



2015 Minerals Yearbook

SLAG—IRON AND STEEL [ADVANCE RELEASE]

SLAG—IRON AND STEEL

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Total sales of iron and steel slags increased by 7% in 2015, to an estimated 17.7 million metric tons (Mt); this followed a 7% increase in 2014. The value of sales in 2015 was about \$345 million, up by nearly 10% (table 1).

Iron and steel (or ferrous) slags are silicate melts that result from the addition of slagging agents and fluxes (chiefly limestone or dolomite and silica sand) to blast furnaces and steel furnaces to remove impurities from iron ore, steel scrap, and other ferrous feeds. The molten slag floats on top of the molten crude iron or steel and is tapped from the furnace separately from the liquid metal. Following cooling by various means to solid form, the slag is processed and may then be stockpiled for eventual sale or, in some cases, returned to the furnace. Processed slags have much lower unit values than do iron and steel (metal); accordingly, iron and steel (steel) companies generally contract with outside slag-processing companies to cool the slag and remove it. Typically, the processing company receives the slag for free, crushes it to various marketable sizes, uses screens and magnetic separators to recover entrained metal from the slag (metal to be returned to the furnace for a low charge), sells the slag on the open market, and may pay a small percentage of the net slag sales revenues or profits to the steel company. At a number of sites, some slag is returned to the furnaces for use as flux and as a supplemental source of iron but, despite having a value, this return flow is not always included in the reported sales tonnages.

A listing of slag processors, processing sites, slag types, and the steel companies serviced is provided in table 4. Apparent duplication at some sites stems from the transfer of processing contracts to other companies during the year and because integrated iron and steel plants may have processing or marketing contracts with various companies for the different types of slag produced at the plant. In some cases, the slag is cooled by one company but is then further processed or marketed by another company or at another site.

Legislation and Government Programs

Most slag is sold into the construction sector, and the market for slag is influenced by Federal and State programs that affect construction spending and those that promote the use of “alternative” raw materials in construction. Likewise, the slag market is affected by policies that influence the availability or promote the use of competing materials. Slags can substitute directly or indirectly for virgin materials in certain applications and are thus considered to be sustainable raw materials. The main examples of such substitution are for natural stone aggregates in concrete and for natural raw materials in cement manufacture. In the specific case of ground granulated blast furnace slag (GGBFS), the material is a supplementary cementitious material (SCM) that can partially substitute for clinker in finished cement or for some of the portland cement in concrete. In clinker (cement) manufacture, substitution of slags for natural raw materials can reduce the unit consumption

of fuel and limestone in the kiln, which then reduces the overall and unit emissions of certain pollutants, most notably carbon dioxide. Use of granulated blast furnace slag in the finish mill [either introduced as GGBFS, or unground material (GBFS)] allows more finished cement to be made from the same amount of clinker.

The 2010 final rule within the National Emissions Standards for Hazardous Air Pollutants (NESHAP) took effect on September 9, 2015, and set very low limits for cement plant emissions of mercury, total hydrocarbons, hydrochloric acid, and particulates (U.S. Environmental Protection Agency, 2013). A number of U.S. cement plants may find it uneconomic to install the monitoring and emissions abatement equipment or enact abatement procedures to comply with the NESHAP limits for the plants overall or for specific, currently idle kilns (commonly older, or of older technology), and such plants or specific kilns may thus be closed or used only sparingly in the future. The resulting loss of cement production capacity has the potential to increase demand for alternative SCMs, such as GGBFS and fly ash. The NESHAP likely would make fly ash (typically high in mercury) less attractive as an alternative raw material for clinker manufacture and thus might increase demand for slag for this purpose.

Production

The amount of ferrous slag tapped from the furnaces is not routinely measured and not all of the slag formed is tapped during a heat; accordingly, data on annual production of slag are generally unavailable. Production levels can, however, be estimated broadly based on typical slag-to-metal production ratios, which in turn are related to the chemistry of the ferrous feeds to the furnaces. For typical iron ore grades (60% to 66% iron), a blast furnace normally will produce about 0.25 to 0.30 metric ton (t) of slag per ton of crude or pig iron produced. For ores of lower than average grade, the slag output will be higher (in some cases, as much as 1.0 to 1.2 t of slag per ton of crude iron). Steel furnaces typically produce about 0.2 t of slag per ton of crude steel, but up to 50% of this melt is entrained metal, much of which would likely be recovered during slag processing and returned to the furnace. The amount of marketable steel slag remaining after entrained metal removal is thus usually equivalent to about 10% to 15% of the crude steel output. Using these ratios and data for U.S. and world iron and steel production from the World Steel Association (2016, p. 1–2, 91–92), domestic blast furnace slag production in 2015 was estimated to be in the range of about 6 to 8 Mt, and world output was 289 to 347 Mt. Steel slag (after metal removal) output by U.S. furnaces was estimated to be in the range of 8 to 12 Mt, and world output of steel slag, 162 to 243 Mt.

The main determinant of the commercial uses of ferrous slag is the method by which the slag is cooled. Blast furnace slags are cooled to three main product types—air-cooled, granulated,

and pelletized (or expanded). Air-cooled blast furnace slag results from allowing the molten slag to cool relatively slowly under ambient conditions; final cooling can be accelerated with a water spray. Although commonly having a vesicular texture with closed pores, air-cooled slag is hard and dense and is especially suitable for use as construction aggregates. To make GBFS, molten slag is quenched in water to form sand-sized particles of glass. The disordered structure of this glass gives the material inherent moderate (“latent”) hydraulic cementitious properties when the slag is finely ground into GGBFS, and the cementitious properties become strong if the GGBFS accesses free lime. In concrete with GGBFS in the mix, hydration of portland cement releases the lime needed to fully activate the slag. Concretes incorporating GGBFS generally develop strength more slowly than concretes that contain only portland cement but can have similar or even superior long-term strength, release less heat during hydration, generally exhibit improved resistance to chemical attack, and have reduced permeability. Pelletized or expanded slag is cooled through a water jet, which leads to rapid steam generation and the development of innumerable vesicles within the slag, which itself is glassy. The vesicles reduce the overall density of the slag and allow for good mechanical binding with hydraulic cement paste. This slag type is most commonly used as a lightweight aggregate but, if very finely ground, pelletized slag has cementitious properties similar to those of GGBFS. Blast furnace slag (generally air-cooled) also can be made into mineral wool. To make mineral wool, slag is remelted and then poured through an air stream or jet of steam or other gas to produce a spray of molten droplets; alternatively, the droplets can be formed by passing the melt through a perforated or fast spinning disc. The droplets elongate into long fibers that are collected and layered, and this material is suitable for use as thermal insulation.

Steel furnace slag is cooled similarly to air-cooled blast furnace slag, has similar properties to it, and is used for some of the same purposes. Steel slags containing large amounts of dicalcium silicate are prone to expansion and commonly are cured in piles for several months to allow for the expansion and for leaching out of lime.

Iron and steel slags are also used in environmental applications, such as water filtration, although the data on such uses are incomplete.

Consumption

The data in this report are based on an annual U.S. Geological Survey (USGS) canvass of slag processors and importers and pertain to sales of processed slag rather than the amount of slag produced or processed during the year. In 2015, canvasses were sent to 27 companies, covering 132 processing and (or) importation sites, and at least partial data (some within consolidated responses) were received for 118 sites, accounting for almost 86% of the total slag tonnage listed for 2015 in table 1. Importantly, the reported data included 96% of the GBFS tonnage in the table. In 2014, canvasses to 26 companies, covering 140 sites, yielded data for 129 sites or 93% of the total tonnage for that year. Responses to the USGS canvasses varied greatly in the detail provided and estimates for missing data were made where needed; accordingly, the tonnage data in

table 1 have been rounded to the nearest 0.1 Mt and the value data to the nearest \$1 million. For both years, data on pelletized blast furnace slag have been withheld to avoid disclosing company proprietary information, but the quantities sold were very small. Sales data for granulated slag (mostly GGBFS) in both years miss some material sold by a few importers who as yet do not take part in the USGS canvass. The data in table 1 also do not include the free metal recovered from the slag; this metal is sold separately.

Although the domestic output of crude iron and crude steel determines the approximate output of slag, it has relatively little to do with the subsequent market availability or actual sales of processed slag. Estimates of slag production (given above), or in relative shifts thereof, can significantly differ from total sales of slag in a given year because of a combination of undocumented returns of slag to the furnaces, stockpiling of slag by processors, and the fact that all slag sales are from stockpiles, including material in old piles (slag banks) from iron and steel plants long-since closed. For example, in 2015, U.S. production of crude iron decreased by about 13%, and production of crude steel decreased by nearly 11% (World Steel Association, 2016), but overall U.S. sales by processors of blast furnace slag increased by an estimated 4.9%, and sales of steel slag increased by an estimated 8.3% (table 1). The steel slag sales included 1.5 Mt (significantly unchanged from those in 2014) of documented returns to furnaces but, as noted earlier, such tend to be underreported.

Together, sales in 2015 of air-cooled blast furnace slag and steel furnace slag again accounted for about 85% of total sales tonnages (table 1). These two types of slag are mainly used as general construction aggregates (table 3). Because of their low unit values (table 2), these slags generally can only compete with natural aggregates in market regions close to active iron and steel furnaces or to slag banks so as to avoid long-distance transportation charges. Because of transportation costs, the common existence of long-term sales contracts, more restricted geographic availability, and tendencies by processors to stockpile slag to allow bidding on large contracts, trends in external (not returned to furnaces) sales volumes for slag can sometimes differ significantly from those for competing natural aggregates and for portland and blended cement (a proxy for concrete). In 2015, the overall 7.1% increase in sales of air-cooled and steel slags was somewhat higher than that (USGS data) of sales of crushed stone (up by 5.9%), but was significantly higher than the 3.8% increase in the sales of portland and blended cement and the 4.4% increase in sales of sand and gravel.

Potential expansion problems with steel slag reduce its applicability for uses that require maintenance of a fixed volume (for example, ready-mixed concrete). Both air-cooled and steel slags can be used as a raw material for cement (clinker) manufacture, but steel slag has proven to be especially suitable for this use. Relative changes, especially small percentages, in sales by type of use are difficult to evaluate because the data incorporate estimates (more so in 2015 than in recent previous years) and most of the plant-level data reported in recent years have revealed only the dominant use(s) for the slag or have combined the uses as “Other,” leaving the less common uses

understated. Among the identified uses for air-cooled blast furnace slag, that for ready-mixed concrete represented an apparent decrease of about 16% and that for fill a decrease of about 17%. Similarly, steel slag sales for fill decreased by nearly 15%. These trends are in contrast to significantly higher spending levels in most construction sectors in 2015. However, the nearly 8% apparent increase in sales of air-cooled blast furnace slag for asphaltic concrete and the apparent 17% increase in sales for road bases and surfaces are similar to a 7% increase in steel slag sales for asphaltic concrete and of 10% for road bases and surfaces. These changes are in general agreement with increased spending for roads and highways. Although some of the apparent inconsistency may reflect a higher proportion of estimates for these slag types in 2015, it also is likely that increased construction spending may have favored slag sales into the more expensive (unit price) usage categories.

Sales of granulated slag (all reported as GGBFS in 2014–15) increased by nearly 0.1 Mt (not visible at the scale of rounding in table 1). Although this slag type only accounted for about 15% of the total ferrous slag tonnage in table 1, it accounted for about 84% of the total value of blast furnace slag sales in 2015 and 72% of total slag sales value (both being similar to the contribution in 2014); the value contribution reflects the high unit price for this material in its primary role as an SCM. Actual sales of GGBFS in some years have been higher than those shown in table 1 because of some imports being missed by the USGS canvass; however, it is unclear if this was significant in 2014–15. Although the USGS slag survey does not distinguish between GGBFS sold for cementitious use to cement companies from that sold to concrete companies for the same use, data from USGS canvasses of cement producers continue to indicate that the major component of GGBFS sales are to the concrete industry. An alternative source of data for sales of GGBFS, under the designation “slag cement,” is the Slag Cement Association (SCA), whose members account for much of the country’s GGBFS output and sales. For 2015, the SCA reported sales of slag cement of 2.432 Mt, but this tonnage excluded the content of GGBFS in blended hydraulic cements (Slag Cement Association, 2017) and is thus not strictly comparable to the datum in table 1; data published by SCA for 2014 and earlier years have been similar to those presented by the USGS.

Prices

Price data continued to be lacking for many slag canvasses sent to the USGS, or, for a number of forms, the USGS was provided with an average unit price on the total sales only and not on the sales breakouts by type of use. Accordingly, the data in table 2 include many estimates or assignments of reported averages to all usage types, but have been left unrounded to better show the range of reported values. Small unit differences (of less than \$1 per metric ton) are likely of no statistical significance. Unit prices did not change significantly for air-cooled blast furnace slag, although the reported price range narrowed. Steel furnace slag prices appear to have increased modestly, but the increase in the average price appears to reflect, in the main, fewer tons reported as sold at the very lowest or nominal prices. Market factors affecting the prices of these two

slag types include local competition from natural aggregates, the overall level of construction activity (particularly for roads), and the existence of long-term supply contracts. Air-cooled and steel furnace slags sold for uses other than aggregates can command higher prices than slags sold as aggregates. Pelletized slag (not shown in tables 1–3) can sell for prices well above those for air-cooled slag. Unit prices for GGBFS (shown in table 2 only for cementitious uses) increased by about 4%; the relatively high prices reported reflect the dominant use of GGBFS as a partial substitute for portland cement in blended cements and, especially, in concrete. For many years, GGBFS sold for unit prices that were 20% to 25% lower than those for gray portland cement, but more recently the price difference has been more in the range of 10% to 15% lower owing to relative stability of GGBFS prices compared to those for portland cement.

Foreign Trade

A significant fraction of the granulated slag consumed in the United States is imported GBFS (for grinding at domestic facilities) or GGBFS; both forms of the slag are covered by the dedicated Harmonized Tariff Schedule of the United States (HTS) code 2618.00. Import data within HTS 2618.00 commonly contain entries that, based on excessively high or low unit dollar values, are either slags of other metallurgical industries (especially copper slag) or unrelated materials altogether (such as silica fume, fly ash pozzolan, cenospheres from fly ash, other industrial residues, or metal concentrates). Trade data from the U.S. Census Bureau showed total imports under HTS 2618.00 of 1.69 Mt, but only about 1.36 Mt of this appeared to be GBFS or GGBFS, based on unit values, and this total becomes 1.40 Mt if likely granulated slag imports within HTS 2619.00 (which mainly includes various metallic residues of high unit value) are included. The major sources of the apparent granulated slag in 2015 were, in descending order, Japan, Canada, Spain, Germany (including material listed as from the Netherlands), and China. The equivalent likely granulated slag imports in 2014 were 1.40 Mt on HTS 2618.00 and 0.21 Mt on HTS 2619.00. Much of the material excluded in the adjusted totals in both years was inexpensive copper slag from Japan imported for use mainly as sand-blasting grit.

Import data from the United Business Media Ltd.’s PIERS trade database has, for many years, shown higher totals for likely granulated slag imports than those of the U.S. Census data. For 2015, the PIERS data for HTS 2618.00 had imports of likely granulated blast furnace slag of about 1.65 Mt, with much of the difference being material into Florida. The unit pricing assigned by PIERS is not useful in fully distinguishing between granulated slag and other materials, but most of the material that was presumed not to be granulated slag consisted of small shipments of just a few tons each. PIERS data for imports under HTS 2619.00 could not be definitively identified.

After exclusion of about 2,500 t of very high unit value materials, U.S. Census Bureau exports of apparent granulated slag under HTS 2618.00 totaled only about 28,400 t in 2015, with an additional 500 t (after exclusion of 20,600 t) under HTS 2619.00; exports of likely granulated slag under these two tariff codes totaled about 40,500 t in 2014.

Outlook

Most ferrous slag will continue to be sold for use as construction aggregate. Demand for slag for more specialized uses, such as raw materials for clinker and glass manufacture and as media for water treatment and filtration, has significant growth potential, but growth will be difficult to verify given that the data on such sales are likely to remain incomplete. The domestic supply of blast furnace slag is limited by the fact several blast furnaces have closed in recent years; only 21 were operating in 2015 and 1 of these had closed by yearend. The remaining blast furnaces' long-term economic viability is in doubt, and no prospects for the construction of new furnaces were likely. Cement and concrete companies are trying to reduce their associated overall and unit emissions of carbon dioxide, and this will likely lead to an increase in demand for GGBFS (and other SCMs) in cement and concrete to reduce the clinker content; the quality of the concrete is generally improved by use of SCMs as well. At yearend 2015, only two U.S. blast furnaces were equipped with granulation cooling, and although some others were being evaluated for installation of granulators, the granulation equipment is very expensive and requires that a grinding plant for the slag also be available or constructed. Installation of granulators would thus only make economic sense for blast furnaces that are expected to remain in production for many years. Given this severe constraint on the domestic output of GBFS, higher demand for GGBFS most likely will be met by increased slag imports, but the availability of imported granulated slag itself faces constraints from increasing demand for GGBFS in many countries overseas.

The long-term domestic supply of basic oxygen furnace (BOF) steel slag faces the same constraints as for blast furnace slag, except to the degree to which BOFs also process some scrap as part of their ferrous feeds. Slag from U.S. electric arc steel furnaces is in more assured supply because these furnaces are numerous, most of them are not part of integrated iron and steel complexes, and the furnaces rely on scrap for all or most of their ferrous feeds. In the production of portland cement clinker, carbon dioxide emissions can be reduced through the

substitution of noncarbonate calcium-rich raw materials for some of the limestone that is the traditional major raw material for this manufacture. Ferrous slags (especially steel furnace slags) have proven to be highly suitable for such substitution but, in this use, commonly compete with fly ash and bottom ash from coal-fired power plants. Demand for ferrous slag for clinker manufacture could increase if the cement industry reduces its consumption of fly ash to meet more stringent NESHAP limits on mercury emissions, especially if the cement plants are unable to substitute bottom ash for fly ash. Closure of U.S. coal-fired powerplants, or their conversion to natural gas, is already constraining the supply of coal combustion ashes in many market regions.

References Cited

- Slag Cement Association 2017, U.S. slag cement shipments: Farmington Hills, MI, Slag Cement Association. (Accessed August 31, 2017, at <https://www.slagcement.org/resources/shipments.aspx>.)
- U.S. Environmental Protection Agency, 2013, National emissions standards for hazardous air pollutants from the portland cement manufacturing industry and standards of performance for portland cement plants: Federal Register, 40 CFR Parts 60 and 63, v. 78, no. 29, February 12, p. 10006–10054.
- World Steel Association, 2016: Steel statistical yearbook 2016: Brussels, Belgium, World Steel Association, 123 p. (Accessed January 6, 2017, at <https://www.worldsteel.org/statistics/statistics-archive/yearbook-archive.html>.)

GENERAL SOURCES OF INFORMATION

U.S. Geological Survey Publications

- Historical Statistics for Mineral and Material Commodities in the United States. Data Series 140.
- Iron and Steel Slag. Ch. in Mineral Commodity Summaries, annual.

Other

- National Slag Association.
- Portland Cement Association.
- Slag Cement Association.

TABLE 1
IRON AND STEEL SLAG SOLD OR USED IN THE UNITED STATES

(Million metric tons and million dollars)

	2014					2015				
	Blast furnace slag ¹			Steel furnace slag	Total iron and steel slag ²	Blast furnace slag ¹			Steel furnace slag	Total iron and steel slag ²
	Air-cooled	Granulated	Total ²			Air-cooled	Granulated	Total ²		
Quantity ^c	5.8	2.7	8.4	8.2	16.6	6.1	2.7	8.8	8.9	17.7
Value ^e	44	231	275	40	315	48	248	296	48	345

^cEstimated.

¹Excludes expanded (pelletized) slag to protect company proprietary data. The quantities are very small (about 0.1 unit or less).

²Data may not add to totals shown because of independent rounding.

TABLE 2
SELLING PRICES FOR IRON AND STEEL SLAG IN THE UNITED STATES¹

(Dollars per metric ton)

Slag type	2014		2015	
	Range	Average	Range	Average
Blast furnace:				
Air-cooled	2.20–20.15	7.62	3.31–13.32	7.87
Granulated ²	79.37–104.72	86.85	78.10–110.23	90.37
Steel furnace	0.06–34.36	4.88	1.65–36.93	5.46

¹Data, although rounded, contain a large component of estimates and some respondents provide values only on their total sales of a slag type, not value by type of use.

Thus, the value ranges shown are likely too restrictive.

²Values are for material reported for use as a cementitious additive in cement or concrete manufacture. No sales of unground material were reported in 2014–15, although such sales certainly took place; the price ranges shown are thus just for ground material.

Sales other than for cementitious use were generally at unit values below the ranges shown.

TABLE 3
SALES OF FERROUS SLAGS IN THE UNITED STATES, BY USE¹

(Percentage of total tons sold)

Use	2014			2015		
	Blast furnace slag ²		Steel furnace slag	Blast furnace slag ²		Steel furnace slag
	Air-cooled	Granulated		Air-cooled	Granulated	
Ready-mixed concrete	9.7	--	(3)	7.7	--	--
Concrete products	1.9	--	--	2.7	--	1.1
Asphaltic concrete	21.4	--	11.9	21.9	--	11.8
Road bases and surfaces	44.7	--	49.7	49.7	--	50.7
Fill	10.2	--	12.6	8.0	--	9.9
Cementitious material	--	99.7	--	--	99.8	--
Clinker raw material	--	--	2.6	--	--	2.9
Miscellaneous ⁴	6.4	0.3	1.2	5.8	0.2	1.3
Other or unspecified ⁵	5.7	--	22.0	4.2	--	22.3

-- Zero.

¹A number of respondents provide breakouts that represent only the dominant use(s) of their slag; accordingly, the minor use categories are likely underreported. The data also incorporate some estimates and thus should be viewed as accurate to no more than two significant figures.

²Excludes expanded or pelletized slag; this material is generally sold as lightweight aggregate.

³Less than 0.05%.

⁴Reported as used for railroad ballast, roofing, mineral wool, or as a soil conditioner.

⁵Includes return to furnaces (likely underreported) and other uses.

TABLE 4
PROCESSORS OF IRON AND STEEL SLAG IN THE UNITED STATES IN 2015

Slag processing company	Plant location	Steel company serviced ^{1,2}	Slag and furnace types ³					
			Blast furnace slag			Steel furnace slag		
			AC	GG	Exp	BOF	OHF	EHF
Alexander Mill Services Inc.	Hollsopple, PA	North American Höganas, Inc.						X
Argos USA Corp.	Tampa, FL	Foreign		X				
Ash Grove Cement Co.	Portland, OR	do.		X				
Barfield Enterprises, Inc.	LaPlace, LA	ArcelorMittal USA						X
BDM Warren Recycling LLC	Warren, OH	Slag pile (former RG Steel LLC)	X			X		
Beaver Valley Slag, Inc.	Aliquippa, PA	Old slag pile site	X			X		X
Beelman Truck Co.	Granite City, IL ⁴	United States Steel Corp.	X					
Beemsterboer Slag Corp.	East Chicago, IN	ArcelorMittal USA ("East side")	X					
Do.	Gary, IN	United States Steel Corp.	X			X		
Blackheart Slag Co.	Muscataine (Montpelier), IA	SSAB Americas						X
CEMEX, Inc.	Miami, FL	Foreign		X				
City Slag LLC	Sharon (Hermitage), PA	Old slag pile site						X
Diproinduca (USA) Ltd	Sparrows Point, MD	Slag pile (former RG Steel LLC)				X		
Dragon Products Co., Inc.	Thomaston, ME	Domestic and foreign		X				
Edw. C. Levy Co.	Butler, IN	Steel Dynamics, Inc.						X
Do.	Columbia City, IN	do.						X
Do.	Crawfordsville, IN	Nucor Corp.						X
Do.	Detroit (Dearborn), MI	AK Steel Corp.	X			X		
Do.	Detroit (Ecorse), MI	United States Steel Corp.	X			X		
Do.	Columbus, MS	Steel Dynamics, Inc.						X
Do.	Canton, OH	The Timken Co.						X
Do.	Delta, OH	North Star Bluescope Steel LLC						X
Do.	Huger, SC	Nucor Corp.						X
Do.	Memphis, TN	do.						X
Do.	Seattle, WA	do.						X
Esroc Corp.	Middlebranch, OH	Miscellaneous domestic and foreign		X				
Do.	Camden, NJ ⁵	Foreign		X				
Fritz Enterprises, Inc.	Fairfield, AL ⁶	United States Steel Corp.	X	X		X		
Do.	Indiana Harbor, IN	ArcelorMittal USA (Indiana Harbor Long Carbon)						X
Do.	Sparrows Point, MD	Slag pile (former RG Steel LLC)	X					
Gerdau Long Steel North America	Jacksonville, FL	Gerdau Long Steel North America						X
Go Green American Recycling, LLC	Mingo Junction, OH	Slag pile (former RG Steel LLC)	X			X		X
Harsco Metals & Minerals	Blytheville (Armored), AR	Nucor-Yamato Steel Co.						X
Do.	Newport, AR	Arkansas Steel Associates, LLC						X
Do.	Pueblo, CO	Evrz Inc. NA						X
Do.	Wilton (Muscatine), IA	SSAB Americas						X
Do.	Pittsboro, IN	Steel Dynamics, Inc.						X
Do.	Ghent, KY ⁷	Gallatin Steel Co.						X
Do.	do.	North American Stainless						X
Do.	Ahoscie (Coffield), NC	Nucor Corp.						X
Do.	Brackenridge, PA	Allegheny Technologies Inc. (ATI)						X
Do.	Butler, PA	AK Steel Corp.						X
Do.	Koppel, PA	TMK IPSCO						X

See footnotes at the end of the table.

TABLE 4—Continued
PROCESSORS OF IRON AND STEEL SLAG IN THE UNITED STATES IN 2015

Slag processing company	Plant location	Steel company serviced ^{1,2}	Slag and furnace types ³															
			Blast furnace slag			Steel furnace slag												
			AC	GG	Exp	BOF	OHF	EAF										
Harsco Metals & Minerals—Continued	Latrobe (Natrona Heights), PA	Allegheny Technologies Inc. (ATI)																
Do.	Midland, PA	do.																
Do.	Steelton, PA	ArcelorMittal USA																
Do.	Midlothian, TX	Gerdau Long Steel North America																
Do.	Geneva (Provo), UT	Old slag pile site	X															
Holcim (US) Inc. ⁸	Birmingham (Fairfield), AL ⁶	United States Steel Corp.				X												
Do.	Camden, NJ ⁵	Foreign				X												
Do.	Gary, IN ⁹	United States Steel Corp.				X												
Lafarge North America Inc. ⁸	South Chicago, IL	ArcelorMittal USA				X												
Do.	East Chicago (Indiana Harbor), IN ¹⁰	do.				X	X											
Do.	Sparrows Point, MD	Domestic and foreign				X												
Do.	Detroit, MI	do.				X												
Do.	Cleveland (Cuyahoga Co.), OH ⁴	ArcelorMittal USA				X												
Do.	Lordstown, OH	Old slag pile site														X		
Do.	West Mifflin (Duquesne), PA	United States Steel Corp. (ET Works)				X												
Do.	Seattle, WA	Foreign					X											
Lehigh Hanson, Inc.	San Francisco, CA	do.				X												
Do.	Cape Canaveral, FL	do.				X												
Do.	Cementon, NY	do.				X												
Do.	Evansville, PA	do.				X												
Mountain Materials, Inc.	Ashland, KY ⁴	AK Steel Corp.					X											
Phoenix Services, LLC	Blytheville, AR	Nucor Corp.																
Do.	Riverdale, IL	ArcelorMittal USA														X		
Do.	Indiana Harbor, East Chicago, IN	do. ("E" and "W" sides)				X										X		
Do.	Burns Harbor, IN	do.				X										X		
Do.	Wilton, IA	Gerdau Long Steel North America																X
Do.	Ghent, KY ⁷	Gallatin Steel Co.																X
Do.	Sparrows Point, MD	Slag pile (former RG Steel LLC)														X		
Do.	Cool Springs/Steubenville, OH	Old slag pile site														X		
Do.	Marion, OH	Nucor Corp.																X
Do.	Johnstown, PA	Old slag pile site					X											
Do.	Latrobe, PA	Latrobe Specialty Steel Co.																X
Do.	Georgetown, SC	ArcelorMittal USA																X
Do.	Vinton (El Paso), TX	do.																X
Do.	Roanoke, VA	Steel Dynamics, Inc.																X
Do.	Weirton, WV	Old slag pile site															X	
Skyway Cement Co. (Eagle Materials)	Gary, IN ⁹	United States Steel Corp.					X											
St. Marys Cement Inc.	Detroit, MI	Foreign					X											
Stein, Inc.	Decatur (Trinity), AL	Nucor Corp.																X
Do.	Alton, IL	Alton Steel Inc.																X
Do.	Granite City, IL ⁴	United States Steel Corp.				X												X
Do.	Sterling, IL	Sterling Steel Co., LLC																X

See footnotes at end of table.

TABLE 4—Continued
PROCESSORS OF IRON AND STEEL SLAG IN THE UNITED STATES IN 2015

Slag processing company	Plant location	Steel company serviced ^{1,2}	Slag and furnace types ³							
			Blast furnace slag			Steel furnace slag				
			AC	GG	Exp	BOF	OHF	EAF		
Stein, Inc.—Continued	Ashland, KY ⁴	AK Steel Corp.	X				X			
Do.	Canton, OH	Republic Engineered Products, Inc.								X
Do.	Cleveland, OH ⁴	ArcelorMittal USA	X				X			
Do.	Lorain, OH	Republic Engineered Products, Inc.	X				X			X
Do.	Mansfield, OH	AK Steel Corp.					X			
Do.	Warren, OH	Warren Steel Holdings LLC								X
Do.	Coatesville, PA	ArcelorMittal USA								X
Tervita Corp.	Rancho Cucamonga, CA	Gerdau Long Steel North America								X
Tube City IMS, LLC	Axis, AL	SSAB North America								X
Do.	Birmingham, AL	Nucor Corp.								X
Do.	Calvert, AL	Outokumpu Stainless USA, LLC								X
Do.	Tuscaloosa, AL	Nucor Corp.								X
Do.	Mesa, AZ	CMC Steel								X
Do.	Fort Smith, AR	Gerdau Special Steel North America								X
Do.	Cartersville, GA	Gerdau Long Steel North America								X
Do.	Kankakee, IL	Nucor Corp.								X
Do.	Peoria, IL	Keystone Steel & Wire Co.								X
Do.	Gary, IN	United States Steel Corp.							X	
Do.	Portage, IN	NLMK Indiana								X
Do.	Jackson, MI	Gerdau Special Steel North America								X
Do.	Monroe, MI	do.								X
Do.	St. Paul, MN	Gerdau Long Steel North America								X
Do.	Jackson, MS	Nucor Corp.								X
Do.	Charlotte, NC	Gerdau Long Steel North America								X
Do.	Norfolk, NE	Nucor Corp.								X
Do.	Sayreville, NJ	Gerdau Long Steel North America								X
Do.	Auburn, NY	Nucor Corp.								X
Do.	Middletown, OH	AK Steel Corp.	X							X
Do.	Youngstown, OH	Vallourec Star, LP (ex-V&M Star, LP)								X
Do.	McMinnville, OR	Cascade Steel Rolling Mills, Inc.								X
Do.	Braddock, PA	United States Steel Corp.							X	
Do.	Bridgeville, PA	Universal Stainless & Alloy Products, Inc.								X
Do.	New Castle, PA	Ellwood Quality Steels Co.								X
Do.	Park Hill (Johnstown), PA	Old slag pile site						X		X
Do.	Pricedale, PA	do.						X		X
Do.	Reading, PA	Carpenter Technology Corp.								X
Do.	Cayce, SC	CMC Steel								X
Do.	Darlington, SC	Nucor Corp.								X
Do.	Gallatin, TN	Hoegaens Corp.								X
Do.	Jackson, TN	Gerdau Long Steel North America								X
Do.	Knoxville, TN	do.								X
Do.	Beaumont, TX	do.								X
Do.	Jewett, TX	Nucor Corp.								X

See footnotes at end of table.

TABLE 4—Continued
PROCESSORS OF IRON AND STEEL SLAG IN THE UNITED STATES IN 2015

Slag processing company	Plant location	Steel company serviced ^{1,2}	Slag and furnace types ³																
			Blast furnace slag			Steel furnace slag													
			AC	GG	Exp	BOF	OHF	EAF											
Tube City IMS, LLC—Continued	Lone Star, TX	United States Steel Corp.																	
Do.	Longview, TX	Joy Global, Inc.																	
Do.	Seguin, TX	CMC Steel Group																	
Do.	Plymouth, UT	Nucor Corp.																	
Do.	Petersburg, VA	Gerdaul Long Steel North America																	
Do.	Saukville, WI	Charter Steel																	
Do., do. Ditto.																			

¹Currently operating iron and (or) steel company. Company is not shown for most old slag pile sites.

²“Foreign” refers to the fact that the facility imports unground granulated blast furnace slag and grinds it onsite to make ground granulated blast furnace slag—commonly now referred to as “slag cement.” “Domestic” implies grinding of slag sourced from the domestic market.

³Blast furnace slag type abbreviations: AC = air-cooled; GG = granulated; Exp = expanded. Steel furnace slag types: BOF = basic oxygen furnace; OHF = open hearth furnace; EAF = electric arc furnace. ⁴For the air-cooled slag, Stein, Inc. was responsible for the cooling, but the processing and marketing were handled by Beelman Truck Co. (Granite City, IL), Lafarge North America Inc. (Cleveland, OH), or Mountain Materials, Inc. (Ashland, KY).

⁵The Camden, NJ, grinding plant was sold to Essroc Corp. in July 2015 during the merger of Holcim (US) Inc. and Lafarge North America Inc.

⁶For granulated slag, Fritz Enterprises, Inc. operated the granulator but Holcim (US) Inc. owned the apparatus and marketed the slag. Owing to the permanent closure of the United States Steel Corp. blast furnace early in 2015, slag supplies ceased and subsequent sales of ground granulated slag ceased, and the grinding plant closed by year-end.

⁷The Gallatin Steel Co. processing contract at Ghent, KY, was transferred to Phoenix Services, LLC, in October 2015.

⁸In July 2015, with the merger of their parent companies, Holcim (US) Inc. and Lafarge North America Inc. were merged to become LafargeHolcim, although the premerger company names were retained in the United States for certain business purposes.

⁹The Gary, IN, granulator and downstream Chicago, IL, grinding plant were sold to Eagle Materials Corp. in July 2015 during the merger of Holcim (US) Inc. and Lafarge North America Inc. A subsidiary, Skyway Cement Co., was then formed by Eagle to operate the facilities and market the slag.

¹⁰Lafarge North America Inc. ground some of the granulated slag from East Chicago, IN, at various of its cement plants located elsewhere.