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FERROALLOYS [ADVANCE RELEASE]

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Ferroalloys

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Ferroalloys are alloys of iron used to add chemical elements into molten metal, usually during steelmaking. The alloying elements delivered by ferroalloys impart distinctive qualities to steel and cast iron or serve important functions during production. In 2014, 12 companies in the United States produced seven ferroalloys at 13 plants (table 1); production statistics were withheld to avoid disclosing proprietary data. The leading ferroalloy-producing countries in 2014 were, in decreasing order of production, China [36.8 million metric tons (Mt)], South Africa (4.48 Mt), India (3.5 Mt), Russia (1.97 Mt), and Kazakhstan (1.56 Mt) (table 8). These five countries accounted for 84% of world ferroalloy production. Excluding U.S. production, world production of bulk ferroalloys—ferrochromium (including ferrochromium-silicon), ferromanganese, ferrosilicon, and silicomanganese—was estimated to have been 39.3 Mt in 2014, a slight increase compared with the revised amount of 38.5 Mt in 2013.

In 2014, the average price for all grades of ferrochromium increased by 2% to 13% compared with those in 2013 (table 5). The average price for medium-carbon ferromanganese and silicomanganese increased by about 9% and 13%, respectively, whereas the average price for standard high-carbon ferromanganese increased slightly. Average prices for 50%-grade ferrosilicon and 75%-grade ferrosilicon each increased by 5% from those in 2013. The weighted average price for ferrotungsten in 2014 was $46.74 per kilogram of contained tungsten, a slight decrease from $47.22 in 2013. In 2014, the average U.S. spot-market price range for 70%-grade ferrotitanium reported by Platts Metals Week increased to $2.90 to $3.10 per pound, up from $2.75 to $2.80 per pound in 2013. The average price for ferrovanadium decreased to $13.04 per pound of contained vanadium in 2014, 3% less than $13.43 per pound of contained vanadium in 2013.

U.S. reported consumption, by gross weight, of ferromanganese, ferrosilicon, and silicomanganese in 2014 was approximately 776,000 metric tons (t), a 7% decrease from the revised amount of 834,000 t in 2013 (table 3). In 2014, reported consumption, on a gross-weight basis, of ferromanganese and silicomanganese decreased by 14% and 4%, respectively, from that in 2013, whereas ferrosilicon increased slightly. U.S. consumption of ferrochromium in 2014, by alloying element content, was 261,000 t, a 3% increase from 252,000 t in 2013 (table 4). Among nonbulk alloys, ferrotungsten had the largest increase in consumption (10%), followed by ferromolybdenum (8.6%), ferronickel (3.2%), ferrovanadium (3.1%), and ferrotitanium (0.2%) (tables 3, 4).

The United States was a net importer of ferroalloys in 2014. On a gross-weight basis, U.S. total ferroalloy imports increased by 26% and exports increased by 8% compared with those of 2013, which resulted in a 26% increase in net imports. Ferrochromium had the largest increase in net imports in 2014 (195,000 t), followed by silicomanganese (118,000 t), ferromanganese (29,800 t), ferronickel (19,900 t), ferrosilicon (17,300 t), and ferroniobium (2,010 t). Ferrovanadium had the largest decrease in net imports in 2014 (657 t), followed by ferrophosphorous (605 t) and ferrotungsten (including ferrosilicon-tungsten) (125 t), with "Other ferroalloys: Ferroalloys, other" decreasing as well (4,160 t).

Ferrochromium

The leading chromite-ore-producing countries in 2014, in descending order of production, were South Africa (12 Mt), Kazakhstan (3.7 Mt), India (3.5 Mt), and Turkey (2.6 Mt) (Papp, 2016). Chromite ore was mostly smelted in electric arc furnaces to produce ferrochromium for the metallurgical industry. The leading ferrochromium-producing countries, excluding ferrochromium-silicon and in descending order of production, were China (38%), South Africa (31%), Kazakhstan (10%), and India (8%) (table 8). Most of the 11.7 Mt of ferrochromium produced globally was consumed in the manufacture of stainless steel. In 2014, 41.7 Mt of stainless and heat resisting steel was produced globally. The leading stainless-steel-producing areas of the world were Asia (primarily China, India, Japan, the Republic of Korea, and Taiwan), Europe (primarily Western Europe and Scandinavia including Belgium, Finland, France, Germany, Italy, Spain, Sweden, and the United Kingdom), and the Americas (primarily Brazil and the United States) (International Stainless Steel Forum, undated).

More information on chromium and ferrochromium is available on the Chromium—Statistics and Information Web page of the U.S. Geological Survey (USGS) National Minerals Information Center at http://minerals.usgs.gov/minerals/pubs/commodity/chromium/.

Ferromanganese

Two manganese ferroalloys, ferromanganese and silicomanganese, are key ingredients for steelmaking. In the United States, two companies produced manganese ferroalloys: Eramet Marietta Inc. (owned by France's Eramet Group) and Felman Production LLC (owned by Miami-based Georgian American Alloys, Inc.) (table 1). Data on 2014 domestic production were withheld to avoid disclosing company proprietary information. In addition to this supply, the United States imported 808,000 t of ferromanganese and silicomanganese (gross weight) (table 7). Of that amount,

44% was imported from South Africa (357,000 t), 18% from Georgia (144,000 t), 15% from Australia (122,000 t), and 9% from Norway (72,100 t) (Corathers, 2015, tables 3, 4). China was the leading world producer of manganese ferroalloys, with output about 270% greater than that of the next three major producers—India, South Africa, and Ukraine—combined (table 8).

More information on ferromanganese, manganese, and silicomanganese is available on the Manganese—Statistics and Information Web page of the USGS National Minerals Information Center at http://minerals.usgs.gov/minerals/pubs/commodity/manganese/.

Ferromolybdenum

Chile, China, and the United States accounted for about 78% of the global production of molybdenite ore, on a contained-weight basis, in 2014 (Polyak, 2016a, table 10). Three other molybdenite-ore-producing countries—Canada, Mexico, and Peru—supplied an additional 15% of world production. Molybdenite concentrates are roasted to form molybdic oxide, which can then be converted into ferromolybdenum, molybdenum chemicals, or molybdenum metal. Of the total reported molybdenum materials consumed in the United States (19,500 t of contained molybdenum), about 47% was in the form of molybdic oxides, and about 24% was consumed as ferromolybdenum (Polyak, 2016a, table 3). The steel industry accounted for most of the ferromolybdenum consumed in the United States in 2014, principally in the production of stainless and full alloy steels (table 3).

More information on ferromolybdenum and molybdenum is available on the Molybdenum—Statistics and Information Web page of the USGS National Minerals Information Center at http://minerals.usgs.gov/minerals/pubs/commodity/molybdenum/.

Ferronickel

In 2014, most of the ferronickel consumed in the United States was used in stainless, heat-resisting, and certain alloy steels (table 4). No ferronickel was produced in the United States from lateritic ores in 2014. The International Metals Reclamation Co. produced a remelt alloy from recycled materials, which was used as a combiner substitute for ferrochromium and ferronickel in the production of austenitic stainless steel. In 2014, the major ferronickel-producing countries, by gross weight, were China (2.5 Mt, including nickel pig iron), Japan (379,000 t), New Caledonia (231,000 t), Brazil (144,000 t), and Colombia (133,000 t) (table 8). In 2014, China and Indonesia were the only two countries producing nickel pig iron, a nickel-iron alloy containing less than 15% nickel. Nickel pig iron is a low-grade product as opposed to conventional ferronickel grades, which range from 18% to 80% nickel content.

More information on ferronickel and nickel is available on the Nickel—Statistics and Information Web page of the USGS National Minerals Information Center at http://minerals.usgs.gov/minerals/pubs/commodity/nickel/.

Ferrosilicon

Silicon ferroalloy consumption is driven by cast iron and steel production, where silicon alloys are used as deoxidizers. Silicon metal was also used as an alloying agent with iron. Domestic data for silicon metal containing less than 99.9% silicon—silicon metal used as feedstocks for chemical, electronic, and metallurgical applications—were aggregated with those of ferrosilicon to avoid disclosing company proprietary data for both material categories. In 2014, total domestic ferrosilicon and silicon metal gross production was 502,000 t on a gross-weight basis, which was a 7% increase compared with 2013 production. In addition to domestic production in 2014, the United States imported 270,000 t of ferrosilicon (gross weight). Of that amount, 81% was imported from China (93,700 t), Russia (89,400 t), and Canada (36,300 t) (Schnebele, 2016). Excluding U.S. production, China produced more ferrosilicon than the rest of the world combined, about 69% of the world total (table 8).

More information on ferrosilicon is available on the Silicon—Statistics and Information Web page of the USGS National Minerals Information Center at http://minerals.usgs.gov/minerals/pubs/commodity/silicon/.

Ferrotitanium

Titanium is used in steelmaking for deoxidation, grain-size control, and carbon and nitrogen control and stabilization. During steelmaking, titanium is usually introduced as ferrotitanium, because it has a lower melting temperature and higher density than titanium scrap. Steels with relatively high titanium content include interstitial-free, stainless, and high-strength low-alloy steels. Ferrotitanium is typically produced by induction melting of titanium scrap with iron or steel; however, it also is produced directly from titanium mineral concentrates. The standard grades of ferrotitanium are 30% and 70% titanium. U.S. producers of ferrotitanium were Global Titanium Inc. (Detroit, MI), with 10,000 metric tons per year (t/yr) of ferrotitanium production capacity, and RTI International Metals, Inc. (Canton, OH), with 7,260 t/yr of ferrotitanium and specialty alloy production capacity (Bedinger, 2016, p. 78.2). The leading ferrotitanium-producing countries in 2014 were India, Russia, and the United States.

In the United States, reported consumption of titanium products in steel and other alloys in 2014 was 11,900 t (gross weight), unchanged from that of 2013. The steel industry accounted for most of the ferrotitanium consumed in the United States. In 2014, the average U.S. spot-market price range for 70%-grade ferrotitanium reported by Platts Metals Week increased to $2.90 to $3.10 per pound, up from $2.75 to $2.80 per pound in 2013.

More information on ferrotitanium and titanium is available on the Titanium—Statistics and Information Web page of the USGS National Minerals Information Center at http://minerals.usgs.gov/minerals/pubs/commodity/titanium/.

Ferrotungsten

Tungsten is an important alloying element in high-speed and other tool steels and is used to a lesser extent in some stainless and structural steels. Tungsten can be added to steel melts as

(1) ferrotungsten, which is a master alloy typically containing between 75% and 85% tungsten; (2) tungsten melting base, which is a master alloy containing as much as 38% tungsten; (3) tungsten metal scrap; or (4) scheelite ore concentrates. Ferrotungsten can be produced from high-grade tungsten ore, concentrates of the tungsten minerals scheelite or wolframite, artificial scheelite (calcium tungstate), or soft scrap (Lassner and Schubert, 1999, p. 307–312; Roskill Information Services Ltd., 2014, p. 234–238).

World ferrotungsten production was dominated by China, with leading producers in Fujian, Hunan, Jiangxi, Jilin, and Sichuan Provinces. In Vietnam, two companies produced ferrotungsten—Hazelwood Resources Ltd. and Vietnam Youngsun Tungsten Industry Co., Ltd. Ferrotungsten was also produced in Brazil, Germany, Russia, and Sweden.

U.S. reported consumption of ferrotungsten increased by 10% in 2014 from that of 2013, but remained at a low level. Platts Metals Week ferrotungsten prices trended steadily downward in 2014 to levels last reported in late 2010. The annual arithmetic mean of weekly prices, at $46.74 per kilogram of contained tungsten, was slightly less than the annual arithmetic mean of $47.22 per kilogram of contained tungsten in 2013.

More information on ferrotungsten and tungsten is available on the Tungsten—Statistics and Information Web page of the USGS National Minerals Information Center at http://minerals.usgs.gov/minerals/pubs/commodity/tungsten/.

Ferrovanadium

In 2014, China, Russia, and South Africa accounted for 98% of world vanadium mine production. In these countries, vanadium was primarily recovered from titanium-bearing magnetite ore processed to produce pig iron. The process produced a slag containing 20% to 24% vanadium pentoxide, which was further processed to ferrovanadium containing 40% to 50% vanadium (Polyak, 2016b, table 7). In 2014, secondary vanadium produced from various industrial waste materials, such as vanadium-bearing coal fly ash, petroleum residues, pig iron slag, and spent catalysts, was the leading source of U.S. vanadium production. Most of U.S. reported vanadium consumption was for steelmaking, principally in carbon, full alloy, and high-strength low-alloy steels. Ferrovanadium supplied 79% of the 4,070 t of vanadium consumed in the United States (Polyak, 2016b, table 2). Steel manufacturing consumed almost all of the ferrovanadium in 2014 (table 4).

More information on ferrovanadium and vanadium is available on the Vanadium—Statistics and Information Web page of the USGS National Minerals Information Center at http://minerals.usgs.gov/minerals/pubs/commodity/vanadium/.

Outlook

The near-term trend for domestic ferroalloy consumption is expected to follow closely that of U.S. steel production. Details of the outlook for the steel industry are discussed in the "Outlook" section of the Iron and Steel chapter of the 2014 USGS Minerals Yearbook, volume I, Metals and Minerals. Raw steel production in the United States increased slightly to 88.2 Mt in 2014 from 86.9 Mt in 2013 (Fenton, 2016). According to the World Steel Association (2015a), world raw steel production in 2014 increased by 1.2% to 1.66 billion metric tons (Gt) from 1.64 Gt in 2013. Raw steel production in China, the world's leading producer of raw steel, increased slightly to about 823 Mt, followed by Japan (111 Mt), the United States (88 Mt), India (83 Mt), and the Republic of Korea (71 Mt).

According to the World Steel Association (2014), the steel industry will continue with a restrained growth outlook. A slowdown in China's economic growth as well as limited growth following the most recent recessionary periods are major determinants of global consumption trends. Consumption of steel was expected to decrease slightly to 1.51 Mt in 2015 and increase slightly to 1.52 Mt in 2016. Apparent steel consumption in 2015 was expected to be as follows: Central America and South America, 45 Mt (7.3% decrease); China, 686 Mt (3.5% decrease); Commonwealth of Independent States, 50 Mt (11% decrease); European Union, 150 Mt (1.3% increase); India, 82 Mt (7.3% increase); Japan, 64 Mt (5.4% decrease); Middle East and North Africa, 73 Mt (4.6% increase); and the United States, 104 Mt (3.0% decrease) (World Steel Association, 2015b).

Information on individual commodities, including domestic data coverage, foreign trade by country, outlook, and U.S. Government stockpile information is presented in the respective mineral commodity chapters in the U.S. Geological Survey Minerals Yearbook, volume I, Metals and Minerals, or online at http://minerals.usgs.gov/minerals.

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TABLE 1
DOMESTIC PRODUCERS OF FERROALLOYS IN 2014

Company and Region	Plant location	FeMo	FeMn	FeNb	FeSi	FeTi	FeV	SiMn
Midwest:								
CC Metals & Alloys, LLC	Calvert City, KY				X			
Eramet Marietta Inc.	Marietta, OH		X					X
Global Titanium Inc.	Detroit, MI					X		
Globe Metallurgical, Inc.	Beverly, OH				X			
AMG Vanadium, Inc.	Cambridge, OH						X	
RTI International Metals, Inc.	Canton, OH					X		
Northeast:								
Bear Metallurgical Co.	Butler, PA	X					X	
Felman Production LLC	Letart, WV							X
Reading Alloys Inc.	Robesonia, PA			X				
Evraz Stratcor, Inc.	Butler, PA						X	
Thompson Creek Metals Co. Inc.	Langeloth, PA	X						
WVA Manufacturing, LLC	Alloy, WV				X			
Southeast, Globe Metallurgical, Inc.	Bridgeport, AL				X			

[1]FeMo, ferromolybdenum; FeMn, ferromanganese; FeNb, ferroniobium; FeSi, ferrosilicon; FeTi, ferrotitanium; FeV, ferrovanadium; SiMn, silicomanganese.

TABLE 2
GOVERNMENT INVENTORY OF FERROALLOYS[1, 2]

(Metric tons of alloys)

Alloy	Inventory
Ferrochromium:	
High-carbon	52,500
Low-carbon	24,700
Ferromanganese, high carbon	322,000

[1]Data are rounded to no more than three significant digits.
[2]Inventory as of December 31, 2014.

Source: Defense Logistics Agency Strategic Materials.

TABLE 3
REPORTED U.S. CONSUMPTION OF FERROALLOYS BY END USE[1, 2]

(Metric tons, gross weight)

End use	FeB	FeMn	SiMn	FeP	FeSi	FeTi
2013:						
Steel:						
Carbon and high-strength low-alloy	371	291,000	106,000	3,670	71,000	5,670
Stainless and heat-resisting	207	9,770	15,600	(3)	45,400 r	3,460
Unspecified and other steels	225	107,000	27,600	849	54,800 r	808
Total steel	803	408,000	149,000	4,520	171,000 r	9,940
Alloys and superalloys (excluding alloy steels)	36	600	2,920	(4)	(4)	1,870
Cast irons	(4)	7,900	330	432	91,800	14
Miscellaneous and unspecified	691	(5)	(5)	476	3,050 r	46
Grand total	1,530	416,000	152,000 [6]	5,420	266,000 r	11,900
Consumer stocks, December 31	147	27,200 [7]	5,620 [7]	625	11,100 r	1,490
2014:						
Steel:						
Carbon and high-strength low-alloy	371	279,000	101,000	3,670	69,500	5,790
Stainless and heat-resisting	207	9,870	15,600	(3)	44,800	3,580
Unspecified and other steels	225	63,000	26,000	849	60,100	838
Total steel	803	351,000	142,000	4,520	174,000	10,200
Alloys and superalloys (excluding alloy steels)	36	571	2,760	(4)	(4)	1,640
Cast irons	(4)	7,740	532	432	93,600	11
Miscellaneous and unspecified	691	(5)	(5)	476	3,070	38
Grand total	1,530	360,000	146,000 [6]	5,420	271,000	11,900
Consumer stocks, December 31	147	22,400 [7]	9,700 [7]	625	12,000	1,490

rRevised.
[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; SiMn, silicomanganese; FeP, ferrophosphorus, including other phosphorus materials; FeSi, ferrosilicon, silvery pig iron, silicon carbide, and inoculant alloys; FeTi, ferrotitanium, including titanium scrap and other titanium materials.
[3]All or part included with "Steel, unspecified and other alloys."
[4]All or part included with "Miscellaneous and unspecified."
[5]All or part included with "Alloys (excluding alloy steels and superalloys)."
[6]Internal evaluation indicates that silicomanganese consumption is understated.
[7]Consumer and producer stocks.

TABLE 4
REPORTED U.S. CONSUMPTION OF FERROALLOYS AS ALLOYING ELEMENTS BY END USE[1, 2]

(Metric tons of contained alloying element)

End use	FeCr	FeMo	FeNb	FeNi	FeV	FeW
2013:						
Steel:						
Carbon	2,900	173	1,250	--	649	(3)
High-strength low-alloy	1,330	112	(3)	--	(4)	--
Stainless and heat-resisting	215,000	680 r	828	12,900	61	(3)
Unspecified and other steels	23,600	2,800 r	3,830	96	2,410	97
Total	243,000	3,760 r	5,900	13,000	3,120	97
Alloys and superalloys (excluding alloy steels)	5,380	132 r	1,790	120	6	(3)
Cast irons	(4)	358	--	--	(4)	--
Miscellaneous and unspecified	3,850	121 r	--	1,980	10	--
Grand total	252,000	4,370 r	7,690	15,100	3,130	97
Consumer stocks, December 31	7,760	330	388	1,010	140	W
2014:						
Steel:						
Carbon	3,240	192	1,250	--	689	--
High-strength low-alloy	1,340	110	(3)	--	(4)	--
Stainless and heat-resisting	221,000	715	828	13,300	61	(3)
Unspecified and other steels	26,700	3,160	3,830	32	2,460	107
Total	252,000	4,180	5,900	13,300	3,210	107
Alloys and superalloys (excluding alloy steels)	5,160	112	1,790	124	4	(3)
Cast irons	(4)	346	--	--	(4)	--
Miscellaneous and unspecified	3,760	110	--	2,100	14	--
Grand total	261,000	4,750	7,690	15,500	3,230	107
Consumer stocks, December 31	8,310	374	388	894	147	W

[r]Revised. W Withheld to avoid disclosing company proprietary data. -- Zero.

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

[2]FeCr, ferrochromium, including chromium metal; FeMo, ferromolybdenum, including calcium molybdate; FeNb, ferroniobium, including nickel niobium; FeNi, ferronickel; FeV, ferrovanadium, including other vanadium-carbon-iron ferroalloys; and FeW, ferrotungsten.

[3]Withheld to avoid disclosing company proprietary data; included with "Steel, unspecified and other alloys."

[4]Withheld to avoid disclosing company proprietary data; included with "Miscellaneous and unspecified."

TABLE 5
SELECTED FERROALLOY PRICES

	Unit	2013			2014		
		High	Low	Average[1]	High	Low	Average[1]
Ferrochromium:							
0.05% carbon	Cents per pound, contained weight	XX	XX	219.00	XX	XX	227.00
0.10% carbon	do.	XX	XX	203.00	XX	XX	208.00
0.15% carbon	do.	XX	XX	194.00	XX	XX	201.00
Over 4% carbon:	do.						
47–55% chromium[2]	do.	XX	XX	100.00	XX	XX	107.00
60–70% chromium[3]	do.	XX	XX	101.00	XX	XX	114.00
Manganese:							
Medium-carbon ferromanganese	Cents per pound, contained weight	90.00	83.00	86.87 r	98.00	86.00	94.39
Standard high-carbon ferromanganese	Dollars per metric ton, gross weight	1,100.00	990.00	1,053.83 r	1,120.00	990.00	1,063.24
Silicomanganese	Cents per pound, contained weight	54.00	49.50	52.11 r	62.00	53.00	58.72
Molybdenum:							
Ferromolybdenum	Dollars per pound, contained weight	12.84	11.07	11.955	19.07	11.39	12.83
Molybdenum oxide	do.	11.81	9.35	10.58	14.75	9.54	11.72
Nickel metal, London Metal Exchange	Dollars per metric ton, 99.81% purity (minimum)	17,728.63	13,702.17	15,715.40	19,026.00	14,704.00	16,865.00
Silicon:							
50% ferrosilicon	Cents per pound, contained weight	104.23	100.98	102.605	109.85	105.79	107.82
75% ferrosilicon	do.	95.11	93.07	94.09	99.47	97.22	98.35
Titanium, ferrotitanium, 70% grade	Dollars per pound	2.80	2.75	2.78	3.10	2.90	3.00
Tungsten, ferrotungsten	Dollars per kilogram, contained weight	65.00	41.00	47.22	65.00	36.00	46.74
Vanadium, ferrovanadium	Dollars per pound, contained weight	13.67	13.19	13.43	13.34	12.73	13.04

rRevised. XX Not applicable. do. Ditto.
[1]Arithmetic mean of high and low prices, weekly prices, or monthly prices.
[2]For 2013, value was specific to 49% to 51% chromium content. Prices series discontinued.
[3]For 2013, value was specific to 60% to 65% chromium content. Price series discontinued.

Sources: London Metal Exchange, Platts Metals Week, and CRU Ryan's Notes.

TABLE 6
U.S. EXPORTS OF FERROALLOYS[1]

Alloy	2013 Gross weight (metric tons)	2013 Contained weight (metric tons)	2013 Value (thousands)	2014 Gross weight (metric tons)	2014 Contained weight (metric tons)	2014 Value (thousands)
Chromium ferroalloys:						
Ferrochromium:						
More than 4% carbon	4,460	2,320	$6,580	3,850	1,940	$6,250
Not more than 4% carbon	379	169	698	839	339	1,770
Ferrochromium-silicon	16	6	23	36	13	43
Total, chromium ferroalloys	4,850	2,500	7,300	4,730	2,290	8,060
Manganese ferroalloys:						
Ferromanganese, all grades	1,970	XX	3,300	5,540	XX	8,620
Silicomanganese	5,890	XX	6,500	3,320	XX	3,820
Total, manganese ferroalloys	7,860	XX	9,800	8,870	XX	12,400
Silicon ferroalloys:						
Ferrosilicon, more than 55% silicon	10,800	6,820	18,100	7,870	4,980	14,400
Ferrosilicon, other	6,500	2,930	13,700	8,010	3,670	13,500
Total, silicon ferroalloys	17,300	9,750	31,800	15,900	8,650	27,900
Other ferroalloys:						
Ferromolybdenum	1,240	862	22,900	815	569	18,400
Ferronickel	541	479	8,040	190	111	3,140
Ferroniobium	588 r	XX	7,280 r	1,620	XX	22,900
Ferrophosphorus	619	XX	1,310	544	XX	993
Ferrotitanium and ferrosilicon-titanium	4,110	XX	17,100	2,990	XX	12,400
Ferrotungsten and ferrosilicon-tungsten	80	31	774	152	76	893
Ferrovanadium	395	299	8,790	352	253	7,510
Ferrozirconium	1,980	XX	5,000	1,600	XX	3,930
Ferroalloys, other	2,120	XX	5,730	7,390	XX	15,700
Total, other ferroalloys	11,700 r	1,670	77,000 r	15,600	1,010	85,800
Grand total	41,700 r	13,900	126,000 r	45,100	11,900	134,000

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

Source: U.S. Census Bureau.

TABLE 7
U.S. IMPORTS FOR CONSUMPTION OF FERROALLOYS[1]

Alloy	2013 Gross weight (metric tons)	2013 Contained weight (metric tons)	2013 Value (thousands)	2014 Gross weight (metric tons)	2014 Contained weight (metric tons)	2014 Value (thousands)
Chromium ferroalloys:						
Ferrochromium:						
More than 4% carbon	416,000	227,000	$417,000	595,000	327,000	$640,000
More than 3% but not more than 4% carbon	370	210	238	3,040	1,470	3,060
More than 0.5% but not more than 3% carbon	13,800	9,410	33,100	14,500	10,000	37,400
Not more than 0.5% carbon	36,500	24,800	113,000	43,400	29,600	132,000
Ferrochromium-silicon	12,000	4,230	16,200	17,400	7,330	25,000
Total, chromium ferroalloys	478,000	266,000	580,000	673,000	375,000	837,000
Manganese ferroalloys:						
Ferromanganese:						
More than 4% carbon	259,000	198,000	247,000	266,000	201,000	242,000
More than 2% but not more than 4% carbon	18	14	40	137	101	129
More than 1% but not more than 2% carbon	42,300	33,900	56,900	61,800	49,600	86,000
Not more than 1% carbon	29,100	24,800	51,500	36,400	31,100	66,500
Silicomanganese	329,000	223,000	339,000	444,000	298,000	485,000
Total, manganese ferroalloys	659,000	479,000	694,000	808,000	580,000	880,000
Ferrosilicon:						
55%–80% silicon, more than 3% Ca	4,400	3,270	6,400	8,550	6,340	12,000
55%–80% silicon, other	180,000	136,000	267,000	215,000	163,000	324,000
Magnesium ferrosilicon	19,000	8,620	35,200	22,100	10,200	41,100
Ferrosilicon, other[2]	50,000 r	10,800 r	35,200 r	23,800	6,670	21,100
Total, ferrosilicon	254,000 r	159,000 r	343,000 r	270,000	186,000	398,000
Other ferroalloys:						
Ferrocerium and other pyrophoric alloys	1,390	XX	12,100	1,320	XX	11,700
Ferromolybdenum	6,120	4,090	108,000	7,650	5,110	147,000
Ferronickel	50,300	13,700	212,000	69,800	20,500	313,000
Ferroniobium	9,450	XX	267,000	12,500	XX	341,000
Ferrophosphorus	8,740	XX	4,580	8,060	XX	4,740
Ferrotitanium and ferrosilicon-titanium	1,680	XX	7,260	2,210	XX	9,290
Ferrotungsten and ferrosilicon-tungsten	613	470	19,200	560	454	18,800
Ferrovanadium	4,910	3,710	89,800	4,210	3,230	94,500
Ferrozirconium	4	XX	44	131	XX	774
Ferroalloys, other	8,600	XX	30,600	9,710	XX	32,300
Total, other ferroalloys	91,800	21,900	750,000	116,000	29,300	972,000
Grand total	1,480,000	926,000	2,370,000	1,870,000	1,170,000	3,090,000

rRevised. XX Not applicable.
[1]Data are rounded to no more than three significant digits; may not add to totals shown.
[2]Includes 80%–90% ferrosilicon; more than 90% ferrosilicon; and ferrosilicon, other.

Source: U.S. Census Bureau.

TABLE 8
FERROALLOYS: WORLD PRODUCTION, BY COUNTRY, FURNACE TYPE, AND ALLOY TYPE[1]

(Metric tons, gross weight)

Country, furnace type, and alloy type[2]	2010	2011	2012	2013	2014[e]
Albania, electric furnace, ferrochromium	23,233	28,694	24,018	24,692	34,897 [3]
Argentina, electric furnace:[e]					
Ferrosilicon	18,000 [r]	18,000 [r]	14,000 [r]	15,000 [r]	17,000
Silicomanganese	10,900 [3]	11,000	11,000	11,000	13,000 [3]
Total	28,900 [r]	29,000 [r]	25,000 [r]	26,000 [r]	30,000
Armenia, electric furnace, ferromolybdenum	5,126	5,525	5,836	6,619	6,528 [3]
Australia, electric furnace:[e]					
Ferromanganese	138,000	146,000	106,200 [r, 3]	143,900 [r, 3]	161,900 [3]
Silicomanganese	131,000	130,000	50,800 [r, 3]	110,100 [r, 3]	119,400 [3]
Total	269,000	276,000	157,000 [r, 3]	254,000 [r, 3]	281,300 [3]
Austria, electric furnace:					
Ferronickel, including ferronickel molybdenum	1,906 [r]	1,795 [r]	1,700 [r]	2,090 [r]	4,135 [3]
Other[e]	555,000 [r]	739,000 [r]	698,000 [r]	698,000 [r]	698,000
Total	557,000 [r]	741,000 [r]	700,000 [r]	700,000 [r]	702,000
Bahrain, electric furnace:[3]					
Ferromanganese	5,600	35,300	35,000	35,000	35,000
Silicomanganese	3,700	3,000	3,000	3,000	3,000
Total	9,300	38,300	38,000	38,000	38,000
Bhutan, electric furnace, ferrosilicon, exports	97,528	96,711 [r]	107,819 [r]	110,000 [r, e]	110,000
Bosnia and Herzegovina, electric furnace, ferrosilicon	(4) [r]	(4) [r]	(4) [r]	(4) [r]	(4)
Brazil, electric furnace:					
Ferrochromium[5]	277,114	145,122	165,532	189,088 [r]	185,000
Ferrochromium silicon	16,020	8,378	9,556	10,200	10,000
Ferromanganese	92,000 [r]	82,000 [r]	94,000 [r]	93,000 [r]	92,000
Ferronickel	33,860	90,800 [r]	148,800 [r]	169,200	144,000
Ferroniobium (ferrocolumbium)	80,905 [r]	82,062	77,788 [r]	71,623 [r]	73,846 [3]
Ferrosilicon	145,000	145,000	145,000	147,000 [r]	98,000
Ferrotitanium	-- [r]	-- [r]	-- [r]	-- [r]	--
Silicomanganese[e]	214,000 [r]	214,000 [r]	213,000 [r]	218,000 [r]	138,000
Other	32,897	34,462	33,449	33,500 [e]	33,500
Total	890,000 [r]	800,000 [r]	890,000 [r]	930,000 [r]	770,000
Burma, electric furnace, ferronickel	--	--	--	4,800 [r]	59,000
Canada, electric furnace:[e]					
Ferroniobium (ferrocolumbium)[3]	6,535 [r]	7,018	7,132	7,974	8,485
Ferrosilicon[3]	36,786	31,039	31,979	38,817	35,500
Ferrovanadium	900	900	800	800	800
Total	44,200 [r]	39,000	39,900	47,600	44,800
Chile, electric furnace:[3]					
Ferrochromium	-- [r]	-- [r]	-- [r]	-- [r]	--
Ferromolybdenum	12,485	17,177	15,451	13,072 [r]	14,584
Total	12,485	17,177	15,451	13,072	14,584
China:[e]					
Blast furnace:					
Ferromanganese	350,000	350,000	300,000	300,000	300,000
Other	30,000	--	--	--	--
Electric furnace:					
Ferrochromium	2,400,000	2,700,000	3,040,000	4,001,660 [r, 3]	4,399,600 [3]
Ferromanganese	2,300,000	2,600,000	3,020,000	3,300,000	3,000,000
Ferromolybdenum	90,000	53,000	180,000	200,000	200,000
Ferronickel and high nickel pig iron[3]	900,000	1,280,000	1,400,000	2,510,000	2,470,000
Ferrosilicon	5,300,000	5,400,000	5,760,000	6,000,000	5,500,000
Ferrotitanium	5,600	5,000	--	--	--
Silicomanganese	5,840,000	6,700,000	7,400,000	7,700,000	7,900,000
Other	7,600,000	8,000,000	9,200,000	13,900,000	13,000,000
Total, blast and electric furnaces	24,800,000	27,100,000	30,300,000	37,900,000 [r]	36,800,000
Colombia, electric furnace, ferronickel	145,239	103,371	127,509	139,000	133,000
Dominican Republic, electric furnace, ferronickel	--	34,610	38,852	24,049 [r]	--

See footnotes at end of table.

TABLE 8—Continued
FERROALLOYS: WORLD PRODUCTION, BY COUNTRY, FURNACE TYPE, AND ALLOY TYPE[1]

(Metric tons, gross weight)

Country, furnace type, and alloy type[2]	2010	2011	2012	2013	2014[e]
Egypt, electric furnace:[e]					
Ferromanganese	20,000	30,000	30,000	30,000	30,000
Ferrosilicon	50,000 r	50,000 r	50,000 r	50,000 r	50,000
Total	70,000 r	80,000 r	80,000 r	80,000 r	80,000
Finland, electric furnace, ferrochromium	283,000 r	231,000	230,130 r	434,250 r	449,570 3
France, electric furnace:[e]					
Ferromanganese[3]	138,100	130,500	101,000	104,000 r	115,700
Ferrosilicon	32,000	71,500	63,300	49,600	49,600
Silicomanganese[3]	62,400	63,400	68,500 r	64,900 r	64,800
Other	60,000	60,000	60,000	60,000	60,000
Total	293,000 r	325,000 r	293,000 r	279,000 r	290,000
Georgia, electric furnace:[3]					
Ferromanganese	824	195	--	--	--
Silicomanganese	203,464	242,746	261,075 r	254,115 r	256,677
Total	204,288	242,941	261,075 r	254,115 r	256,677
Germany, electric furnace:[e]					
Ferrochromium	18,300	18,500	17,800	17,500	17,000
Other	9,200	9,985 3	8,248 3	8,200 r	8,200
Total	27,500	28,500	26,000	25,700 r	25,200
Greece, electric furnace, ferronickel[3]	69,596	93,905	96,435	87,100	95,305
Iceland, electric furnace, ferrosilicon	114,231	120,076	131,818 r	125,204 r	115,000
India, electric furnace:[e, 6]					
Ferroaluminum	7,000	7,000	7,100	5,400 r	5,500
Ferroboron	95	98	95	26 r	21 3
Ferrochromium[5]	850,000	830,000 r	800,000 r	800,000 r	915,890 3
Ferrochromium silicon	10,000	11,000	11,000	11,000	11,000
Ferromanganese[3]	413,000	420,000	493,300 r	564,400 r	666,100
Ferromolybdenum	3,000	3,200	3,100	1,200 r	1,200
Ferronickel magnesium	227 3	253 3	270	473 3	473
Ferrosilicomagnesium	17,000	18,000	18,000	21,000 r	22,000
Ferrosilicon	115,164 3	127,092 3	130,000	132,000	132,000
Ferrosilicozirconium	150	170	180	-- r	2
Ferrotitanium	2,200	2,300	2,400	800 r	800
Ferrotungsten	150 3	225 3	-- r	-- r	--
Ferrovanadium	1,800	1,850	1,900	879 r, 3	906 3
Silicomanganese[3]	1,170,000	1,433,600	1,552,600	1,643,200 r	1,740,600
Total	2,590,000	2,850,000 r	3,020,000 r	3,180,000 r	3,500,000
Indonesia, electric furnace:[e]					
Ferromanganese	12,000	12,000	13,000	12,000 r	20,000
Ferronickel[7]	93,300	98,200	91,600	91,000	84,000
Silicomanganese	8,000	8,000	9,000	8,000 r	17,000 3
Total	113,000	118,000	114,000	111,000 r	121,000
Italy, electric furnace:[e]					
Ferromanganese	17,000 3	18,000 3	18,000	7,200 r, 3	7,200 3
Ferrosilicon	-- r	-- r	-- r	-- r	--
Silicomanganese	22,900 3	24,600 3	42,000	-- r, 3	-- 3
Other, excluding calcium-silicon	10,000	10,000	10,000	10,000	10,000
Total	49,900 r	52,600 r	70,000 r	17,200 r	17,200
Japan, electric furnace:					
Ferrochromium	16,208	17,217	19,392	21,700 r	20,000
Ferromanganese	453,265	456,798	436,171	460,936 r	463,345 3
Ferromolybdenum	4,615	5,167	4,616	4,550 r	4,500
Ferronickel	348,420	279,944	371,913	402,768 r	379,291 3
Ferrovanadium	4,190	3,980	4,403	4,433 r	4,400
Silicomanganese	49,865	49,798	52,287	24,741 r	25,000
Other	16,374	20,913	19,364	19,394 r	19,300
Total	892,937	833,817	908,146	938,522 r	916,000

See footnotes at end of table.

TABLE 8—Continued
FERROALLOYS: WORLD PRODUCTION, BY COUNTRY, FURNACE TYPE, AND ALLOY TYPE[1]

(Metric tons, gross weight)

Country, furnace type, and alloy type[2]	2010	2011	2012	2013	2014[e]
Kazakhstan, electric furnace:					
Ferrochromium	1,311,302	1,289,917	1,305,566	1,036,680 [r]	1,200,000
Ferrochromium silicon	159,765	143,296	164,853	165,195 [r]	158,826 [3]
Ferrosilicon	4,813	1,683	494	472	470
Silicomanganese	224,627	232,039	251,530 [r]	203,986 [r]	200,802 [3]
Other	1,283	1,754	1,845	81 [r]	3,470
Total	1,701,790	1,668,689	1,724,288 [r]	1,406,414 [r]	1,560,000
Korea, Republic of, electric furnace:					
Ferromanganese	286,259	355,047	364,800	349,700 [r]	306,000
Ferronickel	54,022	50,069	54,933	74,007	78,900
Silicomanganese	120,779	195,650	184,700	247,700 [r]	240,000
Total	461,060	600,766	604,433	671,407 [r]	625,000
Kosovo, ferronickel	30,400	27,948	16,044	27,512	32,700
Macedonia, electric furnace:					
Ferronickel	62,700	75,200	83,700	87,500 [r]	82,100
Ferrosilicon	30,044	56,167	42,402	72,279	73,014 [3]
Silicomanganese	36,705	50,756	14,179	--	-- [3]
Total	129,449	182,123	140,281	159,779 [r]	155,114
Mexico, electric furnace:[3]					
Ferromanganese	81,019	73,684	61,939	62,000	67,500
Silicomanganese	134,470	139,044	161,336	160,000	164,900
Total	215,489	212,728	223,275	222,000	232,400
New Caledonia, electric furnace, ferronickel	165,506	169,513	184,125	175,451	231,000
Norway, electric furnace:[e]					
Ferromanganese[3]	297,300	337,900	325,900	306,700 [r]	312,400
Ferrosilicon	230,000 [r]	230,000 [r, 3]	250,000	285,000	285,000
Silicomanganese[3]	248,700	266,000	271,400	301,400 [r]	314,300
Total	776,000 [r]	834,000 [r]	847,000	893,000 [r]	912,000
Oman, electric furnace, ferrochromium	--	--	--	20,630	47,810 [3]
Peru, electric furnace, ferrosilicon	-- [r]	-- [r]	-- [r]	-- [r]	--
Poland:					
Blast furnace, ferromanganese[e]	800 [3]	800	800	760	760
Electric furnace:					
Ferrosilicon	53,206	72,668	78,115	75,500	75,500
Silicomanganese	100	400	200	190	190
Other	200	300	300	280	300
Total, blast and electric furnaces	54,306	74,200	79,400	76,700	76,800
Romania, electric furnace:					
Ferrochromium	14,000	--	--	--	--
Silicomanganese	20,000	31,000	17,000	--	--
Total	34,000	31,000	17,000	--	--
Russia:					
Blast furnace:					
Ferromanganese[3]	174,800 [r]	148,100 [r]	160,800 [r]	181,400 [r]	186,000
Ferrophosphorus	3,600	3,600	3,600	3,600	3,600
Spiegeleisen	5,500	6,000	6,000	6,000	6,000
Electric furnace:					
Ferrochromium	607,570 [r]	565,900 [r]	546,360 [r]	487,810 [r]	500,000
Ferrochromium silicon	102,120 [r]	49,740 [r]	57,450 [r]	58,130 [r]	58,000
Ferronickel, high-nickel	19,763	19,881	11,529	--	--
Ferronickel, other[e, 7]	14,600	14,700	8,520	10,000 [r]	13,000
Ferroniobium (ferrocolumbium)	700 [r]	700 [r]	700 [r]	600 [r]	600
Ferrosilicon[3]	920,440 [r]	1,026,170 [r]	1,036,930 [r]	1,012,740 [r]	1,002,000
Ferrotitanium	7,000 [r]	7,000 [r]	7,500 [r]	8,000 [r]	8,000
Ferrovanadium	13,057	13,500	12,500	12,500	12,500
Silicomanganese[3]	148,470 [r]	149,850 [r]	164,350 [r]	169,160 [r]	174,000
Other[e]	8,000 [r]	9,000 [r]	8,000 [r]	8,500 [r]	8,500
Total, blast and electric furnaces[e]	2,030,000 [r]	2,010,000 [r]	2,020,000 [r]	1,960,000 [r]	1,970,000

See footnotes at end of table.

TABLE 8—Continued
FERROALLOYS: WORLD PRODUCTION, BY COUNTRY, FURNACE TYPE, AND ALLOY TYPE[1]

(Metric tons, gross weight)

Country, furnace type, and alloy type[2]	2010	2011	2012	2013	2014[e]
Saudi Arabia, electric furnace:					
Ferromanganese	26,000	26,000	26,000 [e]	25,000	25,000 [3]
Silicomanganese	61,300	96,000	80,000 [e]	80,000	80,000 [3]
Other[e]	90,000	90,000	90,000	91,000 [r]	91,000
Total[e]	177,000	212,000	196,000	196,000 [r]	196,000
Slovakia, electric furnace:[3]					
Ferromanganese	35,449	18,180	12,862	2,119 [r]	17,554
Ferrosilicon	37,034	38,771	36,869 [r]	41,664 [r]	39,000
Silicomanganese	34,960	25,023	50,089	26,794 [r]	29,643
Total	107,443	81,974	99,820 [r]	70,577 [r]	86,200
South Africa, electric furnace:					
Ferrochromium[8]	3,607,132	3,425,911	3,063,257	3,400,000 [r]	3,601,050 [3]
Ferromanganese	460,200 [r]	534,900 [r]	509,800 [r]	558,300 [r]	552,800 [3]
Ferronickel, high-nickel[e]	1,040	933	950	820	900
Ferrosilicon	127,700	126,200	83,000	78,400 [r]	78,400
Ferrovanadium[e]	19,000	19,000	18,000	18,000	19,000
Silicomanganese	274,400	313,600	148,800	133,600 [r]	228,100 [3]
Total	4,490,000 [r]	4,420,000 [r]	3,820,000 [r]	4,190,000 [r]	4,480,000
Spain, electric furnace:[e]					
Ferromanganese[3]	102,200	92,100	80,200	106,900 [r]	227,000
Ferrosilicon	76,300	69,700	68,600	80,500	80,500
Silicomanganese[3]	134,200	142,300	148,100	136,100 [r]	128,700
Total	313,000	304,000	297,000	324,000 [r]	436,000
Sweden, electric furnace, ferrochromium	64,800 [r]	81,500 [r]	39,850 [r]	49,000 [r]	67,000
Turkey, electric furnace:[e]					
Ferrochromium	50,000	40,000	40,000	35,000	35,000
Ferrosilicon	1,000 [r]	2,000 [r]	2,000 [r]	2,000 [r]	2,000
Total	51,000 [r]	42,000 [r]	42,000 [r]	37,000 [r]	37,000
Ukraine, electric furnace:					
Ferromanganese	280,100	180,500	163,921 [r]	88,626 [r]	103,000
Ferronickel	102,940	89,903	119,652	121,586	110,000
Ferrosilicon	195,500	150,900	119,400	147,700	142,200 [3]
Silicomanganese	940,400	843,500	823,131 [r]	724,892 [r]	840,900 [3]
Other	28,500 [e]	28,500 [e]	22,115 [r]	15,908 [r]	16,000
Total	1,550,000	1,290,000	1,248,219 [r]	1,098,712 [r]	1,210,000
United States, electric furnace:					
Ferromanganese	W	W	W	W	W
Ferrosilicon[9]	246,000 [r]	W	W	W	W
Total	246,000	W	W	W	W
Venezuela, electric furnace:					
Ferromanganese	5,300	12,000	9,000	9,000	8,000 [3]
Ferronickel[e]	45,200	51,800	31,300	24,000 [r]	23,300
Ferrosilicon[e]	76,800 [r]	70,000 [r]	72,300	74,300	74,300
Silicomanganese	16,500 [3]	24,000	57,600 [r, 3]	58,800 [r, 3]	18,000
Total	144,000 [r]	158,000 [r]	170,000 [r]	166,000 [r]	124,000
Zimbabwe, electric furnace, ferrochromium	146,000	140,000	137,534	150,060 [r]	214,110 [3]
Grand total	44,400,000	46,800,000 [r]	49,600,000 [r]	57,700,000 [r]	57,600,000
Of which:					
Blast furnace:					
Ferromanganese	526,000 [r]	499,000 [r]	462,000 [r]	482,000 [r]	487,000
Spiegeleisen	5,500	6,000	6,000	6,000	6,000
Other, including ferrophosphorus	33,600	3,600	3,600	3,600	3,600
Total, blast furnace	565,000	509,000	471,000	492,000	496,000
Electric furnace:					
Ferrochromium	9,620,000 [r]	9,510,000 [r]	9,430,000 [r]	10,700,000 [r]	11,700,000
Ferrochromium silicon	288,000 [r]	212,000 [r]	243,000 [r]	245,000 [r]	238,000
Ferromanganese	5,160,000 [r]	5,560,000 [r]	5,900,000 [r]	6,260,000 [r]	6,210,000
Ferromolybdenum	115,000	84,100	209,000	225,000 [r]	227,000

See footnotes at end of table.

TABLE 8—Continued
FERROALLOYS: WORLD PRODUCTION, BY COUNTRY, FURNACE TYPE, AND ALLOY TYPE[1]

(Metric tons, gross weight)

Country, furnace type, and alloy type[2]	2010	2011	2012	2013	2014[e]
Grand total—Continued	44,400,000	46,800,000 [r]	49,600,000 [r]	57,700,000 [r]	57,600,000
Of which—Continued:					
Electric furnace—Continued:					
Ferronickel	2,090,000	2,480,000 [r]	2,790,000 [r]	3,970,000 [r]	3,940,000
Ferroniobium (ferrocolumbium)	88,100 [r]	89,800 [r]	85,600 [r]	80,200 [r]	82,900
Ferrosilicon[9]	7,910,000 [r]	7,900,000 [r]	8,220,000	8,540,000 [r]	7,960,000
Ferrovanadium[e]	38,900	39,200	37,600	36,600 [r]	37,600
Silicomanganese	10,100,000	11,400,000	12,000,000 [r]	12,300,000 [r]	12,700,000
Other[10]	8,450,000	9,040,000 [r]	10,200,000	14,900,000 [r]	14,000,000
Total, electric furnace	43,900,000	46,300,000	49,100,000	57,200,000	57,100,000

[e]Estimated. [r]Revised. W Withheld to avoid disclosing company proprietary data; not included in "Total." -- Zero.

[1]Grand totals, U.S. data, and estimated data are rounded to no more than three significant digits; may not add to totals shown. Includes data available through February 19, 2016.

[2]To the extent possible, ferroalloy production of each country shown has been separated according to the furnace from which production is obtained; production derived from metallothermic operation is included with electric furnace production. Ferroalloys may be produced in other countries, but production information is inadequate for the formulation of estimates of output levels.

[3]Reported figure.

[4]Country was a net importer of ferrosilicon.

[5]May include charge chrome, ferrochromium silicon, or high- and low-carbon ferrochromium.

[6]Reported on a fiscal year basis, which is from April 1 to March 31.

[7]Includes ferronickel chromium, nickel pig iron, or nickel-resist cast iron.

[8]Net exports.

[9]For 2010, "United States, ferrosilicon" is included in "Grand total, ferrosilicon", but for 2011–14 "United States, ferrosilicon" is included in "Grand total, other."

[10]May include ferroaluminum, ferroboron, ferrosilicomagnesium, ferrosilicozirconium, ferrotitanium, and ferrotungsten.