NATIONAL SLAG ASSOCIATION

STEELMAKING SLAG: A SAFE AND VALUABLE PRODUCT

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INTRODUCTION

Steelmaking slag is an environmentally safe product with a wide range of valuable uses. Over the past several years, the Steel Slag Coalition ("SSC"), a group of 63 companies that produce steel, process slag, or both, has undertaken a comprehensive study of the chemical composition of three slag types generated during the steelmaking process and the potential human health and ecological risks associated with possible exposure to such slag. Risk assessments developed during 19981[1/] demonstrate that these "slags pose no meaningful threat to human health or the environment when used in a variety of residential, agricultural, industrial, and construction applications.

This paper considers the importance of steelmaking slag as a product and provides an overview of the regulatory status of steelmaking slag in the United States. In addition. the risk assessment process and results are summarized.

I. STEELMAKING SLAG IS A PRODUCT WITH MANY VALUABLE USES

A. What Is Steelmaking Slag?

Steelmaking slag includes blast furnace (“BF") iron slag, and basic oxygen furnace ("BOF") and electric arc furnace ("EAF") steel slag types. EAF mills produce steel generally by remelting scrap steel. Integrated mills, on the other hand, produce steel principally by combining molten BF iron with scrap steel in the BOF. [2/] In each of these processes, input materials (iron ore, scrap metal, fluxing agents such as lime, *etc.)* are charged to a furnace, refined, and heated beyond their melting points. Two or more liquids are formed when these materials reach a state of complete fusion. The liquid with the lowest specific gravity forms a layer on the surface of the melt that is called slag. The slag is either poured or skimmed off the underlying liquid metal. The liquid metal, iron or

1/ The three risk assessments were performed by ChemRisk (a Service of McLaren/Hart, Inc.) ("ChemRisk").

2/ BF iron is transformed into steel in the basic oxygen furnace or cast into ingot (pigs) and sold. steel, is cast into various forms *(e.g.,* ingots, slabs. and billets) for sale or further processing.

Producing BF, BOF, and EAF slags is an important step in the iron/steel making process. During this process, substances that are incompatible with iron and steel are removed by forming complex metallic and nonmetallic oxides. Chemically, steelmaking slag is a complex matrix structure consisting primarily of oxides of calcium, iron, silicon, aluminum, magnesium, and manganese in complexes of calcium silicates, aluminosilicates and aluminoferite. These compounds are generally similar to those found in the natural environment. At lower temperature, these individual oxidized components would not be fusible, but at a typical operating temperature of about 1600°C in the furnace, these materials are easily fused and captured in the slag. The matrix tightly binds metals found in steelmaking slag, and these metals are not readily liberated from the slag particles. Consequently, the metals in slag are not easily leached into the environment and therefore, are not readily available for uptake by humans, other animals or plants.

After removal from the furnace, the slag is transported into a cooling pit, either directly or via pots depending on the distance between the pit and the furnace. The physical characteristics, density, porosity, and particle size of slag are determined, in part. by the cooling rate and process. Three types of slag cooling methods are most common: air-cooled, expanded. and granulated [3/] Cooling also enables the slag to be transported to the processing area. Between production and sale of the slag to the customer, there often is a time lag that is necessary to make the slag an effective material for many of its uses. [4/] New slag often is

3/ BF slag may be air-cooled, granulated. or expanded, whereas EAF and BOF slags typically are air-cooled. The U.S. Geological Survey ("USGS") 1997 Annual Review explained the various cooling processes as follows:
Air-cooled slag is produced by allowing the molten slag to cool slowly in air in an open pit. When the material solidifies under slow cooling conditions, escaping gases leave. behind a porous, low-density aggregate. When formed under controlled rapid cooling in air (quenching), the slag tends to be hard and dense, making it especially suitable for use in road base and similar structural applications. Expanded slag is formed through controlled rapid cooling of molten slag in water or in water with a combination of steam and compressed air. Steam and other gases enhance the porosity and vesicular nature of the slag, resulting in a lightweight aggregate suitable for use in concrete. Granulated slag is produced by quenching (rapid cooling) the molten slag into glass by using high-pressure water jets.

USGS, U.S. Department of Interior ("DOI"), *Mineral Industry Surveys: Slag --Iron and Steel.* 1997 *Annual Review* (August 1998) (" *USGS Slag Survey").*

4/ For example, incomplete hydration of slag used in a construction application, such as asphalt in road building, may swell as it absorbs water.

dry and contains high levels of free lime that can affect performance. Therefore, slag typically will be stored and "cured" for about six months to hydrate and allow for expansion of dicalcium silicate and to reduce the free-lime content to acceptable levels. The slag then may be crushed, sized, and screened for sale for many different uses, such as construction aggregate.

B. Use of Steelmaking Slag

Steelmaking slag has been used commercially since at least the mid-19th century. It is currently used in all industrialized countries, wherever steel is produced. Beginning in the 20th century, many new uses for steelmaking slag were developed in a variety of industries. Steel mills and slag processors work closely together to ensure that the steelmaking slag remains a high quality product for current and future applications.

BF slag production ranges from about 220 to 370 kilograms per metric ton of pig iron produced; although lower grade ores may yield much higher slag fractions. Based on 1997 production data, about 13 million tons of BF slag was produced in the United States. Marketable BOF/EAF slag is about 10 to I5 percent by weight of steel output.[5/] U.S. steel (BOF/EAF) slag production in 1997 amounted to about 17 million tons.[6/] In 1997, iron and steel slag consumption totaled approximately 21.4 million tons valued at about $147 million. Of this total, BF slag accounted for approximately 65 percent of the tonnage and was worth about $118 million. Steel slags accounted for the remainder. [7/]

The physical shape of slag particles is crucial to its value as a product. Slag particles tend to be cubical with vesicular surfaces that allow the slag particles to interlock. Accordingly, steelmaking slag is much more stable in formation than other

5/ A portion of the steel slag that is generated is entrained steel that generally is recovered and returned to the furnace.

6/ *See USGS Slag Survey* at 1-2.

7/ USGS, DOI, *Mineral Commodity Summaries: Iron and Steel Slag* (Jan. 1998). Note that slag production and availability is not a good indicator of consumption trends due to the time lag necessary for curing. *See USGS Slag Survey* at 1.

aggregates. In fact, slag is found to out-perform natural materials in many applications. It provides excellent adhesion in asphaltic concrete, and the shape improves skid resistance in road materials dramatically. Slag is highly stable when wet, prevents the formation of ice, does not have problematic surface irregularities common to other aggregates, and is easily compacted.

These properties make steelmaking slag a superior material for use as a construction aggregate, currently the major use of steelmaking slag. Natural aggregates,

Table 1: Major Uses of Steelmaking Slag

Aggregate in bituminous mixes such as: pavement surfaces, bases. surface treatments, seal coats. slurry coats. and cold patch
Concrete aggregate and as an ingredient in cement
Anti-skid aggregate (snow and ice control aggregate)
Surfacing of stabilized shoulders, banks and other select material Bank stabilization (erosion control aggregate) Gabions and riprap
Aggregate base courses and sub-bases
Unpaved driveways. surface roads. and walkways Railroad ballast
Neutralization of mine drainage and industrial discharge
Agricultural uses, such as soil remineralization and conditioning, pH supplement/liming agent. fertilizer
Controlled. granular fills, such as those for unpaved parking and storage areas. pipe and tank backfill. been
construction. and other industrial and construction activity At steel mills as construction aggregate or a fluxing agent
Landfill daily cover material
Landscape aggregate
Trench aggregate/drain fields
Sand blast grit . .
Roofing granules .
Bulk filler *(e.g.,* paints, plastics, adhesives)
Mineral wool (home and appliance insulation) Fill

such as limestone, sand, and gravel products, competes with slag for use as a construction aggregate. Because slag is a renewable mineral resource, its use reduces the consumption of natural resources by the construction industry. Examples of construction applications of slag in the United States include: aggregate in asphaltic concrete; fill; unconfined bases; shoulder stabilization; berm construction; railroad sub- base; base for walkways; and rock wool insulation.

Slag also is used for agricultural purposes in the United States; principally as a pH supplement/liming agent, soil conditioner, fertilizer, and remineralization agent. Table 1 provides a complete list of the major uses of steelmaking slag.

II. RISK ASSESSMENTS DEMONSTRATE SAFETY OF STEELMAKING SLAG

The many valuable uses detailed above make clear that steelmaking slag offers significant benefits in terms of performance and the conservation of environmental resources. As a superior alternative to natural aggregate in many of its uses, steelmaking slag should be considered for more widespread use in construction, industrial, agricultural, and residential applications. To address potential questions regarding the safety of current and future uses of steelmaking slag, the Steel Slag Coalition initiated a comprehensive study that culminated in the development of risk assessments for EAF, BOF, and BF slag types. The study utilized worst-case exposure assumptions in the risk calculations and several possible exposure scenarios to ensure the general applicability of the risk assessment conclusions. The reports demonstrate conclusively that the use of steelmaking slag poses no meaningful threat to human health or the environment.

The following discussion describes the risk assessment scope and process, and summarizes the conclusions reached in the report. A thorough presentation and peer review of the risk assessments is expected to be published in the scientific literature during 1999 through a series of three articles developed by ChemRisk, the consultant retained by the SSC to develop the reports.

A. <u>Data Collection and Identification of Slag Constituents</u>

The risk assessments were based on data derived from representative samples of slag collected during 1995 and 1996 at 45 EAF, 17 BOF, and II BF mills in active operation in different geographical locations across the United States and Canada. The slag samples were collected pursuant to a specific technical protocol that, in part, required facilities to supply samples in each of the size ranges normally produced by the mill. Each facility was instructed to provide an estimate of the percentage by weight that each size range contributed to the total slag produced by the mill based on 1994 data. The samples then were delivered to a single certified lab, En Chern, Inc. ("En Chern"), in a clean, laboratory-supplied container with the following label information: SSC-supplied sample number; slag size grade; date, time, and place of collection; and the name of same collector. Each shipment was accompanied by a chain of custody record.

En Chern processed and analyzed the slag samples using analytical methods approved by the U.S. Environmental Protection Agency ("EPA"). A wide range of data was collected. including (1) total concentrations of major and trace metal constituents; (2) Toxicity Characteristic Leachate Potential ("TCLP") of certain metals; (3) other parameters *(e.g.,* pH); (4) American Society of Testing Materials (" ASTM") distilled water leachate tests for certain metals; (5) bioaccessibility of certain metals; and (6) particle size distribution. The data collection and analysis process described below.

The first four tests identified above were performed to characterize the chemical constituents of steelmaking slag. The slag samples were analyzed for the following metals: antimony, aluminum, arsenic, barium, beryllium, cadmium, calcium, carbon. chromium (total). chromium (hexavalent), cobalt, copper, iron, lead, magnesium, manganese, mercury, molybdenum, nickel, phosphorous, selenium, silicon, silver, sulfur, thallium, tin, vanadium, and zinc. Leachate analyses were conducted to determine if the metals present in steelmaking slag could be mobilized by dissolution under both acidic and neutral conditions. Weak acidic conditions, simulated under the TCLP test, are presumed to occur in sanitary, hazardous or industrial waste landfills. Given the typical uses of steelmaking slag, most conditions likely will be pH neutral *(e.g.,* normal environmental conditions).

Based upon the results of these tests, an initial screening process was conducted to identify those constituents that should be included in the risk assessment. This process was conducted pursuant to established EPA procedures and information in the scientific literature. Metals were screened from consideration in the risk assessment if they were (1) present in only very few samples (low detection frequency) [8/] (2) considered essential for normal human growth and metabolism and, therefore, of extremely low potential toxicity [9/]; or (3) below naturally occurring background soil levels.[10/] Finally, the concentration of those metals in slag present at levels greater than background were compared against various state, regional EPA, and federal EPA health-based screening criteria for both residential (including farmers) and non-residential *(i. e,.* industrial, construction, commercial) scenarios.[11/] If a metal exceeded at least one of these agency criteria, it was retained for analysis in the risk assessment.

8/ The following metals were screened out due to low detection frequency for the three slag types: (I) EAF -- thallium; (2) BOF -- beryllium; and (3) BF -- antimony, cadmium, hexavalent chromium, mercury, silver and thallium.

9/ Iron, magnesium, calcium, carbon, sulfur, silicon, and phosphorous were screened out on this basis.

10/ The following metals were determined to be present at less than or equal to naturally occurring background levels in soil: (I) EAF -- aluminum, arsenic, barium. beryllium, cobalt. lead and mercury; (2) BOF -- aluminum, barium. cobalt, copper, lead, mercury, nickel and zinc; and (3) BF -- aluminum, arsenic, barium, cobalt, copper, lead, nickel, tin. vanadium and zinc. Background soil levels were taken from Dragun, J. and Chiasson, A., *Elements in North American Soils* (Hazardous Materials Control Resources Institutes, 1991).

11/ The following state and EP A screening criteria were used: California, Illinois, Indiana, Michigan, Ohio, Oregon, Pennsylvania, Texas, Wisconsin, EP A Region III Risk-Based Concentrations ("RBCs"), EP A Region IX Preliminary Remediation Goals ("PRGs"), and EP A Soil Screening Levels ("SSLs"). Because South Carolina uses Region III screening criteria, this state's requirements inherently are addressed. New York utilizes background levels for screening metals in soil based on the state's position that the potential for metals to leach from soil and impact groundwater must be assessed on a site-specific basis. Hence, in New York, any level in excess of background requires a site-specific health risk assessment or remedial action. As the risk assessments include a slag-specific groundwater analysis, New York guidance inherently is addressed.

Table 2: Metals in Steelmaking Slag Evaluated in the Risk Assessments

Slag Type	Residential	Non-Residential	Groundwater	Ecological
EAF	Antimony, Cadmium, Chromium (total), Chromium (hexavalent), Manganese, Vanadium	Chromium (total), Manganese, Vanadium	None	Aluminum, Barium
BOF	Cadmium, Chromium (total), Manganese, Thallium, Vanadium	Chromium (total), Manganese, Vanadium	None	None
BF	Beryllium, Chromium (total), Manganese	Beryllium, Chromium (total)	None	None

In addition, the results of the TCLP and ASTM leaching tests were used to determine if any metals in slag potentially would affect groundwater and surface water bodies. These test results were compared to the appropriate TCLP/drinking water quality standards and EPA Ambient Water Quality Criteria.

The initial screening process allowed the risk assessment to focus on a limited set of slag constituents, or "chemicals of interest." In general, the levels of metals in steelmaking slag were lower than expected, and, similarly, leachability was found to be very low. Table 2 presents the slag constituents that were identified through this screening process for further evaluation in the risk assessments. The constituents are grouped according to the relevant screening criteria.

B. The Risk Assessment Process

Risk assessment attempts to quantify potential threats to human health or the environment based on an analysis of exposure to substances that have certain intrinsically hazardous properties. In other words, risk assessment puts into perspective the actual threat posed by hazards in the real world environment. Accordingly, while most, if not all, substances are *potentially* hazardous, the *actual* risk a substance presents depends on factors such as dose and exposure route, frequency, and duration. The formal risk assessment had three basic phases: (1) dose-response assessment; (2) exposure assessment; and (3) risk characterization. The first phase, dose-response assessment, presented the relevant toxicity values used for determining the dose of a substance (here, the chemicals of interest ("COIs"» that would result in potentially adverse health effects. The latest EPA-verified toxicity values were used for assessing potential noncarcinogenic and carcinogenic impacts *of* relevant *COls.* The utilized values included reference doses ("RfDs"), reference concentrations ("RfCs"); cancer slope factors ("SFs"); and cancer unit risk values ("URs").[13/]

Dose is based on the quantity of a COI that may enter the body through all potential routes of exposure *(i.e.*, oral (ingestion), dermal (contact), and inhalation). Accordingly, the second phase in this risk assessment, exposure-assessment, quantified exposures to COIs from the various uses of steelmaking slag. Highly conservative and health-protective exposure assumptions were used to ensure broad applicability of the risk assessments. Both Reasonable Maximum Exposure ("RME”) and Most Likely Exposure ("MLE") levels[14/] were determined using standard EPA default exposure assumptions, information provided in the peer-reviewed literature, and slag-specific data. Analyzed exposure parameters included: soil/slag ingestion rate, exposure frequency/duration, oral bioavailability, body weight, averaging time, skin surface area and slag-to-skin adherence factor, dermal absorption factor, dermal bioaccessibility, inhalation rate, particulate emission factor, and particle size.[15/]

The many uses of steelmaking slag were grouped into nine generic Application Scenarios based on similarity of exposure conditions. Exposures were quantified for potentially exposed populations under each Application Scenario. Construction workers potentially are exposed to slag from a variety of applications, such as the use of slag for

12/ The metals addressed for potential ecological impacts, aluminum and barium, were screened for inclusion in the risk assessment on the basis of ASTM water leach test results.

13/ Toxicity values were obtained from EP *A's* Integrated Risk Information System ("IRIS") and, if unavailable in IRIS, from EPA's Health Effects Assessment Summary Tables ("HEAST").

berms, aggregate base courses/sub-bases, and other construction activities. Maintenance workers may be exposed during routine maintenance activities at industrial sites where slag is used. Industrial workers potentially are exposed to slag used as fill materials at industrial or commercial facilities. For these worker groups, only adults were evaluated as children are not expected to conduct these activities or be present at an industrial facility on a regular basis. Residents (both children and adults) may be exposed to slag used in driveways or as landscape fill material. Finally, fanners may contact slag applied to crop land as a pH supplement/liming agent, fertilizer, or remineralization agent.

The final phase of this risk assessment, risk characterization, presented a review of the exposure data and comparison to relevant toxicity levels to determine the risks associated \1o'ith exposures to steelmaking slag. Noncarcinogenic health risks were characterized by comparing the estimated doses to maximum "acceptable" doses. Such risks typically are characterized using the hazard quotient ("HQ") approach determining the ratio of the estimated average daily dose for a specific metal to the maximum acceptable "safe" dose for that metal *(i.e..* EPA's RfD). HQs less than one indicate that the dose is below the level typically associated with a toxic effect and would be expected to present no significant risk to human health.

The hazard index ("HI") approach was used to assess the noncarcinogenic health risks associated with potential exposure to more than one metal in slag, and to account for the potential additivity of effects from metals that impact similar biological endpoints. The effects of all slag metals ("HQs") were assumed to be additive for purposes of the risk assessment. HIs less than one indicate that exposure levels are acceptable. Two types

14/ EP A considers the RME as the highest exposure that is reasonably expected to occur at impacted sites, and is determined using upper bound estimates for key exposure parameters. For example, the 95111 percentile estimates of exposure parameters and the 95111 percentile upper confidence limit ("UCL ") of the arithmetic mean concentration for metals in environmental media were used to quantify dose. The MLE is used to represent the median or average exposure in a given population.

15/ Slag-specific data were collected with respect to oral bioavailability and particle size. The bioaccessibilty study determined the fraction of metals in slag solubilized in biological fluids and available for absorption. The fraction of slag particulates less than five micrometers in diameter was quantified to assess the inhalation dose based on the percentage of slag that is respirable. EPA has determined that this size fraction is the most appropriate dose measure to use when applying the inhalation RfD for manganese, the only COI relevant to assessing potential health effects related to the inhalation of slag during certain construction activities.

of HIs were calculated: (1) a metal-specific HI that calculates risk from a particular metal across all exposure pathways within each Application Scenario; and (2) a total HI that presents the cumulative risk for all cars across all exposure pathways for each scenario. The metal-specific HIs identify the relative contribution of each COI and exposure pathway to the potential health risks for a particular scenario. The total HI represents the highest potential risk associated with each exposure scenario.

Carcinogenic health risks are defined in terms of the probability of an individual developing cancer over a lifetime as the result of exposure to a given metal at a given concentration. These risks are determined by applying the EPA-determined cancer slope factor for a particular metal to the potential dose of that metal received through exposure to slag. The theoretical lifetime increased cancer risks calculated through this process then were compared to EPA's target risk range of between one-in-a-million (10^{-6}) to one-in-ten-thousand (10^{-4}). To be conservative, the risk assessments applied the more stringent one-in-a-million criterion to determine acceptable levels of risk.

The initial risk characterization, following EPA guidelines, was based on point estimate calculations. This approach creates extremely conservative results by compounding many single value, upper-bound parameters. For example, the RME derived under the point estimate approach repeatedly uses upper-bound, or 95^{th} percentile values, for exposure parameters and site media, concentrations. This ultimately leads to unrealistic and overly conservative estimates of health risk given that it is highly unlikely that the worst case for all conditions would occur at the same time. EPA therefore advocates the use of Monte Carlo analysis, if necessary, to address the significant overestimates of risk that result from the point estimate approach.

Monte Carlo analyses were performed to refine the dose and hazard quotient calculations related to inhalation exposures to manganese in the EAF and BOF reports, and oral (incidental ingestion) exposures to beryllium in the BF report. Monte Carlo analysis is a mathematical method that involves the calculation and use of a range of exposure parameter values, rather than a single value (a point estimate), to more accurately characterize the uncertainty and variability associated with specific exposure parameters.

For this risk assessment to be broadly applicable, highly conservative exposure parameter values were assumed in both the Monte Carlo and point estimate analyses. For example, it was assumed that individuals were exposed to the 95^{th} percentile UCL or maximum soil concentration for the entire duration of exposure, in most cases, 25 to 30 years. Thus, as noted above, while the risk assessments are not site-specific *per se,* the worst-case exposure scenarios evaluated in the reports renders them generically applicable.

C. <u>Results</u>

The results of the three risk assessments demonstrate that BF, BOF, and EAF slags are safe for use in a broad variety of applications and pose no significant risks to human health or the environment. The key findings of the risk assessments are summarized below:

0 Carcinogenic and noncarcinogenic risks associated with steelmaking slag are insignificant for potentially exposed residential populations, farmers, or maintenance, industrial, and construction workers.

0 Metals in steelmaking slag will not leach readily in substantial amounts to groundwater or, surface water and, therefore, pose little or no concern for drinking water quality.

0 Steelmaking slag will not significantly impact animals and other terrestrial life in or near areas of application. Metals in steelmaking slag do not bioaccumulate in the food web and are not expected to bioconcentrate in plant tissue.

0 Steelmaking slag may be applied safely in aquatic environments such as rivers, lakes and streams without impacting water quality or aquatic life. Such aquatic environments normally provide sufficient dilution (at least

1.000-fold) to protect against possibly elevated pH levels and, in the case of EAF slag, potential concentrations of aluminum and barium. Care should be taken when applying slag in smaller aquatic bodies where low water flow conditions exist, such as wetlands or shallow ditches.

III. REGULATORY TREATMENT

Neither the federal government nor any states currently regulate steelmaking slag as a hazardous waste. At the federal level, slag that is processed and sold is not regulated as a solid or hazardous waste by EP*A*.

Steelmaking slag is addressed more directly under the regulatory systems of key slag producing states. RCRi\ provides individual states with broad discretionary authority to fashion regulatory programs governing non-hazardous "solid wastes" pursuant to relatively general federal guidance. Consequently, such state programs differ widely in terms of both the scope of regulated materials and substantive requirements. Generally, steelmaking slag either is specifically exempted from the state definition of "solid waste" or labeled as a "coproduct" that is not a waste. Some of the more prominent state regulations that affect steelmaking slag are highlighted below.

A. Pennsylvania

The Pennsylvania system is notably complex and has been discussed as a potential national model. Under Pennsylvania's residual waste management regulations, steelmaking slag producers and processors have secured determinations from the state Department of Environmental Protection ("DEP")[17/] that their slag is a "coproduct" --

16/ The definition of "solid waste" is set forth in 40 C.F .R. § 261.2. BF and BOF slags are excluded specifically from the federal definition of "hazardous waste" under the Bevell Amendment. *See* 40 C.F .R. § 261.4(b)(7). EAF slag also does not exhibit any of the characteristics of a hazardous waste, as the risk assessments discussed above demonstrate. *See* 40 C.F .R. § 261.3(a). The U.S. Fourth Circuit Court of Appeals, in *Owen Electric Steel Co. of South Carolina v. Browner,* 37 F .3d 146 (1994), found that slag processing areas may be considered solid waste management units under the Resource Conservation and Recovery Act ("RCRi\ "). The court's ruling does not affect slag that is processed and sold.

rather than a "byproduct" or "waste" subject to regulation -- when used in place of natural aggregate in certain applications. A "coproduct" is defined as a:

> *material generated by a manufacturing or production process, or an expended material, of a physical character and chemical composition that is consistently equivalent to the physical character and chemical composition of an intentionally manufactured product or produced raw material, if the use of the material presents no greater threat of harm to human health and the environment than the use of the product or raw material.*

25 Pa. Code § 287.1 (I997).[18/] The "coproduct" definition also specifies that the term only applies if the material is "transferred in good faith as a commodity in trade" or "to be used by the manufacturer or producer of the material" in lieu "of an intentionally manufactured product or produced raw material, without processing that would not be required of the product or raw material, and the material is actually used on a regular basis." 25 Pa. Code §§ 287.1 (1997).

Current regulatory practice in Pennsylvania requires slag producers or processors to demonstrate a rough equivalency in terms of chemical consistency and performance between the proposed coproduct and the natural aggregate (or other product) that it would replace. Recently, the Pennsylvania Environmental Quality Board proposed amendments to these regulations intended to clarify the coproduct determination process. *See* 28 Pa. Bull. 4,073 (Aug. 15, 1998). DEP has indicated that the agency is pleased with the status of slag as a coproduct and that the intent of the proposal is not to impose additional burdens on slag coproduct determinations.[19/]

17/ Formerly, the Pennsylvania Department of Environmental Resources ("DER").

18/ Pennsylvania defines "product" as a "commodity that is the sole or primary intended result of a manufacturing or production process." 25 Pa. Code § 287.1.

19/ The existing language of the proposed amendments could make the coproduct showing stricter by requiring that a coproduct not contain levels of hazardous constituents in excess of natural aggregate (or another product/material) that slag is intended to replace. However, the preamble to the proposed amendments states that the addition of new section 287.8 ("Coproduct Determinations") is intended to clarify existing DEP procedure. In addition, slag processors in

(continued...)

B. Michigan

Michigan law provides a simple exclusion for "slag" from its definition of solid waste. The statute provides that the definition of solid waste does not include "slag or slag products directed to a slag processor or to a reuser of slag or slag products." Mich. Compo Laws § 324.11506(I)(f). "Slag" is defined as "the nonmetallic product resulting from melting or smelting operations for iron or steel." *Id.* § 324.11505(8). Under this system, slag may be used in a variety of applications -- industrial, construction, residential, or agricultural -- without the need to navigate or comply with extensive administrative requirements or regulations.

C. Ohio

The State of Ohio also broadly excludes "slag and other substances that are not harmful or ,. inimical to public health" from the definition of solid waste. Ohio Admin. Code § 3745-27-01(40).[20/] Ohio EPA also has established an "interim policy" that encourages the use of steel/blast furnace slag in asphalt and concrete. *See* Division of Surface Water, Ohio EPA, Interim Final Policy DSW 0400.027, *Use of Blast Furnace and Steel Slag* (June 1, *1995).*[21/] The policy also notes that blast furnace slag generally does not present environmental problems when used as a construction

19/ (...continued)
Pennsylvania have commented that, for existing slag coproduct demonstrations, they already have demonstrated that slag presents no greater threat of harm than natural aggregate.

Also, proposed section 287.9 would grant DEP the authority to make industry-wide coproduct determinations for classes of material, if certain criteria are met. Steelmaking slag would be a candidate for such an industry-wide determination given the large number of existing specific coproduct determinations for steelmaking slag.

20/ Ohio's definition of "solid waste" also is notable in its emphasis on *"unwanted* residual solid or semisolid material as results from industrial, commercial, agricultural, and community operations . . .." *Id.* (emphasis added). Given the many current and potential uses of slag described in the risk assessments (see below), steelmaking slag clearly is not an "unwanted" material. In fact, it has substantial economic value and is a valuable product.

21/ While the interim policy expired on May 31, 1996 according to its original terms, in practice Ohio EP A has stated that the policy still is in effect. Ohio EP A currently is attempting to incorporate the policy into its solid waste rules.

material, but should meet certain analytical requirements if used in aquatic environments with poor drainage. Ohio EPA also requires that the processing, stockpiling, and storage of steel/blast furnace slag meet applicable environmental regulations pertaining to dust control and storm water runoff.

D. Indiana

Steelmaking slag arguably[22/] is subject to the solid waste land disposal regulations in the Indiana Administrative Code, specifically as a solid waste resulting from iron and steel manufacturing or foundries under the definition of "industrial process waste." 329 Ind. Admin. Code. 10-2-95(5). However, the use of steelmaking slag is exempted from these regulations if the use is "legitimate." *See* 329 Ind. Admin. Code. 10-3-1(13). Specified legitimate uses include "use as a base for road building." *Id.* Other uses of steelmaking slag, including for land reclamation. may be approved upon a determination that such uses do not pose a threat to public health or the environment. *Id.* 10-3-1(15).

E. Illinois

Similar to Indiana's regulatory system, the State of Illinois exempts certain uses of steelmaking slag from its requirements for steel industry wastes. *See* 35 Ill. Admin. Code § 817.10 I. The regulations do "not apply to the not otherwise prohibited use of iron and steelmaking slags, including the use as a base for road building. . . [or] to the use or reuse of iron and steelmaking slags . . . as ingredients in an industrial process to make a product." *Id* § § 817.10 I (c) and (f). The sizing, shaping, and, sorting of slag by slag processors should be considered such an "industrial process" to make a product -- namely steelmaking slag as a replacement for natural aggregate in various construction, industrial, residential, or agricultural applications. For land reclamation purposes,

22/ Because steelmaking slag, in fact. is a useful product of the steelmaking process, it should I not be considered a waste. Therefore, steelmaking slag should not be covered by the Indiana or other state solid waste regulations.

steelmaking slag only may be used upon a demonstration that such use will not cause an exceedence of applicable groundwater standards. *Id* § 817.10 I (e). Uses of steelmaking slag not exempt under the above provisions must meet the maximum allowable leaching concentrations ("MALCs"), based on federal National Primary/Secondary Drinking Water Standards, specified in section 817.106 for beneficially usable wastes. *See id* § 817.201. If these standards are met, the steelmaking slag then only may be used as a substitute for commercially available materials. */d* § 817.202(a).

CONCLUSION

Steelmaking slag -- specifically slag generated from EAFs. BOFs, and BFs during the iron/steel making process -- has many important and environmentally safe uses. In many applications, due to its unique physical structure, slag outperforms the natural aggregate for which it is used as a replacement. Hence, not only does slag offer a superior material for many construction, industrial, agricultural, and residential applications, but the use of slag promotes the conservation of natural resources. As a result, the market for slag has remained strong and, as further applications are promoted, is expected to grow. The existence of this market and the broad variety of potential uses offered by steelmaking slag demonstrate that it is clearly a safe, useful and valuable product and not a "solid waste."

State and federal regulatory systems should recognize the value of steelmaking slag as a *product* and remove unnecessary and burdensome administrative requirements that may constrain its marketability. Many state regulatory systems, including those of Pennsylvania, Illinois, and Indiana. Michigan, and Ohio -- states that account for over 50 percent of the steel produced in the United States and that have substantial experience in the production and use of slag -- already have made substantial movement in this direction and appear to recognize the value of steelmaking slag as a product. The three risk assessments described in this document provide ample evidence of the insignificant risk posed by steelmaking slag to human health and the environment, and support further easing of state and federal regulatory requirements. In sum, steelmaking slag is an environmentally safe product and, considering its superior performance to natural aggregate, its further use should be encouraged.

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For further information on steelmaking slag, the Steel Slag Coalition, or the slag risk assessments, please contact John Wittenborn or Joe Green of Collier, Shannon, Rill & Scott, PLLC, at (202) 342-8400.

SSC Study Applications

Application Number	Uses of Steel Slag	Scenario	Exposure Pathway
Application 1	a) Anti skid b) Stabilized shoulders c) Bank Stabilization d) Gabion and riprap e) Railroad ballast	Construction	Soil Ingestion Dermal Contact Particulate Inhalation
		Maintenance	Soil Ingestion Dermal Contact
Application 2	f) Aggregate base g) Disposal slag from highways, etc h) Landfill daily cover material	Construction	Soil Ingestion Dermal Contact Particulate Inhalation
		Maintenance	Soil Ingestion Dermal Contact
Application 3	i)Unpaved driveways, roads, and walkways j) Landscape Aggregate k) Fill	Residential	Soil Ingestion Dermal Contact
		Industrial	Soil Ingestion Dermal Contact
		Construction	Soil Ingestion Dermal Contact Particulate Inhalation
		Maintenance	Soil Ingestion Dermal Contact
Application 4	l) Limestone for mine/industrial	Industrial	Soil Ingestion Dermal Contact
Application 5	m) Agricultural uses	Farmer (adult only)	Particulate Inhalation Soil Ingestion Dermal Contact

Application 6	n) Controlled, granular fill	Industrial	Soil Ingestion Dermal Contact
		Construction	Soil Ingestion Dermal Contact Particulate Inhalation
Application 7	o) Various uses at steel mills	Industrial	Soil Ingestion Dermal Contact
		Construction	Soil Ingestion Dermal Contact Particulate Inhalation
		Maintenance	Soil Ingestion Dermal Contact
Application 8	p) Trench aggregate drain fields	Construction	Soil Ingestion Dermal Contact Particulate Inhalation
		Maintenance	Soil Ingestion Dermal Contact
Application 9	q) Sand blast grit	Construction	Soil Ingestion Dermal Contact