

# 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 six ferroalloy producers in the world in 2001, in decreasing order, were China, South Africa, Ukraine, Kazakhstan, Norway, and Russia. 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 2001 of the bulk ferroalloys chromium, manganese, and silicon, was estimated at 18.8 million metric tons (Mt), a 3.6% decrease compared with that of 2000. U.S. bulk ferroalloy reported consumption in 2001 was 1.0 Mt. Declines in consumption took place in the bulk ferroalloys manganese (including silico-manganese), 13%, and silicon, 8%. Ferrochromium consumption was 11% lower than that of 2000. Total U.S. ferroalloy production, calculated on a gross weight basis, decreased by 24%. Total U.S. ferroalloy imports, gross weight, dropped by 22% and exports by 68%. These percentages reflect the sharp downturn in the U.S. economy in 2001, in which the steel industry was particularly affected.

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 (niobium), 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 that of major ferroalloy-producing countries, U.S. ferroalloy production was moderate in silicon and manganese and 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 during the past 20 years. A decline in unit consumption is significant during the long term for the ferroalloy industry because such a decline moderates any increases in ferroalloy consumption resulting from greater steel production. Conversely, it exacerbates any decreases. 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 materials costs. For many stainless steel applications, there are no acceptable substitutes, and their 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 mineral 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 2001 were India, Kazakhstan, and South Africa. Brazil, Finland, Turkey, 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 (primarily 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 2001 operated with production capacity in excess of demand. In anticipation of demand growth, new ferrochromium-producing plants were brought into production, under construction, and planned in South Africa. The following four industry trends were evolving: (1) ferrochromium production using environmentally friendly, energy- and recovery-efficient, prerreduction, closed-furnace process; (2) chromium recovery from ferrochromium slag; (3) consolidation of ownership in both the ferrochromium and stainless steel production industries; and (4) 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 importing countries combined (Australia, France, and Mexico). Manganese ferroalloys were produced domestically only at a plant near Marietta, OH, which was owned by France's Eramet. Eramet Group and BHP Billiton plc of the United Kingdom accounted for a significant portion of the world's production of manganese ferroalloys. In addition to its U.S. plant, Eramet controlled plants in China, France, Italy, and Norway, and BHP

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 increased from less than 50% to 57% of apparent consumption of ferrosilicon in 2000 and 2001, respectively, because of a significant decrease in ferrosilicon imports in 2001. Norway was the leading source of U.S. imports. China was estimated to be the world's largest producer of ferrosilicon, with production almost 1.5 times greater than that of the next two largest producing countries combined, Norway and Russia. This chapter includes data for silicon metal, which generally was produced like ferrosilicon in submerged-arc 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

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TABLE 1  
GOVERNMENT INVENTORY OF FERROALLOYS, DECEMBER 31, 2001 1/

(Metric tons of alloy unless otherwise specified)

Alloy	Stockpile grade	Nonstockpile grade	Total
Ferrochromium:			
High-carbon	560,000	601	561,000
Low-carbon	237,000	6,890	243,000
Ferrochromium-silicon	6,740	230	6,970
Ferromanganese, high carbon	772,000	--	772,000
Ferrotungsten (kilograms contained tungsten)	201,000	342,000	543,000

-- 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 2001 1/ 2/

(Metric tons of alloys unless otherwise specified)

End use	FeB	Manganese		FeP	FeSi	FeTi
		FeMn	SiMn			
Steel:						
Carbon and high-strength low-alloy	751	228,000 3/	63,800	4,420	17,000 3/ 4/	3,760
Stainless and heat-resisting	(5/)	10,900 3/	4,180	(5/)	36,500	2,950
Other alloy	159	18,400 3/	16,900	644	8,030 3/	164
Tool	--	(3/)	(3/)	--	22,200 3/	(5/)
Unspecified	--	2,410	678	(5/)	34,500	--
Total steel	910	259,000	85,500	5,070	118,000	6,870
Cast irons	--	8,560	1,040	1,350	102,000	45
Superalloys	(6/)	(6/)	--	(7/)	95 8/	827
Alloys (excluding alloy steels and superalloys)	325	17,400	(4/)	(7/)	(4/ 8/)	367
Miscellaneous and unspecified	--	(6/)	(4/)	(7/)	236,000	(6/)
Grand total	1,230	285,000	86,500	6,410	456,000	8,110
Total 2000	1,430	321,000	107,000	6,620 r/	494,000 r/	7,620 r/
Percentage of 2000	86	89	81	97	92	106
Consumer stocks, December 31	215	24,900 9/	16,200 9/	1,080	13,500	863

r/ Revised. -- Zero.

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

2/ FeB--ferroboron, including other boron materials; FeMn--ferromanganese, including manganese metal; SiMn--silicomanganese; FeP--ferrophosphorus, including other phosphorus materials; FeSi--ferrosilicon, including silicon metal, silvery pig iron, and inoculant alloys; and FeTi--ferrotitanium, including titanium scrap and 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 2001 1/ 2/

(Metric tons of contained elements unless otherwise specified)

End use	FeCr	FeMo	FeNb	FeNi	FeV	FeW
<b>Steel:</b>						
Carbon and high-strength low-alloy	4,640 3/	382	1,300	--	1,970	--
Stainless and heat-resisting	146,000	116	660	10,400	18	(4/)
Other alloy	20,600 5/	1,960	1,030	8	707	(4/)
Tool	3,390	384	(3/)	--	58	(4/)
Unspecified	--	--	--	--	--	(4/)
Total steel	175,000	2,840	2,990	10,400	2,750	343
Cast irons	W	417	--	(6/)	W	--
Superalloys	8,090	W	1,230	--	15	--
Alloys (excluding alloy steels and superalloys)	1,280	96	W	64	2	(4/)
Miscellaneous and unspecified	11,300 7/	54	11	(6/)	34	--
Grand total	196,000	3,410	4,230	10,500	2,800	343
Total 2000	220,000 r/	4,140 r/	4,090 r/	13,500	3,030 r/	388
Percentage of 2000	89	82	103	78	92	88
Consumer stocks, December 31	16,600	167	NA	543	249	37

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

3/ All or part included with "Steel: Other alloy."

4/ Included with "Total steel."

5/ Includes full alloy and high-strength low-alloy steel.

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

7/ Includes cast irons, electric steel, and unspecified uses.

TABLE 4  
FERROALLOY PRICES IN 2001

		High	Low	Average 1/
<b>Chromium:</b>				
Charge-grade ferrochromium	cents per pound of contained chromium	39.00	28.25	32.38
High-carbon ferrochromium	do.	37.00	27.00	31.10
Low-carbon ferrochromium	do.	68.00	55.00	61.91
<b>Manganese:</b>				
Medium-carbon ferromanganese	cents per pound of contained manganese	45.00	36.00	40.16
Standard-grade ferromanganese	dollars per long ton	490.00	425.00	452.14
Silicomanganese	cents per pound	25.00	21.00	23.38
<b>Molybdenum:</b>				
Ferromolybdenum	dollars per pound of contained molybdenum	3.40	2.90	3.14
Molybdenum oxide	do.	2.65	2.15	2.39
<b>Silicon:</b>				
50% ferrosilicon	cents per pound of contained silicon	48.00	36.00	42.80
75% ferrosilicon	do.	35.00	31.00	31.89
Silicon metal	cents per pound	56.00	46.00	50.50
Vanadium, ferrovanadium	dollars per pound of contained vanadium	4.40	3.50	3.94

1/ Annual time-weighted average.

Sources: American Metal Market and Platts Metals Week.

TABLE 5  
U.S. IMPORTS FOR CONSUMPTION AND EXPORTS OF FERROALLOYS AND FERROALLOY METALS IN 2001 1/

(Metric tons unless otherwise specified)

Alloy	Imports			Exports		
	Gross weight	Contained weight	Value (thousands)	Gross weight	Contained weight	Value (thousands)
<b>Ferroalloys:</b>						
<b>Chromium ferroalloys:</b>						
<b>Ferrochromium containing:</b>						
More than 4% carbon	236,000	137,000	\$79,200	8,390	3,380	\$6,260
Not more than 4% carbon	XX	XX	XX	7,880	5,400	6,160
More than 3% but not more than 4% carbon	20	13	20	XX	XX	XX
More than 0.5% but not more than 3% carbon	2,290	1,440	1,430	XX	XX	XX
Not more than 0.5% carbon	17,200	11,800	25,700	XX	XX	XX
Ferrochromium-silicon	14,600	6,110	5,910	86	27	92
<b>Total</b>	<b>271,000</b>	<b>156,000</b>	<b>112,000</b>	<b>16,400</b>	<b>8,800</b>	<b>12,500</b>
<b>Manganese ferroalloys:</b>						
<b>Ferromanganese containing:</b>						
More than 4% carbon	180,000	142,000	64,300	XX	XX	XX
More than 1% but not more than 2% carbon	55,100	44,700	33,800	XX	XX	XX
Not more than 1% carbon	14,900	12,600	13,200	XX	XX	XX
Ferromanganese, all grades	XX	XX	XX	9,240	XX	5,780
Silicomanganese	269,000	177,000	113,000	3,640	XX	2,350
<b>Total</b>	<b>519,000</b>	<b>377,000</b>	<b>225,000</b>	<b>12,900</b>	<b>XX</b>	<b>8,130</b>
<b>Silicon ferroalloys:</b>						
<b>Ferrosilicon containing:</b>						
More than 55% silicon	321	265	305	5,400	3,270	3,970
More than 55% but not more than 80% silicon and more than 3% calcium	385	262	457	XX	XX	XX
More than 55% but not more than 80% silicon and not more than 3% calcium	142,000	101,000	82,700	XX	XX	XX
Magnesium ferrosilicon	22,900	10,500	18,300	XX	XX	XX
Ferrosilicon, other 2/	11,100	3,710	8,560	17,900	7,110	24,500
<b>Total</b>	<b>176,000</b>	<b>115,000</b>	<b>110,000</b>	<b>23,300</b>	<b>10,400</b>	<b>28,500</b>
<b>Other ferroalloys:</b>						
Ferrocerium and other pyrophoric alloys and other	132	NA	1,470	XX	XX	XX
Ferromolybdenum	5,580	3,580	21,000	27,800	NA	110,000
Ferronickel	29,900	11,600	62,300	135	50	479
Ferroniobium (columbium)	6,890	NA	61,500	109	NA	1,260
Ferrophosphorus	10,300	NA	2,440	2,590	NA	1,740
Ferrotitanium and ferrosilicon-titanium	4,120	NA	10,800	980	NA	3,110
Ferrotungsten and ferrosilicon-tungsten	451	352	2,170	2	1	11
Ferrovandium	3,330	2,550	20,500	92	70	768
Ferrozirconium	240	NA	501	251	NA	462
Ferroalloys, other	25,000	NA	30,900	6,270	NA	10,200
<b>Total</b>	<b>86,000</b>	<b>XX</b>	<b>214,000</b>	<b>38,200</b>	<b>XX</b>	<b>128,000</b>
<b>Total ferroalloys</b>	<b>1,050,000</b>	<b>XX</b>	<b>661,000</b>	<b>90,700</b>	<b>XX</b>	<b>177,000</b>
<b>Metals:</b>						
Chromium	8,190	XX	50,100	1,040	XX	10,700
<b>Manganese, other:</b>						
Unwrought	19,400	XX	26,800	1,820	XX	6,900
Other	1,130	XX	2,260	XX	XX	XX
<b>Silicon:</b>						
Less than 99% silicon	42,900	41,200	41,200	6,120	5,950	10,000
Less than 99.99% but not less 99% silicon	75,300	73,500	89,200	1,370	1,350	2,030
Not less than 99.99% silicon	1,320	XX	69,800	5,180	XX	251,000
<b>Total</b>	<b>148,000</b>	<b>XX</b>	<b>279,000</b>	<b>15,500</b>	<b>XX</b>	<b>281,000</b>
<b>Grand total</b>	<b>1,200,000</b>	<b>XX</b>	<b>940,000</b>	<b>106,000</b>	<b>XX</b>	<b>458,000</b>

NA Not available. XX Not applicable.

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/	1997	1998	1999	2000	2001 e/
Albania, electric furnace, ferrochromium	31,144	30,252	28,120	9,900 e/	19,500
Argentina, electric furnace:					
Ferromanganese	8,381	5,016	-- r/	-- e/	--
Ferrosilicon	17,835	11,245	2,568	2,500 r/ e/	2,500
Silicomanganese	26,134	25,388	-- r/	4,900 r/	5,000
Silicon metal	--	7,000	8,000 e/	8,000 e/	8,000
Other 6/	14,223	22,974	13,850 r/	15,500 r/ e/	15,000
Total	66,573	71,623	24,418 r/	30,900 r/ e/	30,500
Australia, electric furnace: e/					
Ferromanganese	95,000	110,000	98,000	115,000	115,000
Silicomanganese	95,000	105,000	116,000	135,000	135,000
Silicon metal	30,000	30,000	30,000	30,000	30,000
Total	220,000	245,000	244,000	280,000	280,000
Austria, electric furnace: e/					
Ferronickel	5,000	4,500	4,250	4,200	4,000
Other	5,900	5,000	5,000	5,000	4,000
Total	10,900	9,500	9,250	9,200	8,000
Belgium, electric furnace, ferromanganese e/ 7/	25,000	20,000	--	--	--
Bhutan, electric furnace, ferrosilicon e/	15,000	18,000	18,000	15,000	16,000
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 8/	74,485	72,507	90,784	142,522 r/	105,000
Ferrochromiumsilicon e/	5,000	5,000	5,000	5,000	5,000
Ferromanganese	153,000	122,000	117,000 r/ e/	121,277 r/	96,016 9/
Ferronickel	32,015	26,389	19,807	19,315	20,000
Ferrosilicon	212,183	166,278	200,833	188,735 r/	159,345 9/
Silicomanganese	175,000	124,000	117,000 r/ e/	171,304 r/	180,235 9/
Silicon metal	136,884	124,000 r/	120,000 r/	166,344 r/	112,123 9/
Other e/	76,000	76,000	76,000	76,000	76,000
Total	864,567	716,174 r/	746,068 r/	890,497 r/	754,000
Bulgaria, electric furnace: e/					
Ferrosilicon	8,000	8,000	8,000	8,000	8,000
Other	2,000	2,000	2,000	2,000	2,000
Total	10,000	10,000	10,000	10,000	10,000
Canada, electric furnace: e/					
Ferrosilicon	56,000	56,000	56,000	56,000	56,000
Ferrovanadium	1,000	1,000	1,000	1,000	1,000
Silicon metal	30,000	30,000	30,000	30,000	30,000
Total	87,000	87,000	87,000	87,000	87,000
Chile, electric furnace:					
Ferromanganese	5,517	3,652	2,833 r/	2,800 r/ e/	2,850
Ferromolybdenum	3,157	1,978	2,079 r/	2,000 e/	2,000
Ferrosilicon	1,294	1,159	1,000 r/	1,000 r/ e/	1,000
Silicomanganese	3,175	3,921	2,048 r/	2,000 r/ e/	2,050
Total	13,143	10,710	7,960 r/	7,800 r/ e/	7,900
China: e/					
Blast furnace:					
Ferromanganese	500,000	550,000	550,000	500,000	500,000
Other	100,000	48,000	100,000	100,000	100,000
Electric furnace:					
Ferrochromium	480,000	424,000	400,000	450,000	450,000
Ferromanganese	680,000	500,000	550,000	520,000	600,000
Ferrosilicon	1,250,000	1,290,000	1,120,000	1,400,000	1,650,000
Silicomanganese	770,000	639,000	822,000	900,000	950,000
Other	260,000	110,000	258,000	160,000	250,000
Total	4,040,000	3,560,000	3,800,000	4,030,000	4,500,000
Colombia, electric furnace, ferronickel	55,079	61,180	61,620	63,000	85,438 9/
Croatia, electric furnace, ferrochromium	24,231	11,771 r/	--	15,753	361 9/
Czech Republic, electric furnace, other e/	1,000	1,000	1,000	1,000	1,000
Dominican Republic, electric furnace, ferronickel	84,897	69,419	61,561	73,234 r/	57,003 9/

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/	1997	1998	1999	2000	2001 e/
Egypt, electric furnace: e/					
Ferromanganese	26,000	18,000	30,000	30,000	30,000
Ferrosilicon	44,000	44,000	44,000	45,000	45,000
Total	70,000	62,000	74,000	75,000	75,000
Finland, electric furnace, ferrochromium	236,652	230,906	256,290	260,600	236,710 9/
France: e/					
Blast furnace, ferromanganese	326,000 9/	321,000	302,000 9/	300,000	300,000
Electric furnace:					
Ferromanganese	100,000 9/	100,000	138,000	140,000	130,000
Ferrosilicon	109,000	110,000	110,000	110,000	100,000
Silicomanganese 10/	66,000	65,000	55,000	60,000	50,000
Silicon metal	74,000	75,000	75,000	75,000	75,000
Other	20,000	20,000	20,000	20,000	65,000
Total	695,000	691,000	700,000	705,000	720,000
Georgia, electric furnace: e/					
Ferromanganese	4,000	10,000	6,500	7,000	7,000
Silicomanganese	16,600	35,000	25,000	25,000	25,000
Total	20,600	45,000	31,500	32,000	32,000
Germany, electric furnace: e/					
Ferrochromium	25,856 9/	20,879 9/	16,960 9/	21,600 r/ 9/	19,308 9/
Silicon metal	20,000	20,000	20,000	26,000	25,000
Other 11/	30,000	30,000	30,000	30,000	32,000
Total	75,900	70,900	67,000	77,600 r/	76,300
Greece, electric furnace, ferronickel	70,440	60,020	59,545	81,662	80,000
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	70,000 e/	68,000	70,900	70,000 e/	70,000
India, electric furnace: e/					
Ferrochromium 13/	286,973 9/	345,125 9/	312,140 r/ 9/	376,693 r/ 9/	266,395 9/
Ferrochromiumsilicon	10,000	10,000	10,000	10,000	10,000
Ferromanganese	166,000	165,000	160,000	160,000	165,000
Ferrosilicon	74,000	55,000	55,000	60,000	50,000
Silicomanganese	198,000	193,000	190,000	185,000	150,000
Other	9,000	9,000	9,000	9,000	9,000
Total	744,000	777,000	736,000 r/	801,000 r/	650,000
Indonesia, electric furnace:					
Ferromanganese e/	15,000	13,000	12,000	12,000	12,000
Ferronickel	50,000	42,260	46,030	50,550	51,510 9/
Silicomanganese e/	7,000	7,000	7,000	7,000	7,000
Total	72,000 e/	62,260	65,030	69,550 r/	70,500
Iran, electric furnace:					
Ferrochromium	11,450	13,745	13,680	11,505 r/	8,430 9/
Ferrosilicon e/	40,000	40,000	46,000	40,000	40,000
Total e/	51,500	53,700	59,700 r/	51,500 r/	48,400
Italy, electric furnace:					
Ferrochromium	11,295	11,487	-- r/	-- r/	--
Ferromanganese	40,000	49,000	19,000	40,000 e/	40,000
Silicomanganese e/	100,000	70,000	67,000	90,000	90,000
Silicon metal	12,619	8,094	6,257	5,000 e/	6,000
Other e/ 14/	10,000	10,000	10,000	10,000	10,000
Total e/	174,000	149,000	102,000 r/	145,000 r/	146,000
Japan, electric furnace:					
Ferrochromium 15/	186,432	142,931	119,777	130,074	111,167 9/
Ferromanganese	376,633	334,081	315,152	337,694	368,293 9/
Ferronickel	352,841	345,772	332,293	367,181	367,739 9/
Ferrosilicon	--	951	1,452	--	-- 9/
Silicomanganese	78,323	70,886	65,744	67,926	62,238 9/
Other 16/	10,217	8,678	12,860	15,020	12,940 9/
Total	1,004,446	903,299	847,278	917,895	922,377 9/

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/	1997	1998	1999	2000	2001 e/
<b>Kazakhstan, electric furnace:</b>					
Ferchromium	600,000	535,000	731,563 r/	799,762 r/	761,900 9/
Ferchromiumsilicon	48,000 e/	33,550	49,282 r/	55,634 r/	79,800 9/
Ferromanganese	--	--	--	1,075 r/	5,329 9/
Ferrosilicon	133,000 e/	92,000 e/	140,263 r/	133,269 r/	145,800 9/
Silicomanganese	55,000 e/	57,000 e/	78,495 r/	102,719 r/	141,200 9/
Other	9,000	8,000	9,000 e/	9,000 e/	9,000
Total	845,000	725,550	1,008,603 r/	1,101,459 r/	1,143,029 9/
<b>Korea, North, electric furnace: e/</b>					
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
<b>Korea, Republic of, electric furnace:</b>					
Ferromanganese	158,755	158,418	140,208	146,373 r/	146,000
Silicomanganese	77,375	106,997	116,091	103,522 r/	105,000
Other	2,174	2,785	4,639	4,676 r/	4,500
Total	238,304	268,200	260,938	254,571 r/	256,000
<b>Macedonia, electric furnace:</b>					
Ferchromium	460	--	--	-- e/	--
Ferronickel	14,000	15,200	5,000	-- e/	--
Ferrosilicon e/	55,000	55,000	50,000	50,000	50,000
Silicon metal e/	1,000	500	--	--	--
Total e/	70,500	70,700	55,000	50,000	50,000
<b>Mexico, electric furnace: 17/</b>					
Ferromanganese	132,481 r/	153,513 r/	147,899 r/	90,500 r/	60,014 9/
Silicomanganese	116,636 r/	104,566 r/	127,666 r/	107,923 r/	74,290 9/
Total	249,117 r/	258,079 r/	275,565 r/	198,423 r/	134,304 9/
<b>New Caledonia, electric furnace, ferronickel</b>					
	159,018	157,959	157,592	157,000 e/	162,000
<b>Norway, electric furnace: e/</b>					
Ferchromium	145,124 9/	174,678 9/	159,714 9/	153,500 r/ 9/	82,600 9/
Ferromanganese	235,000	235,000	235,000	235,000	240,000
Ferrosilicon	470,000	470,000	460,000	460,000	450,000
Silicomanganese	230,000	230,000	230,000	230,000	230,000
Silicon metal	110,000	110,000	100,000	100,000	100,000
Other 10/	15,000	15,000	15,000	15,000	15,000
Total	1,210,000	1,230,000	1,200,000	1,190,000 r/	1,120,000
<b>Peru, electric furnace, ferrosilicon e/</b>					
	600	600	600	600	600
<b>Poland:</b>					
Blast furnace, ferromanganese e/	47,500	50,152 9/	100 r/	100 r/	100
<b>Electric furnace:</b>					
Ferchromium	6,200	4,200	-- r/	-- r/	--
Ferrosilicon	77,300	75,000	62,481	70,000 e/	70,000
Silicomanganese	20,000	15,100	10,000 r/	10,000 r/	10,000
Silicon metal e/	1,400	1,400	1,200	1,500	1,500
Other e/	7,300	11,848 9/	2,700 r/	2,700 r/	2,700
Total	159,700	157,700	76,481 r/	84,300 r/	84,300
<b>Romania, electric furnace:</b>					
Ferchromium	950	873	--	--	--
Ferromanganese	11,505	4,170 e/	25 e/	1,044	1,000
Ferrosilicon	9,620	5,553	5,000 e/	5,000 e/	5,000
Silicomanganese	62,570	83,617	550 e/	21,158	20,000
Silicon metal e/	300	150	--	--	--
Total e/	84,900	94,400	5,580	27,200	26,000
<b>Russia: e/</b>					
<b>Blast furnace:</b>					
Ferromanganese	47,100 9/	65,000 9/	90,000	70,700	70,000
Ferrophosphorus	3,600 9/	3,500	3,500	3,500	3,500
Spiegeleisen	7,000	7,000	7,000	7,000	7,000
<b>Electric furnace:</b>					
Ferchromium	247,000	203,000 9/	249,000 9/	274,000 9/	210,600 9/
Ferchromiumsilicon	5,000	4,000	4,500	4,500	4,000
Ferronickel	40,000	30,000	33,000	35,000	30,000

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/	1997	1998	1999	2000	2001 e/
Russia--Continued: e/					
Electric furnace--Continued:					
Ferrosilicon	510,000	496,000 9/	601,000 9/	652,000 9/	707,100 9/
Silicon metal	40,000	40,000	40,000	40,000	40,000
Other	40,000	40,000	40,000	40,000	35,000
Total	940,000	889,000	1,070,000	1,130,000	1,110,000
Saudi Arabia, electric furnace, other e/	83,000	83,000	83,000	83,000	83,000
Serbia and Montenegro, electric furnace, ferronickel	6,338	1,243	--	--	--
Slovakia, electric furnace: e/					
Ferrochromium	11,394 9/	11,715 9/	6,986 9/	17,702 r/ 9/	5,968 9/
Ferromanganese	20,000	20,000	20,000	20,000	20,000
Ferrosilicon	50,133 9/	49,963 9/	50,000 r/	70,000	50,000
Silicomanganese	45,159 9/	46,627 9/	35,000 r/	35,000	35,000
Other	5,000	5,000	5,000	5,000	5,000
Total	132,000	133,000	117,000 r/	148,000 r/	116,000
Slovenia, electric furnace:					
Ferrochromium	9,232	10,621	560	-- r/	--
Ferrosilicon e/	8,000	8,000	8,000	8,000	8,000
Other e/ 6/	200	200	200	200	200
Total e/	17,400	18,800	8,760	8,200 r/	8,200
South Africa, electric furnace:					
Ferrochromium	1,939,500	2,025,300	2,155,202	2,574,000 r/	1,992,773 9/
Ferromanganese	499,000	542,000	527,000	596,873 r/	600,000
Ferrosilicon	102,000	108,400	106,000	109,000 r/	109,000
Silicomanganese	286,000 e/	265,000 e/	267,000	268,000 r/	270,000
Silicon metal	34,000	32,600	35,800	40,600 r/	40,000
Other e/ 18/	48,000	15,000	32,000	30,000	30,000
Total e/	2,910,000	2,990,000	3,120,000	3,620,000 r/	3,040,000
Spain, electric furnace:					
Ferrochromium	490	1,145	935	905 r/	--
Ferromanganese e/	23,000	18,000	10,000	10,000	10,000
Ferrosilicon	38,340	39,115	40,000 e/	40,000 e/	40,000
Silicomanganese e/	122,000	108,000	95,000	100,000	100,000
Silicon metal	19,220	18,424	28,000 e/	30,000 e/	30,000
Other e/	5,000	5,000	5,000	5,000	5,000
Total e/	208,000	190,000	179,000	186,000	185,000
Sweden, electric furnace:					
Ferrochromium	101,842	123,958	113,140	135,841 r/	109,198 9/
Ferrosilicon	22,409	20,356	21,440	20,000	22,000
Total	124,251	144,314	134,580	155,841 r/	131,000
Taiwan, electric furnace:					
Ferromanganese	12,130	12,532	--	-- e/	-- 9/
Ferrosilicon	3,391	3,775	3,212	2,975 r/	1,181 9/
Total	15,521	16,307	3,212	2,975 r/	1,181 9/
Turkey, electric furnace:					
Ferrochromium	108,320	110,175	99,105 r/	97,240 r/	50,735 9/
Ferrosilicon	4,730 e/	4,810	420 r/	-- r/	--
Total	113,050	114,985	99,525 r/	97,240 r/	50,735 9/
Ukraine:					
Blast furnace: e/					
Ferromanganese	125,000	112,400 9/	57,800	85,400	85,000
Spiegeleisen	2,500	2,500	2,500	5,400	5,000
Electric furnace:					
Ferromanganese	160,000 e/	150,000 e/	199,539	252,679	250,000
Ferronickel e/	--	--	--	10,800	41,000
Ferrosilicon	300,000 e/	222,511	243,600	323,417	325,000
Silicomanganese	560,000 e/	485,560	498,905	684,040	685,000
Other e/	25,000	20,000	25,000	25,000	25,000
Total	1,172,500 r/	992,971 r/	1,027,344 r/	1,386,736 r/	1,420,000

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/	1997	1998	1999	2000	2001 e/
United States, electric furnace:					
Ferromanganese 19/	60,700	W	W	W	W
Ferromanganese 20/	W	W	W	W	W
Ferronickel	32,100	8,590	--	-- e/	--
Ferrosilicon	359,000	334,000	325,000	250,000 e/	191,000 9/
Silicon metal	183,000	188,000	186,000	175,000 e/	131,000 9/
Other 21/	W	W	W	W	W
Total	635,000	531,000	511,000	425,000 e/	322,000
Uruguay, electric furnace, ferrosilicon e/	200	200	200	200	200
Venezuela, electric furnace:					
Ferromanganese	--	7,671 r/	10,694 r/	15,655 r/	15,000
Ferronickel	--	--	--	133	28,400
Ferrosilicon	58,000 r/	36,277 r/	38,886 r/	56,926 r/	60,000
Silicomanganese	57,876 r/	48,504	47,635	69,735 r/	70,000
Total	115,876 r/	92,452 r/	97,215 r/	142,449 r/	173,000
Zimbabwe, electric furnace:					
Ferromanganese	233,386	246,782	244,379	246,324	249,841 9/
Ferrosilicon	17,000	21,000	16,267	19,631	16,848 9/
Total	250,386	267,782	260,646	265,955	266,689 9/
Grand total:	18,500,000	17,500,000 r/	17,900,000	19,500,000 r/	18,800,000
Of which:					
Blast furnace:					
Ferromanganese 22/	1,050,000	1,100,000	1,000,000 r/	956,000 r/	955,000
Spiegeleisen 22/	9,500	9,500	9,500	12,400	12,000
Other 23/	104,000	51,500	104,000	104,000	104,000
Total	1,160,000	1,160,000	1,110,000 r/	1,070,000 r/	1,070,000
Electric furnace:					
Ferromanganese 24/	4,830,000	4,750,000	5,000,000 r/	5,720,000 r/	4,680,000
Ferrosilicon	37,000	40,000	35,800	39,100	35,800
Ferromanganese 25/ 26/	2,950,000 r/	2,760,000 r/	2,740,000 r/	2,860,000 r/	2,920,000
Ferronickel	902,000	823,000	781,000	862,000 r/	927,000
Ferrosilicon	4,110,000	3,900,000	3,900,000 r/	4,260,000	4,440,000
Silicomanganese 26/ 27/	3,170,000 r/	2,890,000	2,970,000 r/	3,380,000 r/	3,400,000
Silicon metal	694,000	686,000 r/	681,000 r/	729,000 r/	630,000
Other 28/	679,000	501,000	660,000 r/	564,000 r/	692,000
Total	17,400,000 r/	16,300,000	16,800,000 r/	18,400,000 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, 2002.

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.

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: ferromanganese, 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/ Includes, if any, silicomanganese.

8/ Includes high- and low-carbon ferromanganese.

9/ Reported figure.

10/ Includes, if any, silicospiegeleisen.

11/ Includes, if any, ferrosilicon and ferronickel.

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

13/ Includes charge chrome and ferrochrome.

14/ Excludes calcium-silicon.

15/ Includes high- and low-carbon ferromanganese and ferrosilicon.

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

17/ Salable products from Autlán.

18/ Includes, if any, ferronickel.

19/ U.S. output of ferromanganese includes chromium metal, high- and low-carbon ferromanganese, ferrosilicon, and other chromium materials.

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

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

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- 21/ May include ferroboration, ferrocolumbium, ferromolybdenum, ferrophosphorus, ferrotitanium, ferrotungsten, ferrovanadium, nickel columbium, and silvery pig iron.
- 22/ Spiegeleisen, if any, for Germany is included with blast furnace ferromanganese.
- 23/ Includes ferrophosphorus and data contained in "Blast furnace: Other."
- 24/ Ferrochromium includes ferrochromiumsilicon, if any, for Japan, South Africa, and the United States.
- 25/ Ferromanganese includes silicomanganese, if any, for North Korea.
- 26/ U.S. production is included in "Other."
- 27/ Includes silicospiegeleisen, if any, for France.
- 28/ Includes calcium-silicon, ferromolybdenum, ferrovanadium, silicomanganese for the United States, and data contained in "Electric furnace: Other" for each country indicated.