

FERROALLOYS

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Ferroalloys are alloys of iron that contain one or more other chemical elements. These alloys are used to add these other elements into molten metal, usually in steelmaking. The top five ferroalloy producers in the world in 2000, in decreasing order, were China, South Africa, Norway, Russia, and Ukraine. Ferroalloys impart distinctive qualities to steel or cast iron or serve important functions during the production cycle. The ferroalloy industry is closely associated with the iron and steel industry, its largest customer. World production in 2000 of the bulk ferroalloys chromium, manganese, and silicon, was estimated at 16.6 million metric tons (Mt). U.S. bulk ferroalloy reported consumption in 2000 was 1.1 Mt.

The principal ferroalloys are those of chromium, manganese, and silicon. Manganese is essential to the production of virtually all steels and is important to the production of cast iron. Manganese is used to neutralize the harmful effect of sulfur and as an alloying element. Silicon is used primarily for deoxidation in steel and as an alloying element in cast iron. Boron, chromium, cobalt, columbium, copper, molybdenum, nickel, phosphorus, titanium, tungsten, vanadium, zirconium, and the rare-earth elements are among the other elements contributing to the character of the various alloy steels and cast irons (Brown and Murphy, 1985, p. 265).

Compared with the major ferroalloy-producing countries, U.S. ferroalloy production is moderate in silicon and manganese, but relatively low in other ferroalloy metals. Consequently, U.S. ferroalloy production meets only a small percentage of domestic demand. One important exception is ferrosilicon. For all forms of silicon, the United States has been meeting about 70% of its needs. In countries with competitive mineral resources, the trend is toward production of value added products, particularly in the case of chromium. Because of the unlikely prospect of new or expanded U.S. production and because of the uncompetitive U.S. mineral resources for most of the ferroalloy metals, the overall domestic ferroalloy production trend is one of decline. Nickel and chromium are prime examples. By 1999, U.S. production of ferronickel and common grades of ferrochromium had ceased. In both cases, when production stopped, resources were low-grade, producers were relying on imported ore for feedstock, and operating costs were high. In contrast, ferrosilicon and manganese ferroalloy production have fluctuated, but have been relatively strong (Sibley and others, 2001, p. 33).

In the major ferroalloys and probably some specialty ferroalloys, alternative materials to ferroalloys use, principally alloy scrap and oxide, overall have gained moderately on ferroalloys use per ton of steel production over the past 20 years. A combination of factors, including technology, availability, and price, is responsible for this general decline in unit consumption of the ferroalloy form, and ferroalloy metal from all sources, for the major ferroalloys in steelmaking. U.S. customer needs for ferroalloys in alloy and stainless steel for a multitude of applications have been and will continue to be

strong, even while the steel industry continues to improve processing technology to reduce raw materials needs, and metallurgists develop steel grades with lower alloying metal content and equal or better performance to lower costs. For many stainless steel applications there are no acceptable substitutes, and its key constituents, chromium and nickel, are essential. As technology and industry practices result in greater efficiency of use of ferroalloys, the strong demand for metals in construction, the chemical industry, transportation, and household appliances is expected to more than offset any basic reduction in unit consumption in the future. Competition from other materials, such as plastics and nonferrous metals in the transportation sector, will be strong, but the use of lightweight, high-strength grades is expected to make steel competitive for many years (Sibley and others, 2001, p. 40).

Chromium, manganese, silicon, and other ferroalloys are discussed in more detail, including domestic data coverage and outlook, and U.S. Government stockpile, in the respective commodity chapters in the U.S. Geological Survey Minerals Yearbook. These chapters are also published individually in the Mineral Industry Surveys Annual Review series. The tables in this chapter contain information on all ferroalloys for which data are available.

The major world chromite ore producing countries in 2000 were India, Kazakhstan, South Africa, and Turkey. Brazil, Finland, and Zimbabwe were significant chromite ore producing countries. Most chromite ore was smelted in electric-arc furnaces to produce ferrochromium for use by the metallurgical industry. Stainless steel manufacture consumed most ferrochromium. The country with the largest ferrochromium production was South Africa. China, Finland, India, Kazakhstan, Russia, and Zimbabwe were also significant ferrochromium producing countries. The major stainless steel producing areas of the world—Europe (including Western Europe and Scandinavia), Asia (Japan, Korea, and Taiwan), and the United States—account for about 80% of world stainless steel production.

The ferrochromium industry developed in close proximity to the stainless steel industry. However, the closing of ferrochromium facilities in these historically-producing areas has resulted in the migration of ferrochromium production capacity to chromite-producing areas. The world chromium industry in 2000 operated with production capacity in excess of demand. In South Africa, ferrochromium production capacity was brought on-stream and new furnaces were planned and under construction. Four industry trends were evolving—ferrochromium production using an environmentally friendly, and energy- and recovery-efficient, prereduction, closed-furnace process; chromium recovery from ferrochromium slag; consolidation of ownership in both the ferrochromium and stainless steel production industries; and strategic alliances between the latter two industries.

Manganese ferroalloys, consisting of various grades of

ferromanganese and silicomanganese, are used to provide a key ingredient for steelmaking (Matricardi and Downing, 1995, p. 970). Most U.S. supply was imported. The leading foreign source of ferromanganese and silicomanganese was South Africa, whose exports of manganese ferroalloys to the United States were greater than those of the next three largest sources combined (Australia, Kazakhstan, and Mexico). Manganese ferroalloys were produced domestically only at a plant near Marietta, OH, which was owned by France's Eramet. Eramet and Billiton plc of the United Kingdom accounted for a significant portion of the world's production of manganese ferroalloys. Eramet controlled plants in China, France, Italy, and Norway, and Billiton controlled plants in Australia and South Africa. On a country basis, China was by far the largest producer of manganese ferroalloys, with an output greater than that of South Africa and Ukraine combined, the countries with the next largest production.

Demand for silicon ferroalloys is driven principally by the production of steel and cast iron (Dosaj, 1997, p. 1115). On the basis of content, U.S. production of silicon ferroalloys declined to less than 50% of apparent consumption of ferrosilicon because of a significant increase in imports. Norway was the leading source of U.S. imports. China was estimated to be the

world's largest producer of ferrosilicon, with production more than twice that of either Norway or Russia, the countries with the next largest production. This chapter includes data for silicon metal, which generally was produced like ferrosilicon in submerged-arc electric furnaces. Silicon metal was not used as a ferroalloy, but rather for alloying with aluminum and for production of chemicals, especially silicones (Dosaj, 1997, p. 1108).

References Cited

- Brown, R.E., and Murphy, G. F., 1985, Ferroalloys, *in* Mineral facts and problems: U.S. Bureau of Mines Bulletin 675, p. 265-275.
- Dosaj, Vishu, 1997, Silicon and silicon alloys—Chemical and metallurgical, *in* Kirk-Othmer encyclopedia of chemical technology (4th ed.): New York, John Wiley and Sons, v. 21, p. 1104-1122.
- Matricardi, L.R., and Downing, James, 1995, Manganese and manganese alloys, *in* Kirk-Othmer encyclopedia of chemical technology (4th ed.): New York, John Wiley and Sons, v. 15, p. 963-990.
- Sibley, S.F., Blossom, J.W., Cunningham, L.D., Fenton, M.D., Gambogi, Joseph, Jones, T.S., Kuck, P.H., Papp, J.F., Reese, R.G., Jr., and Shedd, K.B., 2001, Trends in U.S. customer needs for ferroalloys, *in* The Ninth International Ferroalloys Congress and the Manganese 2001 Health Issues Symposium, Quebec City, Canada, June 3-6, 2001, Proceedings: Washington, DC, The Ferroalloys Association, p. 29-58.

TABLE 1
GOVERNMENT INVENTORY OF FERROALLOYS, DECEMBER 31, 2000 1/

Alloy		Stockpile grade	Nonstockpile grade	Total
Ferrochromium:	metric tons of alloy			
High-carbon	do.	560,000	601	561,000
Low-carbon	do.	263,000	6,890	270,000
Ferrochromium-silicon	do.	11,900	230	12,100
Ferrocolumbium	metric tons of contained columbium	52	--	52
Ferromanganese, high carbon	metric tons of alloy	772,000	--	772,000
Ferrotungsten	kilograms of contained tungsten	240,000	357,000	598,000

-- Zero.

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

Source: Defense National Stockpile Center; Inventory of Stockpile Material R-1.

TABLE 2
REPORTED U.S. CONSUMPTION OF FERROALLOYS AS ADDITIVES BY END USE IN 2000 1/ 2/

(Metric tons of alloys unless otherwise specified)

End use	Manganese			FeP	FeSi	FeTi
	FeB	FeMn	SiMn			
Steel:						
Carbon	827	254,000 3/	79,500	4,180	36,700 3/ 4/	4,180
Stainless and heat-resisting	115	15,200 3/	6,350	(5/)	52,700	1,520
Other alloy	97	22,100 3/	19,600	656	12,600 3/	185
Tool	--	(3/)	(3/)	--	24,100 3/	(5/)
Unspecified	--	826	275	(5/)	10,500	--
Total	1,040	292,000	106,000	4,830	137,000	5,890
Cast irons	--	9,170	1,340	1,790	114,000	60
Superalloys	(6/)	(6/)	--	(7/)	118 8/	918
Alloys (excluding alloy steels and superalloys)	393	20,500	(4/)	(7/)	(4/ 8/)	734
Miscellaneous and unspecified	--	(6/)	(4/)	(7/)	241,000	7
Grand total	1,430	321,000	107,000	6,620	492,000	7,610
Total 1999	1,710	316,000	118,000	6,400 r/	481,000	7,410 r/
Percentage of 1999	84	102	91	103	102	103
Consumer stocks, December 31	312	36,200 9/	10,700 9/	1,150	16,300	788

r/ Revised. -- Zero.

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

2/ FeB, ferroboration, includes other boron materials; FeMn, ferromanganese, includes manganese metal; SiMn, silicomanganese; FeP, ferrophosphorus, includes other phosphorus materials; FeSi, ferrosilicon, includes silicon metal, silvery pig iron, inoculant alloys; FeTi, ferrotitanium, includes titanium scrap, other titanium materials.

3/ All or part included with "Steel: Unspecified."

4/ All or part withheld to avoid disclosing company proprietary data.

5/ Included with "Steel: Other alloy."

6/ Included with "Alloys (excluding alloy steels and superalloys)."

7/ All or part included with "Cast irons."

8/ Part included with "Miscellaneous and unspecified."

9/ Includes producer stocks.

TABLE 3
REPORTED U.S. CONSUMPTION OF FERROALLOYS AS ALLOYING ELEMENTS BY END USE IN 2000 1/ 2/

(Metric tons of contained elements unless otherwise specified)

End use	FeCr	FeMo	FeNb	FeNi	FeV	FeW
Steel:						
Carbon	6,990	347	1,370	--	2,110	--
Stainless and heat-resisting	162,000	485	682	13,200	W	(3/)
Other alloy	28,000	2,360	1,090	85	790	(3/)
Tool	1,860	398	(4/)	--	43	(3/)
Unspecified	--	--	--	--	--	(3/)
Total	199,000	3,590	3,140	13,300	2,940	388
Cast irons	5,140	523	--	(5/)	W	--
Superalloys	7,080	W	1,060	--	15	(3/)
Alloys (Excluding alloy steels and superalloys)	1,740	102	W	135	2	(3/)

See footnotes at end of table.

TABLE 3--Continued
 REPORTED U.S. CONSUMPTION OF FERROALLOYS AS ALLOYING ELEMENTS BY END USE IN 2000 1/ 2/

(Metric tons of contained elements unless otherwise specified)

End use	FeCr	FeMo	FeNb	FeNi	FeV	FeW
Miscellaneous and unspecified	W	51	10	(5/)	75	--
Grand total	213,000	4,270	4,210	13,500	3,030	388
Total 1999	212,000 r/	4,350 r/	3,460 r/	12,800 r/	3,160 r/	484
Percentage of 1999	101	98	122	105	96	80
Consumer stocks, December 31	15,100	197	NA	768	299	33

r/ Revised. NA Not available. W Withheld to avoid disclosing company proprietary data; included with "Miscellaneous and unspecified. -- Zero.

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

2/ FeCb, ferrocolumbium, including nickel columbium; FeCr, ferrochromium, including other chromium ferroalloys and chromium metal; FeMo, ferromolybdenum, including calcium molybdate; FeNi, ferronickel; FeW, ferrotungsten; and FeV, ferrovanadium, including other vanadium-carbon-iron ferroalloys.

3/ Included with "Total steel."

4/ Included with "Steel: Other alloy."

5/ All or part included with "Alloys (excluding alloy steels and superalloys)."

TABLE 4
 FERROALLOY PRICES IN 2000

	High	Low	Average 1/
Chromium:			
Charge-grade ferrochromium 2/	43.00	37.00	41.44
High-carbon ferrochromium 2/	43.00	37.00	40.13
Low-carbon ferrochromium 2/	76.00	60.00	69.33
Columbium:			
High-purity (vacuum-grade) ferrocolumbium 3/	18.00	17.50	17.75
Regular-grade ferrocolumbium 3/	7.00	6.75	6.88
Manganese:			
Medium-carbon ferromanganese 2/	54.00	35.00	46.00
Standard-grade ferromanganese 4/	530.00	450.00	488.00
Silicomanganese 5/	27.50	19.50	23.80
Molybdenum:			
Ferromolybdenum 3/	3.70	2.90	3.50
Molybdenum oxide 3/	2.98	2.15	2.59
Silicon:			
50% ferrosilicon 2/	47.00	43.00	45.00
75% ferrosilicon 2/	39.00	33.00	35.40
Silicon metal 5/	59.00	49.00	54.80
Vanadium, ferrovanadium 3/	6.80	3.50	5.05

1/ Annual time-weighted average.

2/ Cents per pound of contained element.

3/ Dollars per pound of contained element.

4/ Dollars per long ton.

5/ Cents per pound.

Sources: American Metal Market and Platt's Metals Week.

TABLE 5
 U.S. IMPORTS FOR CONSUMPTION AND EXPORTS OF FERROALLOYS AND FERROALLOY METALS IN 2000 1/

Alloy	Imports			Exports		
	Gross weight (metric tons)	Contained weight (metric tons)	Value (thousands)	Gross weight (metric tons)	Contained weight (metric tons)	Value (thousands)
Ferroalloys:						
Chromium ferroalloys:						
Ferrochromium containing:						
More than 4% carbon	517,000	298,000	\$212,000	33,500	22,200	\$17,500
Not more than 4% carbon	XX	XX	XX	1,570	945	2,180
More than 3% but not more than 4% carbon	--	--	--	XX	XX	XX
More than 0.5% but not more than 3% carbon	9,150	5,930	6,470	XX	XX	XX
Not more than 0.5% carbon	50,300	32,700	50,400	XX	XX	XX
Ferrochromium-silicon	20,700	7,670	10,300	2,700	946	1,490
Total	597,000	344,000	279,000	37,700	24,100	21,200

See footnotes at end of table.

TABLE 5--Continued
U.S. IMPORTS FOR CONSUMPTION AND EXPORTS OF FERROALLOYS AND FERROALLOY METALS IN 2000 1/

Alloy	Imports			Exports		
	Gross weight (metric tons)	Contained weight (metric tons)	Value (thousands)	Gross weight (metric tons)	Contained weight (metric tons)	Value (thousands)
Ferroalloys--Continued:						
Manganese ferroalloys:						
Ferromanganese containing:						
More than 4% carbon	212,000	164,000	\$83,200	XX	XX	XX
More than 1% but not more than 2% carbon	77,700	62,900	48,900	XX	XX	XX
Not more than 1% carbon	22,300	18,800	19,200	XX	XX	XX
Ferromanganese, all grades	XX	XX	XX	7,950	XX	\$5,290
Silicomanganese	378,000	252,000	169,000	1,870	XX	1,200
Total	690,000	498,000	320,000	9,820	XX	6,490
Silicon ferroalloys:						
Ferrosilicon containing:						
More than 55% silicon	420	344	204	11,800	7,420	9,290
More than 55% but not more than 80% silicon and more than 3% calcium	6,430	4,780	3,840	XX	XX	XX
More than 55% but not more than 80% silicon and not more than 3% calcium	275,000	208,000	158,000	XX	XX	XX
Magnesium ferrosilicon	26,600	12,100	21,700	XX	XX	XX
Ferrosilicon, other 2/	13,400	5,630	10,100	31,500	15,000	32,600
Total	322,000	231,000	193,000	43,300	22,400	41,900
Other ferroalloys:						
Ferrocerium and other pyrophoric alloys	133	NA	1,560	XX	XX	XX
Ferromolybdenum	8,310	5,310	35,600	23,600	NA	104,000
Ferronickel	40,800	16,400	125,000	61	37	202
Ferroniobium (columbium)	6,770	NA	62,100	60	NA	526
Ferrophosphorus	13,000	NA	3,310	4,510	NA	3,110
Ferrotitanium and ferrosilicon-titanium	6,050	NA	15,900	1,090	NA	2,990
Ferrotungsten and ferrosilicon-tungsten	610	470	2,600	6	4	62
Ferrovandium	3,340	2,510	24,900	229	172	2,360
Ferrozirconium	281	NA	548	213	NA	482
Ferroalloys, other	31,400	NA	42,400	3,020	NA	6,380
Total	111,000	XX	314,000	32,800	XX	120,000
Total ferroalloys	1,720,000	XX	1,110,000	124,000	XX	190,000
Metals:						
Chromium	9,940	XX	59,400	1,260	XX	13,100
Manganese, other:						
Unwrought	15,100	NA	22,100	2,220	NA	5,020
Other	664	NA	2,270	XX	XX	XX
Silicon:						
Less than 99% silicon	37,200	35,900	39,000	11,500	11,100	17,400
Less than 99.99% but not less 99% silicon	94,100	92,500	111,000	1,460	1,450	1,850
Not less than 99.99% silicon	1,580	XX	269,000	189,000	XX	334,000
Total	159,000	XX	503,000	205,000	XX	371,000
Grand total	1,880,000	XX	1,610,000	329,000	XX	561,000

NA Not available. XX Not applicable. -- Zero.

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

2/ Includes less than 55% silicon and greater than 80% silicon.

Source: U.S. Census Bureau.

TABLE 6
FERROALLOYS: WORLD PRODUCTION, BY COUNTRY, FURNACE TYPE, AND ALLOY TYPE 1/ 2/

(Metric tons, gross weight)

Country, furnace type, and alloy type 3/ 4/ 5/	1996	1997	1998	1999	2000 e/
Albania, electric furnace, ferrochromium	31,189	31,144 r/	30,252 r/	28,120 r/	9,900
Argentina, electric furnace:					
Ferromanganese	7,374	8,381	5,016	2,000 r/ e/	--
Ferrosilicon	22,452	17,835	11,245	2,568 r/	7,000
Silicomanganese	24,654	26,134	25,388	10,000 r/ e/	--
Silicon metal	--	--	7,000	8,000 e/	8,000
Other 6/	21,286	14,223	22,974	20,000 e/	20,000

See footnotes at end of table.

TABLE 6--Continued
FERROALLOYS: WORLD PRODUCTION, BY COUNTRY, FURNACE TYPE, AND ALLOY TYPE 1/ 2/

(Metric tons, gross weight)

Country, furnace type, and alloy type 3/ 4/ 5/	1996	1997	1998	1999	2000 e/
Argentina, electric furnace--Continued:					
Total	75,766	66,573	71,623 r/	42,600 r/ e/	35,000
Australia, electric furnace: e/					
Ferromanganese	110,000	95,000	110,000	98,000 r/	115,000
Silicomanganese	95,000	95,000	105,000	116,000 r/	135,000
Silicon metal	30,000	30,000	30,000	30,000	30,000
Total	235,000	220,000	245,000	244,000 r/	280,000
Austria, electric furnace: e/					
Ferronickel	5,000 7/	5,000	4,500	4,250	4,200
Other	5,900	5,900	5,000	5,000	5,000
Total	10,900 7/	10,900	9,500	9,250	9,200
Belgium, electric furnace, ferromanganese e/ 8/	25,000	25,000	20,000	--	--
Bhutan, electric furnace, ferrosilicon e/	13,000	15,000	18,000	18,000	15,000
Bosnia and Herzegovina, electric furnace: e/					
Ferrosilicon	1,000	1,000	1,000	1,000	1,000
Silicon metal	200	200	200	200	200
Total	1,200	1,200	1,200	1,200	1,200
Brazil, electric furnace:					
Ferrochromium 9/	77,231	74,485 r/	72,507 r/	90,784 r/	91,000
Ferrochromiumsilicon e/	5,000	5,000	5,000	5,000	5,000
Ferromanganese	215,260	153,000	122,000	85,300 r/	110,000
Ferronickel	29,582	32,015	26,389	19,807 r/	19,315 7/
Ferrosilicon	236,838	212,183	166,278	200,833 r/	200,000
Silicomanganese	232,218	175,000	124,000	148,400 r/	150,000
Silicon metal	150,054	136,884	126,744	136,572 r/	165,000
Other e/	76,000	76,000	76,000	76,000	76,000
Total	1,022,183	864,567 r/	718,918 r/	762,696 r/	816,000
Bulgaria, electric furnace: e/					
Ferrosilicon	8,300	8,000	8,000	8,000	8,000
Other	2,000	2,000	2,000	2,000	2,000
Total	10,300	10,000	10,000	10,000	10,000
Canada, electric furnace: e/					
Ferrosilicon	56,000	56,000	56,000	56,000	56,000
Ferrovandium	1,000	1,000	1,000	1,000	1,000
Silicon metal	26,000	30,000	30,000	30,000	30,000
Total	83,000	87,000	87,000	87,000	87,000
Chile, electric furnace:					
Ferrochromium 9/	2,079	-- r/	-- r/	-- r/	--
Ferromanganese	8,498	5,517	3,652	3,700 e/	3,700
Ferromolybdenum	4,222	3,157	1,978	2,000 e/	2,000
Ferrosilicon	4,650	1,294	1,159	1,160 e/	1,160
Silicomanganese	1,599	3,175	3,921	3,950 e/	3,950
Total	21,048	13,143 r/	10,710 r/	10,800 r/ e/	10,800
China: e/					
Blast furnace:					
Ferromanganese	450,000	500,000	550,000	550,000 r/	500,000
Other	200,000	100,000	48,000	100,000	100,000
Electric furnace:					
Ferrochromium	423,000	480,000	424,000	400,000	450,000
Ferromanganese	700,000	680,000	500,000	550,000	520,000
Ferrosilicon	1,490,000	1,250,000	1,290,000	1,120,000 r/	1,400,000
Silicomanganese	840,000	770,000	639,000	822,000 r/	900,000
Other	77,000	260,000	110,000	258,000 r/	160,000
Total	4,180,000	4,040,000	3,560,000	3,800,000	4,030,000
Colombia, electric furnace, ferronickel	52,241	55,079	61,180	61,620	63,000
Croatia, electric furnace, ferrochromium	10,559	24,231	11,770	-- r/	15,753 7/
Czech Republic, electric furnace, other e/	1,000	1,000	1,000	1,000	1,000
Dominican Republic, electric furnace, ferronickel	78,488	84,897	69,419 r/	61,561 r/	70,000
Egypt, electric furnace: e/					
Ferromanganese	35,000	26,000 r/	18,000 r/	30,000 r/	30,000
Ferrosilicon	44,000	44,000	44,000	44,000	45,000
Total	79,000	70,000 r/	62,000 r/	74,000 r/	75,000
Finland, electric furnace, ferrochromium	227,811	236,652	230,906	256,290 r/	260,600 7/

See footnotes at end of table.

TABLE 6--Continued
FERROALLOYS: WORLD PRODUCTION, BY COUNTRY, FURNACE TYPE, AND ALLOY TYPE 1/ 2/

(Metric tons, gross weight)

Country, furnace type, and alloy type 3/ 4/ 5/	1996	1997	1998	1999	2000 e/
France: e/					
Blast furnace, ferromanganese	337,000 7/	326,000 7/	321,000	302,000 7/	300,000
Electric furnace:					
Ferromanganese	100,000 7/	100,000 7/	100,000	138,000 r/	140,000
Ferrosilicon	103,000	109,000	110,000	110,000	110,000
Silicomanganese 10/	61,000	66,000	65,000	55,000 r/	60,000
Silicon metal	73,800 7/	74,000	75,000	75,000	75,000
Other	20,000	20,000	20,000	20,000	20,000
Total	695,000	695,000	691,000	700,000 r/	705,000
Georgia, electric furnace: e/					
Ferromanganese	7,600	4,000	10,000	6,500 r/	7,000
Silicomanganese	7,000	16,600	35,000	25,000 r/	25,000
Total	14,600	20,600	45,000	31,500 r/	32,000
Germany, electric furnace: e/					
Ferrochromium	25,303 7/	25,856 7/	20,879 7/	16,960 7/	17,000
Ferromanganese	10,000 r/	-- r/	-- r/	-- r/	--
Silicon metal	20,000	20,000	20,000	20,000	26,000
Other 11/	30,000	30,000	30,000	30,000	30,000
Total	85,300 r/	75,900 r/	70,900 r/	67,000 r/	73,000
Greece, electric furnace, ferronickel	71,204	70,440	60,020	59,545 r/	81,662 7/
Hungary, electric furnace: e/ 12/					
Ferrosilicon	7,000	7,000	7,000	7,000	7,000
Silicon metal	1,000	1,000	1,000	1,000	1,000
Total	8,000	8,000	8,000	8,000	8,000
Iceland, electric furnace, ferrosilicon	70,520	70,000 e/	68,000	70,900 r/	70,000
India, electric furnace: e/					
Ferrochromium 13/	261,666 7/	286,973 7/	345,125 7/	350,000	352,000
Ferrochromiumsilicon	9,000	10,000	10,000	10,000	10,000
Ferromanganese	190,000	166,000	165,000	160,000	160,000
Ferrosilicon	78,000	74,000	55,000 r/	55,000	60,000
Silicomanganese	170,000	198,000	193,000	190,000	185,000
Other	8,500	9,000	9,000	9,000	9,000
Total	717,000	744,000	777,000 r/	774,000	776,000
Indonesia, electric furnace:					
Ferromanganese e/	14,000	15,000	13,000	12,000 r/	12,000
Ferronickel	47,800	50,000	42,260	46,030 r/	50,550 7/
Silicomanganese e/	7,000	7,000	7,000	7,000	7,000
Total	68,800	72,000 e/	62,260	65,030 r/	69,600
Iran, electric furnace:					
Ferrochromium	10,500	11,450	13,745	13,680 r/	14,000
Ferrosilicon e/	40,000 r/	40,000 r/	40,000 r/	46,000 r/	40,000
Total e/	50,500 r/ 7/	51,500 r/	53,700 r/	60,000 r/	54,000
Italy, electric furnace:					
Ferrochromium	29,915	11,295	11,487	12,000 e/	12,000
Ferromanganese	25,143	40,000 r/	49,000 r/	19,000 r/	40,000
Silicomanganese e/	100,353 7/	100,000	70,000 r/	67,000 r/	90,000
Silicon metal	14,433 r/	12,619 r/	8,094 r/	6,257 r/	5,000
Other e/ 14/	10,000	10,000	10,000	10,000	10,000
Total e/	180,000 r/	174,000 r/	149,000 r/	114,000 r/	157,000
Japan, electric furnace:					
Ferrochromium 8/	193,695	186,432	142,931	119,777	130,074 7/
Ferromanganese	343,104	376,633	334,081	315,152	337,694 7/
Ferronickel	328,699	352,841 r/	345,772	332,293 r/	367,181 7/
Ferrosilicon	--	--	951	1,452	-- 7/
Silicomanganese	75,802	78,323	70,886	65,744	67,926 7/
Other 15/	10,131	10,217	8,678	12,860 r/	15,020 7/
Total	951,431	1,004,446 r/	903,299	847,278 r/	917,895 7/
Kazakhstan, electric furnace:					
Ferrochromium	352,000	600,000	535,000	597,946	640,000
Ferrochromiumsilicon e/	20,000	48,000	33,550 7/	60,000	65,000
Ferromanganese	--	--	--	--	5,000
Ferrosilicon e/	119,000	133,000	92,000	120,000	120,000
Silicomanganese	50,000	55,000	57,000	75,000	100,000

See footnotes at end of table.

TABLE 6--Continued
FERROALLOYS: WORLD PRODUCTION, BY COUNTRY, FURNACE TYPE, AND ALLOY TYPE 1/ 2/

(Metric tons, gross weight)

Country, furnace type, and alloy type 3/ 4/ 5/	1996	1997	1998	1999	2000 e/
Kazakhstan, electric furnace--Continued:					
Other	10,000	9,000	8,000	9,000 e/	9,000
Total	551,000	845,000	725,550	861,946 r/	939,000
Korea, North, electric furnace: e/					
Ferromanganese 11/	6,000	6,000	6,000	6,000	6,000
Ferrosilicon	3,000	3,000	3,000	3,000	3,000
Other 12/	1,000	1,000	1,000	1,000	1,000
Total	10,000	10,000	10,000	10,000	10,000
Korea, Republic of, electric furnace:					
Ferromanganese	126,135	158,755	158,418	140,208 r/	140,000
Silicomanganese	83,375	77,375 r/	106,997	116,091 r/	110,000
Other	4,687	2,174	2,785 r/	4,639 r/	4,000
Total	214,197	238,304 r/	268,200 r/	260,938 r/	254,000
Macedonia, electric furnace:					
Ferrochromium	3,780	460	--	--	--
Ferronickel	7,900	14,000	15,200	5,000	--
Ferrosilicon e/	57,220 7/	55,000	55,000	50,000	50,000
Silicon metal e/	1,000	1,000	500	--	--
Total e/	69,900	70,500	70,700	55,000	50,000
Mexico, electric furnace: 16/					
Ferromanganese	69,000	68,000	87,000	79,000	91,000
Silicomanganese	93,000	105,000	105,000	114,000	108,000
Total	162,000	173,000	192,000	193,000	199,000
New Caledonia, electric furnace, ferronickel	168,700	159,018 r/	157,959	157,592	157,000
Norway, electric furnace: e/					
Ferrochromium	108,900 7/	145,124 7/	174,678 7/	159,714 7/	165,000
Ferromanganese	215,000 7/	235,000	235,000	235,000	235,000
Ferrosilicon	462,423 7/	470,000	470,000	460,000 r/	460,000
Silicomanganese	210,000	230,000	230,000	230,000	230,000
Silicon metal	110,000	110,000	110,000	100,000	100,000
Other 10/	15,000	15,000	15,000	15,000	15,000
Total	1,120,000	1,210,000	1,230,000	1,200,000 r/	1,210,000
Peru, electric furnace, ferrosilicon e/	600	600	600	600	600
Philippines, electric furnace, ferrochromium	6,736	--	--	--	--
Poland:					
Blast furnace, ferromanganese	59,900	47,500 e/	50,152	60,000 e/	60,000
Electric furnace:					
Ferrochromium	1,100 r/	6,200 r/	4,200 r/	3,500 e/	3,500
Ferrosilicon	71,800	77,300	75,000	62,481 r/	70,000
Silicomanganese	25,000	20,000	15,100 r/	25,000	25,000
Silicon metal e/	1,300	1,400	1,400	1,200	1,500
Other e/	4,500 r/	7,300 r/	11,848 r/ 7/	20,000	20,000
Total	163,600 r/	159,700 r/	157,700 r/	172,181 r/	180,000
Romania, electric furnace:					
Ferrochromium	9,650	950	873	--	--
Ferromanganese	20,150	11,505	4,170 e/	25 e/	1,044 7/
Ferrosilicon	23,827	9,620	5,553	5,000 e/	5,000
Silicomanganese	78,590	62,570	83,617	550 e/	21,158 7/
Silicon metal e/	300	300	150	--	--
Total e/	133,000	84,900	94,400	5,580	27,200
Russia: e/					
Blast furnace:					
Ferromanganese	67,000 7/	47,100 7/	65,000 7/	90,000	70,700
Ferrophosphorus	2,300 7/	3,600 7/	3,500	3,500	3,500
Spiegeleisen	7,000	7,000	7,000	7,000	7,000
Electric furnace:					
Ferrochromium	135,000	247,000	203,000 7/	249,000 7/	274,000 7/
Ferrochromiumsilicon	5,000	5,000	4,000	4,500	4,500
Ferronickel	75,000 7/	40,000	30,000	33,000	35,000
Ferrosilicon	460,000	510,000	496,000 7/	601,000 7/	652,000 7/
Silicon metal	40,000	40,000	40,000	40,000	40,000
Other	40,000	40,000	40,000	40,000	40,000
Total	831,000	940,000	889,000	1,070,000	1,130,000

See footnotes at end of table.

TABLE 6--Continued
FERROALLOYS: WORLD PRODUCTION, BY COUNTRY, FURNACE TYPE, AND ALLOY TYPE 1/ 2/

(Metric tons, gross weight)

Country, furnace type, and alloy type 3/ 4/ 5/	1996	1997	1998	1999	2000 e/
Saudi Arabia, electric furnace, other e/	20,000	83,000	83,000	83,000	83,000
Serbia and Montenegro, electric furnace, ferronickel	6,501	6,338	1,243	--	--
Slovakia, electric furnace: e/					
Ferrochromium	19,900 7/	11,394 7/	11,715 7/	6,986 7/	7,000
Ferromanganese	25,000	20,000	20,000	20,000	20,000
Ferrosilicon	70,000 r/	50,133 r/ 7/	49,963 r/ 7/	70,000 r/	70,000
Silicomanganese	12,000	45,159 r/ 7/	46,627 r/ 7/	37,000 r/	35,000
Other	8,000	5,000	5,000	5,000	5,000
Total	135,000 r/	132,000 r/	133,000 r/	139,000 r/	137,000
Slovenia, electric furnace:					
Ferrochromium	22,819	9,232	10,621	560	600
Ferrosilicon	10,000	8,000	8,000	8,000	8,000
Other e/ 6/	200	200	200	200	200
Total e/	33,000	17,400	18,800	8,760	8,800
South Africa, electric furnace:					
Ferrochromium 17/	1,478,000	1,939,500	2,025,300	2,155,202 r/	2,200,000
Ferromanganese	548,000 r/	499,000	542,000	527,000 r/	530,000
Ferrosilicon	87,000 r/	102,000	108,400 r/	106,000 r/	100,000
Silicomanganese e/	254,000 r/	286,000	265,000	267,000 r/ 7/	270,000
Silicon metal	28,500	34,000	32,600 r/	35,800 r/	34,000
Other e/ 18/	1,000	48,000	15,000	32,000 r/	30,000
Total e/	2,400,000 r/	2,910,000	2,990,000	3,120,000 r/	3,160,000
Spain, electric furnace:					
Ferrochromium	805	490	1,145	935	1,000
Ferromanganese e/	16,000 r/	23,000 r/	18,000 r/	10,000 r/	10,000
Ferrosilicon	35,890 r/	38,340 r/	39,115 r/	40,000 e/	40,000
Silicomanganese e/	102,000 r/	122,000 r/	108,000 r/	95,000 r/	100,000
Silicon metal	16,936 r/	19,220 r/	18,424 r/	28,000 r/ e/	30,000
Other e/	5,000	5,000	5,000	5,000	5,000
Total e/	177,000 r/	208,000 r/	190,000 r/	179,000 r/	186,000
Sweden, electric furnace:					
Ferrochromium	138,110	101,842	123,958	113,140	135,000
Ferrosilicon	21,287	22,409 r/	20,356 r/	21,440 r/	20,000
Total	159,397	124,251 r/	144,314 r/	134,580 r/	155,000
Taiwan, electric furnace:					
Ferromanganese	14,059	12,130	12,532	--	--
Ferrosilicon	2,481	3,391	3,775	3,212	3,000
Total	16,540	15,521	16,307	3,212	3,000
Turkey, electric furnace:					
Ferrochromium	101,450	108,320	110,175	110,000 e/	110,000
Ferrosilicon e/	4,460	4,730	4,810 7/	4,800	4,800
Total	105,910	113,050	114,985	115,000 e/	115,000
Ukraine: e/					
Blast furnace:					
Ferromanganese	100,000	125,000	112,400 7/	57,800	85,400
Spiegeleisen	2,500	2,500	2,500	2,500	5,400
Electric furnace:					
Ferromanganese	170,000	160,000	150,000	199,539 r/ 7/	252,679 7/
Ferronickel	8,300 7/	--	--	--	--
Ferrosilicon	250,000	300,000	222,511 7/	243,600 7/	323,417 7/
Silicomanganese	600,000	560,000	485,560 7/	498,905 7/	684,040 7/
Other	25,000	25,000	20,000	25,000	25,000
Total	1,160,000	1,170,000	993,000	1,030,000	1,380,000
United States, electric furnace:					
Ferrochromium 19/	36,800	60,700	W	W	W
Ferromanganese 20/	(21/)	W	W	W	W
Ferronickel	30,500	32,100	8,590	--	--
Ferrosilicon	362,000	359,000	334,000	325,000	250,000
Silicon metal	171,000	183,000	188,000	186,000	175,000
Other 22/	194,000	W	W	W	W
Total	795,000	635,000	531,000	511,000	425,000
Uruguay, electric furnace, ferrosilicon e/	200	200	200	200	200

See footnotes at end of table.

TABLE 6--Continued
FERROALLOYS: WORLD PRODUCTION, BY COUNTRY, FURNACE TYPE, AND ALLOY TYPE 1/ 2/

(Metric tons, gross weight)

Country, furnace type, and alloy type 3/ 4/ 5/	1996	1997	1998	1999	2000 e/
Venezuela, electric furnace:					
Ferromanganese e/	--	--	8,000	11,000	--
Ferronickel	--	--	--	--	133 7/
Ferrosilicon e/	63,000	60,000	36,000 r/	57,000	60,000
Silicomanganese	53,034 r/	64,200 r/	48,504 r/	47,635 r/	50,000
Total e/	116,000 r/	124,000 r/	92,500 r/	116,000 r/	110,000
Zimbabwe, electric furnace:					
Ferrochromium	243,000	233,386	246,782	244,379 r/	246,324 7/
Ferrochromiumsilicon	33,175	17,000	21,000	16,267 r/	19,631 7/
Total	276,175	250,386	267,782	260,646 r/	265,955 7/
Grand total:	17,900,000 r/	18,500,000 r/	17,400,000	17,900,000 r/	18,800,000
Of which:					
Blast furnace:					
Ferromanganese 23/	1,010,000	1,050,000	1,100,000	1,060,000 r/	1,020,000
Spiegeleisen 23/	9,500	9,500	9,500	9,500	12,400
Other 24/	202,000	104,000	51,500	104,000 r/	104,000
Total	1,230,000	1,160,000	1,160,000	1,170,000 r/	1,130,000
Electric furnace:					
Ferrochromium 25/	3,950,000	4,830,000 r/	4,750,000 r/	4,930,000 r/	5,130,000
Ferrochromiumsilicon	52,200	37,000	40,000	35,800 r/	39,100
Ferromanganese 26/ 27/	3,000,000 r/	2,890,000 r/	2,690,000	2,650,000	2,760,000
Ferronickel	910,000	902,000 r/	823,000 r/	781,000 r/	848,000
Ferrosilicon	4,280,000 r/	4,110,000 r/	3,900,000 r/	3,920,000 r/	4,260,000
Silicomanganese 27/ 28/	3,180,000 r/	3,160,000 r/	2,890,000 r/	3,020,000 r/	3,360,000
Silicon metal	685,000 r/	694,000 r/	689,000 r/	698,000 r/	721,000
Other 29/	590,000 r/	679,000 r/	501,000 r/	684,000 r/	585,000
Total	16,600,000	17,300,000 r/	16,300,000 r/	16,700,000 r/	17,700,000

e/ Estimated. r/ Revised. W Withheld to avoid disclosing company proprietary data; not included in total. -- Zero.

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

2/ Table includes data available through August 21, 2001.

3/ In addition to the countries listed, Iran is believed to have produced ferromanganese and silicomanganese, but production figures are not reported; general information is inadequate for the formulation of reliable estimates of output levels. Production of ferrosilicon, manganese ferroalloys, and silicon metal began in 1996 in Saudi Arabia but data for actual production were not available.

4/ To the extent possible, ferroalloy production of each country has been separated according to the furnace type from which production is obtained; production derived from metallothermic operation is included with electric furnace production.

5/ To the extent possible, ferroalloy production of each country has been separated to show the following individual major types of ferroalloys: ferrochromium, ferrochromiumsilicon, ferromanganese, ferronickel, ferrosilicon, silicomanganese, silicon metal, and spiegeleisen. Ferroalloys other than those listed that have been identified specifically in sources, as well as those ferroalloys not identified specifically but which definitely exclude those listed previously in this footnote, have been reported as "Other." Where one or more of the individual ferroalloys listed separately in this footnote have been inseparable from other ferroalloys owing to a nation's reporting system, deviations are indicated by individual footnotes.

6/ Includes calcium-silicon.

7/ Reported figure.

8/ Includes silicomanganese, if any.

9/ Includes high- and low-carbon ferrochromium.

10/ Includes silicospiegeleisen, if any.

11/ Includes ferrochromiumsilicon and ferronickel, if any.

12/ Hungary is believed to produce some blast furnace ferromanganese.

13/ Includes charge chrome and ferrochrome.

14/ Excludes calcium-silicon.

15/ Includes calcium-silicon, ferrocolumbium, ferromolybdenum, ferrotungsten, ferrovanadium, and other ferroalloys.

16/ Salable products from Autlán.

17/ Includes production from Bophuthatswana and net production of ferrochromiumsilicon, if any.

18/ Includes ferronickel, if any.

19/ U.S. output includes chromium metal, high- and low-carbon ferrochromium, ferrochromiumsilicon, and other chromium materials.

20/ U.S. output of ferromanganese includes manganese metal and silicomanganese.

21/ Withheld to avoid disclosing company proprietary data; included with "Other."

22/ May include ferroboron, ferrocolumbium, ferromolybdenum, ferrophosphorus, ferrotitanium, ferrotungsten, ferrovanadium, nickel columbium, and silvery pig iron.

23/ Spiegeleisen, if any, for Germany is included with blast furnace ferromanganese.

24/ Includes ferrophosphorus and data contained in "Blast furnace: Other."

25/ Ferrochromium includes ferrochromiumsilicon, if any, for Japan, South Africa, and the United States.

26/ Ferromanganese includes silicomanganese, if any, for North Korea.

27/ U.S. production is included with "Other."

28/ Includes silicospiegeleisen, if any, for France.

29/ Includes calcium-silicon, ferromolybdenum, ferrovanadium, silicomanganese for the United States, and data contained with "Electric furnace: Other" for each country indicated.