 to improve U.S. company competitiveness in computer chip manufacturing technology. The U.S. Department of Defense provides about $90 million per year to Sematech's research. The consortium plans to continue its research utilizing corporate funding.[1]

In mid-March, the U.S. Department of Commerce (DOC) announced in the Federal Register an antidumping duty order on ferrosilicon from Brazil. The DOC determined that ferrosilicon from Brazil is being, or is likely to be, sold in the United States at less than fair value. The U.S. International Trade Commission (ITC), which conducts its own investigation, determined that an industry in the United States is materially injured by reason of ferrosilicon imports from Brazil. The period of investigation was July 1, 1992 through December 31, 1992. The DOC directed the Customs Service to assess antidumping du-ties, margin amount, equal to the amount by which the foreign market value of the product exceeds the U.S. price. The duties were to be assessed on all unliquidated entries of fer-rosilicon from Brazil entered, or withdrawn from warehouse, for consumption on or after August 16, 1993. A duty of 3.46% exists for Companhia Ferroligas Minas Gerais, 88.86% for Italmagnesio S.A. Industria e Comercio, 15.53% for Companhia Brasileira Carbureto de Calcio, and 35.95% for all others, effective March 14, 1994.

The Brazilian investigation was the culmination of a series of antidumping and countervailing duty cases initiated in response to a petition filed in May 1992. Prior to the decision on Brazil, the DOC assessed dumping duties for China at 137.73%; Kazakhstan, Russia, and Ukraine at 104.18%; and Venezuela at 9.55%. Venezuela also was assessed a countervailing duty of 22.08%. However, in the cases of Argentina and Egypt, it was determined that an industry in the United States is not materially injured or threatened with material injury by reason of ferrosilicon from the two countries.

The DOC and ITC investigations were instituted in response to petitions filed by Applied Industrial Minerals Corp., Alabama Silicon Inc., American Alloys, Globe Metallurgical Inc., Silicon Metaltech Inc. (American Silicon Technologies), and union locals of the United Autoworkers of America, the United Steelworkers of America, and the Oil, Chemical & Atomic Workers.

DOC's administration review of the countervailing duty order on ferrosilicon from Venezuela was terminated in mid-December, with no changes being made to the initial duty order.

In early-April, the DOC announced in the Federal Register an amendment to its December 1993 final results of the administrative review of the antidumping duty order on silicon metal from Argentina. Owing to a clerical error, the dumping margin for Silarsa S.A. was lowered to 24.62% from 54.67%. Final dumping margins of 2.06% for Electrometalurgica S.A.I.C. (Andina) and 8.65% for "all others" remained unaffected by the amendment.

In August, the DOC also announced in the Federal Register final results of its administrative review of the antidumping duty order on silicon metal from Brazil. DOC's review of Brazil covered four manufacturers/exporters: Companhia Brasileira Carbureto de Calcio, Companhia Ferroligas Minas Gerais, Eletrosilex Belo Horizonte, and Rima Electrometalurgia S.A. (RIMA). As a result of its review, DOC determined that a margin of 91.06% existed for RIMA for the period March 29, 1991 through June 30, 1992.

On December 8, 1994, the President of the United States signed legislation adopting the Uruguay Round accords of the General Agreements on Tariffs and Trade (GATT) which included renewal of the GSP program until July 31, 1995. The GSP program had expired on September 30, 1994. The legislation extending the GSP was retroactive to September 30. Under GSP, the United States grants duty-free access to goods from more than 140 developing countries and territories. In 1994, U.S. import duties for selected silicon materials ranged from duty free to 9% ad valorem for most-favored-nation (MFN) status and from $0.044 per kilogram of contained silicon to 45% ad valorem for non-MFN status.

In Proclamation 6650 of February 16, 1994, the President of the United States designated Kazakhstan and Romania as beneficiary developing countries for purposes of the GSP, effective March 4, 1994. In Proclamation 6655 of March 3, 1994, the President also granted GSP status to Ukraine, effective March 23, 1994. The extension of GSP status is part of

the Administration's overall effort to facilitate Kazakhstan, Romania, and Ukraine's transformation to free market economies. Additionally, GSP status was granted to the Republic of South Africa in Proclamation 6676 of April 21, 1994, effective May 10, 1994.

Production

Overall gross production of silicon products in the United States decreased 7% compared with that of 1993. Production of silicon metal was down slightly, while production of ferrosilicon and miscellaneous alloys was up by about 11%. Overall shipments of silicon-containing products increased by 2%. Producer stocks of silicon-containing materials were down by about 9% overall. Ferrous scrap used in the production of these products was estimated to be about 150,000 tons. Domestic production data for the silicon commodity are developed by the U.S. Bureau of Mines by means of monthly and annual voluntary surveys, and Bureau estimates. The "Silicon Alloys" survey canvasses the operations listed in table 3. The figures in table 2 represent 100% of the production and shipments from these operations. *(See tables 1, 2, and 3.)*

Production of silicon metal and silicon alloys is extremely power intensive, requiring a power input, for some operations, of up to 14,000 kilowatt-hours per ton of silicon content.

The location of ferrosilicon and silicon metal smelters is normally determined by balancing marketing costs against processing costs. Principal elements in the cost of silicon and ferrosilicon production are (1) delivered costs of the ore; (2) energy cost; (3) cost of reductant coke or low ash coal; (4) cost of iron in the form of steel scrap, if required; and (5) labor. The cost of all these elements, and particularly the cost of energy, has increased rapidly since 1970. In addition, new capital costs for pollution control equipment were added.

Recovery of silicon from secondary sources is not normally practiced. The only secondary possibility is recovery from scrap metal. However, any value of contained silicon would be incidental to the value of the primary metal. In 1994, the average price for ferrosilicon was about $0.42 per pound and the average price for silicon metal was about $0.64 per pound. For the future, recycling of silicon in the form of ferrosilicon and silicon metal is expected to be insignificant.

In early February, Elkem Metals Company announced that it had decided to temporarily shut down production of the 50-megawatt ferrosilicon furnace at its plant in Ashtabula, OH. The shutdown would occur about April 15, resulting in the layoff of about 200 of the plant's 300 employees. The shutdown was prompted by noncompetitive power costs and high labor requirements to operate an aging facility. Production would resume when economic factors improve enough to allow the company to operate the furnace profitably. Elkem will continue to supply its North American customers with ferrosilicon products from the company's Canadian and Norwegian production facilities.[2] The furnace at Ashtabula produces about 60,000 tons per year of 50%-grade ferrosilicon and related products for use in the steel and foundry industries.[3]

In late December, Globe Metallurgical Inc., Cleveland, OH, announced the purchase of SKW Metals & Alloys Inc.'s Niagara Falls, NY, silicon manufacturing facility. Financial details of the acquisition were not disclosed. The facility, built in 1913, reportedly is the oldest operating ferroalloys plant in the United States. The facility houses two 36-megavolt-ampere electric furnaces. One built in 1976 produces ferrosilicon and the other built in 1987 produces silicon metal.[4] Globe, a producer and worldwide distributor of foundry alloys and silicon metal, has additional U.S. silicon production facilities in Beverly, OH; Selma, AL; and Springfield, OR. SKW will continue to produce ferroalloys at its facilities in Calvert City, KY; Quebec, Canada; and Germany.

In November, it was reported that Dow Corning Corp., Midland, MI, planned to move ahead to the commercialization phase of the company's direct current closed-furnace silicon metal manufacturing technology development program. The company was seeking partners to commercialize the technology, with plans for having a facility on-line by 1997. Dow reported that testing at its pilot plant in Selkirk, Manitoba, Canada, showed that the technology is more energy efficient, environmentally friendly, and safer to operate than current open-furnace processes. The plant, commissioned in 1992, was scheduled to be shut down at the end of November 1994. Funding for the pilot plant was provided by Dow, about $20 million; Western Economic Development Canada, $5 million; the Province of Manitoba, $5 million; and the U.S. Department of Energy, $2 million.[5]

Consumption

The aluminum industry used silicon metal in the production of wrought and cast products, while ferrosilicon was used primarily as a deoxidizing and alloying agent in the production of iron and steel products. Metallurgical-grade silicon metal also was used as the basic raw material in the manufacturing of many chemical products and intermediates such as silicones and silanes. Overall reported consumption of silicon alloys and metal increased slightly from that of 1993. *(See table 4.)*

U.S. apparent consumption of silicon metal and silicon-containing ferroalloys was estimated to be about 607,000 tons of contained silicon. Consumption of silicon metal was estimated at about 247,000 tons, while consumption of ferrosilicon and miscellaneous silicon alloys was estimated to be about 360,000 tons. Compared with that of 1993, consumption of silicon metal increased by about 10%, while consumption of ferrosilicon and other alloys increased by about 7%. Ferrosilicon and miscellaneous silicon alloys accounted for about 60% of all the silicon materials consumed, based on silicon content.

Prices

Demand for metallurgical-grade silicon alloys and metal is determined by the level of activity in the steel, ferrous foundry, aluminum, and chemical industries and is little affected in the short term by prices for these materials. As a result, prices tend to vary widely with changes in demand and supply.

The Metals Week "dealer import" price, posted in cents per pound of contained silicon, for 50%- and 75%-grade ferrosilicon was in decline for most of the year. However, the average annual price for the materials increased from that of 1993. *(See table 1.)* The import price for 50%-grade ferrosilicon started the year at a range of $0.44 to $0.45 per pound, fell to a range of $0.425 to $0.435 through mid-December, then rose to finish the year at $0.435 to $0.445. The import price for 75%-grade ferrosilicon decreased progressively from a range of $0.435 to $0.445 per pound to $0.40 to $0.41 through November, then increased to $0.410 to $0.425 by yearend.

The Metals Week "dealer import" price, posted in cents per pound of contained silicon, for silicon metal increased during the year, but the average annual price for the material decreased from that of 1993. *(See table 1.)* The import price for silicon metal rose from a range of $0.59 to $0.62 per pound to $0.65 to $0.67 by midyear, where it remained through December.

Foreign Trade

U.S. exports of ferrosilicon decreased by about 4% compared with that of 1993, based on gross weight, while total value of the exports was down slightly. *(See table 5.)* Almost 50% of the exported material was shipped to Canada.

Silicon metal exports increased by about 14% based on gross weight, with total value of the exports up by about 5%. Canada, Japan, and Mexico were major recipients of the materials, with almost 70% of the total.

U.S. imports of silicon-containing alloys were up by 2% compared with that of 1993. *(See table 6.)* Total value of the exports were up by about 13%. Imports of ferrosilicon categorized as "55% to 80% silicon, other" increased by about 5% based on gross weight, with the total value for this category increasing by more than 10%. Brazil, Ireland, and Norway were the leading suppliers for this category, with about 65% of the total. Imports of ferrosilicon categorized as "Other," which included all ferrosilicon of less than 55% silicon content, continued to decline. Norway accounted for over 30% of total ferrosilicon imports.

Overall imports of silicon metal products increased by almost 40%, with total value of imports up by about 20%. Imports of silicon metal categorized as "99.00% to 99.99% silicon" increased by about 35%, with Canada providing over 40% of both total volume and value. Imports of "Other" silicon metal increased by about 40%, with Russia supplying about 80% of both volume and value for this category.

The schedule of applied tariffs during 1994 to U.S. imports of selected silicon materials can be found in the U.S. International Trade Commission's (USITC's) 1994 Harmonized Tariff Schedule of the United States, USITC Publication 2690.

The U.S. net import reliances for ferrosilicon and silicon metal products were estimated to be 36% and 35%, respectively, compared with 38% and 28% the previous year. The overall import reliance for silicon products was estimated to be 36%.

World Review

Bhutan.—In mid-March, it was reported that Bhutan Farewells Ltd. would commence ferrosilicon production at its new plant being constructed by Elam Metals Co. Production from the plant is planned at about 15,000 tons per year. One-half of the plant's production reportedly will be exported to Japan, and the remaining production will be sold in India.

Brazil.—In August, it was reported that a new company, Silicio de Alta Pureza de Bihia (SILBASA), had been formed to produce ferrosilicon in Brazil. The new company is a joint venture between Brazil's Cia. De Ferro-Ligas da Bahia SA (Ferbasa), 51% share, and Japan's Japan Metals & Chemicals Co. Ltd. and Marubeni Corp., both companies with 24.5% shares. The SILBASA plant will have an annual capacity to produce about 14,000 tons of "special high-grade ferrosilicon" for possible use in the production of electrical sheet steel. Details on material specification were not disclosed. Ferbasa will provide the plant with ferrosilicon for conversion to the high-grade material. Plant output is planned at 8,000 tons in 1995, 10,000 tons in 1996, and 14,000 tons in 1997.[6]

Ligas de Aluminio SA (Liasa), a major Brazilian silicon metal producer, reportedly recovered from bankruptcy status by making final payment, $14 million, to its creditors. Liasa had sought protection from its creditors under the Brazilian bankruptcy law in 1992. Liasa reportedly produces about 38,000 tons of silicon metal per year.[7]

Late in the year, ferrosilicon and silicon metal production were being affected in the Minas Gerais State by a severe drought and resulting increased cost of electric supply. Around November, Nova Era Silicon, formerly Eletrovale SA Industria e Comercio, and Cia. Brasileira Carbureto de Calcio each shut down a 30,000 kilowatt ferrosilicon furnace. Silicon metal producers Liasa and Rima Electrometalurgia SA were also said to be affected by the drought/expensive power supply.

China.—According to The TEX Report, production of ferrosilicon in China in 1993 totaled 760,000 tons and Chinese consumption of ferrosilicon totaled 440,000 tons. In the year 2000, Chinese ferrosilicon production was expected to be 875,000 tons with domestic consumption at 575,000 tons.[8] The TEX Report also reported that Chinese exports of ferrosilicon in 1994 totaled about 300,000 tons valued at about $148 million, compared with 340,000 tons valued at $157 million the previous year.

Germany.—Huls AG, Marl, reportedly will spend about $173 million to expand silicone production at Nunchritz, its affiliate in eastern Germany. The expansion at Nunchritz will raise annual siloxanes capacity from 12,000 tons to 60,000 tons by the end of the decade.[9] Bayer AG plans to double production of silicone products at its facility in Leverkusen. Bayer will expand annual capacity on a "step-by-step" basis to about 150,000 tons of crude silanes, the base product for silicones.[10]

India.—The Kerala State in southern India has been the beneficiary of new ferrosilicon production facilities due to the lower cost of electric power. The region's two new plants, Silcal Metallurgic Ltd. and Indsil Electrosmelt Ltd., along with the Travancore Electro-Chemical Industries Ltd. plant, account for about 30,000 tons of annual ferrosilicon production capacity. India has an overall ferrosilicon production capacity of about 150,000 tons.[11] In March, it was reported that changes as presented in India's annual budget would lower the import duty on bulk alloys and silicon metal from 85% to 50%. The lower duties, with a potential increase in imports, were seen locally as possibly leading to curtailment of some production capacity for power intensive products such as ferrosilicon and silicon metal.[12]

Iran.—In March 1995, the Iran Ferrosilice Co. reportedly will commence operation of its new 25,000-ton-per-year ferrosilicon plant, Semnan, Iran. The plant will produce 75%-grade ferrosilicon for domestic sale and for export to Europe. The supplier of the equipment for the plant was the German firm Mannesmann Demag Huttentechnik.[13]

Japan.—Japan's production of ferrosilicon was about 13,100 tons, compared with about 29,100 tons in 1993. According to The TEX Report, imports of ferrosilicon by Japan totaled about 484,000 tons, compared with about 542,000 tons the previous year. China continued as the leading supplier accounting for about 238,000 tons of the imports, a 50% increase from that in 1990. Imports of silicon metal by Japan were virtually unchanged at about 152,000 tons. Silicon metal imports from China and Brazil totaled about 83,800 tons and 39,300 tons, respectively. Consumption of silicon metal by the Japanese aluminum alloy sector rose to about 54,000 tons from the 51,000 tons in 1993, influenced by a 3% increase in the production of secondary aluminum alloys.

Kazakhstan.—In May, it was reported that ferrosilicon production at the Yermakovsky Ferroalloy Works (Ermak) was about 450,000 tons. However, with antidumping duties imposed on ferrosilicon from Kazakhstan in the United States and the European Union, Ermak indicated plans to convert some ferrosilicon production capacity to the production of ferrochromium. The conversion project would be undertaken within 3 to 4 years.[14]

Saudi Arabia.—During the year, the Gulf Ferroalloys Co. reportedly commenced construction of its ferroalloy plant at Jubail, Saudi Arabia. The partnership of Germany's Mannesmann Demag Huttentechnik and BHP Engineering of Australia was awarded the contract to build the plant. The plant will cost in excess of $100 million to construct and is expected to be on-line by yearend 1996. When fully operational, the plant will have an annual capacity to produce 35,600 tons of ferrosilicon, 10,000 tons of silicon metal, 27,600 tons of silicomanganese, and 10,000 tons of ferromanganese.[15]

South Africa, Republic of.—In June,

Silicon Technology Pty. Ltd. (Silitech), a subsidiary of Chromecorp Technology Pty. Ltd., temporarily shut down its ferrosilicon plant in Natal, South Africa. The plant commenced operation at the end of 1992, and the closure reportedly resulted from poor market conditions, antidumping duties imposed by the European Commission, technical problems experienced by the electric furnaces, and a labor strike. The plant will remain closed until yearend, at which time Silitech will make a decision to restart production on a smaller scale or possibly produce another product.[16] The plant comprises two electric furnaces, a 40-megavolt-ampere (M•VA) furnace and a 56-M•VA furnace, with a combined annual ferrosilicon production capacity of about 55,000 tons.

Venezuela.—It was reported in September that State-owned ferrosilicon producer CVG Fesilven CA was preparing for privatization by public auction at yearend. The company had received the Venezuela government's approval for a project allowing Fesilven to form a joint venture with a "majority private sector partner." Fesilven's plant production of 75%-grade ferrosilicon in 1994 was expected to be about 60,000 tons, with planned production in 1995 at about 80,000 tons.[17]

Outlook

Demand for silicon metal continues to be driven by consumption in the aluminum and chemical industries. For 1995, industry sources indicate that Western World silicon metal demand will be about 715,000 tons. In the aluminum industry, silicon metal demand is expected to be about 405,000 tons, influenced by the automotive sector, with demand in the chemical industry at about 310,000 tons. By the year 2000, overall silicon metal demand is expected to be more than 900,000 tons. European and North American silicon metal demand in the chemical and metallurgical sectors is strong. However, silicon metal demand in Japan remains flat, owing to a recessed economy and declining automotive sales.[18] Within the chemical industry, silicon metal is used to produce a wide variety of silicone-base products and intermediates. Industry sources, as reported in Chemical Week, indicate that the domestic silicon compounds industry will grow by more than 5% per year through 1997. Silicon growth in this sector is attributed to silicone elastomers (particularly injection-moldable silicone rubbers), silicon alloys used in superalloy production, and silicones used in household and personal care products, all of which are expected to increase about 7% per year during this period.

Ferrosilicon is consumed primarily by the iron and steel industry. The industry uses ferrosilicon for deoxidation of molten metal and as an alloying agent. The reader is referred to the outlook section of the Iron and Steel Annual MIS for discussion on the outlook for the steel industry. Additionally, Metal Bulletin reported that some leading industry sources anticipate that western world steel production and consumption will increase through the year 2000. However, steel demand in countries of the former U.S.S.R. will continue to decline owing to economic problems in those countries. Also, an excellent analysis of future production trends in the ferrosilicon industry was presented by Resource Strategies Inc. at Metal Bulletin's 10th International Ferroalloys Conference in Barcelona, Spain, November 7, 1994.

For 1995, it is estimated that domestic production of silicon-containing ferroalloys and metal will be about 400,000 tons, and U.S. apparent consumption will be about 600,000 tons.

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[1]The Washington Post. No. 304, Oct. 5, 1994, p. F2.

[2]Elkem Metals Company. News Release, Feb. 1995, 3 pp.

[3]American Metal Market. V. 102, No. 14, Jan. 21, 1994, p. 16.

[4]Globe Metallurgical Inc. News Release, Dec. 30, 1994, 1 p.

[5]Chemical and Engineering News. V. 72, No. 46, Nov. 14, 1994, pp. 11-12.

Chemical Week. V. 155, No. 119, Nov. 16, 1994, p. 9.

[6]Metals Week. V. 65, No. 35, Aug. 29, 1994, p. 3.

[7]American Metal Market. V. 102, No. 105, June 2, 1994, p. 5.

[8]The TEX Report. V. 26, No. 6212, Oct. 5, 1994, pp. 5-6.

[9]European Chemical News. V. 62, No. 1633, Sept. 5, 1994, p. 4.

[10]Chemical Week. V. 155, No. 24, Dec. 21-28, 1994, p. 14.

[11]Metal Bulletin Monthly. No. 282, July 1994, pp. 54-57.

[12]Metal Bulletin. No. 7861, Mar. 7, 1994, p. 13.

[13]———. No. 7928, Nov. 7, 1994, p. 15.

[14]The TEX Report. V. 26, No. 6121, May 25, 1994, p. 1.

[15]Metal Bulletin. No. 7870, Apr. 11, 1994, p. 13.

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[16]Metal Bulletin. No. 7922, Oct. 17, 1994, p. 10.

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[17]Metal Bulletin. No. 7910, Sept. 5, 1994, p. 13.

[18]The TEX Report. V. 26, No. 6147, June 30, 1994, pp. 4-5.

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The Washington Post, daily.

TABLE 1
SALIENT SILICON STATISTICS 1/

(Thousand metric tons of silicon content unless otherwise specified)

	1990	1991	1992	1993	1994
United States:					
Production	418	363	370	367	390
Exports:					
Ferrosilicon	27	27	30	21	20
Silicon metal	9	8	8	10	12
Imports for consumption:					
Ferrosilicon	152	121	161	141	147
Silicon metal	66	43	32	71	108
Apparent consumption:					
Ferrosilicon	390	325	337	335	360
Silicon metal	198	175	195	222	247
Price; average per pound Si: 2/					
Ferrosilicon, 50% Si	42.44	38.34	36.94	40.76	43.93
Ferrosilicon, 75% Si	39.94	36.98	35.41	40.61	40.77
Silicon metal	54.84	61.50	59.95	66.40	64.13
World production (gross weight): e/					
Ferrosilicon	4,800	4,300	4,100	4,200	4,100
Silicon metal	630	590	560	550	540

e/ Estimated.

1/ Previously published and 1994 data are rounded by the U.S. Bureau of Mines to three significant digits, except prices.

2/ Platt's Metals Week dealer import price.

TABLE 2
PRODUCTION, SHIPMENTS, AND STOCKS OF SILVERY PIG IRON,
FERROSILICON, AND SILICON METAL IN THE UNITED STATES IN 1994 1/

(Metric tons, gross weight, unless otherwise specified)

Material	Silicon content (percentage)		Producers' stocks, Dec. 31, 1993	Gross production 2/	Net shipments	Producers' stocks, Dec. 31, 1994
	Range	Typical				
Silvery pig iron	5 - 24	18	W	W	W	W
Ferrosilicon	25 - 55	48	43,900	198,000	136,000	35,400
Do.	56 - 95	76	17,100	112,000	111,000	20,100
Silicon metal (excluding semiconductor grades)	96 - 99	98	6,630	164,000	163,000	6,360
Miscellaneous silicon alloys (excluding silicomanganese)	32 - 65	--	14,700	103,000	95,700	13,400

W Withheld to avoid disclosing company proprietary data.

1/ Data rounded by the U.S. Bureau of Mines to three significant digits.

2/ Ferrosilicon production includes material consumed in the production of miscellaneous silicon alloys.

TABLE 3
PRODUCERS OF SILICON ALLOYS AND/OR SILICON METAL
IN THE UNITED STATES IN 1994

Producer	Plant location	Product 1/
American Alloys Inc.	New Haven, WV	FeSi and Si.
American Silicon Technologies	Rock Island, WA	Si.
Applied Industrial Minerals Corp.	Bridgeport, AL	FeSi.
Elkem Metals Co.	Alloy, WV	Si.
Do. 2/	Ashtabula, OH	FeSi.
Globe Metallurgical Inc.	Beverly, OH	FeSi and Si.
Do. 3/	Niagara Falls, NY	FeSi and Si.
Do.	Selma, AL	Si.
Do.	Springfield, OR	Si.
Keokuk Ferro-Sil Inc.	Keokuk, IA	FeSi and silvery pig iron.
Simetco Inc.	Montgomery, AL	Si.
SKW Metals and Alloys Inc.	Calvert City, KY	FeSi.

1/ FeSi, ferrosilicon; Si, silicon metal.
2/ Production closed down in Apr. 1994.
3/ Formerly SKW Metals and Alloys Inc, Dec. 29, 1994.

TABLE 4
REPORTED CONSUMPTION, BY MAJOR END USE, AND STOCKS OF SILICON ALLOYS
AND METAL IN THE UNITED STATES IN 1994 1/ 2/

(Metric tons, gross weight, unless otherwise specified)

Silicon content (percent)	Silvery pig iron	Ferrosilicon 3/				Silicon metal	Miscellaneous silicon alloys 4/	Silicon carbide 5/
Range	5-24	25-55	56-70	71-80	81-95	96-99	--	63-70
Typical	18	48	65	76	85	98	48	64
End use								
Steel:								
Carbon	--	32,800	(6/)	27,700	(6/)	(6/)	(6/)	(6/)
Stainless and heat-resisting	--	23,700	(6/)	42,100	(6/)	(6/)	(6/)	--
Other alloy	(6/)	20,300	--	31,700	(6/)	(6/)	(6/)	(6/)
Tool	--	(6/)	--	2,490	(6/)	--	--	--
Unspecified	22	49	59	--	632	12,400	2,110	90
Total	22	76,800	59	104,000	632	12,400	2,110	90
Cast irons	20,800	115,000	2,100	21,300	495	W	22,700	37,300
Superalloys	--	W	--	W	18	W	--	--
Alloys (excluding superalloy and alloy steel)	W	W	--	W	--	W	--	--
Miscellaneous and unspecified	11	1,460	--	948	--	205,000 7/	--	--
Grand total	20,800	194,000	2,160	126,000	1,150	217,000	24,800	37,400
Consumers' stocks, December 31	836	6,720	188	8,970	54	2,030	1,240	1,210

W Withheld to avoid disclosing company proprietary data, included with "Miscellaneous and unspecified."
1/ Data rounded by the U.S. Bureau of Mines to three significant digits; may not add to totals shown.
2/ Includes U.S. Bureau of Mines estimates.
3/ Includes briquets.
4/ Primarily magnesium-ferrosilicon but also includes other silicon alloys.
5/ Does not include silicon carbide for abrasive or refractory uses.
6/ Included with "Steel: Unspecified."
7/ Includes silicones, silanes, fumed silica, and other chemicals.

TABLE 5
U.S. EXPORTS OF FERROSILICON AND SILICON METAL, BY GRADE AND COUNTRY 1/

(Metric tons)

Country	1993			1994		
	Gross weight	Contained weight	Value	Gross weight	Contained weight	Value
Ferrosilicon:						
Over 55% silicon:						
Australia	160	96	$250,000	285	171	$414,000
Canada	6,300	3,780	5,090,000	4,410	2,650	3,560,000
Germany	433	260	609,000	156	96	255,000
Honduras	20	12	10,000	18	11	14,600
India	45	27	38,200	96	58	127,000
Japan	127	76	127,000	319	192	407,000
Korea, Republic of	25	15	24,100	36	22	31,600
Malaysia	--	--	--	50	33	86,600
Mexico	3,490	2,190	2,900,000	1,850	1,130	1,780,000
Taiwan	204	122	215,000	670	402	710,000
Other	192 r/	124 r/	217,000 r/	50	30	53,700
Total	11,000	6,710	9,470,000	7,940	4,790	7,430,000
Other ferrosilicon:						
Australia	970	483	1,150,000	1,300	650	1,490,000
Canada	15,900	7,940	11,600,000	13,900	6,950	10,000,000
Egypt	839	420	749,000	292	146	237,000
India	264	131	375,000	546	273	764,000
Japan	2,640	1,300	6,090,000	3,030	1,500	6,350,000
Korea, Republic of	1,380	687	1,320,000	1,830	912	1,500,000
Mexico	1,840	919	1,520,000	1,940	971	1,680,000
Spain	151	76	119,000	351	175	283,000
Thailand	57	28	66,500	295	147	438,000
United Kingdom	3,030	1,510	2,760,000	5,500	2,750	5,090,000
Other	1,470 r/	707 r/	1,550,000 r/	1,050	524	1,050,000
Total	28,500	14,200	27,300,000	30,000	15,000	28,900,000
Total ferrosilicon	39,500	20,900	36,800,000	38,000	19,800	36,300,000
Metal:						
Over 99.99% silicon:						
Czech Republic	1	1	61,200	32	32	1,430,000
Denmark	22	22	1,630,000	25	25	2,030,000
Finland	5	5	145,000	30	30	912,000
Germany	7	7	470,000	66	66	2,630,000
Italy	118	118	5,190,000	75	75	3,440,000
Japan	1,490	1,490	68,400,000	1,370	1,370	66,400,000
Korea, Republic of	201	201	9,430,000	170	170	7,620,000
Malaysia	161	161	30,300,000	145	145	34,600,000
Netherlands	17	17	795,000	23	23	1,600,000
Taiwan	11	11	560,000	38	38	1,080,000
Other	72 r/	72 r/	3,340,000 r/	104	104	4,960,000
Total	2,110	2,110	120,000,000	2,080	2,080	127,000,000
99.00 - 99.99% silicon:						
Australia	--	--	--	112 2/	94	53,200
Canada	19	19	26,100	10	10	12,700
Colombia	29	28	63,900	24	24	40,100
Ghana	--	--	--	56 3/	56	86,100
Israel	--	--	--	385	382	607,000
Mexico	157	156	213,000	38	38	53,600
Peru	--	--	--	9	9	14,000
Singapore	--	--	--	11	11	12,100
United Kingdom	318	315	446,000	9	9	13,300
Venezuela	452	448	707,000	104	103	154,000
Other	142 r/	139 r/	260,000 r/	37	36	62,800
Total	1,120	1,110	1,720,000	796	773	1,110,000
Other silicon:						
Canada	1,920	1,860	2,080,000	2,640	2,560	2,790,000
China	99	94	259,000	118	115	156,000
Germany	277	256	475,000	376	365	523,000
Italy	31	30	40,600	321	312	423,000
Japan	1,610	1,560	3,670,000	681	662	1,890,000
Korea, Republic of	145	141	206,000	342	332	498,000
Mexico	1,910	1,860	2,550,000	3,370	3,270	4,450,000
Taiwan	307	298	420,000	447	434	590,000
Trinidad and Tobago	--	--	--	101	96	59,800
United Kingdom	93	91	124,000	143	139	189,000
Other	999 r/	958 r/	1,480,000 r/	705	684	1,070,000
Total	7,400	7,140	11,300,000	9,240	8,970	12,600,000
Total silicon metal	10,600	10,400	133,000,000	12,100	11,800	140,000,000

r/ Revised.

1/ Previously published and 1994 data are rounded by the U.S. Bureau of Mines to three significant digits; may not add to totals shown.

2/ Contains 16 tons of material with silicon content not yet verified.

3/ Silicon content of material not yet verified.

Source: Bureau of the Census.

TABLE 6
U.S. IMPORTS FOR CONSUMPTION OF FERROSILICON AND SILICON METAL , BY GRADE AND COUNTRY 1/

(Metric tons)

Country	1993			1994		
	Gross weight	Contained weight	Value	Gross weight	Contained weight	Value
Ferrosilicon:						
55 - 80% silicon, over 3% Ca:						
Argentina	100	61	$86,900	--	--	--
Brazil	84	54	125,000	93	60	$93,100
Canada	--	--	--	75	45	16,600
China	172	103	155,000	--	--	--
France	62	38	94,700	80	48	100,000
Germany	4	3	8,600	1	1	3,650
Macedonia	--	--	--	1,500	1,120	976,000
Norway	184	139	216,000	--	--	--
Taiwan	51	36	45,000	--	--	--
United Kingdom	--	--	--	444	333	366,000
Total	657	434	731,000	2,190	1,610	1,550,000
55 - 80% silicon, other:						
Brazil	43,600	33,000	23,200,000	22,700	17,100	13,500,000
Canada	13,900	10,300	9,560,000	9,790	7,430	6,680,000
Iceland	13,100	9,980	7,350,000	29,300	22,500	16,800,000
Macedonia	3,110	2,330	1,720,000	7,600	5,730	4,260,000
Norway	66,200	50,100	39,600,000	66,700	50,500	41,600,000
Poland	9,380	6,980	5,290,000	6,930	5,170	3,890,000
Romania	--	--	--	4,500	3,380	2,680,000
Slovakia	--	--	--	9,980	7,550	6,400,000
South Africa, Republic of	3,810	2,860	2,170,000	6,920	5,220	4,000,000
United Kingdom	2,880	2,170	2,050,000	6,560	4,920	4,460,000
Other	15,300 r/	11,100 r/	9,220,000 r/	8,630	6,430	6,590,000
Total	171,000	129,000	100,000,000	180,000	136,000	111,000,000
80 - 90% ferrosilicon:						
Turkey	18	15	6,220	--	--	--
Over 90% ferrosilicon:						
Australia	320	317	430,000	--	--	--
Brazil	238	224	169,000	--	--	--
Total	558	540	599,000	--	--	--
Magnesium ferrosilicon:						
Brazil	1,740	789	1,060,000	3,120	1,440	2,150,000
Canada	35	17	18,400	336	165	228,000
Germany	776	423	2,590,000	614	332	2,020,000
India	--	--	--	43	20	44,600
Japan	79	37	169,000	62	27	135,000
Norway	--	--	--	2,560	1,080	2,090,000
Total	2,630	1,270	3,840,000	6,740	3,060	6,670,000
Other ferrosilicon:						
Belgium	3	1	8,710	--	--	--
Brazil	9,910	4,190	1,020,000	--	--	--
Canada	10,400	3,690	3,140,000	15,300	5,790	5,560,000
China	34	13	51,800	--	--	--
France	5	3	13,200	--	--	--
Kazakhstan	--	--	--	410 2/	115	205,000
Venezuela	4,500	2,430	948,000	--	--	--
Total	24,900	10,300	5,190,000	15,700	5,900	5,760,000
Total ferrosilicon	200,000	141,000	111,000,000	204,000	147,000	125,000,000
Metal:						
Over 99.99% silicon:						
China	(3/)	(3/)	65,700	4	4	495,000
Czech Republic	2	2	414,000	4	4	765,000
France	2	2	140,000	(3/)	(3/)	119,000
Germany	483	483	14,100,000	463	463	14,300,000
Italy	268	268	28,700,000	223	223	20,200,000
Japan	84	84	2,410,000	250	250	6,440,000
Korea, Republic of	42	42	952,000	104	104	414,000
Taiwan	(3/)	(3/)	5,280	4	4	434,000
Ukraine	1	1	17,800	51	51	1,020,000

See footnotes at end of table.

TABLE 6--Continued
U.S. IMPORTS FOR CONSUMPTION OF FERROSILICON AND SILICON METAL , BY GRADE AND COUNTRY 1/

(Metric tons)

Country	1993			1994		
	Gross weight	Contained weight	Value	Gross weight	Contained weight	Value
Metal--Continued:						
Over 99.99% silicon--Cont'd.:						
United Kingdom	1	1	35,600	20	20	167,000
Other	3 r/	3 r/	543,000 r/	1	1	238,000
Total	886	886	47,300,000	1,120	1,120	44,500,000
99.00 - 99.99% silicon:						
Australia	3,320	3,290	4,210,000	7,510 4/	7,400	9,370,000
Brazil	338	335	391,000	372	369	478,000
Canada	13,200	13,100	18,100,000	15,200	15,100	21,500,000
France	593	589	731,000	4,230	4,200	5,180,000
Germany	20	20	17,000	404	400	524,000
Netherlands	201	199	235,000	400	398	480,000
Norway	621	617	757,000	2,630	2,610	3,210,000
Russia	--	--	--	1,720	1,700	1,700,000
South Africa, Republic of	3,160	3,130	3,650,000	3,160	3,050	3,590,000
Spain	--	--	--	412	408	487,000
Other	5,650 r/	5,530 r/	6,890,000 r/	848	780	982,000
Total	27,100	26,800	35,000,000	36,900	36,400	47,500,000
Other silicon:						
Australia	201	198	246,000	120	60	136,000
Canada	879	864	1,110,000	1,970	1,920	2,500,000
China	2,470	2,560	2,210,000	1,380 5/	5,740	1,150,000
Germany	616	559	881,000	274	264	219,000
Japan	2	2	19,800	477	467	590,000
Macedonia	5,090	5,010	5,400,000	4,810	4,730	4,990,000
Netherlands	548	530	477,000	400 2/	(3/)	94,900
Russia	31,300	30,400	29,600,000	50,900 6/	55,400	48,100,000
South Africa, Republic of	901	887	1,010,000	342	338	358,000
Ukraine	1,920	1,860	1,910,000	1,250	1,210	1,190,000
Other	351 r/	335 r/	351,000 r/	453	444	503,000
Total	44,300	43,200	43,300,000	62,400	70,600	59,900,000
Total silicon metal	72,200	70,900	126,000,000	100,000	108,000	152,000,000

r/ Revised.
1/ Previously published and 1994 data are rounded by the U.S. Bureau of Mines to three significant digits; may not add to totals shown.
2/ Silicon content of material not yet verified.
3/ Less than ½ unit.
4/ Contains 440 tons of material with silicon content not yet verified.
5/ Contains 355 tons of material with silicon content not yet verified.
6/ Contains1,530 tons of material with silicon content not yet verified.

Source: Bureau of the Census.