United States Environmental Protection Agency

Assessing the Management of Lead in Scrap Metal and Electric Arc Furnace Dust

Final Report

EPA530-R-09-004

April 2009

U.S. Environmental Protection Agency
Office of Resource Conservation and Recovery

With assistance from:
ICF International
1725 I Street, Suite 1000
Washington, DC 20006
(202) 862-1100

Table of Contents

Assessing the Management of Lead in Scrap Metal and Electric Arc Furnace Dust

List of Acronyms

AISI – American Iron and Steel Institute
ARA – Automotive Recyclers Association
BOF – Basic Oxygen Furnace
BOP – Basic Oxygen Process
C&D – Construction and Demolition
CMRA – Construction Materials Recycling Association
CZO – Crude Zinc Oxide
EAF – Electric Arc Furnace
EPA – (United States) Environmental Protection Agency
HTMR – High Temperature Metals Recovery
ISRI – Institute of Scrap Recycling Industries
NDA – National Demolition Association
NESHAP – National Emission Standards for Hazardous Air Pollutants
RCC – Resource Conservation Challenge
RCRA – Resource Conservation and Recovery Act
REACH – Registration, Evaluation and Authorization of Chemicals
ROHS – Restriction of Hazardous Substances Directive
SMA – Steel Manufacturers Association
SRI – Steel Recycling Institute
TCLP – Toxicity Characteristic Leaching Procedure
TRI – Toxic Release Inventory
TSCA – Toxic Substances Control Act
TSDF – Treatment, Storage and Disposal Facility
WEEE – Waste Electrical and Electronic Equipment Directive
XRF – X-Ray Fluorescence Analyzer

Foreword

The following study investigates the sources of lead in ferrous scrap metal and potential methods for increasing the recovery of lead. This study was conducted by the Office of Resource Conservation and Recovery (ORCR) based on the interest from state and federal environmental agencies, as well as industry who all recognize that large quantities of lead end up in K061 and is not recovered. There is a mutual desire to capture a valuable commodity and reduce a hazardous constituent of a listed waste. This investigation revealed:

- The residual (contaminant) lead content of ferrous metal scrap can be controlled by electric arc furnace (EAF) operators to some extent; however, the majority of lead content comes from the alloyed lead in ferrous products.

- While there are opportunities at specific facilities to remove residual (non-alloyed) lead, there does not seem to be any unknown lead sources that could be easily identified and separated from scrap to significantly reduce the lead content of K061.

- Reducing the amount of lead in products that can potentially enter the ferrous metal scrap stream seems to be the most feasible and cost effective method of managing lead in scrap.

- Finally, this study outlines for industries in the scrap metal supply chain best practices for managing lead in scrap metal.

The EPA intends to post this study in its entirety on our website to inform future waste minimization activities in both the public and private sectors.

Executive Summary

This study was conducted by EPA's Office of Resource Conservation and Recovery (ORCR) to investigate potential methods for reducing the lead content of scrap metal used as a raw material in Electric Arc Furnaces (EAFs), thereby potentially reducing the lead content of the EAF air emission control dust/sludge (listed as K061 RCRA hazardous waste) generated from EAF operations. Section 1 of this report describes the organization of the report into six sections and four appendices.

Section 2 provides Background information that sets the stage for this study. EAFs use ferrous metal scrap, rather than iron ore, as a raw material, and lead contained in the scrap metal becomes largely incorporated into the EAF dust. This study focused on existing practices and procedures to segregate out lead-containing materials from the ferrous metal scrap stream and potential practices and procedures for management of the lead in scrap metal to further reduce the amount of lead in K061. The study also considered the economic feasibility of further mitigation.

Section 3 provides a Description of the Study Methodology. The objective of the study was to identify the primary sources of lead in scrap metal that contribute to the lead content in K061 and to answer "with statistical significance" questions about lead in scrap metal and lead in K061, including:

- What is the average lead content in K061?
- What is the range of variability?
- How has this average varied historically?
- Can trends be identified that would be responsible for this variation?
- How well can spikes in the concentration of lead in K061 be associated with particular scrap grades charged to a furnace?

Information for the study to address these questions was obtained through a review of published information concerning the characteristics of K061, review of existing studies, [1] and interviews with trade associations and individual company representatives in the scrap metal supply industry, iron and steel manufacturing industry, automobile parts industry, and primary and secondary lead industries.

Section 4 describes Data Gaps and Limitations of the Study. This study provides data concerning the characteristics of K061, the characteristics of scrap metal, and EAF steel production. However, a principal finding of the study is that sufficient data are not available to identify a statistically verifiable relationship between the lead content of K061 and the lead content of the scrap sources and scrap processed. EAF operators indicated either that data are not collected to a sufficient degree to enable a reliable correlation between the types or sources of scrap metal and lead concentrations, or that the scrap metal streams are too variable to enable conclusive definition of their relative contributions to the lead content of K061.

Section 5 provides an overview of Lead in Material Flows, including potential sources of lead in products potentially entering the ferrous metal scrap stream and specific types (grades) of ferrous metal scrap likely to contain lead or lead materials. Sources of lead in products potentially entering the ferrous metal scrap stream include:

- Scrap Automobiles containing batteries; battery terminals; leaded-steel parts (e.g., bearing metal); cast metal parts, etc.
- Structural Steel (containing lead-based paint)
- Construction and Demolition (C&D) Materials (including roofing materials, counterweights, sheet steel, pipes, lead-based paint)
- Cast Metal and Leaded Steel Components (e.g., bearing metal)
- Turnings and Borings (e.g., from steel product fabrication)
- Electronics Components (e.g., solder)
- Foreign Import Products (e.g., package strapping, steel cans)

Scrap metal feed streams (based on the Institute of Scrap Recycling Industries (ISRI) scrap specifications) to EAFs include:

- Shredded scrap (mostly shredded automobiles)
- No. 2 heavy melt steel (over 1/8 inch thickness)
- No. 1 heavy melt steel (over ¼ inch thickness)
- No. 1 busheling (sheet clippings, stampings, etc.)
- No. 1 bundles (No. 1 steel cut to furnace charge box size)
- Cut structural and plate steel
- Turnings and borings
- No. 2 bundles
- Other (e.g., steel cans)

Section 6 contains a description of Industry Processes for Potential Lead-bearing Scrap, and identifies practices and procedures, including best practices, being applied by scrap metal generators, scrap metal recyclers, and EAF operators for managing lead in scrap. These include visual inspection of scrap loads and magnetic or other types of physical separation. One finding of this study is that various grades of ferrous metal scrap, including shredded scrap, heavy melt steel, busheling, and turnings and borings have the potential to contain lead or lead materials. EAF operators therefore can control the types (grades) and quality of ferrous metal scrap that they accept (e.g., turnings and borings) to control the amount of lead in the ferrous metal scrap feed to the EAFs.

Section 7 provides a Summary of the Study Findings. One principal finding of the study is that automobile dismantlers, automobile shredders, scrap metal recyclers, and EAF operators generally believe that they are already recovering the lead-containing material that is feasible for them to separate from the ferrous metal scrap stream, and that identifying, segregating, and recovering additional lead-containing material either would be technically infeasible or would not be cost effective. Study contacts indicated that the most feasible method of reducing the amount of lead in ferrous metal scrap, and the amount of lead in EAF dust, would be to reduce the amount of lead used in products that could potentially enter the ferrous metal scrap stream. Study contacts also indicated that they considered it unlikely that further efforts to reduce the amount of lead in ferrous metal scrap would result in the reduction of the lead content of K061 to below TC toxicity levels, although unless delisted the K061 would still be considered a hazardous waste. This conclusion is supported by the EAF dust lead concentration data and EAF operating data; the average lead concentrations in EAF dust are a factor of ten (10) higher than the concentration that would correspond to the RCRA waste characterization toxicity level.

Section 8 provides an overview of further actions that can be taken to investigate lead reduction and separation strategies and lead recovery strategies to reduce the amount of lead in scrap feed to EAFs and thereby potentially reduce the lead content of EAF dust. These include establishing initiatives to reduce the amount of lead used in products potentially entering the ferrous metal scrap stream, and investigating the cost and effectiveness of improved separation and recovery strategies for lead and lead-containing materials in the ferrous metal scrap stream.

Appendix A includes a list of Study Contacts. Appendix B is a summary of Lead Consumption and Scrap Metal Consumption Data, Appendix C is a summary of Federal K061 Delisting Actions, and Appendix D contains a Glossary of terms used in this report.

1. Introduction

This study was conducted by EPA's Office of Resource Conservation and Recovery (ORCR) to investigate potential methods for reducing the lead content of scrap metal used as raw material in Electric Arc Furnaces (EAFs), thereby potentially reducing the lead content of EAF air emission control dust/sludge (listed as K061 RCRA hazardous waste and referred to hereafter as "EAF dust") generated from EAF operations. The remainder of the report is organized into six sections and four appendices. Specifically:

- Section 2 provides Background information that sets the stage for this study.
- Section 3 provides a Description of the Study Methodology.
- Section 4 describes the Data Gaps and Limitations of the Study.
- Section 5 provides an overview of Lead in Material Flows.
- Section 6 contains a description of Industry Processes for Potential Lead-bearing Scrap, and identifies practices and procedures, including best practices, being applied by scrap metal generators, scrap metal recyclers, and EAF operators for managing lead in scrap.
- Section 7 provides a Summary of Study Findings.
- Section 8 provides an overview of further actions that can be taken to investigate lead reduction and separation and recovery strategies to reduce the amount of lead in scrap feed to EAFs and thereby potentially reduce the lead content of EAF dust.

Appendix A includes a list of Study Contacts, Appendix B is a summary of Lead Consumption and Scrap Metal Consumption Data, Appendix C is a summary of Federal K061 Delisting Actions, and Appendix D contains a Glossary of terms used in this report.

2. Background

EPA created the Resource Conservation Challenge (RCC) as a national effort to identify innovative methods to conserve and protect natural resources, and is moving from a cradle-to-grave approach for waste management to a cradle-to-cradle approach for materials management, with the objective of safely recycling and reusing industrial residuals and by-products as material inputs. The National Partnership for Environmental Priorities (NPEP), a component of the RCC, focuses on hazardous materials management and encourages public and private organizations to form voluntary partnerships with EPA to reduce the use or release of 31 chemicals considered a priority by EPA due to their persistent, bio-accumulative, and toxic properties. NPEP focuses on both source reduction - eliminating the use and generation of toxic materials – as well as the recycling of toxic materials that are generated. Recycling is facilitated when the presence of toxic materials are minimized. The focus of this study is on lead, the priority chemical generated in the largest quantity. In 2006, a total of approximately 499 million pounds (approximately 226,000 metric tons) of lead and lead compounds was reported disposed or otherwise released to the environment, according to EPA's Toxic Release Inventory (TRI). However, a much larger quantity, 643 million pounds, was recycled.

One category of hazardous waste containing lead is EAF dust. EAFs use scrap metal, rather than iron ore, as a raw material, and lead contained in the scrap metal is volatilized, captured by air pollution control devices, and incorporated into K061, usually as a dry dust instead of a wet sludge. Approximately 900,000 metric tons of EAF dust is generated annually in the U.S. of which 600,000 metric tons is further processed for metals recovery (primarily zinc) at Horsehead Corporation facilities in the U.S., while the remainder (300,000 metric tons) is either treated prior to disposal in landfills or exported. Zinc Nacional, S.A. (Monterrey, Mexico), a zinc products producer, also operates an EAF dust metals recovery facility.[2] In 2006, approximately 160,000 short tons (145,000 metric tons) of K061 were exported from the U.S. to Mexico.[3]

EAF dust was listed by EPA as an industry-specific hazardous waste based on the presence of hexavalent chromium, lead, and cadmium.[4] Cadmium, lead, and chromium are the primary hazardous constituents contained in EAF dust generated from carbon steel production. Chromium and nickel also are present in higher quantities in EAF dust generated from stainless steel production. EAF dust generated from carbon steel production can contain on the order of 1.5 percent lead and also can contain chromium, cadmium, and other metals. However, the composition of EAF dust varies widely depending on the types of raw materials used in the EAF and use of furnace additives.[5] For example, one EAF dust processor reported EAF dust containing approximately 8 percent lead, 25 percent iron and 25 percent zinc.[6] Typical lead TCLP concentrations for EAF dust reported by EAF operators ranged from 100 – 500 ppm (mg/l).

Note that the total metal concentration in EAF dust and the TCLP metal concentration of EAF dust are not the same. The TCLP procedure is a leaching procedure that is intended to measure the amount of a metal (e.g., lead) that can leach from the material, and not the total concentration of the metal in the material. The EPA protocol for the TCLP method indicates that if a material is a solid, the maximum leachable TCLP concentration of a constituent can be calculated by dividing the concentration of the constituent in the solid by a factor of 20, although this assumes that all lead in the solid will leach out, which is unlikely to occur. This factor is derived from the liquid/solid ratio that is inherent in the TCLP analytical method.[7] Therefore for EAF dust having a total lead concentration of 15,000 mg/kg (1.5 percent), the maximum leachable concentration of lead would be 750 mg/liter.

The study focused on existing practices and procedures to segregate lead-containing materials from the ferrous metal scrap stream and potential practices and procedures for management of lead in scrap metal to further reduce the amount of lead in K061. The study also considered the economic feasibility of further mitigation.

3. Description of Study Methodology

The objective of the study was to identify the primary sources of lead in scrap metal that contribute to the lead content in EAF dust (K061) generated from the production of steel in electric arc furnaces and to answer “with statistical significance” questions about lead in scrap metal and K061, including:

• What is the average lead content in K061?
• What is the range of variability?
• How has this average varied historically?
• Can trends be identified that would be responsible for this variation?
• How well can spikes in the concentration of lead in K061 be associated with particular scrap grades charged to a furnace?

Information for the study to address these questions was obtained through a review of published information concerning the characteristics of K061, review of the draft Report on Lead and Mercury Flows in Iron and Steel Production, [8] and interviews with trade associations and individual company representatives in the automobile dismantling, scrap metal recycling, iron and steel manufacturing, automobile parts, and primary and secondary lead industries.

Review of Published Information

A review of published data for K061 was conducted, including data from EPA databases such as *RCRAInfo* [Resource Conservation and Recovery Act Information System (RCRIS) and Biennial Reporting System (BRS)]. The objective of this review was to assess the range of composition and other characteristics of K061, the sources that generated the scrap metal, and its methods of management.

In addition, a review of hazardous waste delisting actions pursued by K061 hazardous waste generators was conducted, including delisting actions published by EPA, and delisting actions published by the state environmental regulatory agencies. The objective of this review was to identify generators that have pursued delisting actions, which actions were successful, and identify potential correlations with process data for the delisted hazardous waste generators.

Furthermore, a review was conducted of print and online metal recycling trade journals identified by trade association/industry contacts (e.g., *Scrap*, published by the Institute of Scrap Recycling Industries (ISRI)). The objective of this review was to assess whether these publications contain relevant information for the study.

Review of Report on Lead and Mercury Flows

A Draft Report on Lead in Scrap Metal and Mercury Flows was reviewed. The objective of this review was to identify potentially significant lead flows into the scrap metal stream and identify potential sources of additional data for the study. Note that the Final Report had not been released as this report was being prepared; therefore, the review used the Draft Report and EPA and other external comments on the Draft Report. This report was sponsored by EPA's Great Lakes Program in Region 5. [9]

Trade Association and Industry Contacts

A list of initial trade association and industry contacts was identified, in part using EPA's Office of Resource Conservation and Recovery (ORCR) contacts developed from a previous phase of this study, and in part through research into the generation and flow of scrap metal from the sources that generated the scrap metal to the EAFs. The initial list of contacts included trade association and industry contacts in the following industry sectors:

- Automobile Dismantlers
- Automobile Shredders
- Construction and Demolition (C&D) Materials/Scrap Processors
- Ferrous and Non-ferrous Scrap Metal Facilities (other than Automobile Shredders)
- Ferrous Metal Foundries and Steel (EAF) Mini Mills

Telephone interviews were conducted with these contacts, and an in-person meeting was conducted with the Steel Manufacturers Association (SMA) and several of their member companies. These interviews and additional research led to the identification of other industry and trade association contacts that were then interviewed. These additional contacts included the non-ferrous scrap metal and secondary lead smelting sectors. A list of the initial and additional industry and trade association contacts is included in Appendix A. The SMA consolidated data from eight SMA member EAF operators so operating data for individual member companies could not be identified by company name. Another separate EAF operator was contacted and also provided operating data.

Research and interviews with contacts focused on identifying the flows of scrap material from sources that generated the scrap metal (e.g., automobile dismantlers, construction/demolition operations) to the facilities (e.g., Basic Oxygen Furnaces (BOFs), EAFs, Iron Foundries) where the scrap is reprocessed into steel (and where K061 and other potentially lead-containing residuals are generated) and on identifying the characteristics of the scrap material flows and residuals. Scrap material flows researched included home scrap (i.e., scrap generated at the steel mills); prompt scrap (i.e., scrap generated by manufacturers of iron and steel products) and post-consumer scrap (e.g., automobiles, appliances, C&D scrap).

Information concerning scrap generation, management, and processing obtained from trade association and industry contacts and from supplemental research was also assessed for the purposes of identifying the "best practices" for the scrap generation, scrap supply, and scrap processing sectors. Similarly, practices and procedures for the management of K061 were assessed to identify "best practices" and also to assess the relationship between the characteristics of the K061 generated by EAFs and the characteristics of the scrap processed by the EAFs.

EPA recently promulgated regulations concerning the control of hazardous air pollutants from stainless steel and non-stainless steel EAFs and from steel and iron foundries. [10, 11] These regulations establish requirements for management of scrap at EAF and foundry facilities to control emissions of mercury, lead, and other hazardous air pollutants. The effects of these regulatory requirements are also considered in this study, along with standard industry practices and best practices.

4. Data Gaps and Limitations of the Study

Some questions concerning specific practices and procedures for the management of lead in scrap metal touched on possible business confidentiality issues. Industry trade associations, including the SMA and ISRI indicated that the best approach to address the study questions, while avoiding their members' confidentiality concerns, was for the trade associations to aggregate responses from individual member companies. In such cases, trade associations (e.g., ISRI, SMA) are cited in this report to protect confidentiality interests.

This study provides data concerning the characteristics of K061, including its lead content, data concerning the characteristics of scrap, and operations data for EAF steel production. However, a principal finding of the study is that sufficient data are not available to identify a statistically verifiable relationship between the lead content of K061 and the lead content of the scrap sources and scrap processed. EAF operators indicated either that data are not collected to a sufficient degree to enable a reliable correlation between the types or sources of scrap and lead concentrations, or that the scrap metal streams are too variable to enable conclusive definition of their relative contributions to the lead content of the K061. Several EAF operators also indicated that collecting a sufficient amount of data to assess trends in the concentration of lead in K061 would not be feasible and, even if sufficient data were to be collected, any trends in lead concentration data would likely remain inconclusive. One reason for this is that the overall lead content of the scrap metal processed in EAFs is low and the lead in scrap is "widely dispersed and in low-concentration materials," as opposed to being primarily in relatively large, visually identifiable items. This is because items that may contain lead are – generally – already being removed from the scrap stream using visual inspection and manual sorting procedures. Therefore, attempts were not made to conduct a statistical analysis of the available data concerning the characteristics of EAF dust and the characteristics of scrap processed in EAFs.

5. Lead in Scrap Material Flows

This section describes the flow of lead in scrap material, including lead and lead products, ferrous metal scrap, non-ferrous metal scrap, electric arc furnace operations, and EAF dust treatment and disposal.

5.1. Lead and Lead Products

Sources of lead in products potentially entering the ferrous metal scrap stream include:

- Scrap Automobiles (containing batteries; battery terminals; leaded-steel parts (e.g., bearing metal); cast metal parts)
- Structural Steel (containing lead-based paint)
- Construction and Demolition (C&D) Materials (including roofing materials, counterweights, sheet steel, pipes, lead-based paint)
- Cast Metal and Leaded Steel Components (e.g., bearing metal)

- Turnings and Borings (e.g., from steel product fabrication)
- Electronic Components (e.g., solder)
- Foreign Import Products (e.g., package strapping, steel cans)

Approximately 90 percent of U.S. lead consumption is for storage batteries. In 2006, approximately 2 percent of U.S. lead consumption was used in the production of cast metal parts, including vehicle parts; 1.5 percent in other metal products; and 1.0 percent in coatings and other lead oxide applications. Leaded steel is approximately two percent of total steel production in the U.S.; leaded steel is used in bearings and machined parts. In 2006, only approximately 0.1 percent of U.S. lead production was used in bearing metals. Leaded-steel contains between 0.15% and 0.35% lead according to AISI specifications. Conventional non-leaded steel contains <0.01% lead.

Vehicle batteries and battery components, which are not difficult to remove from scrap vehicles, have higher value as non-ferrous metal scrap; therefore, these leaded materials are mostly removed either at automobile dismantler facilities or automobile shredder facilities. Batteries and battery components enter the non-ferrous metal (lead) scrap stream. Other vehicle components, e.g., lead-containing bearings and cast metal parts, are more difficult to locate and remove from the vehicles and are generally not removed prior to crushing or shredding of the vehicles. Lead-containing components of white goods (appliances), machinery, and other scrap that may also be shredded at automobile shredder facilities would also generally not be removed prior to crushing or shredding.

The use of lead in most product applications other than storage batteries and cast metal and other metal products has declined sharply in the past 15 years, as indicated by U.S. Geological Survey (USGS) data for 1993 and 2006 (see Table 5-1). Applications for which U.S. lead consumption has declined include bearing metals, brass and bronze, extruded products (e.g., pipes) sheet lead and solder for building construction, and lead oxide applications, including pigments. Some of the domestically produced lead-containing products (e.g., electronic components containing lead solder) may have been replaced by similar imported products that would not be reflected in U.S. lead consumption data; therefore the amount of lead entering the scrap metal stream may not be completely represented by U.S. lead consumption data.

As shown in Table 5.1, approximately 30,000 metric tons of lead was used in cast metal parts in 2006 and approximately 23,000 metric tons of lead was used in other metal products. Lead wheel weight quantities would likely be contained in "Other Metal Products" or "Miscellaneous Uses." Because there are so few manufacturers, this product category is not broken out by USGS for proprietary reasons. Some of these products, like wheel weights, would be segregated into the non-ferrous metal scrap stream, but others could remain in vehicles or other products entering the ferrous metal scrap stream. If all of this lead entered the ferrous metal scrap stream (approximately 50 million metric tons of scrap), it would result in an overall lead concentration of approximately 0.1 percent in ferrous metal scrap. Approximately 20 kilograms of EAF dust are generated per metric ton of steel produced, [12] or approximately 28 kilograms of EAF dust per metric ton of ferrous metal scrap charged. Assuming that 100 percent of the lead in the ferrous metal scrap ended up in the EAF dust, the 0.1 percent of lead in the ferrous metal scrap would correspond to a concentration of approximately 3.7 percent lead in the EAF dust. Nine companies reported the lead composition of EAF dust through the SMA, and one other company provided EAF composition data. Based on data received from these ten companies, the average lead content of K061 ranges from 800 mg/kg to 19,850 mg/kg lead, with the average EAF dust lead content (from 26 individual data points) of approximately 7,100 mg/kg lead.

5.2. *Ferrous Metal Scrap*

The flow of ferrous scrap metal feed streams to EAFs is shown in Figure 5-1. Scrap metal grades charged to EAFs include:

- Shredded scrap (mostly shredded automobiles)
- No. 2 heavy melt steel (over 1/8 inch thickness)
- No. 1 heavy melt steel (over ¼ inch thickness)
- No. 1 busheling (sheet clippings, stampings, etc.)
- No. 1 bundles (No. 1 steel cut to furnace charge box size)
- Cut structural and plate steel
- Turnings and borings
- No. 2 bundles
- Other (e.g., steel cans)

TABLE 5-1
U.S. CONSUMPTION OF LEAD, BY PRODUCT[1]
(Metric tons, lead content)

Product	**1993**	**2006**	**1993**	**2006**
Ammunition, shot and bullets	65,100	65,300	5.05%	4.19%
Bearing Metals (1)	4,830	1,240	0.37%	0.08%
Brass and bronze, billets and ingots	5,750	2,620	0.45%	0.17%
Casting Metals (2)	18,500	29,900	1.43%	1.92%
Cable covering	17,200	Not reported	1.33%	NR
Calking lead (buildings)	961	Not reported	0.08%	NR
Pipes, traps, other extruded products:	5,740	845	0.44%	0.05%
Sheet Lead: Building Construction	15,200	7,710	1.18%	0.49%
Sheet Lead: Storage Tanks/Medical	6,030	850	0.47%	0.05%
Solder: Electronic components, accessories and other electrical equipment	9,430	6,860	0.73%	0.46%
Solder: Motor vehicles and equipment, metal cans, building construction	4,970	280	0.39%	0.02%
Total storage batteries	1,050,000	1,400,000	81.40%	89.74%
Other metal products (3)	5,360	22,600	0.42%	1.45%
Total Pigments, glass, and ceramics	63,600	16,200	4.93%	1.04%
Miscellaneous uses	11,800	12,300	0.91%	0.79%
	1,290,000	1,566,705	99.57%	100.45%

Source: USGS Minerals Yearbook, Lead, 2006, 1994
[Numbers in this table do not add up to 100 percent because of rounding.]
(1) Includes Machinery except electrical, Terne metal, Motor vehicles and equipment, and Other transportation equipment.
(2) Includes Electrical machinery and equipment, Motor vehicles and equipment, Other transportation equipment, Nuclear radiation shielding
(3) Includes lead consumed in foil, collapsible tubes, annealing, galvanizing, plating, electrowinning, and fishing weights.

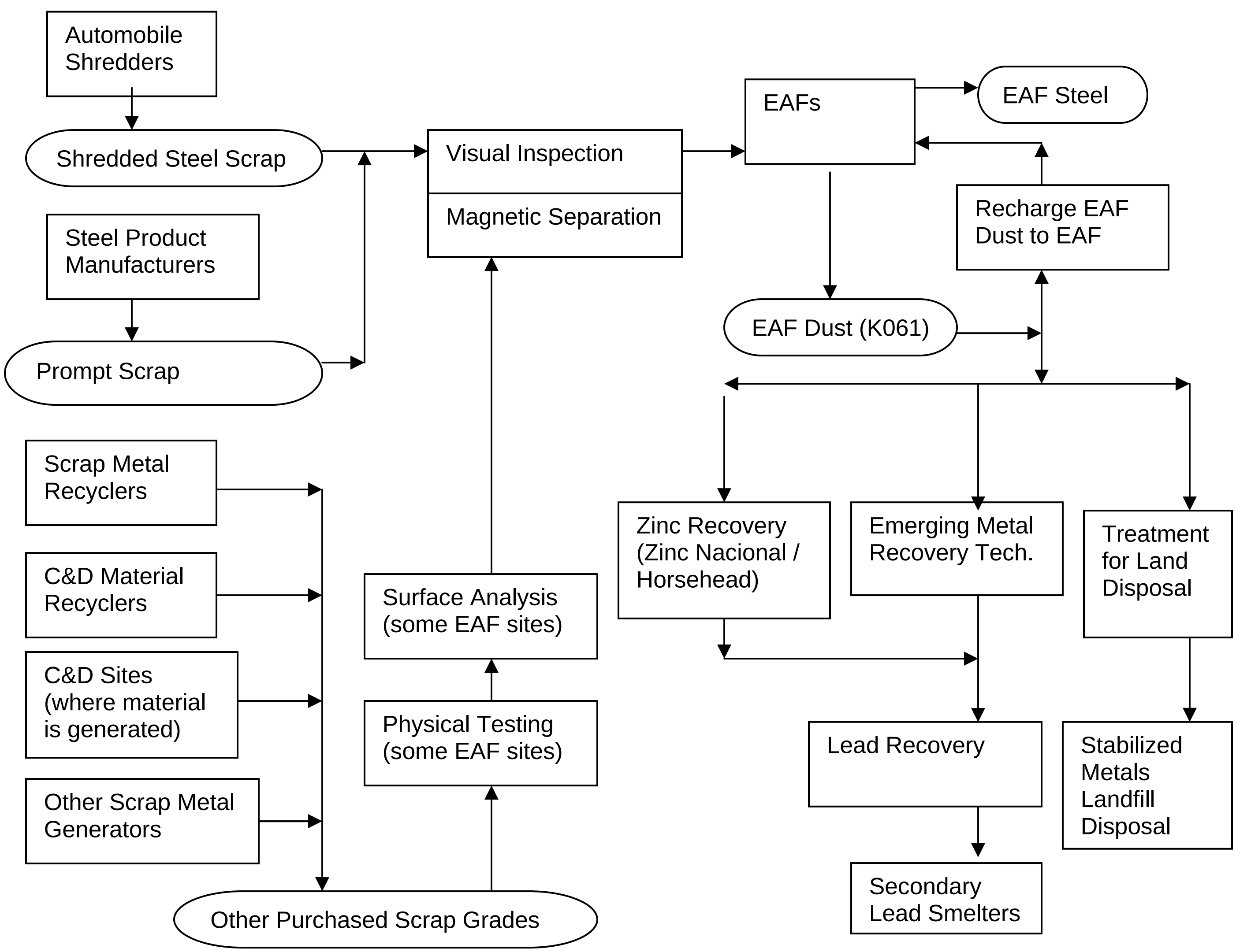
Ferrous scrap grades processed by EAFs are not typically graded with respect to lead content, although certain grades note that lead content should be limited, no numerical specifications are applied; for example No. 2 bundles, by grade, cannot contain lead-coated material, and machine shop turnings by grade are to be free of "non-ferrous metal in a free state." In addition to ferrous scrap grade specifications, individual scrap metal recyclers and EAF and BOF operators may establish site-specific specifications with their suppliers concerning the lead content of ferrous metal scrap.

For example, automobile dismantler, automobile shredder, and scrap metal recycling facilities all reported that they have established requirements that batteries and battery terminals be removed from scrap vehicles before being shredded. Scrap metal recycling facilities and EAF operators also reported that they either do not accept turnings and borings (from machined steel that is typically higher in lead content) or manage these materials separately from the general ferrous metal scrap stream. In addition, scrap metal recycling facilities and EAF operators reported that they have established procedures to segregate non-ferrous metal scrap from ferrous metal scrap through visual inspection, magnetic separation, and other means. However, even with established procedures, they indicated that some lead enters the ferrous metal scrap stream through various pathways. Both scrap metal recycling facilities and EAF operators reported that lead is widely dispersed in low concentrations in scrap containing leaded-steel parts, cast metal parts, lead-containing components, or lead-based coatings, and that these components are not readily identifiable either through visual inspection, magnetic, or other physical means and, therefore, are not readily separable from the general ferrous metal scrap stream. Most ferrous metal scrap coming to EAFs is therefore conventional steel grades that may include such components.

The range of lead content in mixed content grades of scrap like shred is unclear. (Shredded scrap is one of the most common scrap grades; it consists of any ferrous metal that has been processed through a shredder that pounds the ferrous item into fist-sized pieces.) It can be assumed this range would be lower than the average lead content of EAF furnace dust, which ranges from 1 to 2% as discussed in section 6.8.3, since the volatized lead would be concentrated in the air pollution control device. (The lead content in section 6.8.3 is the actual, measured lead content of EAF dust, whereas in the previous section and in this section the lead content is being extrapolated from assumed inputs.) Using shredded scrap as an example: rough calculation for 11,000,000 metric tons of shredded scrap generated and 1,400,000 metric tons of lead used in batteries would indicate that over 7.5% of the batteries would have to enter the shredded scrap stream to produce a lead content of 1%, based on our research. This could mean one of two things: 1) commonly quoted recycling rates for lead acid batteries (>90%) is overstated *and* a majority of this lead is lost in the ferrous metal scrap stream, or 2) lead acid batteries are not big contributors to the lead content of K061. There is some research that suggests that the recycling rates of lead-acid batteries are lower than commonly stated[13], however, mass balances reveal that high estimates of batteries lost to the ferrous metal scrap stream would still not make up a significant percentage of lead in K061. Rather, No. 1 heavy melt steel, potentially containing cast metal parts, is more likely to be a source of lead as compared to structural and plate steel or busheling (e.g., sheet clippings, stampings), according to ISRI. Also, it is reported that the amount of lead used in lead oxide applications, including coatings has decreased significantly (see Table 5-1), although lead is still used in bridge and highway paints. However, much of the structural steel entering the scrap metal market would have been erected decades ago and may have been painted with lead-based coatings when these coatings were more widely used. Therefore, although the use of lead in lead-based coatings is decreasing, there is a lag between the amount of lead being used in coatings today and the amount of lead entering the scrap metal stream in structural steel coatings. Similarly, the use of lead in building construction has also declined; however, buildings undergoing demolition today may have been constructed decades ago when lead was more commonly used in building construction for roofing materials (e.g., roof flashing and sheeting) and pipe connections.

One issue identified by ISRI is that certain types of imported steel (e.g., strapping used for shipping; steel cans) may contain more lead than similar products manufactured in the U.S.; these materials may not be easily distinguishable from domestically-produced materials and would generally not be segregated from the general ferrous-metal scrap stream. Also, such materials would not have sufficient lead content to be processed in secondary lead smelters; therefore if these materials were to be segregated they would not become part of the non-ferrous metal (lead) scrap stream.

Figure 5-1. Flow of Ferrous Scrap to Electric Arc Furnaces and Management of EAF Dust



5.3. Non-Ferrous Metal Scrap

Non-ferrous metal scrap includes lead, aluminum, red metals (e.g., copper, brass) and other metals. Lead scrap is processed at secondary lead production facilities into lead ingots, sheets, and other forms of lead. The major portion of lead to secondary lead smelters is from scrap batteries and battery terminals from vehicles. Approximately 1.4 million metric tons of lead is used in battery manufacturing (2006) and a high percent of lead used in batteries is recovered and recycled at secondary lead facilities. Lead used in vehicle wheel weights is also largely segregated from the ferrous metal scrap stream and are sent to non-ferrous metal scrap recyclers.

5.4. Electric Arc Furnace Steel Production

The approximately 60 million metric tons of ferrous metal scrap (post-consumer, home, and prompt scrap) handled by EAF and BOF steel mills annually contain only up to approximately 20,000 metric tons of lead, according to the Steel Recycling Institute (SRI). While the lead content of scrap inputs can vary widely, EAF operators mix various grades in the furnace to improve melting chemistry. Once the scrap is melted, EAF operators reported that the lead content is closely monitored because only a small amount of lead (e.g., 15 kilograms) in the scrap fed to an EAF could degrade the quality of the steel batch, known as a heat, (a typical EAF heat is 100 - 150 metric tons of steel) and result in the steel produced having to be reprocessed. In other words, only 0.015% of total lead in the heat may cause quality issues depending on the product being produced. However, EAF operators also reported that the lead in the scrap feed would primarily end up in the EAF dust rather than to the steel produced. Therefore, any lead in the scrap feed would likely be concentrated in the EAF dust. This is because lead has a lower melting point than steel. Specifically, lead melts at approximately 328 ºC; depending upon the alloy, steel typically melts at approximately 1,400 ºC. The lead content of the scrap therefore volatilizes more quickly than the steel, leading the lead to volatilize into the EAF vapor recovery system and dust collectors, where the lead becomes incorporated into the EAF dust. If the entire 20,000 metric tons of lead in the ferrous metal scrap estimated by the SRI was incorporated into the approximately 900,000 metric tons of EAF dust produced annually, this would result in the EAF dust containing approximately 2 percent lead. This is in the range of actual EAF dust lead concentrations reported by EAF operators.

5.5. EAF Furnace Dust Recycling

EAF furnace dust recycling flows are also shown in Figure 5.1. There are three methods of managing the EAF dust produced: recycling the EAF dust back into the EAF, processing the EAF dust for recovery of zinc and other metals, including lead, and treating the EAF dust by stabilization for landfill disposal. Approximately two thirds of the approximately 1 million metric tons of EAF dust produced annually is processed for metals recovery in the U.S. at Horsehead Corporation facilities; most of the rest is either treated for landfill disposal or exported to Mexico for metals recovery at Zinc Nacional facilities. There are several emerging processes, however, to treat EAF dust for metals recovery, for which facilities are under construction. The amount of EAF dust recycled into EAFs is relatively low, only one of nine EAF operators reported on-site recycling of K061 into their EAFs. There are several proposed new EAF dust metal recovery facilities in the U.S. that are anticipated to commence operation in 2008 or 2009.

5.6. EAF Dust Characteristics

Section 1.2 of the EPA protocol for Method 1311 (the TCLP method) indicates that if a material is 100 percent solid, the maximum leachable TCLP concentration of a constituent can be calculated by dividing the concentration of the constituent in the solid material by a factor of 20, as an alternative to subjecting the material to the TCLP test. (Note: This assumes that all of the lead in the solid material would leach out, which is not likely to occur.) This factor is derived from the liquid/solid ratio that is inherent in the TCLP analytical method. [14] Therefore for EAF dust having a total lead concentration of 4,000 mg/Kg, the maximum leachable concentration of lead would be 200 mg/l; for EAF dust having a total lead concentration of 1,500 mg/Kg, the maximum leachable concentration of lead would be 75 mg/l. By comparison, the TCLP leachable concentration for classification as a hazardous waste is 5 mg/l for lead. One EAF operator reported that for EAF dust, the typical TCLP concentration for lead is in the 100 – 200 mg/l range.

6. Industry Processes for Potential Lead-Bearing Scrap

This section provides a detailed description of the “key material steps” for the "industry sectors" that were contacted and how those industry sectors are connected to one another with respect to potential flows of lead into the ferrous metal scrap stream.

6.1. Lead and Lead Products

6.1.1. Primary and Secondary Lead Production

There is one primary lead production facility in the U.S. and 16 secondary lead smelters in the U.S. with production capacities greater than 10,000 metric tons per year, including battery recyclers. [15] All of the secondary lead smelters recycle batteries in addition to other types of lead scrap. [16] There are also approximately ten small secondary lead smelters operating in the U.S., with a collective production capacity of less than 10,000 metric tons per year. [17] These facilities are effectively the same type of facility operation as the larger secondary lead smelters, but are estimated to be responsible for less than one percent of U.S. secondary lead production. There are also “battery breaker” facilities that are sometimes operated in conjunction with secondary lead smelter facilities.

Secondary lead smelters were traditionally located near lead operations that recycled lead scrap from lead processing. Some battery manufacturers operate their own secondary lead smelters (either a blast furnace or a reverberatory furnace) to recycle off-spec batteries and other on-site generated lead waste. Some secondary lead smelters reported that their facilities handle only scrap batteries, while others reported that their facilities handle scrap batteries and other lead-containing scrap (e.g., pipe from non-ferrous metal recyclers).

The USGS publishes annual data for U.S. primary and secondary lead consumption. USGS data for the years 2005 and 2006 are included in Appendix B, Table B-1 and Table B-2.[18] Total lead consumption in 2006 was more than 1.5 million metric tons, and, approximately 90 percent of the primary and secondary lead consumed in 2006 was used in the manufacture of batteries. The percentage of total lead used in batteries has been increasing; from 81 percent of total consumption in 2003 to 90 percent in 2006. [19] Of the remaining 10 percent of lead consumption;

- Approximately 1 percent was "other oxides," including lead oxides used in glass, ceramics, and paints and coatings production (a category that includes structural steel coatings);
- Approximately 2 percent was used in casting metals, a category that includes cast motor vehicle parts;
- Approximately 4 percent was used in the manufacture of ammunition;
- Sheet lead for building construction and solder for equipment manufacturing each constituted approximately 0.5 percent of 2006 lead consumption, with solder used in applications other than electrical equipment (which includes solder used in motor vehicle production) at approximately 0.02 percent of the total 2006 lead consumption; and
- Bearing metals, a category that includes Terne metal and lead used in the bearings of motor vehicles and other equipment, constituted less than 0.1 percent of lead consumption in 2006.

6.1.2. Lead Products

Lead products include various types of products that are primarily lead (up to 99+ percent lead), as opposed to "leaded steel" products that are primarily steel and contain much smaller concentrations of lead (less than 1 percent lead – see Section 6.1.3). Approximately 90 percent of the lead consumed in the U.S. is used in manufacturing battery components, including automobile batteries and other types of batteries. One secondary lead manufacturer reported that 85 percent of their lead scrap is from conventional automobile batteries and 15 percent is other types of batteries and non-battery (ancillary) materials. These ancillary materials include lead pipe, automotive wheel weights, lead shielding from hospitals, and ammunition from firing ranges and stockpiles. This manufacturer also reported that 80 percent of the lead sold is to battery manufacturers.[20] Another secondary lead smelter operator reported that 90 percent of their lead scrap is from conventional automobile batteries and that the remainder included leaded glass, radiators, scrap lead from construction (e.g., lead pipe), x-ray shielding, ammunition, and miscellaneous materials (lead cables, lead printer type.) [21]

Certain lead product producers manufacture other types of lead products in addition to battery components. For example, one lead products manufacturer makes the following types of lead products:

1) Sheet lead –used in roofing (flashing), noise attenuation (casinos, sound studios, possibly multiplex theaters) and other uses;

2) Lead brick, used for radiation shielding and other uses;

3) Interlocking lead brick – same sorts of uses as sheet lead, also for shielding;

4) Cane lead – used for stained glass windows;

5) Lead solder – used for electronics, plumbing;

6) Lead shot – ammunition (99 percent of sales) and ballast, and specialty shielding applications (1 percent of sales) and;

7) Lead wool – used for lead fabric and to create seals in cast iron pipe.[22]

Lead is also a component of other products that have lower concentrations of lead. These include leaded glass, brass, counterweights, and other products. One lead product manufacturer reported that conventional leaded glass contains 5 percent lead, and that brass contains 0.2 to 0.7 percent lead. Leaded glass used in CRTs (picture tubes, computer monitors) may contain 3 to 15 percent lead. Radiation shielding glass contains 15 percent barium in addition to lead.[23] Lead in brass is added for cutting and machining properties of the material. Counterweights may be primarily lead or may be lead-coated steel. [24]

Lead is also used in manufacturing various types of coatings. Anti-rust coatings used on structural steel, including for maintenance of bridges and highways, can contain lead. However, one primary lead manufacturer indicated that lead-based primers used in automobile paint have been replaced by non-lead paint substitutes.[25] According to USGS data (as shown in Appendix B Table B-1,) lead used in paints and coatings comprised less than 1 percent of U.S. lead production in 2006. However, it should be noted that structural steel entering the ferrous metal scrap stream today may have been in service for several decades, a time when utilization of lead-based coatings was more common. ISRI reported that coated steel has not been identified as a major issue in shredded ferrous scrap materials, because lead-based paint is typically used on structural steel components that are not shredded. Coated structural steel material also may be subject to lead remediation prior to demolition, generally for the purposes of limiting potential occupational exposure to lead during demolition rather than limiting the amount of lead in the scrap. Coated structural steel material is usually sold directly to markets and sometimes this material goes directly to facilities that make leaded steel. [26]

The potential for lead products to enter the ferrous metal scrap stream varies depending upon how the product is used. As discussed below in Section 6.4, storage batteries (primarily motor vehicle batteries) are managed as non-ferrous metal scrap and form the major portion of the raw material to secondary lead smelters. Ferrous metal scrap recyclers and EAF and BOF operators maintain prohibitions concerning acceptance of ferrous metal scrap containing batteries. Therefore, most storage batteries are recycled by non-ferrous metal recyclers and enter the secondary lead market. Additionally, batteries are more valuable segregated. In most cases, it is in the self-interest of auto dismantlers to remove the batteries.

6.1.3. Leaded Steel Products

The American Iron and Steel Institute (AISI) has related specifications for leaded steel in the range of 0.15-0.35 percent lead, with a target value of 0.20 – 0.25 percent lead. The EAF Area Source Rule (40 CFR Part 63 Subpart YYYYY) also contains a regulatory definition of "leaded steel," shown in the text box.

Regulatory Definition of "Leaded Steel"

Leaded steel means steel that must meet a minimum specification for lead content (typically 0.25 percent or more) and for which lead is a necessary alloy for that grade of steel.

40 CFR Part 63, Subpart YYYYY, § 63.10692

According to one EAF operator (i.e., SMA's member, Company 8), when manufacturing leaded steel, the lead is not introduced into the EAF itself, but is introduced in the form of lead shot into the last production (refining) step in the steelmaking process (i.e., prior to the process of forming and solidifying the steel into a semi-finished product). Leaded steel can be made as a batch process at an EAF facility or at a foundry, and because the steel melt is at 1,650 ºC, and lead vaporizes out of the melt at 980 ºC, the lead must be added after the melt when the temperature has dropped. [27] The amount of lead added in producing leaded steel is approximately 5.5 pounds of lead per short ton of steel. One other EAF operator (Company 7) reported that their facilities manufacture leaded steel only in response to special orders by customers. The other six EAF operators that reported detailed data said their facilities do not manufacture leaded steel. The SMA reported that there are only a "handful" of leaded steel suppliers and that leaded steel manufacturers are a "small market" (i.e., a minor source/product) with respect to overall iron and steel production. Detailed statistics concerning production of leaded steel were not readily available. However, SMA's overall assessment of the leaded steel market size is supported by the primary and secondary lead production statistics published by the USGS (see Appendix B Table B-1.) The primary lead production facility operator indicated that they were not aware of any leaded steel being used to make motor vehicle bodies;[28] however, leaded steel may be used for various automobile parts, including steering mechanisms.[29] Sources of lead in motor vehicles also include transmission components, seals, and gaskets.[30]

As of 1999, the screw machine industry was consuming 2 to 3 million short tons of free machining (leaded) steel annually, approximately two percent of total steel production of 98 million short tons during that year. [31] At a nominal average lead content of 0.25 percent lead, 2 million short tons of leaded steel would contain approximately 5,000 short tons (4,500 metric tons) of lead. The incidence of leaded steel utilization in vehicles and other products has been trending down over time. However, structural steel, vehicles and other products (e.g., white goods) entering the ferrous metal scrap stream today have likely been in service for decades when leaded steel use was higher.

6.1.4. Best Practices for Lead and Lead Products

Scrap metal suppliers and BOF and EAF operators indicated that lead in scrap metal is generally widely dispersed in relatively low concentrations among various grades of scrap, and indicated that they currently have practices and procedures in place to identify and segregate lead items from the ferrous metal scrap stream (see Section 6.3.5 and Section 6.7.7 for a summary of best practices for scrap metal suppliers and EAF operators). The SRI indicated that commodity prices have increased dramatically since 2002 and that this has been due, in part, to increasing demand from Asia for scrap iron and steel, lead, and other metals. Commodity prices are subject to variability in domestic scrap metal prices depending upon seasonal variation in the amount of materials generated, and other issues. [32] [33] [34] The SRI indicated that the prices of commodities are providing further incentives to reduce the amount of lead entering the ferrous metal scrap stream.[35] Scrap lead is currently more valuable per ton than steel or zinc, [36] providing scrap metal recyclers and EAF operators a greater incentive to segregate these materials. [37]

However, where lead is incorporated into components of a product (e.g., solder, surface coatings, and bearings) it would not be visibly identifiable by scrap metal suppliers or EAF operators. Such components do not have sufficient lead content to be of value to non-ferrous metal recyclers and are difficult to feasibly remove from the ferrous metal scrap stream. Therefore, a principal best practice to reduce the amount of lead entering the ferrous metal scrap stream is to reduce the amount of lead being incorporated into products that will eventually enter the ferrous metal scrap stream. This is similar to the approach used by EPA in managing mercury in the municipal solid waste stream, by reducing the use of mercury in products.

Companies can change purchasing and manufacturing decisions to reduce or eliminate lead in products. For example, one global manufacturer of automobile and machinery parts based in the U.S. indicated that their company, as a whole, reduced or eliminated the use of lead in their products in response to international standards and guidelines to reduce the amount of lead in products. This company also indicated that they build and operate their U.S. and foreign manufacturing plants to a single set of corporate standards.

Application of best practices concerning reducing the amount of lead in products would be more effective if applied to production both within and outside of the U.S., as the SRI indicated that a significant issue with respect to the lead content of scrap metal relates to the lead contained in imported materials made from iron and steel. For example, the lead content in metal strapping made in Asia is very high. The metal strapping is used in transporting freight from Asia to the U.S. Strapping containing lead is not easily distinguishable from other strapping, and even if individual shippers change suppliers to avoid the lead, those selling such strapping will simply find other buyers. Such material, even if identified and segregated, has too little lead content to be of interest to non-ferrous metal recyclers. SRI indicated that in 1998, 90% of steel based products were made in the U.S. and 10% were imported, and that in 2008 the ratio is 50:50. Strapping is moving toward non-steel substitutes and, if this continues, the issue of lead in strapping would dissipate. However, metal cans manufactured in Asia and Eastern Europe may also contain lead, and there may be other iron and steel products coming from foreign suppliers that contain lead entering the ferrous metal scrap stream.[38]

Barring regulatory import restrictions (even the European Union and its most recent legislative initiatives to control hazardous materials, REACH [**R**egistration, **E**valuation, **A**uthorisation and Restriction of **Ch**emical substances] do not include lead bearing materials in general), which have potential associated trade agreement implications, labeling initiatives may be one of the more effective means of influencing the use—that is reduction, of lead in products.

Best practices for the management of lead and lead products include source reduction in applications in which lead can potentially enter the ferrous scrap metal stream. For example, the U.S. EPA recently issued a press release announcing the voluntary phase-out of lead wheel weights. [39] The U.S. EPA National Lead-Free Wheel Weight Initiative involves tire companies and retail stores that have agreed to phase-in the use of lead-free alternative wheel weights by 2011. This will reduce the amount of lead released into the environment through wheel weights lost on roads and will also simplify the management of scrap wheels by automobile dismantlers, automobile shredders, and scrap metal recyclers.

6.2. Ferrous Metal Scrap Recycling

This section provides a compilation of data concerning the amount of ferrous scrap metal generated and processed, as well as a description of scrap grades and ferrous metal scrap composition.

6.2.1. Home, Prompt, and Post-consumer Scrap

Regulatory definitions of "home scrap metal" and "prompt scrap metal" are found in 40 CFR 261.1(c)(11) and (12). Specifically:

- "Home scrap" is defined as scrap (unsaleable metal product) that is generated within an iron and steel mill or foundry by the iron and steel making or foundry process. Home scrap may include turnings, cuttings, punchings, and borings.
- "Prompt scrap" is defined as scrap that is generated by iron and steel product producers, including scrap metal generated by the metal working/fabrication industries. Prompt scrap may include turnings, cuttings, punchings, and borings.

"Post-consumer scrap" is defined as scrap that is generated from recycling of products containing iron and steel. Post-consumer scrap includes iron and steel scrap generated from scrap automobiles, used appliances, construction and demolition materials (e.g., rebar, girders, roofing material) and other sources.

6.2.2. Ferrous Metal Scrap Consumption

The USGS publishes annual data for scrap iron and steel consumption; data are summarized in Appendix B, [40] Tables B-3 through B-6. Table B-3 contains data for consumption of scrap in pig iron and raw steel production, iron foundries, and other types of facilities for the years 2002 – 2006, including purchased and home scrap. Table B-4 and Table B-5 contain data for the utilization of iron and steel scrap by scrap grade for the year 2006. Table B-6 identifies the consumption of scrap by facility type, including BOF, EAF, iron foundry, and other types of facilities. USGS does not publish more detailed scrap data for scrap grade utilization by furnace type.[41]

In 2005, shredded steel scrap (derived primarily from shredding scrap automobiles) represented the single largest scrap flow for pig iron and raw steel production; however, shredded steel scrap represented only approximately 19% of the total metal scrap consumption (including carbon and stainless steel) and approximately 23% of the total carbon steel scrap consumption. The amount of No. 1 melt heavy scrap and No.2 melt heavy scrap combined was approximately 24% of the total carbon steel scrap in 2005 (see Appendix B, Table B-5.) Of the total of 54,500 metric tons of scrap consumed in 2006, 41,400 metric tons, or approximately 75 percent, was consumed in EAFs, while 12,800 metric tons, or approximately 23 percent (in 2005), was consumed in BOFs (See Table B-6.)

6.2.3. Ferrous and Non-ferrous Metal Scrap Composition

ISRI publishes specifications for ferrous scrap and non-ferrous scrap.[42] In general, ISRI scrap specifications do not categorize grades of iron and steel scrap with respect to their potential lead content. Shredded steel scrap is the single largest component of the iron and steel scrap stream, with 11 million metric tons being consumed in 2005; however, shredded scrap represented only approximately 23% of the total carbon steel scrap consumed in 2005 and 19% of the total iron and steel scrap consumed in 2005.

Non-ferrous metal scrap grades, including scrap lead, scrap lead products, scrap “red metals” (e.g., copper, brass), and scrap aluminum, are categorized with respect to whether the scrap grade contains lead. Some scrap specifications, e.g., for machinery and hard brass borings, specify a certain minimum and maximum percentage of lead. These non-ferrous grades have the potential to enter the ferrous scrap stream. AISI specifications for leaded steel are 0.15-0.35 percent lead, with a target value of 0.20 – 0.25 percent lead. Rosselot (2007) indicates that the lead content of stainless steel is 0.15 to 0.35 percent lead (i.e., on the order of the lead content of “leaded steel.”) [43] Lead is added to various types of stainless steel to improve machinability, as it is for carbon steels. Other references indicate that lead-containing stainless steel may range from 0.01 percent lead to 0.40 percent lead.[44] Stainless steel has a minimum chromium content of approximately 11.5 percent and may also contain nickel and other metals. [45]

EAF operators also indicated that zinc galvanized steel coatings used in automobiles contain 0.0015 - 0.0030 percent lead and that this low concentration would result in approximately 1 gram of lead in an automobile body. However, the most common grades of scrap processed in EAFs - including structural and plate, No. 1 heavy melt steel, No. 2 heavy melt steel, shredded steel scrap, No. 1 and electric furnace bundles, and No. 1 busheling - are not characterized for lead content in the ISRI scrap specifications.

In addition, EAF operators indicted that, with some limited exceptions, they do not routinely use analytical testing methods to test incoming scrap loads for lead content, and further indicated that such testing would be infeasible. One EAF operator indicated that the amount of lead in scrap metal received at the facility has never been quantified using analytical methods because the facility has had a scrap metal management plan in place since 1986 that has helped to control the amount of lead contained in the scrap.

The chemistry of the steel is monitored in-melt by the EAF operator, and grades of scrap are mixed according to melting efficiency and chemistry requirements (which is related to the quantity of residuals, such as lead, in the scrap). According to EAF operators, the lead content of the scrap feed has not been an important issue for them because of their ability to control the amount of lead in the scrap feed (through mixing of scrap grades) such that the amount of lead doesn't affect the quality of the EAF heats.

EAF operators have generally established specifications for purchasing scrap that specify non-ferrous materials are not to be accepted in scrap shipments. Still, individual scrap commodities (grades) common to EAF operations are not graded on lead content. In general, both EAF operator and scrap metal facility contacts indicated that lead-containing scrap, "red metal" scrap, and other non-ferrous metal scrap are being segregated from the ferrous metal scrap prior to being processed in EAFs because of the higher monetary value of the non-ferrous metal scrap. Practices and procedures for the acceptance, management, and processing of scrap at scrap metal facilities and at EAFs are discussed in Sections 6.3.5 and 6.7.7.

EAF operators indicated that only limited data, if any, are available concerning the gross amount of lead in scrap metal processed at EAFs. The Rosselot Study (2007) identified the lead content of cast metal as the largest potential stream of lead content in scrap that is unlikely to be removed by any upstream sorting process. According to the study, the amount of lead consumed in the production of casting metals for transportation equipment (e.g., engine blocks) amounted to about 30,000 metric tons per year between 1997 and 2003. [46] Cast metal is therefore anticipated to contribute to the lead content of EAF dust. For example, if 100 percent of this 30,000 metric tons was transferred directly into the approximately one million metric tons of EAF dust generated annually, the EAF dust would be three percent lead on average; in practice, EAF dust may have on the order of 1,500 to 15,000 mg/Kg (0.15% - 1.5%) lead based on data provided by EAF operators.

Scrap metal processors and EAF operators also identified several types [grades] of scrap that they consider to contain or potentially contain lead, but without having specific analytical data concerning the actual lead content of these scrap grades. One of the nine EAF operators that provided detailed data concerning the management of lead in scrap metal indicated that lead components are "typically found" in No. 2 heavy melt and that their facilities do not purchase No. 2 heavy melt. No. 2 heavy melt is wrought iron and steel scrap that can contain automobile and appliance scrap. Other EAF operators did not identify No. 2 heavy melt as being a potential issue with respect to the management of lead in scrap metal. Another EAF operator indicated that No. 1 busheling is a scrap grade that can contain some terne plate, and several EAF operators identified turnings and borings (ISRI Grades 219-222) as scrap grades that potentially contain lead. Therefore, these grades are either not accepted by their facilities or subject to analytical testing for lead content. Earlier comments in this section regarded the infeasibility of testing all incoming scrap and therefore the difficulty of making general conclusions about the overall lead content of scrap inputs. However, it is possible to test the lead content of *specific* grades from *specific* generators with the presumption of homogeneity. One EAF operator reported that their facilities accept terne plate, but not leaded steel grades. Other EAF operators reported that their facilities do not accept either terne plate or leaded steel grades.

Shredded or fragmented scrap (principally automobile shred) is the single largest scrap grade processed at pig iron, raw steel and castings facilities, representing approximately 20 percent of the overall scrap processed according to USGS data (see Appendix B). According to EAF operator scrap acceptance criteria, scrap loads are to be free of identifiable automobile parts, including electrical components, solder, radiators, gasoline tanks, battery cables, “core parts” (alternators, starters, master cylinders, etc.) and automotive wheel weights. Shredder contracts with auto suppliers and EAF operator contracts with scrap suppliers generally require that such components be removed from the scrap stream prior to shipment to the EAFs. However, even with these limitations , it is anticipated that shredded steel scrap will contain some amount of lead that contributes to the lead content of EAF dust. One EAF operator that operates multiple facilities reported that the lead content of EAF dust is typically about two percent, but is expected to be lower for facilities that do not purchase shredded steel scrap.

Aside from scrapped automobiles, shredded steel scrap is also generated by shredding white goods (e.g., appliances), as well as virtually any scrap device composed partially of steel and partially other materials. A shredder serves as an efficient mechanism to separate steel from non ferrous components and depending on the feed stream into the shredder, non automotive steel can comprise a significant (80% is possible) of the feed stream at one time and at other times very little. As shred is not readily distinguishable after processing, it is not practical to assess when feeding it into an EAF, what the source of the shred was. Thus a shred feed stream could be comprised of relatively clean steel at one moment and a few moments later contain residue from electronic components, undetected lead painted metals, and other small lead bearing component parts.

A general conclusion from the observations provided by suppliers and EAF operators is that shredded scrap (primarily scrap automobiles) and heavy melt scrap are the principal contributors to lead in ferrous metal feed to electric arc furnaces. However, no data linking certain grades of scrap to higher lead content was provided as most EAF operators mix grades in forming heats; obtaining dust samples representative of the grades melted also make this data difficult to obtain.

6.3. Ferrous Metal Scrap Suppliers

Ferrous metal scrap suppliers include automobile dismantler and automobile shredder facilities that primarily process scrap automobiles, scrap metal recycling facilities that process a wide variety of scrap grades, and construction and demolition sites and C&D

processing facilities that generate scrap structural steel and other scrap metal grades. Figure 5.2 illustrates the flow of materials to automobile dismantler and automobile shredder facilities. Figure 5.3 illustrates the flow of materials to scrap metal recycling facilities, and Figure 5.4 illustrates the flow of materials to C&D material recycling facilities.

6.3.1. Automobile Dismantlers

Automobile dismantlers are facilities that remove parts from scrap motor vehicles for potential resale to customers or recycling. According to SRI, dismantlers almost always remove certain items, such as lead-acid batteries. (Note: The USGS reported that 87 percent of all lead-acid batteries (by weight) are vehicle batteries, and that in 2003, 93 percent of lead-acid batteries were recovered for recycling.[47]) Vehicle wheels also are removed, rims are sold to steel mills, and the lead wheel weights also have value and are typically recycled to non-ferrous metal recyclers. According to SRI, the principal trade association for automobile dismantlers and shredder operators, automobile dismantlers remove radiators (which may be 100% copper or aluminum, depending upon the age of the vehicle), catalytic converters, alternators, and other parts from vehicles.[48] Some dismantlers operate their own shredders to shred the scrap motor vehicles after the parts are removed. SRI also noted that the shredded steel sent to the steel mills directly from dismantlers that operate their own shredders typically has less lead content than if these operations were separate.[49]

Dismantlers tend to remove only motor vehicle parts that are relatively easily accessible and that have either resale value or recycling (scrap) value. In general, the labor cost of removing the part has to conform to the potential value of the part. Auto dismantling issues noted by the Automotive Recyclers Association (ARA) include: [50]

1) Ball bearings are generally not removed since they are difficult to get to. Ball bearings occur in motor vehicles anywhere there are joints, including the drive train, wheels, axles, etc. There are perhaps a dozen different points, mostly underneath the chassis;
2) Gasoline tanks are removed and drained (but then are crushed with the vehicle);
3) Older gasoline tanks have terne coatings; newer gasoline tanks tend to be made of plastic;[51]
4) Wheel weights are easily removed and are generally removed and recycled;
5) Radiators and heater cores are removed if they have market value. Radiators in newer automobiles are more difficult to remove than those in older automobiles;
6) Batteries are removed and separately recycled;
7) Catalytic converters are removed and recycled for their precious metal content;[i]
8) Struts are among the many pressurized systems that are difficult to get to and that therefore are generally not removed.

---

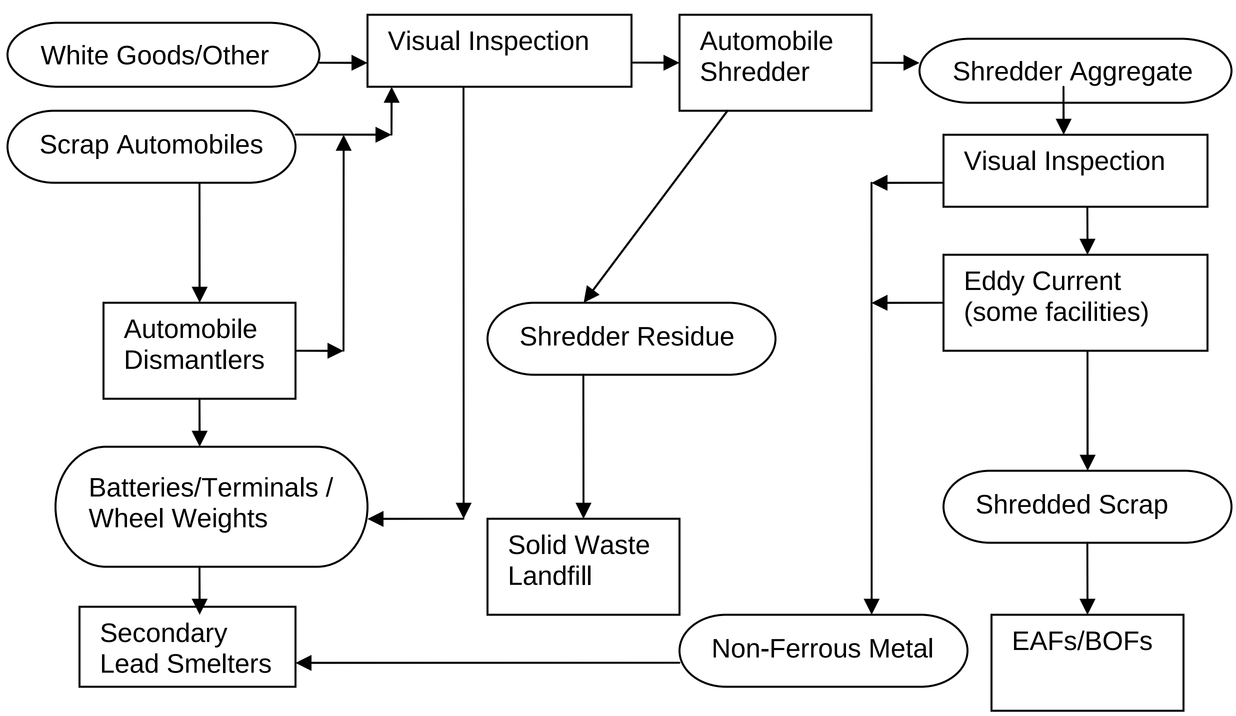
[i] There is an initiative underway to allow the selling of these as "used" catalytic converters rather than recycling them for their precious metal content. There are internal industry discussions at this point to develop testing standards for "used" converters.

The ARA operates a Certified Automotive Recycler (C.A.R.) Program to which members can apply. C.A.R. certified facilities are required to participate in the National Vehicle Mercury Switch Recovery Program or an equivalent State program. The C.A.R. manual also indicates that all batteries are to be removed from vehicles and stored in a manner that prevents release of battery acid to the environment.[52]

Some ARA members are solely "dismantler" facilities and range in capacity from 30 vehicles per month to 1,000 vehicles per month. Approximately 85% of ARA members are "full service" facilities in which parts are removed from scrap automobiles and warehoused for future sale. "You pull it" facilities are facilities in which customers retrieve parts from the scrap automobiles themselves. There are fewer "you pull it" facilities as members, but these tend to have larger volumes of automobiles than the "full service" facilities. Among ARA members, 140 are C.A.R. members, 15 are "you pull it" facilities, and others are "full service" facilities. [53]

One primary lead manufacturer indicated that regulations and standards have been effective in reducing the amount of lead entering the ferrous metal scrap stream, and that 15 years ago lead from batteries was getting into the ferrous metal scrap stream because automobile dismantler and shredder facility operators did not have the incentive to remove them.[54]

Figure 5-2. Automobile Shredders and Dismantlers Materials Flows



6.3.2. Automobile Shredders

Automobile shredder facilities shred scrap vehicles, after they are crushed, to produce shredded steel scrap. Such facilities may also operate as (or be vertically integrated with) automobile dismantlers or they may accept scrap vehicles for shredding after the scrap vehicles have been processed by automobile dismantlers. Some automobile shredder facilities accept whole scrap vehicles and remove parts from the vehicles (including batteries), while other automobile shredder facilities do not remove any parts and accept scrap vehicles only after parts are removed by automobile dismantlers. Some automobile shredder facilities are also integrated with ferrous metal scrap yards that handle other types of ferrous metal scrap in addition to scrap vehicles.

A 2002 study of automobile shredder facilities by the California Department of Toxic Substances Control (DTSC) found that all seven automobile shredder facilities operating in California apply an "acceptance policy" that identifies specific hazardous substances that will not be accepted in the scrap loads and that visual inspection is conducted by "load checkers" to ensure that these visually-identifiable hazardous substances have been removed from the scrap loads. The CA DTSC report indicated that five of the seven facilities only accepted scrap from automobile dismantlers and "feeder yards" that pre-prepare the scrap by removing hazardous substances and that for the other two facilities more than 90% of the scrap is pre-prepared offsite.[55] In California (as of 2002), approximately 47% of shredder feedstock was scrap automobiles and the remaining 53% was appliances and other steel-containing scrap.

The CA DTSC study estimated that the "shredder aggregate" produced by the shredders consists of 10-20% recoverable non-ferrous metal and 80-90% "shredder waste". Shredder waste consists of glass, fiber, rubber, automobile fluids, dirt and plastics found in automobiles and household appliances that remain after the recyclable metals have been removed from the shredder aggregate. All seven of the automobile shredders operating in California apply an eddy current system to separate the non-ferrous metals from the "shredder aggregate"; the CA DTSC has estimated that the eddy current technology increased the efficiency of the non-ferrous metals recovery process from 70% to 90%, but that further "in-line" treatment of the shredder waste is infeasible, resulting in the need for further processing of the shredder waste (either on-site at the shredder facility or in some cases at an offsite location) to further reduce the concentration of non-ferrous metals. The CA DTSC also found that shredder waste that was not further processed for reduction of metals concentration exceeded the California regulatory threshold for soluble lead of 5.0 mg/liter, but that for treated shredder waste the soluble lead concentration was below the regulatory threshold. The total concentration of lead in untreated shredder residue ranged from 1,600 mg/kg to 53,000 mg/kg.[56]

One automobile shredder facility (outside of California) that is not vertically integrated with an automobile dismantler operates a crusher. All scrap vehicles received at the facility from towing companies, etc., are inspected before crushing to ensure that the battery has been removed and the gas tank has been punctured and drained. Crushed automobiles are shipped to a shredder facility operated by the same company. No aftermarket parts are pulled off the vehicles received. Gas tanks and wheels are not removed prior to shredding. Shredded material is visually sorted by "pickers" to remove any copper and other "red metals" (including brass and bronze).[57]

Another automobile shredder facility (outside of California) that accepts whole scrap vehicles described their procedures for acceptance and processing of the scrap vehicles as follows:[58]

1. Inspectors open the vehicle hood and trunk;
2. Batteries and battery terminals are removed;
3. Fluids are drained (e.g., engine oil, antifreeze, gasoline);
4. A hole is drilled in the gasoline tank (gasoline tanks are not removed, but vehicles cannot go through shredder with gasoline in the gasoline tanks);
5. No tires or wheels are accepted for shredding (the facility purchases wheels separately from suppliers, but does not shred them);
6. There is an employee incentive program to remove the catalytic converter; employees check that the gasoline tank is empty and drilled while they are removing the catalytic converter;
7. Only steel wheels and aluminum/alloy wheels are sent to the ferrous/non-ferrous metal scrap yard facility. These procedures keep wheel weights from the wheels and heavy metals found in catalytic converters out of the shredded steel, and lower processing costs.

This company also operates a second facility that includes a ferrous and non-ferrous metal scrap yard.

One automobile shredder operator reported that crushed automobile suppliers “mark” their loads. The company performs periodic inspections to tear apart a crushed car to check for prohibited material (e.g., lead battery terminals). The company can tell from the marking where the crushed car came from, and, if there is a recurring issue (e.g., they find lead battery terminals), they can go back to the supplier. The company has not had to reject loads yet, but could do so. This operator indicated that for most of the larger crushed automobile suppliers, removal of batteries and battery terminals is “habituated” and now routine. Contamination incidents may occur, however, in the event that, for example, the facility hires a new employee in the processing bay who doesn’t follow procedures and only cuts cables to get the battery out, thus leaving the terminals. Also, private parties or “hulk haulers” may bring in vehicles that aren’t crushed, and shipments may include a couple of vehicles on trailers. These are easier to inspect and the company estimated that they inspect 80%-100% of these shipments. The company does encounter batteries, battery terminals, and wheel weights in these inspections, but most vehicles come in without rims, because rims are more valuable if they are sold separately. [59]

ISRI indicated that “white goods” (i.e., large appliances) are also shredded at member scrap yards and, if a “megashredder” is in operation, “No. 1 grade steel” (i.e., construction and demolition scrap) can be shredded. A megashredder typically has an intake that is 10 feet wide and has a high horsepower (e.g., 8,000 HP) motor, enabling the unit to accept large and heavy scrap pieces. One megashredder operation reported a throughput of 300 tons per hour. There are only approximately six of these units in operation in the U.S.[60] Shredder facilities may also operate shears, balers, and other equipment. Vehicles are typically the majority of shredded material at these facilities (e.g., estimated at 70% vehicles, 30% white goods and other materials). However, this ratio can shift dramatically depending on the location of the facility and its customer base (e.g., from 80% 20% to 20%

80%, according to one facility operator) due to regional differences and other factors.[61] One integrated automobile shredder facility indicated that only 30 percent of the scrap the facility processes is from scrap vehicles, the remainder being white goods, industrial scrap, post-consumer ferrous scrap, and a small amount of ferrous metal C&D scrap that is also shredded. More typically, facilities receive the major portion of their scrap from baled automobiles.[62]

ISRI also described other components potentially containing lead that suppliers might be required to remove from scrap vehicles, such as vibration dampers, steering columns, and electronic components. ISRI noted it is difficult to remove these items before shredding without hurting the economics of the shredding process. There is no economic value in taking these materials out of the vehicle before shredding the vehicle, and therefore the labor cost of removing them would be unrecoverable.[63] ARA added that if the steel mills receiving the shredded steel scrap are not satisfied with the quality of the product, both the automobile shredder facility and the automobile dismantlers that are their suppliers would quickly hear about it and be required to take remedial action.[64]

6.3.3. Ferrous and Non-Ferrous Scrap Metal Recycling Facilities

Several operators of scrap metal recycling facilities (also referred to as scrap yards) indicated that they operate separate ferrous and non-ferrous scrap yards. These facilities segregate ferrous and non-ferrous metal in separate operations. At these facilities, incoming loads of metal scrap are visually inspected to identify suspect material (i.e., material that does not meet the scrap acceptance criteria established by the facility). One operator reported that all loads are visually inspected, and that crane operators are trained to look for non-ferrous metals, particularly red metals, including copper and brass.[65] Several facility operators also reported that they have established financial incentive programs for workers to identify and segregate non-ferrous metals from the ferrous metal scrap stream, These financial incentives are effective because the non-ferrous metal scrap is more valuable per ton than the ferrous metal scrap; less lead in the ferrous metal scrap also increases the value of the ferrous metal scrap.

Another operator reported that most loads are visually inspected. This ferrous and non-ferrous scrap metal recycling facility also operates shredders and employs “chasers” to inspect scrap loads as they come in. The company provides training programs on what to look for and what to do if suspect material is found. Suspect material is usually found when offloading the material. If such material can be recycled, the facility will segregate it, as they do with lead acid batteries found in scrap motor vehicles. Scrap either goes through the shredder or through the “burn line,” where material is torch cut and/or sheared for size reduction. Non-ferrous eddy currents, shaker screens, and picker lines are used to sort out non-magnetic (non-ferrous fraction) of the metal scrap. The company reported that very little lead-containing scrap comes out of the picking lines, but mostly aluminum and red metals. This operator also reported that more lead-containing scrap is being identified by the chasers in front of the shredder rather than downstream of the shredder, meaning that the scrap metal suppliers are taking the lead-containing material out of the loads before they arrive.[66]

6.3.4. Construction and Demolition Materials

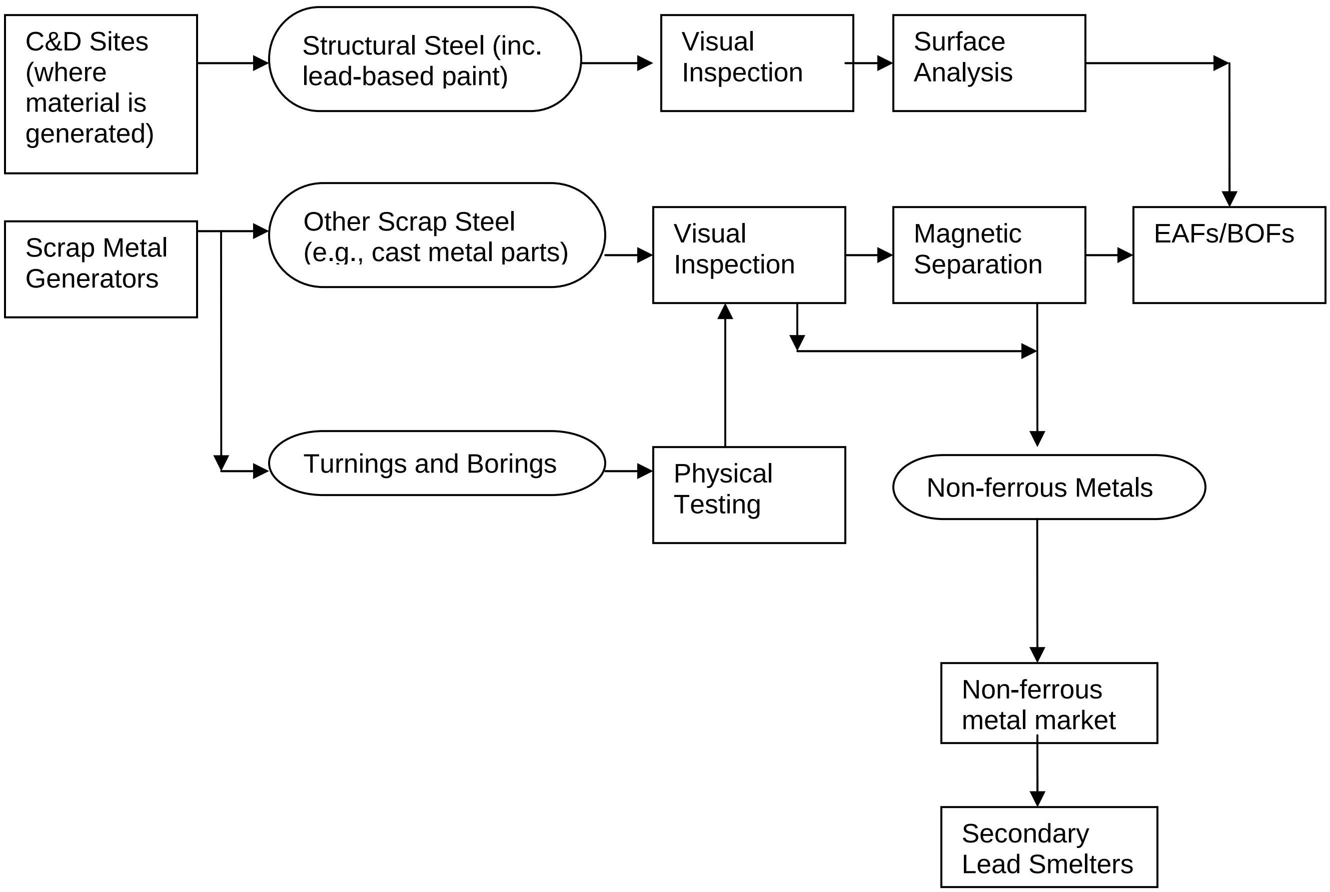
Construction and Demolition (C&D) materials are generated from building and structural construction and demolition projects. During a demolition project, this material is generally managed initially by the demolition contractor or, in the case of lead, an environmental (lead) abatement contractor. According to a survey in 2005 by the National Demolition Association (NDA) - a trade association representing demolition contractors performing residential demolitions, nonresidential demolitions, and nonresidential renovations - about 115 million short tons of debris is generated annually in the U.S., of which about 73 percent is recycled.[67] EPA estimated that 84 million tons of demolition material and 33 million tons of nonresidential renovation material were generated in 2003, for a total of 117 million tons – close to the NDA's estimate of 115 million tons. EPA does not have an estimate on the amount of material recycled specifically from the demolition and renovation of buildings, but did estimate the recovery rate for all building-related activities (including construction, renovation, and demolition). Based on information from eight states that collect C&D material generation, disposal, and/or recovery data, EPA estimated a 48 percent recovery rate for building-related C&D materials from all activities in 2003.[68]

Recyclable C&D materials may be sent to recycling facilities for segregation and potential sale to customers. The Construction Materials Recycling Association (CMRA), a trade association representing C&D recycling facility operators, indicated that demolition contractors, abatement contractors, and C&D material recyclers are generally aware of issues involving lead. This is in part because C&D recyclers do not like lead (e.g., lead-based painted wood) in the C&D materials stream because it contaminates their recycled products. Therefore, demolition contractors are likely separating out lead-containing materials prior to sending the material to C&D recyclers.

The CMRA indicated that given typical market conditions, C&D recyclers do not receive much metal, such as steel beams and rebar because they are too valuable as scrap metal. In some areas (e.g., West Virginia), demolition contractors can sell scrap steel directly to the steel mill without going through a C&D recycler or a ferrous scrap metal recycling facility. The steel mills are not requesting any additional processing of this material from the demolition contractor because the value of the iron is high. In other areas, transportation distances to steel mills are such that scrap metal goes through a scrap yard or recycler.[69]

Demolition contractors are separating as much metal, concrete, etc., at the demolition site as is economically feasible for them to do. In many instances, these "mixed" C&D materials are sent to C&D materials recyclers. However, in other instances, these materials are sent directly to the scrap metal recyclers. This is, in part, because the contractors cannot afford to move the material twice (i.e., once to the C&D material recycling facility and again to the scrap metal recycling facility).[70]

Figure 5-3. Scrap Metal Recycler Materials Flows



The typical makeup of the C&D materials stream that mixed C&D recyclers[ii] receive includes:[71]

1) Concrete/asphalt pavement, 25%;
2) Wood, 19.5%;
3) Fines, 17.1%;
4) Metals, 4.5%;
5) Other recycled materials, 5.2%;
6) Materials not recycled,[iii] 29%.

C&D fines are the fraction of mixed construction and demolition debris that is screened during the recycling process. This material typically consists of material that is <1 inch screen, but may also include larger materials (<3 inch screen). The C&D fines can include dirt, gypsum (from wallboard) and other materials.[72]

Lead in the C&D materials stream usually originates in lead-based paint. According to the NDA, lead-based paint is being managed well by contractors both with respect to occupational exposure to lead dust and with respect to the generation and management of lead-containing waste (e.g., lead-based paint chips).[73] Loads of drywall, wood, etc. with lead-based paint contamination are usually not accepted by the recyclers. Therefore, demolition contractors would generally not send such loads to the recyclers, but segregate the loads so that the lead-containing material goes into fines, which are then generally disposed in a landfill. Painted drywall and wood that end up in the loads received by recyclers are usually sorted out and disposed in a landfill.

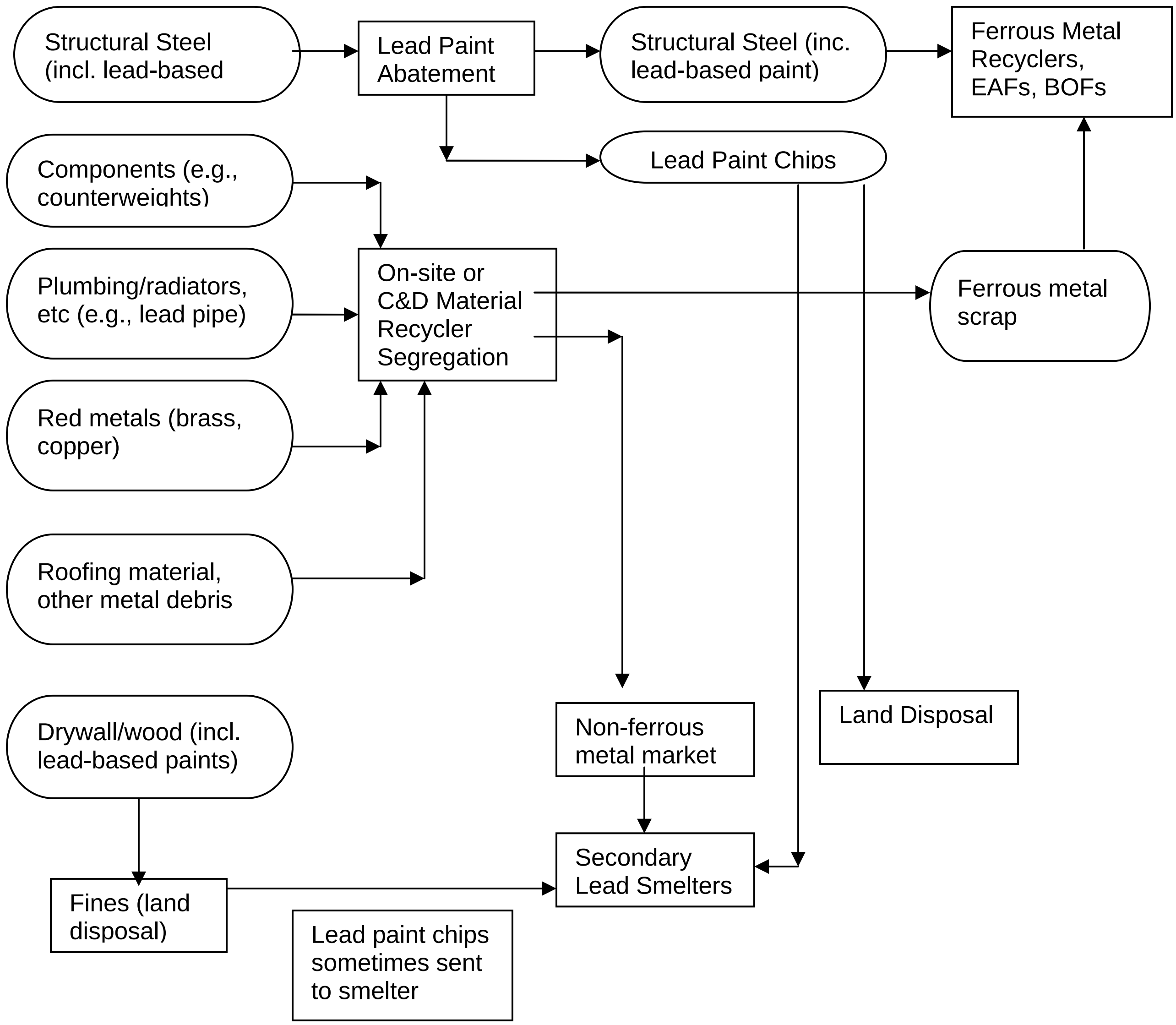
At C&D recycling facilities, a magnet is typically used to pull out ferrous metals. Copper and other materials of value are pulled out by hand on a picking line.[74] Eddy current equipment, however, is generally not used by C&D recyclers because of the bulkiness of C&D materials, the generally low quantity of aluminum in the C&D materials stream, and the high capital cost of eddy current separators compared to paying pickers. Scrap yards receive the segregated materials from the recyclers in designated bins. As a specific example, Environmental Alternatives in Maryland operates C&D materials sorting facilities. C&D materials typically get put into roll off bins at a demolition site. [75] If metals are segregated from other materials onsite, lead flashing from roofs would go into the non-ferrous metal bin (along with radiators, pipes, etc.), unprepared prior to shipment to the non-ferrous metal scrap yard. Structural steel is generally prepared on site prior to shipment directly to a ferrous scrap metal recycling facility.[76]

One ferrous and non-ferrous scrap metal recycling facility operator indicated that materials from demolished buildings, elevators, and other sources are usually shipped whole from the demolition site to the facility, where they are separated. Specific lead-containing items like counterweights, fishing gear, plumbing, x-ray walls, sound dampers, and lead sheeting (from hospitals), sheathing, and other materials of value are separated

[ii] "Mixed C&D materials recyclers" are those that receive a mixed C&D materials stream, as opposed to those that received one material only (such as concrete recyclers or wood recyclers).
[iii] There are many reasons why some materials are not recycled, such as the lack of a recycling market or contamination problems.

from other materials in the C&D materials stream and are directed into the "lead bin" for management as non-ferrous metal scrap. This facility receives all types of solid materials from C&D materials, but typically does not receive much lead flashing.[77] Lead flashing is reportedly commonly used in California and Florida,[78] and in some states, including Florida, Texas, Illinois, roof vents are lined with lead to prevent water in-leakage. In New England, "valleys" in roofs are lined with lead.[79]

Figure 5-4. Construction and Demolition Recycler Material Flows



6.3.5. Best Practices for Scrap Metal Suppliers

General best practices for scrap metal suppliers, including automobile dismantler facilities, automobile shredder facilities, ferrous and non-ferrous scrap metal recycling facilities, and C&D recyclers include establishing written practices and procedures for acceptance of incoming scrap shipments that identify acceptable and prohibited materials; written practices and procedures for identification and segregation of non-ferrous metals from the ferrous metal scrap stream, and associated quality assurance procedures, training, and internal auditing programs for these practices and procedures. Specific best practices for the various types of scrap metal suppliers include:

Automobile Dismantlers

- Visual inspection;
- Segregation and separate management of wheels and wheel weights;
- Removal and segregation of batteries and battery terminals;
- Removal and segregation of radiators and heater cores;
- Selected gas tank removal;

Automobile Shredders

- Segregation and separate management of wheels and wheel weights (i.e., wheels and rims are only accepted separate from scrap vehicle loads and are not shredded);
- Requiring scrap vehicle suppliers to mark each scrap shipment so that any shipments identified as having prohibited material (e.g., battery terminals, wheel weights) can be tracked back to the supplier for purposes of quality assurance;
- Periodic inspection of incoming crushed scrap vehicle loads, incoming "hulk" vehicles (non-crushed vehicles), and other [non-vehicle] scrap to ensure that prohibited materials (e.g., batteries and battery terminals) have been removed;

Ferrous and Non-ferrous Scrap Metal Recycling Facilities

Best practices for scrap metal recycling facilities (both non-ferrous metal and ferrous metal operations) include establishing multiple points of inspection for the purposes of identifying and segregating non-ferrous metal from the ferrous metal scrap stream. These practices can include initial visual inspection of incoming scrap loads followed by application of equipment, including non-ferrous eddy currents, shaker screens, and magnets, as well as picker lines, to identify and segregate non-ferrous metals from the ferrous metal scrap stream. Eddy current separators combined with magnetic separation can be specifically designed for segregation of non-ferrous metal from ferrous metal. Establishing financial incentives for scrap facility operators to identify and segregate non-ferrous metal from the ferrous metal scrap steam can also be effective in increasing the level of segregation achieved.

C&D Material Recyclers

Best practices for C&D material generation (at demolition sites) and for C&D recyclers include initial segregation of ferrous and non-ferrous metals from non-metal C&D materials at the demolition sites. This includes implementing practices and procedures to identify, segregate, and separately manage lead-containing materials (e.g., plumbing, counterweights, flashing) at the demolition site in separate "lead bins" that would be sent directly to non-ferrous scrap metal recycling facilities. Some metal scrap (e.g., elevators) generated at demolition sites may also go directly to such facilities, bypassing C&D material recyclers; in this case, the scrap metal recycling facility operator segregates the ferrous metals and non-ferrous metals. Best practices for segregating ferrous metal and non-ferrous metal at C&D recycler facilities includes application of magnets and also "picker lines" to visually identify and segregate metals from other debris. C&D material recyclers can also establish financial incentive programs for identification and segregation of non-ferrous metal at demolition sites and recycler facilities. Under a financial incentive program, pickers receive all or a portion of the re-sale value of the residual metals removed from the C&D material.

6.4. Non-ferrous Metal Scrap Recycling

6.4.1. Automobile and Industrial Batteries

Scrap motor vehicle batteries are generated from facilities, such as automotive service centers or from automobile dismantlers. Management of batteries from scrap motor vehicles at automobile shredder facilities is discussed in Section 6.3.2. Most automotive service centers operate an exchange program in which customers return old batteries when purchasing new ones.[80] Batteries collected through exchange programs may be shipped directly to battery manufacturers (some of which operate secondary lead smelters), to secondary lead smelters, or to non-ferrous scrap metal recycling facilities, and would likely not encounter the ferrous metal scrap stream. The lead produced by the secondary lead smelters would generally be sold directly to U.S. battery manufacturers or exported. Conventional automobile batteries weigh about 35 pounds and are approximately 50 percent lead, with plastic and ancillary materials comprising the other 50 percent. Industrial batteries are also subject to exchange programs in which the vendor removes the old battery when installing the new battery. Industrial batteries (e.g., used at cell phone towers and as backup power for computer centers) are a growing segment of the battery market.[81]

Scrap batteries are processed in blast furnaces or reverberatory furnaces. One secondary lead manufacturer that operates several blast furnaces reported that batteries delivered to the facility are tested for lead content, crushed and the plastic and metal are separated. Materials are carefully scanned with an ICP-MS (Inductively coupled plasma mass spectrometry) and analyzed prior to being charged to the furnace. Suspect materials undergo testing in the on-site analytical laboratory, and suppliers are charged back if there is any off-spec material. Screws and bolts in the raw material feed would not affect the furnace operations, but any aluminum or magnesium fed to the furnace would cause the furnace zone to explode. [82] The lead is charged to the furnace with cast iron, conventional steel, and limestone. The iron, limestone, silica and other materials form a slag that is used to form a mat over the lead to prevent the lead from contacting oxygen in the air. The lead is removed from the bottom of the furnace, while the slag is removed from the top of the furnace. Lead furnace slag from secondary lead smelters is a RCRA-listed (K069) waste. [83]

Another secondary lead manufacturer reported that their facilities have an automated system for processing scrap batteries in which the batteries are palletized and tipped directly into the furnace receiving hopper. Lead materials other than batteries bypass the automated process and furnace and are fed directly to the refining process.

6.4.2. Construction and Demolition Materials

As discussed in Section 6.3.4, demolition contractors may segregate C&D materials on site to separate ferrous metal scrap from non-ferrous metal scrap. These materials are put into separate bins pending transportation to either a C&D materials recycling facility or a scrap metal recycling facility. The scrap metals removed from the C&D materials may be shipped directly to scrap metal recycling facilities rather than first to C&D recycling facilities if the value of the scrap metal is high and the cost of transporting the material is also high.

One operator of shredders and both ferrous and non-ferrous scrap metal recycling facilities expressed the view that it is more efficient to segregate the non-ferrous scrap metal at the recycling facility than at the demolition site. In this system, the non-ferrous metal is sent to the scrap metal recycling facility unprocessed, where the lead scrap is separated from the other types of non-ferrous metal scrap. [84] The scrap metal recycling facility operator indicated that with respect to processing C&D materials, counterweights and lead sheeting (e.g., from hospitals) are relatively easy to remove from the scrap stream and that they do not encounter much in the way of lead flashing, perhaps one 20 cubic yard bin (aka roll-off) per year. [85]

6.4.3. Other Lead and Lead Product Scrap

According to SRI, conventional brass and bronze (e.g., used in plumbing fixtures, bearings) have relatively high lead contents and have contributed to the lead content of K061. [86] Conventional leaded brass may have up to 8 percent lead.[87] Since 2002, the value of metals has increased dramatically. Therefore, there is now a lot of sorting happening using magnetic separation and eddy current systems to remove valuable metals prior to the scrap shredding stage. Automobile dismantler and shredder facility workers (who may be paid $10 to $12 per hour) are often given an incentive to remove targeted items from scrap vehicles in the form of a holiday bonus that is generally equivalent to the resale value of the material removed. Therefore, the amount of these materials entering the ferrous metal scrap stream is decreasing. [88] One secondary lead facility manufacturer concurred with this assessment, and indicated that scrap lead is now more valuable per ton than scrap steel or zinc, providing increased financial incentives for scrap processors to segregate these materials.[89]

One secondary lead manufacturer expressed the view that the overall steel industry scrap processing approach (shearing, shredding, etc.) does not lend itself to ready recovery of lead from scrap, and that incentives should focus on better scrap segregation. In this view, EAF operators could do a better job of segregating lead-containing products; such as lead in solder, electronics, and non-removed batteries, which contribute to the lead content of K061. However, it should also be noted that lead use in some of these applications is a relatively small percentage of total U.S. primary and secondary lead consumption, approximately 90% of which is used in the production of batteries (see Table B-5). Even high estimates of non-removed batteries do little to increase the lead content of K061 (see page 15). In addition, scrap metal recyclers and EAF operators noted that the lead content of iron and steel scrap is widely distributed in various scrap grades having relatively low lead concentrations, as opposed to large, easily identifiable items such as vehicle batteries. Further complicating the EAF operators job is the fact that processes like shredding, cutting and bailing (essentially, initial processing) of scrap prior to bulk shipment of scrap to the EAF makes sorting at the EAF site largely impractical. Therefore, the primary tool EAF operators have to ensure higher quality scrap is spot checking of scrap and a graduated payment scale for higher grades of scrap.

6.4.4. Other Lead-Containing Materials

One secondary lead manufacturer reported that the lead furnace slag (K069) generated by the secondary lead smelters may be 60 – 70 percent lead, and also has a high iron content (the iron is needed for slag). Further, 40% of the K069 is re-entered back into the furnace (after it is broken apart). The remainder is treated with sodium silicate and magnesium hydroxide to ensure it does not exhibit the toxicity characteristic so it can be disposed of in an on-site, Company-owned, non-hazardous, Subtitle D monofill. Dust from the furnace and bag houses is analyzed daily. The facility operates a flue dust agglomeration furnace to process the K069. [90] An agglomeration furnace contacts the flue dust with soda ash and limestone or iron oxide in a hearth furnace to form a molten product that is solidified for subsequent disposal.[91]

Another secondary lead manufacturer that operates a reverberatory furnace and blast furnace reported that approximately 50 kilograms of lead furnace slag was generated for every metric ton of batteries processed by the facility (batteries being approximately 50 percent lead, which corresponds to approximately 1 kilogram of slag per 100 kilograms of lead produced). In 2007, 97 percent of the slag tested as non-hazardous vs. 3 percent tested as hazardous (i.e., for barium, lead). Each load of slag is subject to testing using the toxicity characteristic leaching procedure (TCLP) and the slag is rerun through the furnace process if high levels of lead are detected (i.e., greater than 3% - 4%). The normal lead content range of the slag is 0.5% - 3%. In addition, barium is very soluble and is very difficult to get out of the furnace system because it gets into the flue dust and circulates within the system. [92]

The same secondary lead manufacturer reported that refractory brick removed from the furnace is subjected to testing using the TCLP. If the material passes (most of the time), it goes to an industrial landfill. If the material fails the test, it goes to a hazardous waste management facility where it is subject to treatment using a Portland cement stabilization mix. On average, approximately 6.5 tons of bricks (or about 1/2 of a roll-off container) is subjected to the testing using the TCLP for every 100,000 tons of batteries processed.[93]

6.5. Iron Foundries

One operator of an iron foundry provided information concerning scrap acceptance procedures. The foundry operator indicated that it is difficult for scrap dealers to investigate entire rail cars of scrap. Therefore, the operator indicated that the foundry runs each rail car through a radiation detector, and then unloads the rail cars using a magnet. Anything remaining inside the rail car (i.e., non-magnetic non-ferrous metal) is collected by the operator as a "secondary source of income." The operator indicated that they generally receive a bonus equivalent to the resale value of the recovered metals. Red metals, including brass are broken from cast iron valves and other articles and segregated because of the high value of red metals. The operator also indicated that recyclers are not very detailed in separating scrap and that there are varying practices and procedures at scrap metal recycling facilities. The foundry operator has rejected rail cars of scrap occasionally because of exceedance of "size limitations" or other scrap specifications (e.g. oily scrap, etc.); however we are not aware of any rejections due to high lead content. While many iron foundries use shredded scrap for its melt, this particular foundry does not melt shredded scrap, and pays a premium to purchase high grades of non-shredded scrap. Non-acceptance of shredded scrap results in the foundry producing a better quality product. [94]

6.6. Integrated Iron and Steel Production

The BOF steelmaking process uses a combination of pig iron from blast furnace and scrap metal. One BOF operator reported an average 28 percent scrap feed to the BOF, with a range of 26 percent to 30 percent, depending on furnace operating conditions. Approximately 60 percent of the scrap is post-consumer scrap and 40 percent is home scrap. The average amount of scrap used at this particular BOF is 75,000 short tons per month. Scrap suppliers include: scrap metal recycling facilities, stamping plants, other company subsidiaries, and demolition contractors. Scrap grades used include bundles, shred, plate and structural, heavy melt, tin cans, and miscellaneous grades.

Another BOF operator identified procedures that they use to identify lead in scrap. These include: inspection of scrap directed into the scrap bin using a crane with a magnet. Scrap with high lead levels would be less likely to be picked up by a magnet, and therefore the lead or other non-ferrous metals in the scrap (e.g., lead counterweights) could be identified. No incoming materials are processed separately from other materials. The company specification for scrap quality given to scrap suppliers says (effectively speaking) "no lead." The company reported that their facilities may be using grab samples to test scrap for non-ferrous metal content, but these samples would not necessarily be representative of the whole scrap load. For quality assurance purposes, "testing" is more by visual inspection and whether the magnet leaves lead-containing material in the scrap bin. [95]

BOF processed furnace wastes are not regulated as a hazardous waste, as these materials are exempt from RCRA Subtitle C under the Bevill Exemption. Nevertheless, one BOF operator reported that the facility conducts testing using the TCLP for furnace wastes annually for lead, mercury, arsenic, cadmium, chromium, and other metals. [96] These furnace wastes include BOP (Basic Oxygen Process) Sludge, BF (Blast Furnace) Belt Press Sludge, BOP Fugitive Baghouse Dust, BOP Slag Fines, BF Classifier Sludge, BF Flue Dust, and BOP Mixer Baghouse Dust. The company reported that lead in the scrap would generally come out in the baghouse dust, and that their facilities are not recovering metals from the baghouse dust as low concentrations make it infeasible. With the exception of the BOP Fugitive Baghouse Dust, TCLP results for lead for all BOF process wastes were reported at less than 0.05 mg/l lead. The TCLP results for the BOP Fugitive Baghouse Dust were reported at 36 mg/l lead.

6.7. Electric Arc Furnace Steel Production

EAF operators manage the lead content of scrap used in EAF steel production through a combination of written (contractual) scrap metal acceptance criteria, visual inspection of incoming scrap loads, and limited analytical testing of scrap. Practices and procedures for accepting and processing incoming loads of scrap metal to EAFs were identified through contacts with EAF steel mill operators. In general, the EAF operators contacted have established contract provisions with suppliers for what grades of scrap the EAF steel mill will and will not accept, procedures for screening and visual inspection of incoming scrap loads, and procedures for determining that the quality of the incoming scrap load meets the requirements of established site-specific contracts with the supplier. Several EAF operators indicated that they also conduct limited analytical testing of scrap loads for lead content. Scrap metal acceptance, processing, and management procedures implemented by EAF operators are described in this section.

6.7.1. EAF Scrap Metal Acceptance and Processing

Scrap acceptance and processing procedures differed somewhat for each of the nine EAF operators that provided detailed information concerning their procedures. Among the nine EAF operators, eight indicated that their facilities are implementing specific scrap inspection and/or materials segregation practices related to the management of lead in scrap metal. Several EAF operators indicated that their facilities do not accept terne plate bundles (ISRI Grade 216) or turnings/borings (ISRI Grade 219-222.) A number of EAF operators also indicated that their facilities do not accept leaded steel grades. One EAF operator said that their facilities do accept turnings, but not if visible borings are mixed in, and another EAF operator indicated that every shipment of turnings is analyzed for lead content. Two EAF operators that provided data indicated that their facilities do accept turnings/borings subject to inspection. Turnings/borings represent approximately 5 percent of the overall scrap metal accepted by pig iron and raw steel manufacturers (see Appendix B, Table B-5). In addition to ISRI Scrap Grades 216 and 219-222 and turning/borings, one EAF operator said that lead components are also "typically found" in No. 2 heavy melt, which this particular facility does not purchase. (No. 2. heavy melt scrap may contain automobile or appliance scrap.) One EAF operator said that small amounts of #1 busheling are accepted by their facilities and that this scrap grade can contain some terne plate, potentially increasing the lead content of this scrap grade. No. 2 heavy melt represents approximately 13 percent and #1 busheling represents approximately 18 percent of the overall scrap metal accepted by pig iron, raw steel, and casting manufacturers (see Appendix B, Table B-5). The information provided by EAF operators provides an indication that various grades of scrap are potentially contributing to the lead content of ferrous metal scrap streams and also that different EAF operators are implementing different scrap metal acceptance and processing procedures.

6.7.2. Scrap Acceptance Criteria

EAF operators indicated that scrap acceptance criteria bans "lead and lead-containing materials" from scrap loads. However, this provision is interpreted and implemented somewhat differently by the various EAF operators. EAF operators independently confirmed/identified tinned steel, batteries and battery cables, leaded steel grades, Babbitt bearings, solder, wheel weights, "materials with excessive amounts of lead-based paint," terne plate, gasoline tanks, computers/electronics, and lead-lined containers as "non-conforming materials." The presence of these materials represents grounds for rejection of the scrap load. One EAF operator indicated that leaded seals in the "bell" (end connector) of old sewer pipes is of particular concern as that amount of lead could affect the heat. Another indicated that a specific screening method is being implemented at their facility to detect the presence of radioactive materials in the scrap load, which could also identify the presence of lead shielding in the scrap load. Two EAF operators indicated that their facilities accept galvanized steel (note: galvanized steel is not a separate grade of scrap). However, one of these EAF operators indicated that the amount of galvanized steel acceptable in an individual scrap load is limited to no more than 10 percent in order to limit the amount of zinc in the scrap load.

6.7.3. Visual Inspection Practices and Procedures

EAF operators indicated that all incoming scrap loads are subject to visual inspection for the purposes of identifying any "non-conforming" materials in the scrap loads. Such "non-conforming materials" are typically identified in the scrap supplier contracts. EAF operators indicated that there are several levels of inspection conducted for incoming scrap loads. One EAF operator (Company No.2) indicated that the yard crane operator, laborer, and scrap crane operator involved in scrap acceptance are all responsible for conducting visual inspections of the scrap loads. This operator indicated that, in the event that visual inspection conducted on scrap loads identifies suspected lead-containing material, the scrap is further analyzed using an X-Ray Fluorescence (XRF) Gun which can remotely detect the lead content on metal surfaces. Another EAF operator (Company No. 8) indicated that, in addition to visual inspection, their facilities employ video cameras to identify non-conforming materials.

6.7.4. EAF Scrap Metal Management

Analytical Testing of Scrap Loads for Lead Content

EAF operators indicted that, with some limited exceptions, they do not routinely use analytical testing methods to test incoming scrap loads for lead content, and further indicated that such testing would be infeasible. One EAF operator, however, said that every shipment of turnings is analyzed for lead content, and another EAF operator indicated that laboratory spectrometer testing is conducted on samples of individual pieces of scrap (e.g., flashing roofing material) to identify lead content, but that other grades of scrap are not routinely tested for lead content. As noted above, one EAF operator (Company No. 2) indicated that their facilities have the capability to conduct spot tests of incoming scrap loads using an X-Ray (XRF) Gun. One reason cited by EAF operators for the infeasibility of such data collection is associated with the difficulty in obtaining representative samples of scrap feed to the EAF furnace. Routine collection of analytical data is not practical because the scrap is high volume, and heterogeneous from a lead standpoint.

Rather, EAF operators indicated that they rely primarily on facility-specific scrap metal acceptance criteria and visual inspection of incoming scrap loads to detect and remove lead-containing materials.

Lead Content of Steel Produced

EAF operators indicated that their facilities test every batch of steel produced for lead content, and that the lead content of the steel produced is closely controlled. One EAF operator (Company 7) reported that there are no lead limits in the specifications for "non-leaded" grades of steel. Company 7 added that the lead content of the "non-leaded" steel their facilities produce is controlled to less than 1 percent lead in structural products in order to prevent surface quality issues. Other EAF operators reported that the lead content of the steel produced is less than 1 part per million (1 ppm, or 0.0001 percent,) and that there are no identifiable trends in the lead content of the steel produced related to the grades (or lead content) of the scrap processed.

EAF operators indicated that their facilities do not need to know the lead content of the EAF dust in order to manage the lead content of the steel product, and do not apply data for lead content of EAF dust to the management of the lead content of the steel produced. Because of the low melting point of lead as compared to steel, the majority of the lead in the feed into an EAF initially flashes off (or volatilizes) and becomes part of the EAF dust and does not remain in the steel. However, EAF operators did say that they actively manage the amount of lead contained in the feed stream indirectly by way of melt chemistry (not individual feed stream analysis), because a relatively small amount of lead in the heat (e.g., on the order of 30 pounds) can result in the steel produced having to be reprocessed. Tracing the lead back to individual scrap streams is difficult because the lead content is monitored only after the different grades have been melted together. These different grades are typically from different sources as well. Scrap grades are also usually mixed in layers (e.g., dense/less dense) to facilitate melting in the furnace. EAF operators did indicate, however, that they use data concerning the amount of lead in EAF dust to predict TCLP lead concentrations, for Toxic Release Inventory reporting, and for other waste management reporting purposes.

6.7.5. Hazardous Air Pollutant Emissions Standards for EAF Facilities

EPA NESHAP regulations (40 CFR Part 63, Subpart YYYYY), concerning the control of air emissions of hazardous air pollutants from stainless steel-making and non-stainless steel-making EAFs, establish regulatory requirements for the management of scrap metal at EAF facilities.[97] The Subpart YYYYY Area Source Rule regulations were established principally to control air emissions of mercury, lead, and other hazardous air pollutants from EAFs. The Subpart YYYYY regulations were published and took effect in December 2007. EAF operators were required to develop implementation plans for the regulations by June 30, 2008.

Under Subpart YYYYY, control of hazardous air pollutant emissions from EAFs is achieved by establishing scrap metal management practices. (Application of air pollution control devices to EAFs is separately regulated.) Under Subpart YYYYY, EAF operators are required to comply with one of the following two options for control of air emissions of lead and other hazardous air pollutants from EAF operations: [98]

1. Prepare, submit for approval, and implement a pollution prevention plan for scrap selection and inspection to minimize the amount of chlorinated plastics, free organic liquids, and lead (except for the production of leaded steel); or

2. Not charge scrap to the EAF that contains scrap from motor vehicle bodies, engine blocks, oil filters, oily turnings, machine shop borings, transformers or capacitors containing polychlorinated biphenyls, lead-containing components (except for the production of leaded steel), chlorinated plastics, or free organic liquids. This restriction does not apply to any post-consumer engine blocks, post-consumer oil filters, or oily turnings that are processed or cleaned to the extent practicable, such that the materials do not include lead components, chlorinated plastics, or free organic liquids.

EAF operators may have certain scrap metal subject to one option and other scrap metal subject to the other option if the scrap remains segregated until it is combined for charging to the EAF.

The regulations indicate that under Option 1, the EAF pollution prevention plan is required to include the following elements:

(i) Specifications that scrap materials must be depleted (to the extent practicable) of un-drained used oil filters, chlorinated plastics, and free organic liquids at the time of charging to the furnace.

> (ii) A requirement in [the] scrap specifications for removal (to the extent practicable) of lead-containing components (such as batteries, battery cables, and wheel weights) from the scrap, except for scrap used to produce leaded steel.
>
> (iii) Procedures for determining if the requirements and specifications in paragraph (a)(1) [discusses scope and approval process of plan][99] of this section are met (such as visual inspection or periodic audits of scrap providers) and procedures for taking corrective action with vendors whose shipments are not within specifications.

The Area Source Rule is focused primarily on the management of mercury, not lead, and the implementation of the Area Source Rule will not affect the RCRA-hazardous waste categorization of K061, as K061 is listed as hazardous because of its lead, trivalent chromium, and cadmium content. In general, research conducted for this study indicates that EAFs already have scrap metal management practices and procedures in place to control the amount of lead contained in scrap processed in EAFs.

6.7.6. International Standards and Guidelines

International standards and guidelines can affect the operation of EAFs and result in the reduction or minimization of the use of lead in products. For example, one EAF operator indicated that as a global supplier of steel parts, the company's global operations fall under various European Union regulations, including Restriction of Hazardous Substances (RoHS) directive, [100] **R**egistration, **E**valuation, **A**uthorisation and Restriction of **Ch**emical substances (REACH) directive, [101] and the Waste Electrical and Electronic Equipment (WEEE) directive. [102] These EU Standards regulate the management of hazardous substances, including lead, in various types of products. In this regard, this EAF operator has established a single set of corporate standards for their global steel parts production operations, including reduction or elimination of the use of lead in their products. This includes reducing or eliminating the use of lead in solder and welding materials.[103]

6.7.7. Best Practices for EAF Operators

Best practices for the management of lead flows to EAFs include the practices and procedures established by EAF operators, and described above in this section for acceptance and processing of various scrap metal grades. As discussed above, EAF operators have established scrap grade acceptance criteria that prohibit acceptance of certain grades of scrap potentially containing lead (e.g., leaded steel scrap) or that require the segregation and separate management of certain grades of scrap metal potentially containing lead (e.g., turnings and borings.) Such prohibitions and restrictions on certain grades of scrap potentially containing lead by EAFs would drive this scrap towards BOFs (these scrap grades do not contain sufficient quantity of lead to be processed at secondary lead smelters). Lead in scrap fed to BOFs would either be incorporated into the steel slag from the BOF or be incorporated into particulate air emissions from the BOF. EAF operators have also established procedures to identify and segregate visibly identifiable and magnetically separable non-ferrous metal scrap, including lead scrap. These practices and procedures are integrated with site-specific and supplier-specific specifications established between EAF operators and suppliers for the quality of ferrous metal scrap that will be accepted. EAF operators can identify the source of specific loads of scrap and can either downgrade the price they pay for the scrap load or reject the scrap load if the supplier specifications are not met.

EAF operators have indicated that they have established these specific practices and procedures for scrap acceptance and processing explicitly to manage the amount of lead entering the EAF scrap metal feed in order to control the amount of lead in the steel produced, not for the purposes of the managing the amount of lead in the EAF dust generated. EAF dust composition data and operating data provided by EAF operators indicates that simple non acceptance of shredded steel scrap (or other specific grades of scrap) is likely not going to be sufficient to reduce the lead concentration of EAF dust to below TCLP; EAFs that don't accept shredded steel scrap (there are some) still don't meet TCLP for lead in their EAF dust. EAF operators that accept carefully controlled grades of home and prompt scrap could potentially reduce the lead content of the EAF dust to below TCLP; however this would be infeasible to apply across all EAF operators because this would leave the vast majority of ferrous metal scrap to be processed by the BOFs. Lead in scrap feed to BOFs would either be incorporated into the steel slag from the BOF or incorporated into the particulate air emissions from the BOF.

6.8. EAF Dust

This section includes a compilation of data concerning the amount of K061 generated/ processed, the range of composition (lead content, zinc content, etc.) and trends (based on available data.)

6.8.1. Generation

EAF operators reported, with one exception, that there are no identifiable trends in the amount of K061 generated per ton of steel produced, and that the amount of K061 generated is generally a function of the loading operation and the amount of steel produced. EAF operators, with one exception, also did not report taking any specific actions to reduce the amount of K061 generated at their facilities. Company No. 6, on the other hand, indicated that they had noted trends in the amount of K061 generated related to changes in the mode of mill operation and related to the types of scrap processed. No additional information was provided by Company No. 6 concerning these changes.

MAX Environmental Technologies (2003) reported that approximately one million metric tons of EAF dust are generated annually in the U.S. This corresponds to approximately 20 kg of EAF dust for each metric ton of EAF steel produced.[104] Horsehead (2008) reported that approximately 900,000 metric tons of EAF dust is generated annually in the U.S. of which 600,000 metric tons is further processed by Horsehead for metals recovery (primarily zinc), and 300,000 metric tons are either treated prior to disposal or exported.[105] In 2006, approximately 145,000 metric tons (160,000 short tons) of EAF dust were exported to Mexico. Export data for K061 are summarized in Table 6.8.1-1.[106]

Table 6.8.1-1. Exports of K061 to Mexico, 1996-2005 (short tons)

Exporter ID	Exporter Name	1996	1999	2001	2002	2003	2004	2005	2006
ALD000622852	BIRMINGHAM STEEL CORPORATION - BIRMINGHAM, AL STEEL DIVISION	8,880	10,700	8,914	8,490	9,481	9,365		10,676
ALD0167123570	SMI STEEL INC.								3,005
ARD053730701	QUANEX CORP - MACSTEEL DIVISION			1,836	6,870	6,564	7,489		6,689
ARD091691261	ARKANSAS STEEL ASSOCIATES	4,041	3,233	3,063	3,767	4,216	4,534	4,667	
CAD982361404	TAMCO		2,773	6,930	9,920	11,051		9,141	7,283
COD007057961	CF&I STEEL, L.P.		12,085		17,240	14,928	14,423	10,263	9,916
FLD083812537	AMERISTEEL - JACKSONVILLE STEEL MILL DIVISION		3,866		4,816	6,310	5,826		
GAD030059182	BIRMINGAM SOUTHEAST LLC		5,585	6,517	3,504	5,896	13,725	8,590	9,863
ILD980996862	BIRMINGHAM STEEL CORPORATION - KANKAKEE, IL STEEL DIVISION	10,278							
MO0000031823	GST STEEL COMPANY	16,391	15,148						
MSD008158685	NUCOR STEEL JACKSON, INC. (FORMERLY BIRMINGHAM SOUTHEAST, LLC)	5,181	5,876	5,030	4,073	6,398	7,091		6,504
NJD078873270	NEW JERSEY STEEL CORPORATION	3,295							
OKD007219181	SHEFFIELD STEEL CORPORATION		7,140	6,027	6,510	7,683	8,514	8,037	8,338
ORD045776432	CASCADE STEEL ROLLING MILLS, INC	1,115	288	170					
SCD003353760	OWEN ELECTRIC STEEL COMPANY OF S.C., INC.		4,266	6,051					8,773
SCD044940369	NUCOR STEEL COMPANY – SOUTH CAROLINA FACILITY		10,829		12,492				7,670
TXD008119414	STRUCTURAL METALS INCORPORATED		9,994	14,720	16,131	16,435	15,161	16,765	16,456
TXD066362559	CHAPARRAL STEEL MIDLOTHIAN L.P.	7,667	18,680		18,228	17,218	19,046	18,191	20,725
TXD071378582	NUCOR STEEL COMPANY - TEXAS FACILITY		10,154		12,560	11,350	10,903	13,560	22,142
VAR000013292	CHAPARRAL VIRGINIA, INC.		1,160	7,763	8,357	8,099	9,654		11,070
WAD988487583	BIRMINGHAM STEEL CORPORATION - SEATTLE, WA STEEL DIVISION	10,200	10,537	11,039	10,418	11,880	10,137		10,897
	TOTALS	**67,050**	**132,313**	**78,059**	**143,376**	**137,510**	**135,869**	**89,214**	**160,006**

6.8.2. Processing

There are two primary methods of managing EAF dust in the U.S.: 1) Recovery of metals (primarily zinc) via High Temperature Metals Recovery (HTMR) processes; and 2) Waste stabilization/fixation and subsequent landfill disposal. [107] EAF dust may also be briquetted and then recycled back into the EAF onsite. One EAF operator (Company No. 7) reported recycling some of the EAF dust generated on site. Another EAF operator (Company No. 2) reported that the company is investigating the economic feasibility of on-site K061 recycling. Most EAF dust generated is either treated for disposal or used for metals recovery.

In the past, Horsehead operated the only HTMR facility for processing EAF dust in the U.S. In June 2008, however, Steel Dust Recycling LLC (SDR) commenced operation of their new HTMR facility (employing the Waelz Kiln process) in Millport, Alabama. The SDR facility is reported to have an EAF dust processing capacity of 110,000 short tons per year. [108, 109] A third EAF dust processing facility, using an induction furnace process, is also under construction in Mississippi. This operation is being built by Heritage Environmental Services, and is expected to commence operation in 2009. This facility is expected to have an EAF dust processing capacity of 50,000 short tons per year. [110]

Table 6.8.2-1 contains EAF dust disposition data reported by the nine reporting EAF operators. In general, EAF dust having a relatively high zinc concentration (i.e., on the order of 20 percent) is processed for metals recovery. By comparison, EAF dust having lower concentrations of zinc is generally treated by stabilization and then disposed of in landfills. The economics of processing the EAF dust for metals recovery vs. treating the EAF dust by stabilization for disposal depends in part on the concentration of zinc in the EAF dust and in part on the market value of zinc (and other metals) that are recovered from the HTMR process. Transportation costs is another important factor in decision making concerning management of EAF dust.

Table 6.8.2-1: Disposition of EAF Dust Generated by EAFs (2008)

Company	Recycled onsite	Offsite treatment for landfill disposal	Offsite metals (zinc) recovery process
1	0%	100%	0%
2	0%	1.3%	98.7%
3	0%	100%	0%
4	0%	100%	0%
5	0%	0%	100%
6	0%	40 – 60%	40 – 60%
7	8%	4%	88%
8	0%	1.6%	98.4%
9	0%	100%	0%

Company No. 2 reported that the facility sends one truckload of K061 for landfill disposal in order to maintain a disposal contract with the disposal company, while sending the remainder of the K061 for metals recovery. Company No. 8 reported that the K061 sent for landfill disposal is generally material that is contaminated with non-K061 material (e.g., cleanup and housekeeping dust) and therefore unsuitable for metals recovery. Company

No. 7 reported that the company prefers to recycle their K061, but sends material having low zinc concentrations (or high transportation cost) to landfill disposal. Company No. 5 reported that the facility initiated recycling of K061 for metals recovery in response to a State Source Reduction Strategy.

One secondary lead smelter operator that is permitted as a RCRA hazardous waste treatment, storage, and disposal facility (TSDF) reported that they were approached by an EAF operator to determine whether their lead smelter could process K061. The secondary lead smelter operator indicated that they cannot process K061 because the trace metals in the K061, including aluminum interfere with the quality of the lead product. These trace metals damage the casting process and some materials in the K061 "harden" the lead product. No primary or secondary lead smelters contacted for this study reported handling K061.

6.8.3. Composition

Rosselot (2007) conducted a study of lead flows in iron and steel production for the year 2003, and estimated that a flow rate of lead contained in furnace dust of 46,000 metric tons per year, including 30,000 metric tons from EAFs producing steel and 12,000 metric tons from BOFs producing steel. Rosselot estimated total EAF dust generation from steel production of 640,000 metric tons in 2003. [111] This value, combined with the lead flow rate from steel production using EAFs estimated in this material flow study (30,000 metric tons Pb), results in an average EAF dust lead concentration of approximately 5 percent. Rosselot indicated that this mass-balance-based estimate of EAF dust lead content compared favorably to measured values (citing data from 1999). This calculation-based estimate is higher than the recent direct measurements of lead content (see Tables 6.8.3-1 and 6.8.3-2.) but lower than the concentration reported in the delisting petition below. The varying lead content of K061 confirms the difficulty of obtaining a representative concentration given the heterogeneity of the scrap metal stream.

A K061 delisting petition filed by MAX Environmental Technologies reported K061 composition data for several EAF operators.[112] This delisting petition was submitted by a K061 treatment facility operator in Pennsylvania. Delisting petitions are further discussed in Section 6.8.5 and Appendix C. Data from the MAX Environmental Technologies delisting petition, shown in Table 6.8.3-1, indicates that typical EAF dust contains on the order of 8 percent lead, [113] More detailed data on the lead content of EAF dust and the TCLP concentration for lead are summarized in Table 6.8.3-3. More recent EAF dust composition data provided by the EAF operators indicate that the lead content of EAF dust is generally between 0.5 percent and 1.5 percent (See Table 6.8.3-2). Horsehead also reported that the typical range of lead concentration in EAF dust received by Horsehead is from 0.9 percent to 1.2 percent lead, and that individual shipments of EAF dust with lead concentrations of 3 percent to 4 percent lead have been received.[114]

Table 6.8.3-2 summarizes the recent K061 lead content measurements reported by nine EAF operators, which ranges from 0.5 percent to 1.5 percent. These EAF operators reported that there are no identifiable trends in K061 lead content related to the grades or characteristics of the scrap metal processed or modes of mill operation, and, with two exceptions, reported that the composition of the K061 is relatively consistent from year to year.

As shown in Table 6.8.3-2, Company No. 5 reported trend data for the lead content of EAF dust that shows a reduction in the average lead content from 1,500 mg/Kg (0.15%) to 800 mg/Kg (0.08%) over a five year period. Company No. 5 indicated that actions taken by the company concerning management of lead in scrap were focused on reducing the lead content of the steel produced, not on reducing the lead content of the EAF dust. The company's scrap metal management practices may have had an additional effect of reducing the amount of lead in the EAF dust.

Also, as shown in Table 6.8.3-2, Company 3 reported trend data for the lead content of EAF dust that shows a reduction in the average lead content from approximately 15,500 mg/Kg to 8,300 mg/Kg over the period of 1997 to 2005. The company reported that the only variable that is known to have changed from 1997 to 2005 was the amount of galvanized scrap material which was annealed (heat treated) with lead that originated from the mill. The last lead annealing frame was removed from service in 2001.

One EAF operator reported both the actual lead content of K061 and the leachable lead concentration, using the TCLP, in the K061. The threshold TC concentration for lead is 5 mg/liter, while the reported EAF dust leachable lead concentrations range from 100 mg/liter to 500 mg/liter. This is an indication that sufficient reduction of lead in scrap metal to reduce the K061 leachable lead content to below TC levels is unlikely for a typical EAF operation.

Liebman (2000) surveyed 73 EAF steel producers in the U.S and Canada and reported data concerning the lead of EAF dust and the quantity of EAF dust generated. Liebman reported that the 73 EAF facilities that were surveyed accounted for approximately 1,070,000 short tons of EAF dust. This represented 90 percent of the estimated 1.09 million metric tons of EAF dust generated in 1999 in the U.S. and Canada. Further, eight of the facilities surveyed in Liebman (2000) accounted for 27 percent of the EAF dust generated, and 40 facilities accounted for 49 percent of the EAF dust generated. [115] Table 6.8.3-4 provides a summary of the Liebman survey results.

Sixty one of the 73 EAF facilities surveyed reported EAF composition data. Forty percent (25) of the 61 EAF facilities reported the lead oxide content in the EAF dust at less than one percent; 31 percent (19) of the facilities reported a lead oxide content between 1 and 2 percent, 16 percent (10) of the facilities reported the lead oxide content as between 2 and 3 percent, 8 percent (5) facilities reported a lead oxide content as between 3 and 4 percent, and 5 percent (3) reported a lead oxide content as greater than 4 percent. [116] Liebman (2000) did not report data concerning how (or whether) the types and quantities of scrap charged to the EAFs or how (or whether) the production capacity of the EAFs relate to the EAF dust composition.

Table 6.8.3-1: Typical EAF Dust Composition: MAX Environmental Technologies delisting petition					
Metal	**Concentration**		**Metal**	**Concentration**	
	(mg/Kg)	**Percent**		**(mg/Kg)**	Percent
Aluminum	3,400	**0.34%**	Manganese	28,400	**2.84%**
Arsenic	230	**0.02%**	Nickel	340	**0.03%**
Calcium	34,300	**3.43%**	Phosphorus	1,280	**0.13%**
Chromium	1,700	**0.17%**	Potassium	16,300	**1.63%**
Copper	4,200	**0.42%**	Silicon	8,700	**0.87%**
Iron	248,500	**24.85%**	Sodium	19,800	**1.98%**
Lead	**78,200**	**7.82%**	Titanium	480	**0.05%**
Magnesium	13,100	**1.31%**	Zinc	232,900	**23.29%**

Source: Delisting Petition For Treated K061, Max Environmental Technologies, Inc. (Hazardous Waste Management Services), Yukon, PA, CEC Project 210966, 11/2003.
http://www.depweb.state.pa.us/pubpartcenter/lib/pubpartcenter/EQB/2004/yukon_delisting_petition.pdf

Table 6.8.3-2: EAF Dust Composition reported by EAF operators					
Company	**Actual Lead Concentration(mg/Kg)**			**TCLP Lead Conc.(mg/liter)**	**Data Year**
	Low	Average	High		
1	8,500	14,525	39,000		2005-2008
2	10,900	12,300	15,900		2006
2	8,500	11,900	15,200		2007
3		8,300			2005
3	12,930	15,515	17,940		1997
4	19,700	19,850	20,000		2007
5		800			2007
5		800			2006
5		1,000			2005
5		1,300			2004
5		1,500			2003
6		<4,000			2007
7		<2,000	<4,000	100-500 [a]	[typical]
8	8,400	10,830	11,800		1992
	9,400	10,250	12,000		1993
	7,200	8,640	10,200		1998
	4,500	5,960	8,500		1999
	3,500	4,310	6,400		2000
	2,650	4,160	6,190		2001
	3,930	4,750	6,620		2002
	2,710	3,660	4,660		2003
	4,200	5,460	6,620		2004
	3,390	6,120	8,970		2005
	4,950	5,650	6,090		2006
	4,990	6,670	10,900		2007
9	11,300	13,900	16,300		2007

[a] The TCLP threshold for classification of EAF dust as K061 hazardous waste is 5 mg/liter
Source: Consolidated data from Steel Manufacturer Association member companies, consolidated by the SMA June 15, 2008, and data from an additional EAF operator contacted separately.

Table 6.8.3-3: EAF Dust Composition reported in MAX Environmental Technologies Delisting Petition					
Company	**Actual Lead Concentration(mg/Kg)**			**TCLP Lead Conc. (mg/liter)**	**Data Year**
	Sample 1	Sample 2	Sample 3		
J&K Steel	10,200	--	--		2003
Ellwood Quality	9,460	9,190	--	1	2003
Allegheny Ludlum	4,980	3,590	3,470	17.2	2003
AK Steel	3,460	1,440	--		2003
Source: Delisting Petition For Treated K061, Max Environmental Technologies, Inc. (Hazardous Waste Management Services), Yukon, PA, CEC Project 210966, 11/2003. http://www.depweb.state.pa.us/pubpartcenter/lib/pubpartcenter/EQB/2004/yukon_delisting_petition.pdf					

Table 6.8.3-4: EAF Dust Composition reported by Liebman Survey of EAF Operators		
Range of EAF Dust Lead Concentration	**Number of EAF Facilities Reporting**	**Percent of EAF Facilities Reporting**
< 1 percent	25	40 percent
1 to 2 percent	19	31 percent
2 to 3 percent	10	16 percent
3 to 4 percent	5	8 percent
> 5 percent	3	5 percent
Total number of EAF Facilities Reporting	61	100 percent
Source: Liebman, Marc, 2000. The Current Status of Electric Arc Furnace Dust Recycling in North America, AIM Market Research, Pittsburgh PA, 2000, Figure 2.		

6.8.4. Treatment and Recycling (Zinc Recovery)

This section provides an overview of EAF dust treatment for disposal and processing for zinc recovery. These processes include HTMR for zinc recovery, emerging processes for zinc recovery, and K061 stabilization and fixation for disposal.

Zinc Recovery/HTMR Process

Approximately two-thirds of the EAF dust generated in the U.S. is processed by Horsehead in their HTMR process located in Pennsylvania. The quantity of EAF dust processed equals about 600,000 tons per year. Steel Dust Recycling LLC's HTMR facility that recently began operation in 2008 has an estimated EAF dust throughput capacity of 110,000 short tons per year.[117] Air emissions of lead from this facility after application of air emission controls have the *potential* to be 4.23 short tons per year, according to environmental documentation for the facility. However, the total *expected* lead emissions are approximately 1.43 short tons per year.[118] This would represent approximately 0.2 percent of the total lead content of the EAF dust processed, assuming 110,000 tons a year

EAF dust processed and an average of 2 percent lead content in the EAF dust. It is anticipated that the lead content of the EAF dust that is not emitted as air emissions would go either into the Waelz iron product or into the slag produced by the process.

At the Horsehead facility, the EAF dust is first processed through a Waelz Kiln. This is an iron separation process. All of the non-ferrous metals in the EAF dust generated from the Waelz Kiln are captured into a single product. Crude Zinc Oxide (CZO) is created by the Waelz Kiln process, and is further processed in a calcining kiln into zinc feedstock. The lead and other metals are separated at this point in the process, and the zinc feedstock is sent to the Horsehead Monaca, PA Plant for processing into zinc. Horsehead attempts to separate the lead from the zinc so it doesn't go into the zinc recovery operation and contaminate the equipment. The lead fraction is shipped to the Horsehead Bartlesville, OK Plant and processed to separate metals and lead carbonate. The lead carbonate is sent to a primary lead smelter.

The separation of the EAF dust lead from the zinc in the HTMR process is not 100 percent. The PW Metal (the zinc product that Horsehead produces) also has lead in it. Horsehead estimates that there may be 1.5 percent lead in the zinc product, but that the bulk of the lead content of the EAF dust is going into the lead residue and ultimately to the primary lead smelter.

The SDR facility now under construction would also use a Waelz kiln process to recover zinc from the EAF dust. According to the facility process description, the zinc product produced by the process would be provided to primary zinc smelters. The Waelz Kiln iron product could be used in cement and asphalt production (no mention is made of recovery of lead content or of where the lead content goes in the process). [119]

Emerging Zinc Recovery Processes

There are several initiatives underway to provide additional U.S. capacity to treat K061 for metals recovery. Heritage Environmental Services has developed a new process to process EAF dust for metals recovery. The company constructed a "demonstration plant" in Indiana to process EAF dust for metals recovery using the PIZO Technologies LLC channel induction furnace process, and is now constructing a full-scale facility in Arkansas to process EAF dust from several EAF dust generators.[120] [121] A minor source construction permit has been issued by the Arkansas Department of Environmental Quality for the proposed full-scale facility. [122] The minor source permit for the facility includes a process description for the PIZO Process. [123]

With this process, EAF dust, and potentially other zinc-containing materials, would be heated in a molten iron bath and melted and separated into molten metal, volatile metals, and slag. The zinc content of the melted material would volatilize into gasses and would subsequently oxidize in the process vent hood to form crude zinc oxide (CZO). The CZO would be collected in baghouses and then conveyed to a storage silo for shipment to zinc product producers. The PIZO process would also produce pig iron and slag. The pig iron, derived from the iron content of the EAF dust, would be transferred from the melting furnace in ladles into a pig casting machine to be made into iron pigs. The slag from the process would be cooled in steel boxes and crushed and then potentially sold to customers. Air emissions of lead from the proposed facility would be approximately 1 short ton per year according to environmental documentation for the proposed facility, indicating that most of the lead content of the feed to the process is recovered in the products of the PIZO process rather than emitted to the atmosphere. [124]

As the full-scale PIZO process facility is only now under construction, the PIZO process is not currently considered a proven technology with respect to managing lead in EAF dust. While the PIZO process may result in the generation of saleable material streams (CZO, pig iron, and slag), the process description does not indicate that the lead content of the EAF dust is recovered/reclaimed (as lead) and separated from the other product streams from the process. The minor source permit for the proposed facility indicates that the air emissions from the PIZO process would be less than one ton per year of lead. Therefore, the lead content of the EAF dust would likely be contained in one or more of the product flows out of the process (i.e., the CZO, the slag, or the pig iron) and could be subject to potential release to the environment during downstream processing/use of these materials. The commercially proven HTMR process, by comparison, separates the lead content of the EAF dust into a saleable lead product that is further processed at a primary lead smelter.

The economics of K061 treatment for metals recovery may change with the anticipated startup of these new facilities in the U.S. to recover zinc from EAF dust. Currently, EAF operators are limited to recycling the EAF dust on site, sending the material to one of two HTMR facility operators (one in the U.S. and one in Mexico) or treating the material for landfill disposal. It may be the case that EAF operators that are currently sending their EAF dust to landfill disposal may instead send the material to one of the proposed metals recovery facilities.

K061 Stabilization/Fixation Processes

Typical stabilization/fixation processes for treatment of EAF dust (K061) are intended to reduce the leachability of metals from the EAF dust such that the treated material (if delisted) can be disposed of in a non-hazardous waste landfill. One such treatment process described in a MAX Environmental Technology 2003 delisting petition [see Appendix C] would treat EAF dust using a combination of chemical fixation and macroencapsulation and would increase the density of the material from approximately 0.53 g/cm^3 (untreated EAF dust) to approximately 0.84 g/cm^3 (treated EAF dust residuals). The treatment process would also reduce the leachability of metals from the treated material under acidic, neutral, and alkaline conditions. According to the delisting petition, the leachability of lead would be reduced by 99.9 percent as compared to the untreated EAF dust. Reductions in the leachability of selected metallic constituents in the treated EAF dust versus the untreated EAF dust are summarized in Table 6.8.4-1:

Table 6.8.4-1: Reductions in Leachability of Metals in Treated EAF Dust from MAX Environmental Technology Process

Metallic Component	TCLP Concentration (mg/L)	TCLP Concen. (mg/L)	Percent Reduction	TCLP Concen. (mg/L)	TCLP Concen. (mg/L)	Percent Reduction
	Untreated	Treated		Untreated	Treated	
	(AL)	(AL-T2)		(EQ)	(EQ-T1)	
Antimony	ND (0.12)	0.00019	--	0.038	0.0021	94%
Arsenic	0.093	ND (0.001)	>99%	0.17	ND (0.001)	>99%
Barium	0.13	0.084	35%	0.69	0.38	45%
Beryllium	ND (0.005)	ND (0.001)	--	0.006	ND(0.0010)	>83%
Cadmium	ND (0.1)	0.0036	--	3.1	0.0011	99.96%
Chromium	47.1	ND (0.002)	>99.9%	0.068	0.031	54%
Lead	17.2	0.00099	99.9%	1	0.00016	99.98%
Mercury	0.0024	ND (0.0002)	>92%	0.001	ND(.00020)	>80%
Nickel	ND (0.04)	0.006	--	0.11	0.0093	92%
Selenium	0.052	ND (0.005)	>90%	0.039	0.0011	97%
Silver	0.0042	ND (0.001)	>76%	ND(0.05)	ND(0.0010)	--
Thallium	ND (2)	0.00072	--	ND (2)	0.0057	--
Vanadium	0.063	ND (0.001)	>98%	0.0037	ND(0.0010)	>73%
Zinc	4.8	0.013	99.7%	170	0.0032	100%

EQ = Elwood Quality Facility data; EQ-T1 = Treatment Test 1 data
AL = Allegheny Ludlum Facility data; AL-T2 = Treatment Test 2 data

Source: Delisting Petition For Treated K061, Max Environmental Technologies, Inc. (Hazardous Waste Management Services), Yukon, PA, CEC Project 210966, 11/2003. http://www.depweb.state.pa.us/pubpartcenter/lib/pubpartcenter/EQB/2004/yukon_delisting_petition.pdf

6.8.5. Federal K061 Waste Delisting Actions

In 2002 EPA conducted a Study on RCRA Hazardous Waste Delisting, the study noted 12 federal delisting actions associated with BOFs and Steel Mills. Of these, 6 were for delisting K061. These 6 EPA K061 delisting actions do not include K061 delisting actions issued by state agencies. At least 1.5 million tons of K061 derived from steel production at mills using EAFs had been delisted as of 2002.[125] Several additional delisting petitions have been submitted to U.S. EPA or to state agencies since the 2002 EPA Study was published. Federal and state-agency delisting petitions for K061 are further discussed in Appendix C.

Facilities reporting delisting of K061 waste achieved this status through the application of various treatment methods to the K061. Data provided by the EAF operators contacted for this study and from literature searches do not indicate any K061 being delisted solely through changes to the characteristics of the scrap metal feed to EAFs (i.e., to reduce the content of lead or other metals in the K061). ISRI reported that some EAF operators have been able to delist the K061 generated by their facilities because their facilities only accept prompt scrap, and not shredded steel or other post-consumer scrap.[126] Prompt scrap generated from iron and steel manufacturers that are not using leaded steel or stainless steel would contain very low concentrations of lead. EAF operators reported that the lead content of the steel produced in their facilities is on the order of 0.01 percent lead. By comparison, leaded steel or stainless steel would contain on the order of 0.25 percent lead. In other words, if the lead content of the raw material to the EAF is reduced sufficiently, the K061 generated can possibly be delisted. However, utilization of solely prompt scrap as a raw material to an EAF would not be feasible for EAF operators in general. As shown in Table 6.2.2-3, in 2005, shredded steel scrap (derived primarily from shredding scrap automobiles) represented the single largest scrap flow for pig iron and raw steel production. This scrap stream comprised about 20 percent of the total iron and steel scrap used in iron and steel production. Heavy melt grade steel (including structural steel potentially containing lead-based coatings) comprises a similar percentage of the total.

7. Study Findings

This section provides a summary of study findings concerning management of lead in scrap metal and management of lead flows to EAFs.

- There is no apparent statistically verifiable relationship between the lead content of furnace dust/K061 and the lead content of scrap sources based on available data. EAF operators indicated either that data are not collected to a sufficient degree to enable a correlation between the types or sources of scrap and lead concentrations, or that the scrap streams are too variable to enable conclusive definitions of the relative contributions to the lead content of K061. A correlation between scrap grade and K061 lead content is more readily made if steel mills use one grade exclusively, such as prompt scrap. However, this is an atypical condition and would still need to be verified on a facility-by-facility basis.

- The concentration of lead in the most common grades of scrap, e.g. shredded scrap, cast metal scrap, is relatively low and widely dispersed, and only a small amount of lead in scrap feed to an EAF would result in the lead content of the EAF dust exceeding TC thresholds, since the lead content of the scrap largely ends up in the EAF dust. Once lead becomes incorporated into the scrap, it is difficult to identify and remove.

- EAF operators indicated that collecting sufficient data to assess trends in the concentration of lead in K061 would be infeasible, and, even if sufficient data were to be collected, any trends in lead concentration would likely remain inconclusive.

Part of the reason is that EAF operators reported the lead content of scrap overall is low and the lead is "widely dispersed and in low-concentration materials" (i.e., as opposed to being in relatively large, identifiable articles). Scrap metal suppliers and EAFs that are implementing "best practices" (see Section 8.0) are removing lead-containing materials that are relatively easily identifiable and recoverable, and are controlling the quality of the scrap that they receive to eliminate known sources of lead-containing scrap.

- Based on the responses from EAF operators, lead in scrap metal is an accepted operational cost to be managed. In general, research conducted for this study indicates that EAFs already have scrap management practices and procedures in place to control the amount of lead contained in scrap processed at EAFs. EAF operators reported that they can control the lead content of their scrap metal supply to the extent necessary to ensure that lead does not affect the quality of the produced steel. One EAF operator indicated that merely 15 kilograms of lead contained in a heat would ruin the finished product (a typical EAF heat is 100 - 150 metric tons of steel). EAF operators indicated that they control the lead content of their produced steel to less than 0.01 percent (or as low as 0.001 percent) and that most of the lead in scrap ends up in the EAF Dust, not to the produced steel.

- BOF operators also reported that they have procedures in place to control the amount of lead in the scrap feed to the BOFs. One BOF operator reported that a concentration of 0.03 percent lead by weight in the produced steel would result in a "missed heat" and would trigger a response from the plant quality control system. This BOF operator[127] indicated that the plant quality control system could apply a combination of detailed heat information and video surveillance to narrow down the source of the lead causing a "missed heat" to within "three or four rail cars" of scrap metal.

- The Rosselot Study (2007) identified the lead content of cast metal as the largest potential stream of lead content in scrap that is unlikely to be removed by any upstream sorting process. According to the study, the amount of lead consumed in the production of casting metals for transportation equipment (e.g. engine blocks) amounted to about 30,000 metric tons per year between 1997 and 2003. [128] These scrap metals would be utilized at both EAFs and BOFs. EAF operators [and the SMA] indicated that, for the most part, there are no restrictions applied to acceptance of cast metal by EAFs. Visual inspection of cast metal would not easily distinguish lead-containing castings, and castings are a large enough scrap stream that segregating castings from the general scrap metal stream would be problematic. Furthermore, segregating casting metals would not enhance lead recovery since these metals would still need to be recycled by BOFs or foundries. The alloyed lead content is too small to make secondary lead smelting a viable alternative.

- EAF operators indicated that the lead content of EAF Dust is on the order of 0.5 - 1.5 percent and that the leachable lead content, using the TCLP, of EAF Dust is typically on the order of 100 ppm – 500 ppm. Considering that the lead in scrap is "widely dispersed and in low-concentration materials," EAF operators do not see a practical solution to reducing the lead content of the scrap sufficiently to reduce the lead content of EAF Dust below the TC level; ***to delist the material, the leachable lead levels would need to get much lower***. Based on EAF operator data and other sources of TCLP data for K061, delisting of K061 for an EAF accepting anything other than uniformly controlled prompt scrap is not realistic, unless the EAF dust is subsequently treated.

- For low-concentration lead or alloyed lead in scrap metal streams (i.e., streams that cannot be easily identified/recovered by visual inspection and grades of scrap that do not contain identifiably high lead content), removal of lead at the production level (pollution prevention approach) seems most feasible. This approach has merit as separation of visually-identifiable lead in steel and iron is in large part already a well developed practice and it is likely that the major portion of visually-identifiable lead is already being segregated. While this approach can be improved, even if all visually-identifiable lead and certain scrap grades were eliminated, the bulk of the currently remaining lead in the feed stream to EAFs would remain in low concentration, widely dispersed alloyed material.

- Scrap metal is being classified under a number of commercial grades. However, scrap metal grades are largely not classified based on lead content. Because lead is largely an operational cost being managed by the EAFs (i.e., they have procedures in place to control the lead content of their produced steel), commercial incentives do not exist to drive scrap classification in this way. As such, the lead content is not a primary driver in scrap grading.

- Lead content in different scrap grades is highly variable. According to scrap metal suppliers and EAF and BOF operators, there are certain identifiable grades of ferrous metal scrap that are known to contain lead. Examples of grades where lead is used as an alloy include: terne plated steel, terne plate bundles, busheling, Babbitt metal (e.g., bearings), turnings, borings, and galvanized steel. These grades are in addition to residual (contaminant or non-alloyed lead) material, e.g., wheel weights, counterweights. One EAF operator reported that lead components are found in #2 heavy melt grade scrap, which this particular operator does not accept. One BOF operator [129] also identified a "small chance" that heavy melt grade scrap could contain lead in the form of counterweights, but still accepts heavy melt grade scrap subject to visual inspection. In general, the study contacts indicated that these grades of scrap are already being segregated by scrap metal recyclers prior to shipment, particularly for mills whose steel products would be adversely affected by the increased lead content of these grades. EAF and BOF operators indicated that contracts with scrap suppliers explicitly prohibit acceptance of residual lead materials and that inspection procedures are in place to identify and reject such materials.

- Both scrap metal suppliers and EAFs have procedures in place to identify and remove ferrous-metal components containing lead (e.g., sewer pipe connectors). However, visual inspection procedures would not be expected to identify all "leaded steel" components. One EAF operator that produces "leaded steel" indicated that approximately 5.5 pounds of lead are added per short ton of steel to produce the leaded steel. Leaded steel components may contain only 0.15 - 0.35 percent lead according to supplier specifications. These components are not necessarily visually identifiable or identifiable by scrap grade, and would need to be subjected to chemical analysis in order to be identified and segregated from the general scrap metal stream. One EAF operator reported applying spectroscopy to identify and segregate lead-containing turnings. Several other EAF operators reported that their facilities are applying newer technologies (e.g., XRF Gun) to identify suspected lead-containing material or anticipate doing so in the future. However, according to EAF operators, these technologies are not likely to be feasible for identifying the lead content of bulk or shredded steel scrap on a routine basis because these technologies analyze metal surfaces not within the metal volume. As with casting metals, segregation of leaded steel would still not enhance lead recovery as this material would still need to be recycled by ferrous mills of some variety resulting in the capture of lead by air pollution control devices. Minimal lead content makes secondary lead smelting not feasible. However, XRF-type technologies may still be useful in indentifying non-alloyed residual lead contamination.

- One company indicated that they consume 150 (22.5-ton) truckloads and 50 (75-ton) railcar loads of scrap every day, and suggested that it would be infeasible to subject anything, but a small fraction of such volume of material to analytical testing (i.e., as opposed to visual inspection). The diverse origins of these scrap metal loads would also make representative sampling infeasible.

- Continued diligence and knowledge transfer within the scrap industry will ensure a majority of lead components that are visually identifiable or identifiable by scrap grade are removed. These include: items that are primarily lead and are managed as non-ferrous metal scrap; items that contain an economically viable level of lead (or other non-ferrous metals) that are separated from the ferrous metal scrap stream; and certain identifiable scrap grades (e.g., turnings.) Visually-identifiable lead-containing materials include pipe seals, counterweights, roofing materials, batteries and battery components.

8. K061 Lead Reduction Strategies

This section provides a brief description of potential strategies to reduce the lead content of K061. It provides recommendations for potential lead reduction and separation strategies to be investigated, including next steps for EPA and new industry initiatives.

8.1. Future Strategy Considerations

The following considerations should be kept in mind while pursuing future waste minimization activities and judging their effectiveness:

One principal consideration concerning future strategies to reduce the amount of lead in scrap metal processed at EAFs is that such strategies are not likely to reduce the amount of lead in ferrous metal scrap to levels resulting in EAF dust with lead levels lower than the TC threshold level; indeed the TC value would need to be much lower than the threshold level to be considered for delisting. This is because, as discussed above, lead concentrations of EAF dust are much higher than the TC threshold. The residual (contaminant) lead content of ferrous metal scrap that can be controlled by EAF operators does not contribute to the lead content of K061 as much as the alloyed lead in ferrous products. Residual (contaminant) lead is largely controlled by scrap metal recycling facilities to capture the higher non-ferrous commodity value and by EAFs to ensure the quality of their steel product. Thus, the resources devoted to further reduction of residual lead should be tempered with this limitation in mind.

Future reduction and separation strategies would also have to account for the fact that the lead-content of materials entering the scrap metal stream is generally at low concentrations and is dispersed throughout a wide range of materials and scrap grades; management of the flow of such materials to the EAFs by further controlling the grades of scrap accepted by EAFs would simply leave a larger fraction of the ferrous metal scrap to be accepted by BOF operators, since the scrap would likely be recycled in one process or the other. Thus, even if these grades were segregated, the lead would still be captured in the same way – just not as a K061. Accordingly, strategies based on controlling the acceptance of specific scrap grades by EAF operators would not solve the broader issue of minimizing the lead content of ferrous scrap recycling materials.

Much of the lead-content of ferrous metal scrap is contained in products that may have been manufactured years or even decades ago, e.g. structural steel, appliances, automobiles. Therefore, strategies based on reducing the amount of lead used in manufactured products would not be expected to have an immediate effect on the lead content of scrap entering the ferrous metal scrap stream, considering the inherent lag between production and when the product reaches the end of its useful life and enters the scrap metal stream.

8.2. Reduction and Separation Strategies

With these considerations in mind, prudent next steps for public and private stakeholders may include:

- Ensure best management practices identified above for lead and lead products, scrap metal suppliers (auto dismantlers, shredders, ferrous/non-ferrous scrap yards, C&D material recyclers), and EAF operators are being implemented industry-wide. This primarily includes efforts to segregate and recover lead product residuals (as opposed to ferrous products with alloyed lead) from the scrap metal stream. The best management practices described in this research provide a bench mark for industries at various parts of the supply chain and should help draw attention to this issue that will lead to further improvements.

- One best practice of note: some facility operators reported that they have established financial incentive programs for workers to identify and segregate non-ferrous metals from the ferrous metal scrap stream. Allowing employees to receive proceeds from the resale of the non-ferrous metals they remove from incoming scrap loads is one type of incentive. These incentives are effective because non-ferrous metal scrap is more valuable than ferrous metal scrap; additionally, removing non-ferrous metals – including lead – increases the value of ferrous scrap itself.

- Scrap metal generators, scrap metal recyclers and EAF operators generally indicated that the most feasible and cost effective method of managing lead in scrap metal is for manufacturers to reduce the amount of lead in manufactured products that can potentially enter the ferrous metal scrap stream. Analysis of empirical data supports these claims. Initiatives to reduce the amount of lead used in products may be the most fruitful avenues for increasing lead recovery. EPA's voluntary initiative to phase out the use of lead wheel weights could be used as a model for this effort. Other industry sectors to consider include: cast metal products, leaded-steel machined parts, automobile parts, and coatings.

- Application of lead source reduction initiatives would be more effective if applied to production both within and outside of the U.S. SRI indicated that a significant issue with respect to the lead content of scrap metal relates to lead contained in imported materials made from iron and steel.
    - For example, the lead content in metal strapping made in Asia is very high. The metal strapping is used in transporting freight from Asia to the U.S. Strapping containing lead is not easily distinguishable from other strapping. Even if the strapping is segregated, it has too little lead content to be of interest to non-ferrous metal recyclers. Metal cans manufactured in Asia and Eastern Europe may also contain lead solder, and there may be other iron and steel products coming from foreign suppliers that contain lead entering the ferrous metal scrap stream.
    - SRI indicated that in 1998, 90% of steel based products were made in the U.S. and 10% were imported; in 2008 the ratio was 50:50.
    - Note: the European Union's recent regulatory initiatives to control hazardous materials e.g. Registration, Evaluation, Authorisation and Restriction of Chemical (REACH), does not include lead bearing materials in general (e.g. leaded steel, cast metals) given their relatively low levels of lead content.

Appendix A: Summary of Contacts

Table A-1 includes a summary of trade association and industry contacts for this study. Most discussions with the trade association and industry contacts were conducted by telephone and electronic mail, with the exception of one meeting conducted March 4, 2008 with representatives of the Steel Manufacturers Association (SMA). Table A-2 identifies the SMA meeting attendees.

Table A-1: Summary of Association and Industry Contacts

Contact Name	Organization	Date	Contact Information
Roy Baggett	Sanders Lead Company	4/02/2008	334-566-1563 rb@sanderslead.com
John Cabaniss	Association of International Automobile Manufacturers Director for Environment and Energy	5/19/2008	703-525-7788 General 703-247-2107 Direct http://www.aiam.org/public/aiam/default.aspx
Therese Cirone	Quemetco, Inc. Vice President	5/05/2008	317-247-1303
Mat Cusma	Schnitzer Steel	3/10/2008	503-286-6944 http://www.schnitzersteel.com/ mcusma@schn.com
Joseph Hanning	U.S. Steel	2/25/2008	412-273-7207 Office 412-952-0474 Cell JEHanning@uss.com
Matt Haslett	Metro Metals NW	2/27/2008	503-287-8861 matth@metrometalsnw.com
Bill Heenan	Steel Recycling Institute	4/25/2008	412-922-2772 x205 bheenansri@aol.com
Mike Hohman	U.S. Steel	2/25/2008	412-233-1467 MHohman@uss.com
Scott Horne	Institute of Scrap Recycling Industries,	2/07/2008	202-662-8533 scotthorne@isri.org
Tom Janeck	Horsehead Corporation Vice President EH&S	5/21/2008	724-773-2272 TJaneck@horsehead.net
Daniel Lake	Timken Company	5/20/2008	330-470-3716 Daniel.lake@timken.com
Drew Lammers	Cohen Brothers, Inc.	2/11/2008	1-513-422-3696

Table A-1: Summary of Association and Industry Contacts			
Contact Name	**Organization**	**Date**	**Contact Information**
	President of National Demolition Association		1-513-617-0541 http://www.cohenbrothersinc.com/ferrous.php
Michael Long	ArcelorMittal Steel	2/26/2008	503-287-8861 michael.long@mittalsteel.com
Joyce Morales	Mayco Industries	5/21/2008	205-942-4242 joyce@maycoindustries.com
Michael Olvera	ABI Foundry Environmental Engineering Manager	3/10/2008	510-632-3467 molvera@abifoundry.com
Jim Reese	Horsehead Corporation	5/21/2008	724-773-2272 office 724-561-9930 cell JReese@horsehead.net
Jon Sampson	Automotive Recyclers Association	2/06/2008	703-385-1001 Note: Jon Sampson may no longer be at ARA
John Tapper	Gopher Resource Corporation	4/07/2008	651 405-2203 http://www.gopherresource.com/lead_faq.asp
Mike Taylor	National Demolition Association Executive Director	2/04/2008	215-348-4949 800-541-2412 Info@demolitionassociation.com
William Turley	Construction Materials Recycling Association (CMRA) Executive Director	1/29/2008	630-585-7530 turley@cdrecycling.org
Mike Vail	Metro Metals NW	2/27/2008	503-287-8861 mikevail@excite.com
Dan Vornberg	Doe Run Company	5/19/2008	314-453-7100 636 933-3187 Direct http://www.doerun.com/
David Wagger	Institute of Scrap Recycling Industries	2/07/2008	202-662-8533 davidwagger@isri.org
Steve Yates	Gopher Resource Corporation EHS Manager	4/07/2008	651-405-2213 Steve.Yates@grcmn.com http://www.gopherresource.com/lead_faq.asp

Table A-2: SMA Meeting Attendees

Contact Name	Organization	Contact Information
Eric Stuart	Steel Manufacturers Association Director Environment and Energy	202-296-1515 stuart@steelnet.org
Dale Harmon	Gerdau Ameristeel	http://www.gerdauameristeel.com/
Mike Peters	CMC Vice President-Environmental Manager	830-372-8305 mike.peters@cmc.com
Brad Bredesen	CMC Asst. Vice President-Environmental Manager	830-372-8331 Steven.Bredesen@cmc.com
Eric Larmore	Nucor Steel Environmental Manager	205-562-1132 Eric.Larmore@nucor.com
Joseph Green	Kelly Drye/Collier Shannon	202-342-8849 jgreen@kelleydrye.com
James Kohler	U.S. EPA Office of Resource Conservation and Recovery Environmental Engineer	703-347-8953 Kohler.James@epamail.epa.gov
Jonathan Kiser	ICF International	703-431-1106 (cell) jkiser@icfi.com
Michael DeWit	ICF International Senior Manager	905-274-0391 mdewit@icfi.com
Robert Lanza	ICF International Senior Chemical Engineer	202-862-1118 rlanza@icfi.com

Appendix B: Lead Consumption and Scrap Metal Consumption Data

The USGS reports annual data for U.S. primary and secondary lead consumption. Tables B-1 and B-2 summarize U.S. primary and secondary lead consumption for the years 2005 and 2006.[130]

The USGS also reports annual data for U.S. scrap iron and steel consumption.[131] Table B-3 contains data for consumption of scrap in pig iron and raw steel production, foundries, and other types of facilities for the years 2002 – 2006, including purchased and home scrap. Tables B-4 and B-5 contain data for on the utilization of iron and steel scrap by scrap grade for the year 2006. Table B-6 identifies consumption of metal scrap by facility type, including BOF, EAF, iron foundry, and other types of facilities. USGS does not publish more detailed scrap data for scrap grade utilization by furnace type.[132]

TABLE B-1
U.S. CONSUMPTION OF LEAD, BY PRODUCT[1]
(Metric tons, lead content)

SICcode[2]	Product	2005		2006
	Metal products:			
3482	Ammunition, shot and bullets	61,300		65,300
	Bearing metals:			
35	Machinery except electrical	W		W
371	Motor vehicles and equipment[3]	W		W
37	Other transportation equipment	W		W
	Total	1,180		1,240
3351	Brass and bronze, billets and ingots	2,100		2,620
36	Cable covering, power and communication	(4)		(4)
15	Calking lead, building construction	(4)		(4)
	Casting metals:			
36	Electrical machinery and equipment	W		W
371	Motor vehicles and equipment	W		W
37	Other transportation equipment	W		W
3443	Nuclear radiation shielding	W		W
	Total	30,400	r	29,900
	Pipes, traps, other extruded products:			
15	Building construction	1,220		845
3443	Storage tanks, process vessels, etc.	(5)		(5)
	Total	1,220		845
	Sheet lead:			
15	Building construction	23,200	r	7,710
3443	Storage tanks, process vessels, etc.	W		W
3693	Medical radiation shielding	W		W
	Total	29,100	r	8,560
	Solder:			
15	Building construction	W		W
	Metal cans and shipping containers	W		W
367	Electronic components, accessories and other electrical equipment	7,720		6,860
371	Motor vehicles and equipment	W		W
	Total	8,370		7,140
	Storage batteries:			
3691	Storage battery grids, post, etc.	579,000	r	661,000
3691	Storage battery oxides	705,000	r	735,000
	Total storage batteries	1,280,000	r	1,400,000
27	Type metal, printing and allied industries	(4)		(4)
34	Other metal products[7]	22,200		22,600
	Grand total	1,440,000	r	1,530,000
	Other oxides:			
285	Paint	W		W
32	Glass and ceramics products	W		W
28	Other pigments and chemicals	W		W
	Total	14,100		16,200
	Miscellaneous uses	32,900		12,300
	Grand total	1,490,000	r	1,560,000

Source: USGS Minerals Yearbook, Lead, 2006
[r] Revised. W Withheld to avoid disclosing company proprietary data; included in appropriate totals.
[1]Data are rounded to no more than three significant digits; may not add to totals shown.
[2]SIC Standard Industrial Classification.
[3]Includes "Metal products: Storage batteries: Terne metal, motor vehicles and equipment."

[4]Included with "Metal products: Grand total."
[5]Included with "Metal products: Sheet lead: Building construction" to avoid disclosing company proprietary data.
[6]Included with "Metal products: Storage batteries: Other metal products" to avoid disclosing company proprietary data.
[7]Includes lead consumed in foil, collapsible tubes, annealing, galvanizing, plating, electrowinning, and fishing weights.

TABLE B-2
U.S. CONSUMPTION OF LEAD, BY PRODUCT[1]
(Metric tons, lead content)

Product	**2005**	**2006**	**2005**	**2006**
Ammunition, shot and bullets	61,300	65,300	4.11%	4.19%
Bearing Metals (1)	1,180	1,240	0.08%	0.08%
Brass and bronze, billets and ingots	2,100	2,620	0.14%	0.17%
Casting Metals (2)	30,400	29,900	2.04%	1.92%
Pipes, traps, other extruded products:	1,220	845	0.08%	0.05%
Sheet Lead: Building Construction	23,200	7,710	1.56%	0.49%
Sheet Lead: Storage Tanks/Medical	5,900	850	0.40%	0.05%
Solder: Electronic components, accessories and other electrical equipment	7,720	6,860	0.56%	0.46%
Solder: Motor vehicles and equipment, metal cans, building construction	650	280	0.04%	0.02%
Total storage batteries	1,280,000	1,400,000	85.91%	89.74%
Other metal products (3)	22,200	22,600	1.49%	1.45%
Total Pigments, glass, and ceramics	14,100	16,200	0.95%	1.04%
Miscellaneous uses	32,900	12,300	2.21%	0.79%
	1,482,870	1,566,705	99.57%	100.45%

Source: USGS Minerals Yearbook, Lead, 2006
[Numbers in this table do not add up to 100 percent because of rounding.]

(1) Includes Machinery except electrical, Terne metal, Motor vehicles and equipment, and Other transportation equipment.

(2) Includes Electrical machinery and equipment, Motor vehicles and equipment, Other transportation equipment, Nuclear radiation shielding

(3) Includes lead consumed in foil, collapsible tubes, annealing, galvanizing, plating, electrowinning, and fishing weights.

TABLE B-3

U.S. IRON AND STEEL SCRAP, PIG IRON, AND DIRECT-REDUCED IRON STATISTICS[1]

(Thousand metric tons)

	2002	2003	2004	2005	2006
Manufacturers of pig iron and raw steel and castings:[2]					
Ferrous scrap consumption	56,400	55,200	57,100	55,000[r]	54,500
Pig iron consumption	42,500	39,700	38,000	36,900	36,700
Direct-reduced iron consumption	2,230	1,790	1,490	1,740	1,530
Net receipts of ferrous scrap[3]	43,600	42,700	45,800[r]	43,600[r]	45,300
Home scrap production[4]	12,700	12,600	11,600	11,400[r]	9,120
Ending stocks of ferrous scrap, December 31	4,360	4,070	4,880	4,430[r]	3,880
Manufacturers of steel castings:[5]					
Ferrous scrap consumption	1,900	1,130	1,310	1,810	1,640
Pig iron consumption	34	31	94	89	56
Net receipts of ferrous scrap[3]	1,160	761	972	1,060	1,320
Home scrap production[4]	717	361	326	743	319
Ending stocks of ferrous scrap, December 31	173	88	80	85	79
Iron foundries and miscellaneous users:[5]					
Ferrous scrap consumption	11,200	8,720	8,490	8,670[r]	9,370
Pig iron consumption	1,280	1,030	1,020	1,080[r]	857
Direct-reduced iron consumption	13	4	4	3	4
Net receipts of ferrous scrap[3]	7,270	6,300	6,320	6,130[r]	6,580
Home scrap production[4]	3,760	2,430	2,370	2,870[r]	3,010
Ending stocks of ferrous scrap, December 31	401	251	459	585[r]	784
Total, all manufacturing types:					
Ferrous scrap consumption	69,500	65,000	66,900	65,500[r]	65,600
Pig iron consumption	43,800	40,800	39,100	38,100[r]	37,600
Direct-reduced iron consumption	2,250	1,790	1,500	1,750	1,540
Net receipts of ferrous scrap[3]	52,100	49,800	53,100	50,800[r]	53,200
Home scrap production[4]	17,200	15,400	14,300	15,000[r]	12,500
Ending stocks, December 31:					
Ferrous scrap at consumer plants	4,930	4,410	5,420	5,100[r]	4,740
Pig iron at consumer and supplier plants	754	381	722	665	701
Direct-reduced iron at consumer plants	269	345	136	263	320
Exports:[6]					
Ferrous scrap (includes tin plate and terne plate):[7]	8,950	10,800	11,800	13,000	14,900
Pig iron, all grades:	34	86	48	51	813
Direct-reduced iron, steelmaking grade:	1	5	13	(8)	(8)
Imports for consumption:[6]					
Ferrous scrap (includes tin plate and terne plate):[7]	3,130	3,480	4,660	3,840	4,820
Pig iron, all grades:	4,620	3,890	6,400	6,030	6,730
Direct-reduced iron, steelmaking grade:	2,010	1,940	2,450	2,170	2,610

Source: USGS Minerals Yearbook, Iron and Steel Scrap, 2006

[r]Revised.

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

[2]Includes manufacturers of raw steel that also produce steel castings.

[3]Net receipts of scrap is defined as receipts from brokers, dealers, and other outside sources plus receipts from other company-owned plants minus shipments.

[4]Home scrap production includes recirculating scrap that results from current operations and obsolete home scrap.

[5]Some consumers in the "Manufacturers of steel castings" category also produce iron castings; some consumers in the "Iron foundries and miscellaneous users" category also produce steel castings

[6]Data from U.S. Census Bureau. Export valuation is free alongside ship, and import valuation is customs value.

[7]Excludes used rails for rerolling and other uses and ships, boats, and other vessels for scrapping.

TABLE B-4
U.S. CONSUMER RECEIPTS, PRODUCTION, CONSUMPTION, SHIPMENTS, AND STOCKS OF IRON AND STEEL SCRAP IN 2006, BY GRADE[1]
(Thousand metric tons)

Grade	Receipts of scrap: From brokers, dealers, and other outside sources	Receipts of scrap: From other company-owned plants	Production of home scrap: Recirculating scrap from current operations	Production of home scrap: Obsolete scrap[2]	Consumption of purchased and home scrap	Shipments of scrap	Ending stocks, December 31
Manufacturers of pig iron and raw steel and castings:							
Carbon steel:							
Low-phosphorus plate and punchings	354	W	517	--	698	71	131
Cut structural and plate	3,430	150	588	--	4,040	51	247
No. 1 heavy-melting steel	4,870	113	1,840	20	6,730	203	490
No. 2 heavy-melting steel	5,710	56	350	W	6,030	24	516
No. 1 and electric furnace bundles	3,940	57	W	--	4,530	117	280
No. 2 and all other bundles	867	W	W	--	889	(3)	37
Electric furnace, 1 foot and under (not bundles)	W	--	W	--	W	W	W
Railroad rails	211	W	W	--	273	W	11
Turnings and borings	1,980	88	59	W	2,190	7	81
Slag scrap	811	106	1,140	--	1,610	477	111
Shredded or fragmentized	10,200	1,350	W	W	12,300	--	611
No. 1 busheling	4,790	52	217	--	5,010	5	347
Steel cans, post consumer	135	--	--	--	149	W	4
All other carbon steel scrap	2,770	238	1,530	W	4,380	160	366
Stainless steel scrap	1,050	65	351	--	1,500	2	56
Alloy steel (except stainless)	122	10	431	--	549	19	19
Ingot mold and stool scrap	1	--	W	83	61	88	13
Machinery and cupola cast iron	6	--	W	W	5	W	W
Cast-iron borings	343	--	W	--	327	4	24
Motor blocks	14	--	--	--	16	--	W
Other iron scrap	875	70	262	--	1,130	90	382
Other mixed scrap	1,710	55	272	--	2,030	21	144
Total	44,300	2,440	8,930	195	54,500	1,410	3,880
Manufacturers of steel castings:							
Carbon steel:							
Low-phosphorus plate and punchings	562	W	68	(3)	629	(3)	30
Cut structural and plate	163	W	8	W	174	W	3
No. 1 heavy-melting steel	33	--	W	--	38	--	3
No. 2 heavy-melting steel	W	--	--	--	W	--	W
No. 1 and electric furnace bundles	W	--	--	--	W	--	W
No. 2 and all other bundles	--	--	--	--	--	--	--
Electric furnace, 1 foot and under (not bundles)	6	--	3	--	8	--	(3)
Railroad rails	W	--	W	--	W	--	W
Turnings and borings	30	--	7	W	38	W	1
Slag scrap	W	--	W	--	185	--	(3)
Shredded or fragmentized	89	--	--	--	89	--	1
No. 1 busheling	38	--	--	--	38	W	1
Steel cans, post consumer	--	--	--	W	--	W	--
All other carbon steel scrap	47	--	99	--	145	W	4
Stainless steel scrap	23	W	24	W	48	--	24
Alloy steel (except stainless)	36	W	32	W	70	--	6
Ingot mold and stool scrap	W	--	W	--	W	W	W

Machinery and cupola cast iron	--	--	--	--	--	--	--
Cast-iron borings	W	--	W	--	W	--	W
Motor blocks	W	--	--	--	W	--	--
Other iron scrap	1	--	1	--	2	--	--
Other mixed scrap	35	--	W	14	50	1	W
Total	1,310	5	305	14	1,640	2	79

Source: USGS Minerals Yearbook, Iron and Steel Scrap, 2006

W Withheld to avoid disclosing company proprietary data. -- Zero.

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

[2]Obsolete home scrap includes ingot molds, stools, and scrap from old equipment and buildings.

[3]Less than ½ unit.

TABLE B-4—Continued

U.S. CONSUMER RECEIPTS, PRODUCTION, CONSUMPTION, SHIPMENTS, AND STOCKS OF IRON AND STEEL SCRAP IN 2006, BY GRADE[1]

(Thousand metric tons)

Grade	Receipts of scrap: From brokers, dealers, and other outside sources	Receipts of scrap: From other company-owned plants	Production of home scrap: Recirculating scrap from current operations	Production of home scrap: Obsolete scrap[2]	Consumption of purchased and home scrap	Shipments of scrap	Ending stocks, December 31
Iron foundries and miscellaneous users:							
Carbon steel:							
Low-phosphorus plate and punchings	696	2	180	3	856	23	114
Cut structural and plate	915	31	44	W	995	2	27
No. 1 heavy-melting steel	147	2	W	--	164	--	56
No. 2 heavy-melting steel	281	--	W	--	314	--	2
No. 1 and electric furnace bundles	92	--	--	--	59	--	37
No. 2 and all other bundles	61	--	W	--	58	W	W
Electric furnace, 1 foot and under (not bundles)	93	--	(3)	--	94	--	1
Railroad rails	54	W	34	W	83	5	3
Turnings and borings	122	--	(3)	--	121	1	3
Slag scrap	W	--	13	--	W	W	W
Shredded or fragmentized	1,110	--	W	--	1,090	--	50
No. 1 busheling	510	W	18	(3)	494	1	44
Steel cans, post consumer	W	--	(3)	--	W	--	(3)
All other carbon steel scrap	52	--	57	W	109	(3)	3
Stainless steel scrap	2	--	--	W	2	--	--
Alloy steel (except stainless)	1,290	--	319	--	1,610	11	(3)
Ingot mold and stool scrap	53	W	15	--	68	W	9
Machinery and cupola cast iron	507	W	172	W	655	34	217
Cast-iron borings	47	37	11	W	93	2	1
Motor blocks	264	W	565	--	835	W	6
Other iron scrap	135	23	1,470	3	1,470	13	201
Other mixed scrap	115	W	46	W	178	1	6
Total	6,550	124	2,990	16	9,370	102	784
Grand total, all manufacturing types:							
Carbon steel:							
Low-phosphorus plate and punchings	1,610	5	765	3	2,180	95	275
Cut structural and plate	4,510	183	640	W	5,210	53	278
No. 1 heavy-melting steel	5,050	115	1,860	20	6,940	203	548
No. 2 heavy-melting steel	6,010	56	382	W	6,360	24	519
No. 1 and electric furnace bundles	4,030	57	W	--	4,590	117	317
No. 2 and all other bundles	928	W	2	--	948	3	40
Electric furnace, 1 foot and under (not bundles)	180	--	103	--	219	W	4
Railroad rails	283	W	130	W	428	5	16
Turnings and borings	2,130	88	67	W	2,350	8	84
Slag scrap	1,000	106	1,150	--	1,810	479	112
Shredded or fragmentized	11,400	1,350	332	W	13,500	(3)	662
No. 1 busheling	5,340	52	234	(3)	5,540	6	392
Steel cans, post consumer	137	--	(3)	W	152	W	4
All other carbon steel scrap	2,870	238	1,680	3	4,630	161	373
Stainless steel scrap	1,080	65	376	W	1,550	3	81
Alloy steel (except stainless)	1,450	12	782	W	2,230	30	25
Ingot mold and stool scrap	54	W	93	83	129	88	22
Machinery and cupola cast iron	513	W	174	9	660	35	220

Cast-iron borings	397	37	11	W	426	6	25
Motor blocks	305	W	565	--	877	W	8
Other iron scrap	1,010	93	1,730	3	2,610	103	583
Other mixed scrap	1,860	75	320	14	2,260	23	153
Total	52,100	2,570	12,200	225	65,600	1,510	4,740

Source: USGS Minerals Yearbook, Iron and Steel Scrap, 2006
W Withheld to avoid disclosing company proprietary data. -- Zero.
[1]Data are rounded to no more than three significant digits; may not add to totals shown.
[2]Obsolete home scrap includes ingot molds, stools, and scrap from old equipment and buildings.
[3]Less than ½ unit.

TABLE B-5
U.S. SCRAP CONSUMPTION BY GRADE[1]
(Thousand metric tons)

	2005	2004	2003	2002	2001
Low-phosphorus plate and punchings	700	700	600	300	300
Cut structural and plate	4,800	5,200	5,700	5,500	5,100
No. 1 heavy-melting steel	6,300	6,800	8,600	9,200	10,000
No. 2 heavy-melting steel	6,000	6,300	6,400	6,600	6,400
No. 1 and electric furnace bundles	5,700	6,200	6,900	7,000	7,500
No. 2 and all other bundles	800	900	1,000	1,000	1.000
Turnings and borings	2,100	2,200	2,400	2,400	2,400
Slag scrap	2,000	2,000	2,400	2,300	2,300
Shredded or fragmentized	11,000	11,200	11,000	12,000	11,000
No. 1 busheling	5,300	5,100	5,400	5,800	5,700
Steel cans, post consumer	1,340	1,499	1,562	1,428	1,483
All other carbon steel scrap	3,700	4,900	5,000	4,600	4,700
Total Carbon Steel	**49,700**	**53,000**	**57,000**	**57,000**	**58,000**
Stainless Steel	1,100	1,100	1,200	1,200	1,200
Alloy Steel (ex. Stainless)	600	600	700	800	810
Iron Scrap	1,400	1,200	900	800	810
Other grades or types of scrap	2,500	14500	2,000	2,400	2,000
Total Scrap	**55,300**	**57,300**	**61,800**	**62,000**	**63,000**

Source: American Iron and Steel Institute, 2006
[1]Consumption of both purchased and home scrap by pig iron and raw steel producers
Data from U.S. Geological Survey, except steel can scrap data from Steel Recycling Institute

TABLE B-6

U.S. CONSUMPTION OF IRON AND STEEL SCRAP, PIG IRON, AND DIRECT-REDUCED IRON IN 2006, BY TYPE OF FURNACE OR OTHER USE[1]

(Thousand metric tons)

	Manufacturers of pig iron and raw steel and castings			Manufacturers of steel castings			Iron foundries and miscellaneous users			Total, all manufacturing types		
	Scrap	Pig iron	DRI[2]	Scrap	Pig iron	DRI[2]	Scrap	Pig iron	DRI[2]	Scrap	Pig iron	DRI[2]
Blast furnace	2,510	--	308	--	--	--	3	--	--	2,510	--	308
Basic oxygen process	10,000	33,700	348	--	--	--	--	2	--	10,000	33,800	348
Electric furnace	41,800	2,910	875	1,520	37	--	4,540	434	2	47,800	3,380	877
Cupola furnace	92	--	--	117	19	--	4,820	416	3	5,030	435	3
Other[3]	W	--	--	--	--	--	W	W	--	W	W	--
Direct castings[4]	--	36	--	--	--	--	--	--	--	--	36	--
Total	54,500	36,700	1,530	1,640	56	--	9,370	857	5	65,600	37,600	1,540

Source: USGS Minerals Yearbook, Iron and Steel Scrap, 2006

W Withheld to avoid disclosing company proprietary data. -- Zero.

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

[2]Direct-reduced iron.

[3]Includes air furnaces.

[4]Includes ingot molds and stools.

TABLE B-6

U.S. CONSUMPTION OF IRON AND STEEL SCRAP BY TYPE OF FURNACE OR OTHER USE[1]

(Thousand metric tons)

	2005		2004		2003		2002		2001	
Basic oxygen furnace	12,800	23.15%	14,100	24.61%	15,900	25.73%	14,300	23.06%	15,400	24.44%
Electric furnace	41,400	74.86%	41,900	73.12%	44,600	72.17%	46,300	74.68%	45,200	71.75%
Other	1,100	1.99%	1,300	2.27%	1,300	2.10%	1,400	2.26%	2,400	3.81%
Total	55,300		57,300		61,800		62,000		63,000	

Source: USGS Minerals Yearbook, Iron and Steel Scrap, 2006

Other includes blast furnace, cupola furnace, direct casting, and air furnaces

Appendix C: Federal Delisting Actions Pursued by K061 Waste Generators

U.S. EPA Delisting Report (2002)

The U.S. EPA reported that, as of 2002, there were at least 12 federal delisting actions associated with the Blast Furnace and Steel Mill industry. At least 1.5 million tons of K061 had been delisted, deriving from steel production at mills using EAFs. There were 6 delistings of K061 reported to be granted by EPA, *not including delistings granted by state agencies.* [133] One delisting, granted to [Conversion Systems] in 1995, exempted 306,000 tons of chemically-stabilized EAF dust from RCRA K061 classification. [134] According to a 1993 industry study cited in the 2002 EPA report, over 85 percent of the EAF dust generated in the US had been recycled, primarily for zinc recovery. Such recovery accounted for approximately 30 percent of domestic zinc production, before the delisting action. This study suggested that the delisting would divert those wastes from resource recovery into chemical stabilization followed by disposal in Subtitle D landfills. As of [2002], EPA had not formally assessed the impact of this delisting on zinc recovery from EAF dust. Although the current database contains information on pre-delisting and (planned) post-delisting waste management, there is no clear indication of other materials that have been diverted from recycling to waste disposal. Approximately two thirds of EAF dust generated in the U.S. is processed for metals recovery. The remaining one-third is either treated for subsequent landfill disposal or exported. Below is a sample of facilities that have petitioned to have their K061 delisted:

Pennsylvania: MAX Environmental Technologies, Yukon PA (2004)

MAX Environmental Technologies offers services to treat K061 for disposal in a RCRA Subtitle D landfill. [135] MAX Environmental Technologies filed a Petition to Delist the Non-Hazardous Treated Residue of Electric Arc Furnace Dust (K061). Pennsylvania Environmental Quality Board (EQB) accepted the delisting petition for further study at its meeting of February 17, 2004. [136] The Final delisting rule was approved by the EQB on October 18, 2005 and was published in the Pennsylvania Bulletin February 11, 2006. [137] [138] According to the delisting rule, TCLP constituent concentrations may not exceed the following levels (mg/L): Antimony-0.206; Arsenic-0.0094; Barium-21; Beryllium-0.416; Cadmium-0.11; Chromium-0.60; Lead-0.75; Mercury-0.025; Nickel-11.0; Selenium-0.58; Silver-0.14; Thallium-0.088; Vanadium-21.1; Zinc-4.3. Total mercury may not exceed 1 mg/kg.

Indiana: Nucor Steel, Crawfordsville, IN (2000)

On May 13, 2000, Heritage Environmental Services, Inc. (Heritage) petitioned the Indiana Department of Environmental Management (IDEM) to delist a waste listed in 40 CFR 261.32 as "K061: emission control dust" from the primary production of steel in electric furnaces." The EAF dust for which the delisting was requested is generated at Nucor Steel Corporation in Crawfordsville, Indiana. The delisted waste would be treated by Heritage using a proprietary treatment process described in the petition and disposed of in a non-hazardous municipal solid waste landfill owned and operated by Heritage in Roachdale, Putnam County, Indiana. The landfill is permitted under 329 IAC 10. The portions of the petition describing the proprietary process are protected from release under IC 5-14-3 and 329 IAC 6.1. Heritage has applied for a patent on the treatment process. When the patent is granted, those portions will become public record. The petition requested delisting of up to thirty thousand (30,000) cubic yards of treated EAF dust annually. [139] IDEM subsequently issued an amendment of 329 IAC 3.1-6-6 to increase the amount of treated EAF dust generated by Heritage and Nucor Corporation that can be excluded from regulation as hazardous waste from thirty thousand (30,000) cubic yards to sixty thousand (60,000) cubic yards per year. [140] As discussed above (in Section 6.8.2), Heritage is now pursuing implementation of an induction furnace-based process to recover zinc metal from EAF dust. Heritage constructed and operated a demonstration-scale facility in Indiana and is now constructing a full-scale facility in Mississippi.

Texas: American Ecology/US Ecology, Robstown, Texas (2008)

American Ecology holds a Bethlehem Steel patent to treat and delist K061, EAF Dust captured in EAF steel mill emissions systems and stabilizes over 40,000 tons of steel mill K061 annually.[141] According to American Ecology, the company has historically treated and disposed of K061 from steel mills from multiple states at their Grand View, Idaho facility, and also has established an agreement with Envirosafe Services of Ohio, Inc. ("ESOI") to provide ESOI's K061 "delisting" technology at American Ecology's Robstown, Texas facility. American Ecology submitted delisting petition information to the U.S. EPA in 2007. [142]

Structural Metals (2008)

EPA issued a final rule adding Structural Metals, Inc. to the exclusion granted to Conversion Systems Inc. (CSI) on June 13, 1995. The final rule added the location of U.S. Ecology, Texas Ecology in Robstown, Texas as the treatment facility and Structural Metals, Inc. as the steel mill contracting the services of CSI. [143]

Bethlehem Steel, Johnstown, Pennsylvania; Steelton, Pennsylvania

Bethlehem Steel obtained a delisting for uncured and cured chemically stabilized electric arc furnace dust/sludge (CSEAFD) treatment residue (K061) generated from the primary production of steel at their facilities. This exclusion was issued conditional upon the data obtained from Bethlehem's full-scale CSEAFD treatment facilities. [144]

CF&I Steel Corporation, Pueblo, Colorado

CF&I Steel Corporation obtained a delisting for fully-cured chemically stabilized electric arc furnace dust/sludge (CSEAFD) treatment residue (EPA Hazardous Waste No. K061) generated from the primary production of steel at their facility. The delisting was issued as conditional upon the data obtained from CF&I's full-scale CSEAFD treatment facility.[145]

Roanoke Electric Steel Corporation, Roanoke, Virginia

Roanoke Electric Steel Corporation obtained a delisting for fully-cured chemically stabilized electric arc furnace dust/sludge (CSEAFD) treatment residue (EPA Hazardous Waste No. K061) generated from the primary production of steel at their facility. The delisting was issued as conditioned upon the data obtained from Roanoke's full-scale CSEAFD treatment facility.[146]

USX Steel Corporation, Gary Works, Indiana

USX Steel Corporation obtained a delisting for fully-cured chemically stabilized electric arc furnace dust/sludge (CSEAFD) treatment residue (EPA Hazardous Waste No. K061) generated from the primary production of steel at their facility. This exclusion (for 35,000 tons of CSEAFD per year) was issued as conditional upon the data obtained from USX's full-scale CSEAFD treatment facility. [147]

Peoria Disposal Company (PDC), Peoria Illinois (2008)

The Illinois Environmental Protection agency conducted public hearings in August 2008 concerning a delisting petition filed by the Peoria Disposal Company (PDC) concerning disposal of residue from the company's proprietary K061 dust waste treatment and stabilization process. The delisting is needed to enable the treated material to be disposed of in a local municipal solid waste landfill rather than in the PDC-operated hazardous waste landfill where the material is currently disposed of. The PDC hazardous waste landfill currently receives approximately 72,500 cubic meters per year of K061 from Keystone Steel and Wire and other steel mills. 148

Appendix D: Glossary

American Iron and Steel Institute (AISI) – AISI is comprised of 27 member companies, including integrated and electric furnace steel makers, and 138 associate and affiliate members who are suppliers to customers of the steel industry. AISI's member companies represent approximately 75 percent of both U.S. and North American steel capacity.

Area Source Rule – EPA rule published on 12/28/07 relating to National Emission Standards for Hazardous Air Pollutants for Area Sources: Electric Arc Furnace Steel making Facilities. The final rule establishes mercury emissions control requirements based on the maximum achievable control technology and requirements for the control of other hazardous air pollutants (including lead) that are based on generally available control technology or management practices.

Automotive Recyclers Association (ARA) – Non-profit trade association representing the industry dedicated to the efficient removal and reuse of automotive parts, and the safe disposal of inoperable motor vehicles.

Babbitt Metal - Any of several soft, silvery antifriction alloys composed of tin usually with small amounts of copper and antimony.

Baghouse – An air emission control device consisting of a series of fabric filters through which combustion flue gases are passed to remove particulates prior to atmospheric dispersion.

Basic Oxygen Furnace (BOF) – A large, tiltable, pear-shaped vessel used to convert the molten iron from the blast furnace - with up to 30% steel scrap - into refined steel. High purity oxygen is blown through the molten bath to lower carbon, silicon, manganese, and phosphorous content of the iron, while various fluxes are used to reduce the sulfur and phosphorous levels.

Basic Oxygen Process (BOP) – A steel making process used to produce more than half the world's steel, using pure oxygen to convert a charge of liquid blast-furnace iron and scrap into steel.

Bessemer Process – The first inexpensive industrial process for the mass-production of steel from molten pig iron.

Best Practices – Generically speaking, techniques or methodologies that, through experience and research, has been proven to reliably lead to a desired result.

Bevill Amendment – The Bevill Amendment to RCRA required EPA to complete studies of large volume wastes and report to Congress on the wastes and a Regulatory Determination as to how the waste will be managed. BOF processed furnace wastes are not regulated as a hazardous waste, and such materials are exempt from RCRA waste classification under the Bevill Exemption.

Blast Furnace – A type of metallurgical furnace used for smelting to produce metals, generally iron. Fuel and ore are continuously supplied through the top of the furnace, while air (sometimes with oxygen enrichment) is blown into the bottom of the chamber, so that the chemical reactions take place throughout the furnace as the material moves downward. The end products are usually molten metal and slag phases tapped from the bottom, and flue gases exiting from the top of the furnace.

Borings (Iron) – Clean cast iron or malleable iron borings and drillings, free of steel turnings, scale, lumps or excessive oil (ISRI Grade 223).

Cast Iron – A hard, brittle, nonmalleable iron-carbon alloy, cast into shape, containing 2 to 4.5 percent carbon, 0.5 to 3 percent silicon, and lesser amounts of sulfur, manganese, and phosphorus.

Channel Induction Furnace – An electrically efficient device for the heating and stirring of liquid metals.

Construction and Demolition (C&D) Materials – Materials such as broken concrete, wood, asphalt, and rubble resulting from the construction, remodeling, repair or demolition of buildings, bridges, pavements and other structures.

Construction Materials Recycling Association (CMRA) – The Association represents a diverse group of member companies and agencies from the many construction and demolition materials recycling disciplines and industry specialties active in the United States and other countries.

Delisting Petition – The process by which a waste generator seeks to obtain from environmental regulators an exclusion for managing any RCRA listed waste as a hazardous waste. This would apply to K061 waste in the case of Electric Arc Furnaces.

Electric Arc Furnace (EAF) - Steel making furnace where electricity is used to melt scrap to make steel, and for which scrap steel is generally 100% of the charge.

Ferrous Metals – Metals that are derived from iron. They can be removed using large magnets at separation facilities.

Foundry - A factory which produces metal castings from either ferrous or non-ferrous alloys. Metals are turned into parts by melting the metal into a liquid, pouring the metal in a mold, and then removing the mold material or casting. The most common metal alloys produced are aluminum and cast iron. However, other metals, such as steel, magnesium, copper, tin, and zinc, can be processed.

Galvanized Steel – Steel coated with a thin layer of zinc to provide corrosion resistance in underbody auto parts, garbage cans, storage tanks, or fencing wire.

Heavy Metals – Hazardous elements including cadmium, mercury, and lead which may be found in the waste stream as part of discarded items such as batteries, lighting fixtures, colorants and inks.

High Temperature Metals Recovery (HTMR) – A process by which metals, particularly zinc (but also lead and other metals), are recovered from Electric Arc Furnace dust or other metal-containing dust for subsequent recycling.

Home Scrap - Scrap generated at the mill, refinery, or foundry, and is generally remelted and used again at the same plant. Home scrap never leaves the plant.

Institute of Scrap Recycling Industries (ISRI) - ISRI is the private, non-profit trade association that represents more than 1,600 private, for-profit companies that process, broker, and industrially consume scrap commodities, including ferrous and nonferrous metals, paper, electronics, rubber, plastics, glass, and textiles.

Integrated Steel Mills - Plants that produce steel from mostly virgin raw materials. Generally, the integrated plants concentrate on higher volume flat products and flat products with higher quality specifications.

K061 Waste – RCRA listed hazardous waste generated by Electric Arc Furnaces; listed for lead, cadmium, and trivalent chromium content.

Leaded Steel – Steel meeting a minimum specification for lead content (typically 0.25 percent or more) and for which lead is a necessary alloy for that grade of steel. Leaded steel is used in the manufacture of bearings and machine-fabricated parts.

Matte – An impure metallic sulfide mixture produced in smelting furnaces by smelting the sulfide ores of such metals as copper, lead, or nickel.

Metric Ton – Equals 2,205 pounds, compared to the U.S. Short Ton which is 2,000 pounds, compared to the British Long Ton which is 2,240 pounds.

Minimill – a relatively small type of steel mill using, as raw material, scrap melted in an Electric Arc Furnace rather than iron ore smelted in a blast furnace.

National Demolition Association (NDA) – Non-profit trade organization representing more than 1,000 U.S. and Canadian companies which offer standard demolition services, as well as a full range of demolition-related services and products.

No. 1 Busheling – Clean steel scrap, not exceeding 12 inches in any dimension, including new factory busheling such as sheet clippings and stampings.

No. 2 Heavy Melting Steel – Wrought iron and steel scrap, black and galvanized, 1/8 inch and over in thickness, varying sizes (ISRI Grades 203 – 206).

Nonferrous Metals – Nonmagnetic metals such as aluminum, lead, and copper. Products made all or in part from such metals include: containers, packaging, appliances, furniture, electronic equipment and aluminum foil.

Non-Integrated Steel Mills - Plants that produce steel primarily from steel scrap. Many of the non-integrated mills produce commodity type products such as reinforcing bar, small structural shapes, low volume specialty alloy, and stainless steels.

Pig Iron – Crude iron obtained directly from the blast furnace and cast in molds. The crude ingots, called pigs, are then remelted along with scrap and alloying elements and recast into molds to produce various iron and steel products.

Post-Consumer Scrap – Scrap materials such as automobiles, appliances, and C&D material generated by a business or consumer that have served their intended end use and have been separated or diverted from the waste stream for the purpose of recycling.

Prompt Scrap – Scrap generated by manufacturers of iron and steel products (e.g., turnings from machining operations).

Red Metals –Per the ISRI Scrap Specifications Circular 2008, include such materials as copper wire, refinery brass, nickel silver castings, and manganese bronze solids.

Registration, Evaluation and Authorization of Chemicals (REACH) Directive – European Union legislation initiated in 2003 and approved in 2005 relating to chemical safety. It oblige companies producing more than 10 metric tons of a chemical (less in certain cases) to investigate the potential hazards to human health and to the environment. It would apply to all chemicals commercially available in the EU (approximately 30,000 compounds), in contrast to the U.S.-equivalent Toxic Substances Control Act (TSCA) which only applies to chemicals newly coming into use.

Resource Conservation Challenge (RCC) – A major national effort created by EPA to identify methods to conserve and protect natural resources through voluntary partnerships.

Restriction of Hazardous Substances (ROHS) Directive – This directive was adopted in February 2003 by the European Union, and took effect on 1 July 1, 2006. It restricts the use of six hazardous materials in the manufacture of various types of electronic and electrical equipment.

Reverberatory Furnace (direct fired, open hearth design) – The style most often used for remelt of non-ferrous metals. Applications of the reverb furnaces are melting of all forms of solids, holding of molten metal for temperature adjustment, alloy adjustment or metal treatment, and delivery of molten metal for casting.

Scrap Metal – Products made of metal that become worn out (or are off-specification) and are recycled to recover their metal content, or metal pieces that are generated from machine operations *(i.e.,* turnings, stampings, etc.) which are recycled to recover metal.

Short Ton – The U.S. Ton which is 2,000 pounds, compared to the Metric Ton which is 2,205 pounds, compared to the British Long Ton which is 2,240 pounds.

Slag – A by-product of the steel-making process or other metal smelting processes. Slag from integrated iron and steel mills in ferrous ore smelting is designed to minimize iron loss and so mainly contains oxides of calcium, magnesium, and aluminum.

Steel Manufacturers Association (SMA) – SMA consists of 39 North American companies that operate 125 (mostly electric arc furnace) steel mills and employ approximately 40,000 people. The SMA also has six international steel company members in countries outside of North America, comprising a total membership of 45 steel companies, worldwide.

Subtitle C – The hazardous waste section of the Resource Conservation and Recovery Act (RCRA).

Subtitle D – The solid, non-hazardous waste section of RCRA.

Terne Coating (a.k.a., terne plating) – An alloy of lead with about approximately 15%-20% tin and 80%-85% lead. This is the minimum tin content required to obtain an adherent coating on hot-dipped iron sheet. Terne coating is used to coat sheet steel to inhibit corrosion.

Terne Plate Bundles – New tern plate sheet scrap, clippings or skeleton scrap, compressed or hand bundled, to charging box size, and weighing not less than 75 pounds per cubic foot.

Toxicity Characteristic Leaching Procedure (TCLP) - One of the EPA test methods that are used to characterize waste as either hazardous or non-hazardous for the purpose of disposal.

Turnings (Machine Shop) – Clean steel or wrought iron turnings, free of iron borings, nonferrous metals in a free state, scale, or excessive oil. May not include badly rusted or corroded stock (ISRI Grade 219).

Waelz Kiln Process – This process is a method developed in the early 1900s for zinc production and for treating steel plant dusts containing zinc and lead. EAF dust is converted to an iron-rich slag as well as a zinc and iron-rich dust that is recycled to the kiln.

Waste Electrical and Electronic Equipment (WEEE) Directive – The European Community directive 2002/96/EC which, together with the RoHS Directive 2002/95/EC, became European Law in February 2003, setting collection, recycling and recovery targets for all types of electrical goods.

Waste Minimization/Source Reduction – Includes both source reduction and reuse practices, essentially any activities that minimize the amount of waste destined for disposal and do not involve material processing.

White Goods – large domestic electrical appliances like stoves, washing machines, fridges and freezers.

XRF Gun (a.k.a., X-Ray Fluorescence Analyzer) – Spectrometer testing device that uses low-dose radiation to detect and measure lead and various other metals on surfaces, objects and in the dust and soil.

ENDNOTES

---

[1] A Mass Balance Accounting of Lead and Mercury in the Iron and Steel Industry for the Year 2003, Kirsten Sinclair Rosselot, Process Profiles, Calabasas, California, May 2007
[2] http://www.zincnacional.com/ingles/laempresa.asp
[3] U.S. EPA Office of Solid Waste, Export/Import Database, accessed 07/28/2007.
[4] 40 CFR Part 261, Appendix VII
[5] Pollution Prevention and Abatement Handbook, 1998: Toward Cleaner Production By United Nations Environment Programme, World Bank Group, United Nations Environment Programme, World Health Organization, United Nations Industrial Development Organization, Inc World Book, Published by World Bank Publications, 1999, Page 341
[6] Delisting Petition For Treated K061, Max Environmental Technologies, Inc. (Hazardous Waste Management Services), Yukon, PA, CEC Project 210966, 11/2003. http://www.depweb.state.pa.us/pubpartcenter/lib/pubpartcenter/EQB/2004/yukon_delisting_petition.pdf\
[7] EPA Method 1311 – http://www.epa.gov/sw-846/faqs_tclp.html
[8] Rosselot, Kirsten Sinclair. "A Mass Balance Accounting of Lead and Mercury in the Iron and Steel Industry for the Year 2003." Process Profiles, Calabasas, California. May 2007. Funded by EPA Region 5 Great Lakes Program Office.
[9] Rosselot, Ibid.
[10] 40 CFR Part 63 Subpart YYYYY—National Emission Standards for Hazardous Air Pollutants for Area Sources: Electric Arc Furnace Steelmaking Facilities, 72 FR 74111 December 28, 2007.
[11] 40 CFR Part 63: Subpart ZZZZZ—National Emission Standards for Hazardous Air Pollutants for Iron and Steel Foundries Area Sources, 73 FR 252, January 2, 2008.

[12] Delisting Petition For Treated K061, Max Environmental Technologies, Inc. (Hazardous Waste Management Services), Yukon, PA, CEC Project 210966, 11/2003. http://www.depweb.state.pa.us/pubpartcenter/lib/pubpartcenter/EQB/2004/yukon_delisting_petition.pdf

[13] Genaidy, A.M. et al. "An exploratory study of lead recovery in lead-acid battery lifecycle in U.S. market: An evidence-based approach." *Science of the Total Environment*. 407, 2008, 7 – 22.
[14] EPA Method 1311 – http://www.epa.gov/sw-846/faqs_tclp.html
[15] USGS 2008. Personal Communication between David E. Guberman of the US Geological Survey and Charles Cebul of ICF International. April 15th, 2008.
[16] Roy Baggett, Sanders Lead Company (Secondary Lead Production), 4/02/08.
[17] USGS 2008. Personal Communication between David E. Guberman of the US Geological Survey and Charles Cebul of ICF International. April 15th, 2008.
[18] USGS 2007. Mineral Yearbook Lead 2006, U.S. Geological Survey. http://minerals.usgs.gov/minerals/pubs/commodity/lead/myb1-2006-lead.pdf
[19] USGS 2006. Apparent Consumption vs. Total Consumption—A Lead-Acid Battery Case Study, U.S. Geological Survey Scientific Investigations Report 2006–5155, ONLINE ONLY, By David R. Wilburn and David A. Buckingham, 2006, Page 2 http://pubs.usgs.gov/sir/2006/5155/
[20] Roy Baggett, Sanders Lead Company (Secondary Lead Production), 4/02/08.
[21] Steve Yates and John Tapper, Gopher Resource Corporation (Secondary Lead Production) , 4/07/08
[22] Joyce Morales, Mayco Industries (Lead Products), 5/21/08.
[23] Steve Yates and John Tapper, Gopher Resource Corporation (Secondary Lead Production), 4/07/08.
[24] Joyce Morales, Mayco Industries (Lead Products), 5/21/08.
[25] Dan Vornberg, Doe Run Company (Lead Recycling & Secondary Lead Production), 5/19/08.

[26] David Wagger and Scott Horne, Institute of Scrap Recycling Industries (Ferrous & Non-ferrous Scrap Metals), 2/07/08.
[27] Eric Stuart, et al, Steel Manufacturers Association (Integrated Iron & Steel Production & Ferrous Metal Foundries), 3/04/08.
[28] Dan Vornberg, Doe Run Company (Lead Recycling & Secondary Lead Production), 5/19/08.
[29] Modern Metals, 1999. "Green" Steel Eliminates Lead http://www.laurelsteel.com/greensteel.html
[30] John Cabaniss, Association of International Automobile Manufacturers (Vehicle Manufacturers & Equipment Suppliers), 5/19/08.
[31] Modern Metals, 1999."Green" Steel Eliminates Lead http://www.laurelsteel.com/greensteel.html
[32] William Turley, Construction Materials Recycling Association (CMRA) (Ferrous & Non-ferrous Metals), 1/29/2008.
[33] David Wagger and Scott Horne, Institute of Scrap Recycling Industries (Ferrous & Non-ferrous Scrap Metals), 2/07/08.
[34] Mike Taylor, National Demolition Association (Ferrous & Non-ferrous Metals), 2/04/2008.
[35] Bill Heenan, Steel Recycling Institute (Ferrous Metals), 4/25/08.
[36] http://www.metalprices.com/
[37] Steve Yates and John Tapper, Gopher Resource Corporation (Secondary Lead Production), 4/07/08.
[38] Bill Heenan, Steel Recycling Institute (Ferrous Metals), 4/25/08.
[39] U.S. Environmental Protection Agency News Release: Manufacturers and Retailers Balance Tires and the Environment, August 29, 2008.
http://yosemite.epa.gov/opa/admpress.nsf/bd4379a92ceceeac8525735900400c27/712a156bd2c5ca57852574b4004bc288!OpenDocument
[40] U.S. Geological Survey, Minerals Yearbook, Iron and Steel Scrap, 2006
http://minerals.usgs.gov/minerals/pubs/commodity/iron_&_steel_scrap/myb1-2006-fescr.pdf
[41] Electronic mail message from Michael D Fenton [mfenton@usgs.gov] USGS to Robert Lanza [rlanza@icfi.com] ICF International, received July 16, 2008.
[42] ISRI 2007. Scrap Specifications Circular, 2007. Guidelines for Nonferrous Scrap; Ferrous Scrap; Glass Cullet Paper Stock; Plastic Scrap; Electronics Scrap; Tire Scrap, Effective 11/19/07, Institute of Scrap Recycling Industries, 2007.
[43] A Mass Balance Accounting of Lead and Mercury in the Iron and Steel Industry for the Year 2003, Kirsten Sinclair Rosselot, Process Profiles, Calabasas, California, May 2007, Note to Reviewers
[44] Patent: Austenitic free-cutting stainless steel: http://www.faqs.org/patents/app/20080240970
[45] Stainless Steel Information Center: Chemical and Physical Properties of Stainless Steel http://www.ssina.com/composition/chemical.html
[46] A Mass Balance Accounting of Lead and Mercury in the Iron and Steel Industry for the Year 2003, Kirsten Sinclair Rosselot, Process Profiles, Calabasas, California, May 2007, Note to Reviewers
[47] USGS 2006. Apparent Consumption vs. Total Consumption—A Lead-Acid Battery Case Study, U.S. Geological Survey Scientific Investigations Report 2006–5155, ONLINE ONLY, By David R. Wilburn and David A. Buckingham, 2006, Page 2, Page 3 http://pubs.usgs.gov/sir/2006/5155/
[48] Bill Heenan, Steel Recycling Institute (Ferrous Metals), 4/25/08.
[49] Bill Heenan, Steel Recycling Institute (Ferrous Metals), 4/25/08.
[50] Jon Sampson, Automotive Recyclers Association (Automotive Dismantlers & Shredders), 2/06/08.
[51] Bill Heenan, Steel Recycling Institute (Ferrous Metals), 4/25/08.
[52] Automotive Recyclers Association, Certified Automotive Recyclers Manual, 2008, http://www.a-r-a.org/files/car_manual_2008_web.pdf
[53] Jon Sampson, Automotive Recyclers Association (Automotive Dismantlers & Shredders), 2/06/08.
[54] Dan Vornberg, Doe Run Company (Lead Recycling & Secondary Lead Production), 5/19/08.

---

[55] CA DTSC, 2002. California's Automobile Shredder Waste Initiative, Draft Report, November 2002, California Department of Toxic Substances Control, Hazardous Waste Management Program http://www.dtsc.ca.gov/HazardousWaste/upload/HWMP_REP_ASW_draft.pdf, page 14.
[56] CA DTSC, 2002. California's Automobile Shredder Waste Initiative, Draft Report, November 2002, California Department of Toxic Substances Control, Hazardous Waste Management Program http://www.dtsc.ca.gov/HazardousWaste/upload/HWMP_REP_ASW_draft.pdf, page 15, Table 5.
[57] Drew Lammers, Cohen Brothers, Inc. (President of National Demolition Association) (Ferrous & Non-ferrous Metals Processing), 2/11/08.
[58] Matt Haslett and Mike Vail, Metro Metals NW (Ferrous & Non-ferrous Scrap Supplier), 2/27/08.
[59] Matt Haslett and Mike Vail, Metro Metals NW (Ferrous & Non-ferrous Scrap Supplier), 2/27/08.
[60] Horner & Shrifrin Engineers, 2008. 300 Ton-Per-Hour Mega Shredder, St. Louis, Missouri http://www.hornershifrin.com/ProjectDesc/GrossmanShredder.shtml
[61] David Wagger and Scott Horne, Institute of Scrap Recycling Industries (Ferrous & Non-ferrous Scrap Metals), 2/07/08.
[62] Matt Haslett and Mike Vail, Metro Metals NW (Ferrous & Non-ferrous Scrap Supplier), 2/27/08.
[63] David Wagger and Scott Horne, Institute of Scrap Recycling Industries (Ferrous & Non-ferrous Scrap Metals), 2/07/08.
[64] Jon Sampson, Automotive Recyclers Association (Automotive Dismantlers & Shredders), 2/06/08.
[65] Drew Lammers, Cohen Brothers, Inc. (President of National Demolition Association) (Ferrous & Non-ferrous Metals Processing), 2/11/08.
[66] Matt Haslett and Mike Vail, Metro Metals NW (Ferrous & Non-ferrous Scrap Supplier), 2/27/08.
[67] Mike Taylor, National Demolition Association (Ferrous & Non-ferrous Metals), 2/04/2008.
[68] USEPA. Estimating 2003 Building-Related Construction and Demolition Material Amounts. Accessed on: March 30, 2009. Available at: http://www.epa.gov/epawaste/conserve/rrr/imr/cdm/pubs/cd-meas.pdf
[69] Mike Taylor, National Demolition Association (Ferrous & Non-ferrous Metals), 2/04/2008.
[70] Mike Taylor, National Demolition Association (Ferrous & Non-ferrous Metals), 2/04/2008.
[71] William Turley, Construction Materials Recycling Association (CMRA) (Ferrous & Non-ferrous Metals), 1/29/2008.
[72] Blaisdell, J.S., 2006. A fines challenge: the C&D recycling industry looks for solutions to the problem of H2S generation in ADC made from C&D fines. Construction & Demolition Recycling, March-April, 2006. http://findarticles.com/p/articles/mi_m0QMH/is_2_8/ai_n26824102
[73] Mike Taylor, National Demolition Association (Ferrous & Non-ferrous Metals), 2/04/2008.
[74] William Turley, Construction Materials Recycling Association (CMRA) (Ferrous & Non-ferrous Metals), 1/29/2008.
[75] William Turley, Construction Materials Recycling Association (CMRA) (Ferrous & Non-ferrous Metals), 1/29/2008.
[76] Mike Taylor, National Demolition Association (Ferrous & Non-ferrous Metals), 2/04/2008.
[77] Drew Lammers, Cohen Brothers, Inc. (President of National Demolition Association) (Ferrous & Non-ferrous Metals Processing), 2/11/08.
[78] Roy Baggett, Sanders Lead Company (Secondary Lead Production), 4/02/08.
[79] Joyce Morales, Mayco Industries (Lead Products), 5/21/08.
[80] Roy Baggett, Sanders Lead Company (Secondary Lead Production), 4/02/08.
[81] Steve Yates and John Tapper, Gopher Resource Corporation (Secondary Lead Production), 4/07/08.
[82] Roy Baggett, Sanders Lead Company (Secondary Lead Production), 4/02/08.
[83] Roy Baggett, Sanders Lead Company (Secondary Lead Production), 4/02/08.
[84] Drew Lammers, Cohen Brothers, Inc. (President of National Demolition Association) (Ferrous & Non-ferrous Metals Processing), 2/11/08.
[85] Drew Lammers, Cohen Brothers, Inc. (President of National Demolition Association) (Ferrous & Non-ferrous Metals Processing), 2/11/08.

---

[86] Bill Heenan, Steel Recycling Institute (Ferrous Metals), 4/25/08.
[87] The EPH Regulator, Spring 2007. Re-defining "lead-free" in California Law, published by Underwriters Laboratories (UL). http://www.ul.com/ephregulator/Spring_2007.pdf
[88] Bill Heenan, Steel Recycling Institute (Ferrous Metals), 4/25/08.
[89] Steve Yates and John Tapper, Gopher Resource Corporation (Secondary Lead Production), 4/07/08.
[90] Roy Baggett, Sanders Lead Company (Secondary Lead Production), 4/02/08.
[91] http://www.osha.gov/SLTC/etools/leadsmelter/environmentalcontrols/dustcollectionsystems.html
[92] Steve Yates and John Tapper, Gopher Resource Corporation (Secondary Lead Production), 4/07/08.
[93] Steve Yates and John Tapper, Gopher Resource Corporation (Secondary Lead Production), 4/07/08.
[94] Michael Olvera, ABI Foundry (Ferrous Metal Foundries), 3/10/08.
[95] Mike Hohman, U.S. Steel (Integrated Iron & Steel Production), 2/25/08. USS Fairfield Works
[96] Mike Hohman, U.S. Steel (Integrated Iron & Steel Production), 2/25/08. USS Fairfield Works
[97] 40 CFR Part 63 Subpart YYYYY—National Emission Standards for Hazardous Air Pollutants for Area Sources: Electric Arc Furnace Steelmaking Facilities, 72 FR 74111, December 28, 2007.
[98] U.S. EPA Brochure: Summary of Regulations Controlling Air Emissions From Electric Arc Furnace (EAF) Steelmaking Facilities National Emission Standards For Hazardous Air Pollutants NESHAP (Subpart YYYYY), U.S. EPA Office of Air Quality Planning & Standards (EI 43-02), April 2008
[99] 40 CFR Part 63 Subpart YYYYY Section 10685 Paragraph (a)(1) Discusses pollution prevention plan scope and approval process.
[100] http://www.rohs.eu/english/index.html
[101] http://ec.europa.eu/environment/chemicals/reach/reach_intro.htm
[102] http://ec.europa.eu/environment/waste/weee/index_en.htm
[103] Dan Lake, Timken Company (Integrated Iron & Steel Production), 5/20/08.

[104]http://www.depweb.state.pa.us/pubpartcenter/lib/pubpartcenter/EQB/2004/yukon_delisting_petition.pdf Delisting Petition For Treated K061, Max Environmental Technologies, Inc. (Hazardous Waste Management Services), Yukon, PA, CEC Project 210966, 11/2003.

[105] Jim Reese and Tom Janeck, Horsehead Corporation (EAF Dust Recycling), 5/21/08.
[106] U.S. EPA Office of Solid Waste, Export/Import Database, accessed 07/28/2007.
[107] http://www.dep.state.pa.us/dep/subject/eqb/2004/yukon_delisting_petition.pdf Delisting Petition For Treated K061, Max Environmental Technologies, Inc. (Hazardous Waste Management Services), Yukon, PA, CEC Project 210966, 11/2003.
[108] http://steeldust.com/facility.htm, accessed March 24, 2009
[109] ADEM Public Notice 350: Steel Dust Recycling LLC, June 6, 2007, Alabama Department of Environmental Management, http://216.226.179.150/publicnotice/june/6steela.htm, accessed July 11, 2008
[110] http://pizotech.com/about/facilities.html, accessed July 11, 2008
[111] A Mass Balance Accounting of Lead and Mercury in the Iron and Steel Industry for the Year 2003, Kirsten Sinclair Rosselot, Process Profiles, Calabasas, California, May 2007, Section 3.4.b, Page 26.
[112]http://www.depweb.state.pa.us/pubpartcenter/lib/pubpartcenter/EQB/2004/yukon_delisting_petition.pdf Delisting Petition For Treated K061, Max Environmental Technologies, Inc. (Hazardous Waste Management Services), Yukon, PA, CEC Project 210966, 11/2003.
[113] http://www.dep.state.pa.us/dep/subject/eqb/2004/yukon_delisting_petition.pdf Delisting Petition For Treated K061, Max Environmental Technologies, Inc. (Hazardous Waste Management Services), Yukon, PA, CEC Project 210966, 11/2003.
[114] Jim Reese and Tom Janeck, Horsehead Corporation (EAF Dust Recycling), 5/21/08.
[115] Liebman, Marc, 2000. The Current Status of Electric Arc Furnace Dust Recycling in North America, AIM Market Research, Pittsburgh PA, 2000, Figure 2.

[116] Liebman, Marc, 2000. The Current Status of Electric Arc Furnace Dust Recycling in North America, AIM Market Research, Pittsburgh PA, 2000, Figure 4.
[117] http://steeldust.com/facility.htm, accessed July 11, 2008
[118] Engineering Analysis: Steel Dust Recycling, LLC, Document No. 409-0019, www.adem.state.al.us/PublicNotice/June/SteelA.pdf , accessed July 11, 2008
[119] http://steeldust.com/facility.htm, accessed July 11, 2008
[120] http://pizotech.com/about/facilities.html, accessed July 10, 2008
[121] http://pizotech.com/about/index.html, accessed July 11, 2008
[122] Arkansas Department of Environmental Quality: ADEQ Minor Source Permit: Permit No. 2158-A, issued to PIZO Operating Company, LLC, Blytheville, AR 72515, AFIN: 47-00931
[123] Arkansas Department of Environmental Quality: ADEQ Minor Source Permit: Permit No. 2158-A, issued to PIZO Operating Company, LLC, Blytheville, AR 72515, AFIN: 47-00931, Page 5.
[124] Arkansas Department of Environmental Quality: ADEQ Minor Source Permit: Permit No. 2158-A, issued to PIZO Operating Company, LLC, Blytheville, AR 72515, AFIN: 47-00931, Page 5.
[125] RCRA Hazardous Waste Delisting: The First 20 Years -- *Program Evaluation*, U.S. Environmental Protection Agency, Office of Solid Waste, June, 2002. http://www.epa.gov/epaoswer/hazwaste/id/delist/report.pdf
[126] David Wagger and Scott Horne, Institute of Scrap Recycling Industries (Ferrous & Non-ferrous Scrap Metals), 2/07/08.
[127] Mike Hohman, U.S. Steel (Integrated Iron & Steel Production), 2/25/08, USS Fairfield Works.
[128] A Mass Balance Accounting of Lead and Mercury in the Iron and Steel Industry for the Year 2003, Kirsten Sinclair Rosselot, Process Profiles, Calabasas, California, May 2007, Note to Reviewers
[129] Mike Hohman, U.S. Steel (Integrated Iron & Steel Production), 2/25/08, USS Fairfield Works.
[130] USGS 2007. Mineral Yearbook Lead 2006, U.S. Geological Survey. http://minerals.usgs.gov/minerals/pubs/commodity/lead/myb1-2006-lead.pdf
[131] U.S. Geological Survey, Minerals Yearbook, Iron and Steel Scrap, 2006 http://minerals.usgs.gov/minerals/pubs/commodity/iron_&_steel_scrap/myb1-2006-fescr.pdf
[132] Electronic mail message from Michael D Fenton [mfenton@usgs.gov] USGS to Robert Lanza [rlanza@icfi.com] ICF International, received July 16, 2008.
[133] U.S. EPA 2002. RCRA Hazardous Waste Delisting: The First 20 Years -- *Program Evaluation*, U.S. Environmental Protection Agency, Office of Solid Waste, June, 2002, http://www.epa.gov/osw/hazard/wastetypes/wasteid/delist/
[134] http://www.epa.gov/EPA-WASTE/1995/June/Day-13/pr-247.html, 60 FR 31107, June 13, 1995
[135] http://www.maxenvironmental.com/k061-electric-arc.htm
[136] http://www.dep.state.pa.us/regulations/pubreports.asp?varreport=7
[137] http://www.dep.state.pa.us/regulations/petitionstatus.asp?varID=40
[138] http://www.pabulletin.com/secure/data/vol36/36-6/219.html
[139] http://www.in.gov/legislative/iac/xml/old-ir/Vol24/03Dec/11ID329000255.pdf
[140] http://www.in.gov/idem/files/swmb_2005_apr_04-318_pr.pdf
[141] Customer Audit Handbook, US Ecology Nevada, American Ecology Corporation, May 2007. http://www.americanecology.com/downloads/beatty_forms/beatty_audit_handbook.pdf
[142] 10-K SEC Filing, filed by AMERICAN ECOLOGY CORP on 2/27/2008; http://sec.edgar-online.com/2008/02/27/0000950134-08-003590/Section13.asp
[143] 73 FR 54713, September 23, 2008. http://edocket.access.gpo.gov/2008/E8-22170.htm
[144] 40 CFR Part 261, Appendix IX
[145] 40 CFR Part 261, Appendix IX
[146] 40 CFR Part 261, Appendix IX
[147] 40 CFR Part 261, Appendix IX
[148] Illinois Environmental Protection Agency, 2008. RCRA Delisting Adjusted Standard Petition Of Peoria Disposal Company, August 21, 2008 http://www.watchclintonlandfill.com/images/ILPCBRulingonhearing.pdf