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SLAG—IRON AND STEEL

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SLAG—IRON AND STEEL

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Apparent sales of iron and steel slags in the United States in 2006 totaled about 20.3 million metric tons (Mt), a decrease of about 2% from sales in 2005. Overall, the value of slag sales in 2006 was about $406 million, up by about 11% (table 1).

Iron and steel slags are formed through the addition of slagging agents (chiefly limestone or dolomite) and/or fluxing materials to blast furnaces and steel furnaces to strip the impurities from iron ore, steel scrap, and other ferrous feeds. The slag forms as a silicate melt that floats on top of the molten crude iron or steel and is tapped from the furnace separately from the liquid metal. After cooling to solid form, the slag is processed and may then be sold and/or returned to the furnace. Most forms of processed slag have very low unit values compared to those of iron and steel products. For this reason, iron and steel companies consider slag to be a nuisance and thus generally contract with outside slag-processing companies to cool the slag and remove it. Although the financial arrangements vary, 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 (this metal to be returned to the furnace for a low charge), sells the slag on the open market, and pays a small percentage of the net slag sales revenues or profits to the iron or steel company. Also, slag may be returned to the furnaces for use as flux and as a supplemental source of iron; this return of slag is typically not reported as a sale.

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

Legislation and Government Programs

Consumption of slag in the construction sector is influenced by Federal and State programs that affect construction spending levels. In 2006, the main Federal funding program relating to construction was the Safe, Accountable, Flexible, Efficient Transportation Equity Act: A Legacy for Users (SAFETEA–LU), signed into law in August 2005. This Act authorized Federal funding of surface transportation projects for the period 2005–09 at a total guaranteed minimum funding level of $244.1 billion for the period. In Federally funded and other construction projects, slags are promoted as “sustainable” construction materials, mainly on the basis that slags substitute directly or indirectly for virgin raw materials (for example, for natural stone aggregates in various applications and for natural raw materials in cement manufacture) or, in the specific case of ground granulated blast furnace slag (GGBFS), can partially substitute for portland cement in concrete. With respect to portland cement manufacture, substitution of slags for natural raw materials to make clinker 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 (ground or unground) in the finish mill allows more finished cement to be made from the same amount of clinker.

Production

Data are generally unavailable on the actual annual production of iron and steel slag because not all of the slag is tapped during a heat, and the amount of slag tapped is not routinely measured. Both U.S. and world production of ferrous slags can be broadly estimated, however, 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 tons (t) of slag per metric ton of crude or pig iron produced. For ore grades lower than average, the slag output will be higher—sometimes 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 slag is entrained metal, most of which is generally recovered during slag processing and returned to the furnace. The amount of marketable slag remaining after entrained steel 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 American Iron and Steel Institute (2006, p. 121-126), it was estimated that U.S. blast furnace slag production in 2006 was in the range of about 9 to 11 Mt, and world output was in the range of 218 to 262 Mt. Similarly, U.S. output of steel slag (after metal removal) in 2006 was estimated to be 10 to 15 Mt, and world output, 124 to 186 Mt. The apparent excess U.S. slag production over the sales listed in table 1 likely reflects a combination of undocumented returns of slag to the furnaces and stockpiling of slag by the processors.

Marketed blast furnace slags are of three main types—air-cooled, granulated, and pelletized (or expanded). Air-cooled blast furnace slag is formed by allowing the molten slag to cool relatively slowly under ambient conditions; final cooling can be accelerated with a water spray. The cooled material is hard and dense, although it can have a vesicular texture with closed pores, and is especially suitable for use as aggregates. Granulated blast furnace slag (GBFS) is formed by quenching molten slag in water to form sand-sized particles of glass. The disordered structure of this glass gives the material moderate hydraulic cementitious properties when very finely ground (GGBFS). However, if GGBFS can access free lime during hydration, its cementitious properties become strong. In the United States, production of GGBFS is from both domestically produced GBFS and imported feed processed at domestic grinding plants. One of the latter, in Louisiana, resumed production in February after the completion of repairs to damage sustained in August 2005 during Hurricane

Katrina. 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. The vesicular texture reduces the overall density of the slag and allows for good mechanical binding with hydraulic cement paste; this slag type is most commonly used as a lightweight aggregate, but if very finely ground, can have cementitious properties similar to GGBFS. Blast furnace slag (generally air-cooled) also can be made into mineral wool. Slag for this purpose 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 many of the same purposes. Steel slags containing large amounts of dicalcium silicate are prone to expansion and commonly are cured in piles for some months to allow for the expansion and for leaching out of lime.

Consumption

Data in this report are based on an annual U.S. Geological Survey (USGS) canvass of slag processors and relate to sales of processed slag. Data are not collected on the amount of slag processed by the same firms or to the actual production of slag by iron and steel companies. Processed slag is sold from stockpiles, and although most of the material is a byproduct of current or recent iron and steel production or is of imported material, some of the slag sales are of material mined from old slag piles (slag banks) produced by iron and steel plants now closed.

In 2006, canvasses were sent to 29 companies, covering 143 processing sites, and at least partial data were received for 141 of the sites; the reported data account for nearly 100% of the gross tonnages listed in table 1. By comparison, in 2005, canvasses were sent to 27 companies, covering 131 processing sites, and at least partial data were received for 127 sites; the reported data account for 98% of the gross tonnages listed. For both years, data on pelletized blast furnace slag have been withheld to avoid disclosing company proprietary data, but the quantities sold were very small. For historical comparisons, data prior to 2002 for pelletized slag were presented combined with granulated slag under the term "expanded slag." As noted in the Foreign Trade section below, the sales data for granulated slag in both years exclude material sold by importers who as yet do not take part in the USGS canvass.

Based on the USGS canvass data, nearly 79% of the total U.S. slag sales tonnage in 2006 was of air-cooled blast furnace slag and steel slag (table 1). Air-cooled blast furnace slag sales were about 7.3 Mt, down by about 4% from sales in 2005. Steel furnace slag sales, in contrast, were significantly unchanged. For both years (and all previous years), the sales data for these two slag types largely exclude material returned to the furnaces (and likewise exclude the weight of free metal recovered from the slag and returned to the furnace); data on these returns are very incomplete.

Air-cooled blast furnace and steel furnace slags have a similar set of uses, primarily as aggregates for various applications (table 3). However, because of potential expansion problems, steel slags find little use in applications requiring maintenance of a fixed volume (for example, concrete). Both slag types also find significant use as a raw material for cement (clinker) manufacture (the slag contributes aluminum, calcium, iron, and silicon oxides), but steel slags have proven to be especially suitable for this use. Although shifts for 2005-06 are apparent among the usage breakout percentages for these two slag types in table 3, it is difficult to evaluate their significance because the data incorporate estimates and much of the plant-level data reported in recent years have revealed only the dominant use(s) for the slag; that is, the less common uses are understated. This understating appears especially to apply to the usage percentages shown for "clinker raw material" in 2006. For air-cooled slag, the decline in usage noted for clinker in 2006 could be real (data for this use have shown large fluctuations in recent years) but its magnitude exaggerated; informal discussions with the industry suggest that the true usage in 2006 may have been closer to 3% of total air-cooled slag sales. Likewise, the use of steel slag for clinker in 2006 may have actually increased to something closer to 9% of total sales. In both cases, the "missing" percentages appear to be resident within the sales reported for fill and/or road bases.

Selling prices for air-cooled blast furnace slag and steel slag have changed very little in recent years; no significant changes were apparent in 2006 (table 2). Because of generally low unit sales values, slags for aggregate applications generally cannot be economically transported over long distances, particularly overland. Thus, the major factors affecting the sales volumes and prices of these two slag types are dominated by local competition from natural aggregates, as well as the overall level of construction activity (particularly that for roads), and the existence of some long-term supply contracts. Air-cooled and steel furnace slags sold for uses other than aggregates can command higher prices than do the aggregate applications. Pelletized slag (not revealed in tables 1-3) can sell for prices well above those for air-cooled slag.

Although significantly smaller in tonnage than either air-cooled blast furnace slag or steel slag, sales of GBFS strongly dominate the slag market in terms of value. In 2006, sales of granulated slag accounted for almost 87% of the value of total blast furnace slag sales and about 78% of all ferrous slag sales combined (table 1). However, as discussed in the Foreign Trade section below, the tonnages listed in table 1 understate true GBFS sales volumes (and hence overall values) owing to incomplete data. For the GBFS sales listed in the table, the average unit selling price increased significantly in 2006 and, despite a modest apparent decline in sales tonnage during the year, was largely responsible for the 11% increase in the value of ferrous slag sales overall (table 1).

Of the 4.2 Mt of GBFS listed as sold in 2006, about 3.59 Mt was GGBFS, and the rest was unground material. The value dominance of GBFS reflects its high unit value relative to the other slag types (table 2); this, in turn, reflects the ready market for GGBFS as a partial substitute for portland cement in ready-mixed concrete or as a component of blended cements (also for use in concrete). In concrete containing a proportion of GGBFS, hydration of portland cement releases the lime needed to fully activate the slag. Concretes incorporating GGBFS generally develop strength more slowly than concretes containing only portland cement but can have similar or even superior long-term strength, release less heat during hydration, have reduced permeability, and generally exhibit improved resistance to chemical attack. Despite its relatively high unit price, GGBFS still sells at a 20% to 25% discount to portland cement. Sales of unground GBFS were either to cement plants or to dedicated grinding plants for conversion to GGBFS, or to cement plants to be used as a grinding aid in their finish mills. A small fraction of the unground GBFS on the market has been sourced from old slag piles and lacks cementitious properties as a result of weathering; this material still has use in concrete (as a fine grain aggregate), but sells for much lower prices than those indicated for the cementitious material in table 2.

The USGS slag survey does not distinguish between GBFS sold directly to cement companies and that sold directly to concrete companies, but data collected by recent USGS cement surveys indicate that cement producers themselves consume about 15% of the total granulated slag sold. Sales in the United States of GGBFS under the designation "slag cement" are promoted by the Slag Cement Association (SCA), whose members accounted for much of the country's GGBFS output. The SCA reported sales by its members of 3.62 Mt of GGBFS in 2006, up by 3.5%, which is in close agreement with the GGBFS component of the USGS data (Slag Cement Association, 2007).

Foreign Trade

Based on data from the U.S. Census Bureau, imports of ferrous slags (excluding iron scales) totaled about 1.3 Mt in 2006, down by about 19% from the import levels in 2005. Granulated slag imports were about 1.1 Mt of the total in both years. For granulated slag imports (most of which were of unground material), the average customs value was $39.78 per metric ton, compared with $35.29 per ton in 2005, and the average cost, insurance, and freight (c.i.f) value was $52.24 per ton in 2006, compared with $47.90 per ton in 2005. The leading sources of imported granulated slag were Canada (35%), Italy (28%), Japan (24%), and France (4%). Some import entries showing exceptionally high unit values may in fact be of silica fume or certain very high-quality grades of fly ash and not granulated or other slag. Exports of slag were listed as only about 0.1 Mt in 2006, but this was nearly triple the 2005 levels.

Comparison of the U.S. Census Bureau import data for slag with data from the Journal of Commerce's Port Imports Export Reporting Service (PIERS) strongly suggests that the U.S. Census Bureau import data are substantially incomplete. The PIERS data show imports of "granulated slag" totaling about 3.0 Mt in both 2005 and 2006, including higher tonnages from the same countries listed by the U.S. Census Bureau as well as several country sources not listed by the U.S. Census Bureau. Although some of the PIERS data are actually for cenospheres and pelletized slag (despite being listed as granulated slag), the mislabeled quantities are relatively small and it remains unclear why there are such major discrepancies between the official data and the PIERS import data. By way of comparison, the 2006 USGS canvass data for sales of granulated slag (table 1) can be split between about 2.5 Mt likely derived from U.S. blast furnaces and about 1.7 Mt likely of imported origin (including imported GBFS ground domestically into GGBFS). This apparent import component of the USGS data suggests that the USGS data include about 0.6 Mt of imported material missing from the U.S. Census Bureau data, but the comparison would also suggest that the USGS canvass has understated (because of the existence of importers not included in the canvass) the import component of the 2006 market by at least 1 Mt. Thus, it appears that total sales of granulated slag may have been closer to 5.5 Mt in 2006 instead of the 4.2 Mt listed in table 1; the 2005 data (and likely those for several recent years) may be similarly understated.

Outlook

Consumption of ferrous slags for use as aggregates is expected to continue to parallel trends in the consumption of natural aggregates and thus will depend on overall construction spending levels, especially those in the public sector. Factors affecting the competitiveness of slags relative to natural aggregates include the promotional efforts by the slag industry itself and slag availability. The generally declining trend in the U.S. output of iron and steel implies future overall supply constraints from domestic sources, especially as existing stockpiles get drawn down. This is especially true for the long-term availability of air-cooled slag, given the continuing decline in the number of operating blast furnaces. Steel slag supplies are more assured, especially slag from electric arc rather than basic oxygen furnaces.

Growth in demand for GGBFS is likely because of efforts promoting the performance and environmental benefits of incorporating this material in concrete. The supply of GBFS from domestic blast furnaces is constrained by the fact that granulation cooling is currently installed at only five blast furnaces in the United States, and one of these (at Weirton, WV) has been idle since mid-2005, with no assurance of restarting. Retrofitting other blast furnaces with granulators is possible but expensive. Unless this is done, any growth in supply will depend on the output of existing or new domestic grinding plants that rely on imported GBFS feed or on direct imports of the material.

References Cited

American Iron and Steel Institute, 2006, Annual statistical report: Washington, DC, American Iron and Steel Institute, 126 p.
Slag Cement Association, 2007, U.S. slag cement shipments: Sugar Land, TX, Slag Cement Association. (Accessed August 17, 2007, via http://www.slagcement.org/.)

GENERAL SOURCES OF INFORMATION

U.S. Geological Survey Publication

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)

	2005					2006				
	Blast furnace slag[r, 1]			Steel	Total iron	Blast furnace slag[1]			Steel	Total iron
	Air-cooled	Granulated	Total[2]	furnace slag	and steel slag[2]	Air-cooled	Granulated	Total[2]	furnace slag	and steel slag[2]
Quantity[3]	7.6	4.4	12.0	8.7	20.7 r	7.3	4.2	11.6	8.7	20.3
Value[e, 4]	52	275	327	39	365 r	49	318	367	40	406

[e]Estimated. [r]Revised.
[1]Excludes expanded (pelletized) slag to avoid disclosing company proprietary data. The quantities are very small (about 0.1 unit or less).
[2]Data may not add to totals shown because of independent rounding.
[3]Quantities are rounded to reflect inclusion of some estimated data and to reflect inherent accuracy limitations of reported data.
[4]Values are rounded because of the inclusion of a large estimated component.

TABLE 2
SELLING PRICES FOR IRON AND STEEL SLAG
IN THE UNITED STATES[1]

(Dollars per metric ton)

	2005		2006	
Slag type	Range	Average	Range	Average
Blast furnace slag:				
Air-cooled	2.76-17.50	6.78 r	3.03-16.26	6.63
Granulated[2]	17.63-88.18	67.22 r	19.29-94.80	79.18
Steel slag	0.22-12.85	4.45	0.49-13.16	4.58

[r]Revised.
[1]Data contain a large component of estimates and some respondents provide values only on their total sales of a slag type instead of value by type of use. Thus the value ranges shown are likely too restrictive.
[2]Values are for material reported for use as a cementitious additive in cement or concrete manufacture. Material at or near the low end of the range was sold in unground form. 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 USE[1]

(Percentage of total tons sold)

	2005			2006		
	Blast furnace slag[2]		Steel	Blast furnace slag[2]		Steel
Use	Air-cooled	Granulated	slag	Air-cooled	Granulated	slag
Ready-mixed concrete	17.8	--	--	15.7	--	--
Concrete products	5.4	--	--	4.0	--	--
Asphaltic concrete	13.4	--	15.6	13.3	--	12.1
Road bases and surfaces	32.5	--	53.0	41.3	--	51.0
Fill	12.3	--	10.5	14.6	--	17.9
Cementitious material	--	90.3	--	--	94.1	--
Clinker raw material	4.9	--	6.9	1.5	--	6.9
Miscellaneous[3]	9.6	0.9	2.3	7.6	0.6	0.8
Other or unspecified	4.2	8.8	11.7	2.0	5.3	11.3

[r]Revised. -- Zero.
[1]A 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 good to no more than 2-significant figures.
[2]Excludes expanded or pelletized slag; this material is generally sold as a lightweight aggregate.
[3]Reported as used for railroad ballast, roofing, mineral wool, or soil conditioner.

TABLE 4
PROCESSORS OF IRON AND STEEL SLAG IN THE UNITED STATES IN 2006

			Slag and furnace types[1]					
			Blast furnace slag			Steel furnace slag		
Slag processing company	Plant location	Steel company serviced [2, 3]	AC	GG	Exp	BOF	OHF	EAF
AMSI	Holsopple, PA	North American Höganäs, Inc.						X
Barfield Enterprises, Inc.	La Place, LA	Bayou Steel Corp.						X
Do.	Lone Star, TX	Lone Star Steel Corp.						X
Beaver Valley Slag	Aliquippa, PA	Old slag pile site	X			X	X	
Beelman Truck Co.	Granite City, IL[4]	U.S. Steel LLC	X					
Blackheart Slag Co.	Muscatine (Montpelier), IA	IPSCO Steel, Inc.						X
Border Steel, Inc.	El Paso, TX	Border Steel, Inc.						X
Buffalo Crushed Stone, Inc.	Woodlawn, NY	Old slag pile site	X					
Buzzi Unicem USA, Inc.	New Orleans, LA	Foreign, some donestic.		X				
Dragon Products Co., Inc.	Thomaston, ME	Miscellaneous domestic and foreign		X				
Edward C. Levy Co.	Decatur (Trinity), AL	Nucor Steel Corp.						X
Do.	Butler, IN	Steel Dynamics Inc.						X
Do.	Columbia City, IN	do.						X
Do.	Crawfordsville, IN	Nucor Steel Corp.						X
Do.	East Chicago (Indiana Harbor), IN	Mittal Steel USA	X					
Do.	Detroit, MI	Severstal North America, Inc.	X			X		
Do.	Detroit, MI	U.S. Steel LLC	X			X		X
Do.	Delta, OH	North Star-Bluescope Steel Inc.						X
Do.	Canton, OH	The Timken Co.						X
Do.	Huger, SC	Nucor Steel Corp.						X
Essroc Corp.	Middlebranch, OH	Miscellaneous domestic and foreign		X				
Hanson Slag Cement, Inc.	Cape Canaveral, FL	Foreign		X				
Florida Rock Industries, Inc.	Tampa, FL	do.		X				
Fritz Enterprises, Inc.	Fairfield, AL[5]	U.S. Steel LLC	X	X		X		
Gerdau Ameristeel Corp.	Jacksonville, FL	Gerdau Ameristeel Corp.						X
Do.	Charlotte, NC	do.						X
Holcim (US) Inc.	Birmingham (Fairfield), AL[5]	U.S. Steel LLC		X				
Do.	Gary, IN	do.		X				
Do.	Weirton, WV	Weirton Steel Corp.		X				
Lafarge North America Inc.	Joppa, IL	Mittal Steel USA		X				
Do.	South Chicago, IL	do.		X				
Do.	East Chicago, IN	do.		X	X			
Do.	Sparrows Point, MD	do.		X				
Do.	Cleveland (Cuyahoga Co.), OH[4]	do.	X					
Do.	Lordstown, OH	Old slag pile site		X				
Do.	McDonald, OH	do.	X					
Do.	Salt Springs (Youngstown), OH	do.	X					
Do.	Warren, OH	WCI Steel Inc.	X					
Do.	West Mifflin (Duquesne), PA	U.S. Steel LLC (ET Works)	X					
Do.	West Mifflin (Brown Reserve), PA	Old slag pile site	X					
Do.	Seattle, WA	Foreign		X				
Do.	Weirton, WV (idle in 2006)	Mittal Steel USA	X					
Lehigh Cement Co.	Evansville, PA	Foreign		X				
Lehigh Northeast Cement Co.[6]	Cementon, NY	do.		X				
Levy Co., Inc., The	Burns Harbor, IN	Mittal Steel USA	X			X		
Do.	Gary, IN	U.S. Steel LLC	X	X				
Mountain Enterprises, Inc.	Ashland, KY[4]	AK Steel Corp.	X					
MultiServ	Birmingham, AL	Structural Metals Corp.						X
Do.	Blytheville, AR	Nucor Steel Corp.						X
Do.	Blytheville (Armorel), AR	Nucor-Yamato Steel Co.						X
Do.	Pueblo, CO	Rocky Mountain Steel Mills						X
Do.	Wilton (Muscatine), IA	IPSCO Steel, Inc.						X
Do.	Riverdale, IL	Mittal Steel USA				X		
Do.	East Chicago, IN	do.				X		
Do.	Indiana Harbor, IN	do.				X		
Do.	Pittsboro, IN	Steel Dynamics Inc.						X
Do.	Ghent, KY	Gallatin Steel Co.						X
Do.	do.	North American Stainless LP						X
Do.	Sparrows Point, MD	Mittal Steel USA	X			X		
Do.	Ahoskie (Cofield), NC	Nucor Steel Corp.						X

See footnotes at end of table

TABLE 4—Continued
PROCESSORS OF IRON AND STEEL SLAG IN THE UNITED STATES IN 2006

			Slag and furnace types[1]					
			Blast furnace slag			Steel furnace slag		
Slag processing company	Plant location	Steel company serviced [2, 3]	AC	GG	Exp	BOF	OHF	EAF
MultiServ—Continued	Canton, OH	Republic Engineered Products LLC						X
Do.	Mansfield, OH	AK Steel Corp.				X		
Do.	Warren, OH	WCI Steel Inc.				X		
Do.	Brackenridge, PA	Allegheny Ludlum Corp.						X
Do.	Butler, PA	AK Steel Corp.						X
Do.	Coatesville, PA	Mittal Steel USA						X
Do.	Koppel, PA	Koppel Steel Co. (NS Group, Inc.)						X
Do.	Latrobe, PA	Allegheny Ludlum Corp.						X
Do.	Natrona Heights, PA	do.						X
Do.	Steelton, PA	Mittal Steel USA						X
Do.	Midlothian, TX	Chaparral Steel Co.						X
Do.	Seattle, WA	Nucor Steel Corp.						X
Phoenix Services LLC	Roanoke, VA[7]	Steel Dynamics, Inc.[8]						X
Do.	Latrobe, PA	Latrobe Specialty Steel Co.						X
Recmix of PA, Inc.	Ghent, KY	North American Stainless, LP						X
Do.	Sarver (Brackenridge), PA	Allegheny Ludlum Corp.						X
Rinker Materials Corp.	Miami, FL	Foreign		X				
St. Lawrence Cement, Inc.	Camden, NJ	do.		X				
St. Marys Cement, Inc.	Detroit, MI	do.		X				
Do.	Milwaukee, WI	Foreign, some donestic.		X				
Stein, Inc.	Alton, IL	Alton Steel Co.						X
Do.	Granite City, IL[4]	U.S. Steel LLC	X			X		
Do.	Sterling, IL	Sterling Steel, Inc.						X
Do.	Ashland, KY[4]	AK Steel Corp.	X			X		
Do.	Cleveland, OH[4]	Mittal Steel USA	X			X		
Do.	Loraine, OH	Republic Engineered Products LLC	X			X		
Do.	Georgetown, SC	Georgetown Steel Corp.						X
Thor Mill Services, Inc.[7]	Roanoke, VA	Roanoke Electric Steel, Inc.[8]						X
Tube City-IMS, IMS Division	Axis, AL	IPSCO Steel, Inc.						X
Do.	Birmingham, AL	Nucor Steel Corp.						X
Do.	Tuscaloosa, AL	do.						X
Do.	Fort Smith, AR	Macsteel						X
Do.	Rancho Cucamonga, CA	TAMCO Steel						X
Do.	Claymont, DE	CitiSteel USA, Inc.						X
Do.	Cartersville, GA	Gerdau Ameristeel Corp.						X
Do.	Wilton (Muscatine), IA	do.						X
Do.	Kankakee, IL	Nucor Steel Corp.						X
Do.	Peoria, IL	Keystone Steel & Wire Co.						X
Do.	Gary, IN	U.S. Steel LLC				X		
Do.	Portage, IN	Beta Steel Corp						X
Do.	Ashland, KY	Kentucky Electric Steel LLC						X
Do.	Jackson, MI	Macsteel						X
Do.	Monroe, MI	Macsteel (Quanex)						X
Do.	St. Paul, MN	Gerdau Ameristeel Corp.						X
Do.	Jackson, MS	Nucor Steel Corp.						X
Do.	Norfolk, NE	do.						X
Do.	Perth Amboy, NJ	Gerdau Ameristeel Corp.						X
Do.	Sayreville, NJ	do.						X
Do.	Auburn, NY	Nucor Steel Corp.						X
Do.	Marion, OH	Nucor Steel Corp.						X
Do.	McMinnville, OR	Cascade Steel Rolling Mills, Inc.						X
Do.	Middletown, OH	AK Steel Corp.	X			X		
Do.	Mingo Junction, OH	Wheeling Pittsburgh Steel Corp.	X			X		X
Do.	Youngstown, OH	V&M Star (North Star, Inc.)						X
Do.	Sand Springs, OK	Gerdau Ameristeel Corp.						X
Do.	Bethlehem, PA	Old slag pile site	X			X		
Do.	Braddock, PA	U.S. Steel LLC				X		
Do.	Bridgeville, PA	Universal Stainless & Alloy Products Inc.						X
Do.	Midland, PA	Allegheny Ludlum Corp.						X
Do.	New Castle, PA	Ellwood Quality Steels Co.						X

See footnotes at end of table

TABLE 4—Continued
PROCESSORS OF IRON AND STEEL SLAG IN THE UNITED STATES IN 2006

			Slag and furnace types[1]					
			Blast furnace slag			Steel furnace slag		
Slag processing company	Plant location	Steel company serviced [2, 3]	AC	GG	Exp	BOF	OHF	EAF
Tube City-IMS, IMS Division—Continued	Park Hill (Johnstown), PA	Old slag pile site	X				X	
Do.	Pricedale, PA	do.				X		
Do.	Reading, PA	Carpenter Technology Corp.						X
Do.	Cayce, SC	SMI/CMC Steel Group						X
Do.	Darlington, SC	Nucor Steel Corp.						X
Do.	Jackson, TN	Gerdau Ameristeel Corp.						X
Do.	Knoxville, TN	do.						X
Do.	Beaumont, TX	do.						X
Do.	Jewett, TX	Nucor Steel Corp.						X
Do.	Longview, TX	LeTourneau Steel Group						X
Do.	Seguin, TX	SMI/CMC Steel Group						X
Do.	Plymouth, UT	Nucor Steel Corp.						X
Do.	Petersburg, VA	Chaparral Steel Co.						X
Do.	Saukville, WI	Charter Steel						X
Do.	Weirton, WV	Mittal Steel USA				X		
Uniserve LLC	Newport, AR	Arkansas Steel Association						X

[1]Blast 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.

[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 slag sourced from the domestic market, not a service contract.

[3]Currently operating iron and/or steel company. Company is not shown for old slag pile sites.

[4]For the air-cooled slag, Stein was responsible for the cooling but the processing and marketing were handled by Beelman Trucking (Granite City, IL), Lafarge North American Inc. (Cleveland, OH), and Mountain Enterprises, Inc. (Ashland, KY), respectively.

[5]For granulated slag, Fritz Enterprises operates the granulator but Holcim owns the apparatus and markets the slag.

[6]Formerly Glens Falls-Lehigh Cement Co.

[7]Thor Mill Services and its contract at Roanoke, VA were sold to Phoenix Services LLC in mid-2006.

[8]Steel Dynamics, Inc. purchased Roanoke Electric Steel, Inc. in April 2006.