

Occupational Exposures and Environmental Releases of Lead Wheel-Balancing Weights

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TABLE OF CONTENTS

1.0	INTRODUCTION	3
1.1	Lead Wheel-Balancing Weights on Automobiles	3
1.2	Literature Review	3
2.0	RELEASES AND EXPOSURES FROM LEAD WHEEL-BALANCING WEIGHTS	4
2.1	Lead Wheel-Balancing Weight Manufacturing	4
2.2	Automobile Manufacturing (OEM)	8
2.3	Installation of Wheel-Balancing Weights	9
2.4	Automobile Use	10
2.5	End-of-Life Vehicle Recycling	11
	2.5.1 Salvage Yards	12
	2.5.2 Automobile Shredding	12
	2.5.3 Automobile Metal Recovery	14
3.0	DATA GAPS/UNCERTAINTIES	18
4.0	REFERENCES	24

APPENDICES

A	Steel Plants with Electric Arc Furnaces in the U.S.	26
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LIST OF TABLES

2.0	U.S. Manufacturers of Lead Wheel-Balancing Weights	4
2.1	Employees Involved In Manufacture of Lead Wheel-Balancing Weights	5
2.2	Pounds of lead released (including on-site and off-site transfers) by tire weight manufacturers according to TRI data	7
3.0	Summary of Estimates, Uncertainties and Data Gaps	19

LIST OF FIGURES

1.1	Potential flow of lead tire weights during end-of-life vehicle (ELV) processing	12
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1.0 INTRODUCTION

Wheel balancing weights are installed on motor vehicle wheels to correct for imbalances in wheel and tire assembly. Lead has been preferred for wheel balancing weights because it is inexpensive, dense, ductile and corrosion resistant (EPAB, 2005).

Pursuant to Section 21 of the Toxic Substances Control Act ("TSCA"), 15 U.S.C. § 2620, the Ecology Center has petitioned the Environmental Protection Agency ("EPA") to establish regulations prohibiting the manufacture, processing, distribution in commerce, use, and improper disposal of lead wheel balancing weights "wheel weights" (Ecology Center, 2005). In support of the EPA's review of this Section 21 petition, this report presents a screening-level assessment of environmental releases and occupational exposures to lead resulting from the manufacture, processing, distribution, use and disposal of lead wheel balancing weights. A limited literature search for readily available information and data was conducted to complete this assessment.

1.1 Lead Wheel-Balancing Weights on Automobiles

Lead has traditionally been the preferred metal for wheel-balancing weights because it is corrosion-resistant, dense, malleable, and ductile. Wheels which require maintenance, repair or replacement require balancing. Wheel-balancing weights are installed on vehicle wheels to balance them during vehicle operation. Typically, wheels mounted with tires are placed on machinery to determine the amount and placement of the weights to balance the wheel.

Balanced wheels may be installed on vehicles by the automobile manufacturers at their plants.

1.2 Literature Review

The literature search for this assessment resulted in limited information. Estimating occupational exposures and environmental releases of lead from lead wheel-balancing weights was not always possible due to a lack of information. A complete and accurate mass balance, based on reliable data, may be helpful in addressing some data gaps.

2.0 RELEASES AND EXPOSURES FROM LEAD WHEEL-BALANCING WEIGHTS

2.1 Lead Wheel-Balancing Weight Manufacturing

Lead ingots received from primary and secondary smelters are melted and re-cast into wheel weights (BADA, 2005). These lead wheel-balancing weights are then sold to automobile manufacturers (original equipment manufacturers or OEM), tire weight distributors, tire manufacturers, and tire retailers. OEM utilize these wheel weights to balance wheels installed on new vehicles. Wheel-balancing weights are installed on new and repaired wheels on vehicles. These lead wheel-balancing weights are applied to the rim of wheels during balancing.

In the U.S., an estimated 50 to 60 million pounds of lead are used to make lead wheel-balancing weights (Gust, 2004 & BADA, 2005).

2.1 Number of Workers, Facilities and Operating Days

A literature search resulted in information about three (3) wheel-balancing weight manufacturers in the U.S. (Dun & Bradstreet, 2005). These manufacturers produce wheel-balancing weights at five (5) facilities (EPAB, 2005) (see Table 2.0).

Table 2.0: U.S. Manufacturers of Lead Wheel-Balancing Weights

Manufacturer	Perfect Equipment Company, LLC (a subsidiary of Berwind Corporation)	BADA a division of Hennessy Industries, Inc. (a subsidiary of Danaher Corporation)	Halko Manufacturing, Company (a.k.a. New Products Inc.)
Facilities	Murfreesboro, TN Sparks, NV	Bowling Green, Ky	Clayton, DE Woodbury, TN

There are three major lead tire weight manufactures in the United States: Halko Manufacturing, Hennessy Industries, and Perfect Equipment (EPAB, 2005). Preliminary research has indicated one lead tire weight facility for Hennessy, and two facilities for both Halko Manufacturing and Perfect Equipment. No publicly-available information from the U.S. Census Bureau pertaining to these specific facilities nor for this industry sector was located; however, EPA has obtained data from Halko, Hennessy and Perfect Equipment. The Hennessy facility employs 85 workers, 90% of those working in the manufacturing area (Rice1, 2005). Therefore, the number of workers potentially exposed during manufacturing at the Hennessy facility is:

$(85 \text{ workers})(90\% \text{ working in manufacturing area}) = 77 \text{ workers/ exposed to lead at the Hennessy facility.}$

The workers operate on one 10-hour shift per day, 4 days/week schedule (Rice1, 2005). Each worker has the potential to be exposed up to a total of 208 days/yr, based on 4 days/week. A search of Dun and Bradstreet indicates Perfect Equipment employs 175 at the Murfreesboro, TN site, and 20 at the Sparks, NV site (Rice2, 2005). Thus, the number of employees potentially exposed during manufacture at the two Perfect Equipment facilities, is:

(175 + 20 workers) = 195 workers exposed to lead at the two Perfect Equipment facilities.

Dun and Bradstreet also indicates Halko Manufacturing employs 18 workers at their facility (Rice2, 2005). Correspondence with Halko Manufacturing reports 35 employees total. The Halko facility could have up to 35 employees exposed to lead.

Therefore, the total number of workers with potential lead exposure is:

(77 + 195 + 35) workers = 307 total workers with potential lead exposure.

Table 2.1: Employees Involved In Manufacture of Lead Wheel-Balancing Weights

Facility	Employees (reported in Dunn & Bradstreet)	Total Number of Employees (from company estimates)
Hennessy (KY)	65	85 (77 exposed workers)
Perfect (TN) (NV)	175 20	CBI
Halko (DE) (TN)	18 NR	35 (total)

NR = not reported; Total number of employees reported via correspondence with Cody Rice (EPAB); CBI = claimed as Confidential Business Information

2.1.2 Workplace Exposures

A literature search produced no monitoring data for lead exposures from wheel-balancing weight production. A conservative estimate of occupational exposure was made assuming compliance with the Occupational Safety and Health Administration's permissible exposure limit (OSHA PEL) for lead of 0.05 mg/m³ time weighted average (TWA). This TWA is based on exposure during an 8-hour shift. Contact information from one of the wheel weight manufacturers (Hennessy) noted that their workers are on a 10-hour work day (Rice1, 2005). Thus, 8-hour TWA PEL may not be appropriate. OSHA states that an adjustment factor is necessary if workers are exposed longer than an 8 hour period. Specifically, OSHA regulations for lead

exposure (standard number 1910.1025(c)(2)) state:

“If an employee is exposed to lead for more than 8 hours in any work day, the permissible exposure limit, as a time weighted average (TWA) for that day, shall be reduced according to the following formula:

Maximum permissible limit ($\mu\text{g}/\text{m}^3$) = $(400 \mu\text{g}/\text{m}^3)/(\text{hrs worked in the day})$.”

Therefore, the maximum permissible limit in mg/m^3 is:

Maximum permissible limit = $(400 \mu\text{g}/\text{m}^3)/(10 \text{ hrs})/(1,000 \mu\text{g}/\text{mg}) = 0.04 \text{ mg}/\text{m}^3$.

A possible inhalation exposure may be calculated once the following assumptions are made:

1. inhalation rate = $1.25 \text{ m}^3/\text{hr}$ (CEB’s standard assumption for occupational (NIOSH, 1976));
2. 10 hours per work day estimate (Hennessy Industries’s estimate); and
3. maximum permissible exposure limit = $0.04 \text{ mg}/\text{m}^3$ (calculated above).

Using these assumptions, the potential inhalation exposure to the 307 workers is:

$(0.04 \text{ mg}/\text{m}^3)(1.25 \text{ m}^3/\text{hr})(10 \text{ hr}/\text{day}) = 0.5 \text{ mg}/\text{day}$.

Actual exposure may be lower than this conservative estimate ($0.5 \text{ mg}/\text{day}$), particularly if workers wear appropriate personal protective equipment (PPE) in process areas. Additionally, when actual monitoring data is not available, exposures are sometimes estimated based on monitoring data of other similarly handled operations. A 1994 OSHA study reports an average inhalation exposure of $49 \mu\text{g}/\text{m}^3$ (2 samples) for lead pot tenders (SIC 3949: Fishing Lure and sinker manufacturers) (OSHA, 1994). This exposure results in potential exposure dose rates of $0.49 \text{ mg}/\text{day}$, assuming a breathing rate of $1.25 \text{ m}^3/\text{hr}$ and 8-hr/day. This estimate assumes that the exposures of lead pot tenders would be comparable to the exposures for workers involved in manufacturing lead tire weights.

Dermal exposure from routine contact is not expected during remelting and casting operations because workers are not likely to be in contact with molten lead due to the high temperature (the melting point of lead is 327.5 degrees C (621.5 degrees F)).

Routine contact with lead from the tire weights is expected during washing and product packaging operations, where workers may or may not wear gloves. Also, no data was available to estimate lead exposures from handling solid lead wheel weights.

2.1.3 Workplace Releases

Lead from wheel-balancing weights may result in environmental releases during manufacturing. TRI data (see Table 2-1) has some reported lead releases from lead wheel-weight manufacture. Not all the identified lead wheel weight manufacturing sites have TRI reports (see Table 2.2).

Table 2.2: Pounds of lead released (including on-site and off-site transfers) by tire weight manufacturers according to TRI data.

Company (facility location)	Year	Fugitive Air (Pounds)	Transfer On-Site for Further Waste Management (Pounds)	Transfer Off-Site for Further Waste Management (Pounds)	Total (Pounds)
Halko (DE)	2001	0	0	0	0
	2002	0	4,000	208,000	212,000
	2003	0	5,000	18,775	23,775
Perfect (NV)	2001	5	0	455,551	455,556
	2002	0	0	382,551	382,551
	2003	0	0	455,929	455,929
Perfect (TN)	2001	5	0	588,835	588,840
	2002	0	0	417,015	471,015
	2003	0	0	391,746	391,746
Hennessy	2001	NA	NA	NA	NA
	2002	NA	NA	NA	NA
	2003	NA	NA	NA	NA

NA - No data was found in TRI

The majority of lead release reported is transferred Off-Site for further waste management (or recycled off-site to metal recovery).

2.2 Automobile Manufacturing (OEM)

This sector is under NAICS 336111: Automobile Manufacturing and NAICS 336112: Light Truck and Utility Vehicle Manufacturing. The automobile sector consists of facilities primarily engaged in manufacturing complete automobiles (i.e., body and chassis or unibody) or manufacturing automobile chassis only while the light truck sector consists of facilities engaged in manufacturing complete light trucks and utility vehicles (i.e., body and chassis) or manufacturing light truck and utility vehicle chassis only. Vehicles made include light duty vans, pick-up trucks, minivans, and sport utility vehicles.

There are three predominant U.S. automobile manufacturers with assembly plants in the United States, as well as German and Japanese manufacturer assembly plants located in the United States. Automobile manufacturing consists of automobile parts manufacturing, assembly, and finishing. Once the various automotive parts are produced, they are ready to be brought together for assembly. Automotive assembly is a complex process that involves many different steps (U.S. EPA, 1995a). Installation of lead wheel-balancing weights may be a step in the assembly process.

2.2.1 Numbers of Workers, Facilities, and Operating Days

The 2002 Economic Census reports there are 176 automobile manufacturing facilities in the United States with 85,845 employees, of which there are 75,114 production employees (U.S. Census Bureau, 2004a). The 2002 Economic Census also reports there are 95 facilities manufacturing light truck and utility vehicles in the United States with 107,237 employees, of which there are 96,856 production employees (U.S. Census Bureau, 2005a). The identities and numbers of facilities installing lead wheel-balancing weights in new automobiles cannot be determined. The number of workers exposed to lead due to the installation of lead wheel-balancing weights in these facilities may be subset of production workers within each facility. Large assembly line production facilities generally operate three shifts, 365 days per year.

2.2.2 Workplace Exposures

No monitoring data directly pertaining to installation of lead wheel-balancing weights could be found and no methods could be determined for quantifying lead exposures from lead wheel weight installation.

2.2.3 Workplace Releases

No information or data were found regarding releases or wastes associated specifically with lead wheel weight installation. No methods could be determined for quantifying lead releases from lead wheel weight installation. Landfills may be contaminated with lead during clean-up and improper disposal methods. Sometimes, used lead wheel weights may be sold and/or given to customers for use in home smelting operations to make fishing weights and lures, ammunition and

other miscellaneous projects.

2.3 Installation of Wheel-Balancing Weights

All vehicles require wheel weights to ensure tire balance and prevent vibration at high speeds. Wheel weights are applied to the rim of a vehicle's wheel to provide a smooth ride. Wheels are placed on a machine to determine the amount of weights and their location on the wheel's rim. These balanced wheels may be installed on new and exiting vehicles.

2.3.1 Numbers of Workers, Facilities, and Operating Days

The number of workers can be estimated from a couple of different sources. The first source estimates that up to 22,000 workers install wheel weights at 5,500 aftermarket installation sites (Tire Industry, 2005). Additionally, the Department of Labor Statistics worker data in an annual Occupational Employment Statistics Survey. 2001 through 2003 estimates approximately 81,500 to 86,000 workers for the "tire repairers and changers" occupational category (Bureau of Labor, 2005). The worker estimates from the Department of Labor may be an overestimate, if all the workers are not directly involved in installing lead wheel weights.

2.3.2 Workplace Exposures

No monitoring data directly pertaining to installation of lead wheel-balancing weights was found and no methods could be determined for quantifying lead exposures from lead wheel weight installation.

2.2.3 Workplace Releases

No information or data were found regarding releases or wastes associated specifically with lead wheel weight installation. No methods could be determined for quantifying lead releases from lead wheel weight installation. Landfills may be contaminated with lead during clean-up and improper disposal methods. Sometimes, used lead wheel weights are sold and/or given to customers for use in home smelting operations to make fishing weights and lures, ammunition and other miscellaneous projects.

2.4 Automobile Use

Over a vehicle's lifetime, wheel weights may be lost when they fall off the wheel onto the road. The probability of a weight falling off can be influenced by a number of factors: traffic patterns (stop and go, multiple stops for traffic control devices, etc.), road conditions (pot holes, uneven pavement, etc.), driving conditions (rural, highway or urban), and other possible conditions or hazards. Based on a study cited by the petitioner (Root, 2000), up to 10 % of wheel-balancing weights may be dislodged during vehicle operation and deposited on U.S. streets, roads, and highways. The petitioner reports 200-250 grams (0.44-0.55 lbs) of lead wheel weights per vehicle (Lohse, 2001). Another estimate (EPAB, 2005) assumes two 1 to 1.5 oz lead wheel weights per wheel and with 4 wheels per vehicle making contact with roadway. This would mean 8 to 12 oz (0.50-0.75 lbs) per vehicle. Additionally, EPA estimated there are approximately 200 million automobiles and light trucks on the nation's roadways. (EPA Lead Tire, 2005). Thus, using Root's estimate of 10%, 8,800,000 to 11,000,000 lbs or 10,000,000 to 15,000,000 lbs of lead may be released in the form of lead wheel weights. Root further claims that these lead wheel-balancing weights are abraded (ground up and pulverized by vehicle traffic) releasing lead to the surrounding environment and population.

Used lead wheel-weights may be sold and/or given to customers for use in home smelting operations to make fishing weights and lures, ammunition and other miscellaneous projects. The quantity of wheel weights distributed in this manner is unknown.

2.5 End-of-Life Vehicle (ELV) Recycling

Vehicles reaching end-of-life, either through its normal life cycle or by accident, usually enter the recycling process. For end-of-life vehicles (ELVs), annual recycling rates are nearly 100 percent (Steel Recycling Institute, 2005). In the recycling of ELVs, fluids are first drained and all resalable parts are removed. Next the vehicle may be shredded, crushed or transported for further processing. The wheels containing the lead wheel weights may be removed during initial processing at salvage yards or may remain on the vehicle for shredding, crushing or may be sent to other facilities for further processing. Shredding may take place at the salvage yard or at steel mills where electric arc furnaces (or basic oxygen furnaces) are used to recycle the steel. Vehicles sent to shredders of-site are often crushed to reduce transport volume (New Jersey DEP, 2004). No data was located that could state with certainty where the wheels and wheel weights may go during vehicle recycling.

The petitioner estimates 200-250 grams (0.44-0.55 lb) per vehicle (Lead-Free Wheels, 2005). Another estimate assumes two 1 to 1.5 oz lead wheel-balancing weights per wheel and five (5) wheels per vehicle (including the spare). According to this estimate, a vehicle may have approximately 280-430 grams of lead wheel-balancing weights with 200-340 grams on the operating wheels (EPAB, 2005).

Automobile shredding will be discussed in Section 2.5.2 and the automobile metal recovery process in Section 2.5.3.

Fig. 1.1 illustrates the potential flow of lead wheel-balancing weights during end-of-life vehicle (ELV) processing.

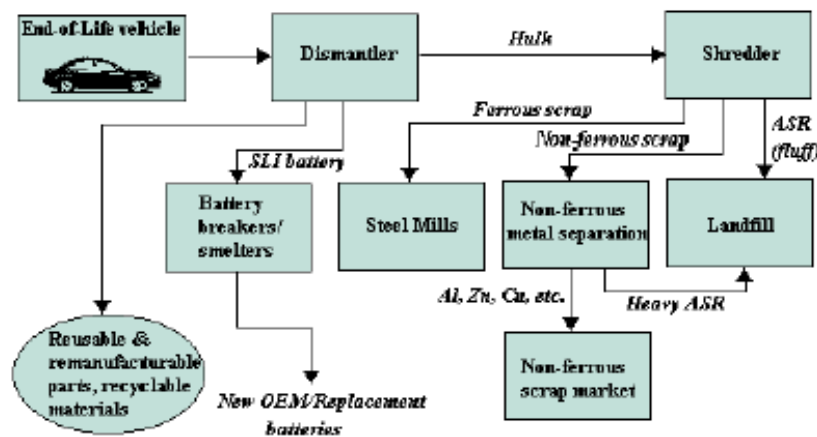


Figure 1.1 Potential flow of lead tire weights during end-of-life vehicle (ELV) processing

2.5.1 Salvage Yards

This sector is covered by NAICS 42114 : Motor Vehicle Parts (Used) Wholesalers. This industry comprises establishments primarily engaged in wholesaling used motor vehicle parts (except used tires and tubes) and establishments primarily engaged in dismantling motor vehicles for the purpose of selling the parts. Automobile salvage yards are used to store used automobiles as well as other metal scrap. Before shredding technology became available, automobiles were often stored in huge fields for their parts. An average automobile may be stored an average of 2 to 5 years before being processed (Recycling Council of Ontario, 1999). Salvage yards may contain lead wheel weights on ELVs delivered to the salvage yards. Shredding or crushing at the salvage yards may release lead. Some salvage yards could remove some lead wheel-balancing weights from ELVs.

2.5.1.1 Numbers of Workers, Facilities, and Operating Days

Based on data obtained from the 1997 U.S. Census Report, this sector contained 7,105 facilities and employed 45,807 employees (U.S. Census Bureau, 2000). The 2002 data has not been released. The identities and numbers of facilities and workers affected by lead from wheel weights cannot be determined. The majority of companies in this sector are small businesses. Only 50 facilities employ more than 50 employees while 6,500 facilities have less than 20 employees. These types of businesses with a small number of employees tend to operate one shift, 5 days per week. Overall, it is assumed that salvage yards normally operate 250 days per year.

2.5.1.2 Workplace Exposures

Exposure could result from the work area becoming contaminated with lead from lead wheel weights, particularly for salvage yards that crush or shred ELVs. Worker exposures due to lead from lead wheel weights that are shredded or crush cannot be quantified. Exposures in facilities that shred ELVs is given additional discussion in Section 2.5.2.

2.5.1.3 Workplace Releases

In salvage yards, ELVs may release lead from shredded or crushed lead wheel weights into the soil, air (from shredding), or water (through storm water runoff). However, environmental releases due lead wheel weights cannot be quantified. Releases from facilities that shred ELVs are included in Section 2.5.2.

2.5.2 Automobile Shredding

Automobile shredders may be located at salvage yards, scrap recycling facilities, steel mills, or independent facilities. However, the distribution of shredders among various types of facilities could not be determined, nor could shredders be linked to a particular NAICS or SIC code. The shredding facility uses hammer mills to first break down the ELV hulk into small chunks. During

the process, automobile scrap is pneumatically and magnetically separated into three fractions: ferrous; nonferrous; and lightweight waste. The ferrous metals are sent for recycling to steel smelters. Historically, the ferrous fraction has accounted for about 70 percent of the weight of the car, but this proportion is decreasing as more and more plastics are used (Ecology Center et al, 2001). Most of the lightweight waste material known as auto shredder residue (ASR) or “fluff” is comprised of foam, textiles, plastics, glass, metal fines (which may include lead from lead wheel weights), residual fluids, and dirt. ASR is removed during the shredding process by air cyclone separation and then landfilled. Historically, the ASR has accounted for about 23 percent of the weight of the car. The non-ferrous metals may be sent to a non-ferrous metal separation facility, where metals like lead, aluminum, copper, and zinc are recovered. Historically, the nonferrous fraction has accounted for about 7 percent of the weight of the car.

2.5.2.1 Numbers of Workers, Facilities, and Operating Days

There are approximately 200 auto shredding facilities operating in the United States (ISRI, 2005). The locations of these facilities are not readily available. The identities and numbers of facilities and workers affected by lead wheel-balancing weights from automobiles cannot be determined. Small, privately owned facilities usually operate five days per week, 50 weeks per year. It is assumed that these types of facilities generally operate 250 days per year. Some of the shredders are co-located at steel mills with EAFs and are operated 364 days per year (Ecology Center et al, 2001). Overall, it is assumed that shredding facilities normally operate 250 days per year.

The reference sources did not have information on the numbers of employees per facility. Many automobile shredder operations tend to be small, independently owned operations. It is expected that such facilities have less than 10 employees per facility. This type of operation requires the use of heavy equipment rather than significant amounts of manual labor. Some fraction of the workers have potential to receive incremental lead exposure from lead wheel weights during ELV processing.

2.5.2.2 Workplace Exposures

Occupational inhalation exposures during the shredding of automobiles may occur due to inhalation of lead contaminated dust or volatilized lead (Ecology Center et al, 2001).

Workers may be exposed to fugitive emissions resulting from lead contaminated dust. Lead dust may be vented through an exhaust stack. No monitoring data was found for workers exposures to lead during shredding operations. Inhalation exposures to lead could be expected to be below the Occupational Safety and Health Administration (OSHA) maximum Permissible Exposure Limit (PEL) for lead of 0.04 mg/m³ time weighted average (TWA).

Most of the ASR is separated from the metal streams by air cyclone separation. This separation process generates airborne dust, and workers can be exposed to lead in this dust. Workers may also be exposed to lead in dust during scrap loading activities.

The OSHA 8-hour Permissible Exposure Level (PEL) for total particulate not otherwise regulated is 15 mg dust/m³ air time-weighted average (TWA). It is expected that worker exposures to dust would be below this OSHA PEL. The lead content of the ASR was estimated between 4,000 and 25,000 mg/kg (Lohse, 2001). The fraction of this lead which comes from tire weights is unknown.

It is assumed that workers may be exposed to lead from lead wheel weights in these facilities for up to 250 days/yr.

Vehicle, scrap, and residue handling at shredding facilities is usually carried out using heavy lifting and separations equipment. Therefore, dermal exposures to lead at these sites are not expected under routine conditions.

2.5.2.3 Workplace Releases

No data were found to estimate either the fraction of lead wheel-balancing weights removed prior to ELV hulk recycling or the fraction of ELVs shredded.

Lead may be released as dust during the shredding process if the wheel-balancing weights are shredded or crushed. Otherwise, the wheel weights may be released as solid lead. Amount of releases are not known.

The shredding process is generally a dry process, but there are several opportunities for water releases. Since the shredders are located outdoors and exposed to the environment, rain water could potentially wash away some residual lead contained on the shredder surface. Another possibility is that plastics from the shredder are separated in a flotation device. Some residual lead contamination on the plastic could enter the separation system. Cleaning the separation system and water recharging could result in a lead release to water. Most of the ASR is sent to landfills (Ecology Center et al, 2001). Although water releases of lead are possible, the amounts could not be quantified.

2.5.3 Automobile Metal Recovery

Facilities that recover metals from ELVs include steel mills with either electric arc furnaces (EAFs) or basic oxygen furnaces (BOFs) and nonferrous separation facilities and smelters (e.g., lead, aluminum, zinc, copper, etc.). The types of facilities reviewed are: steel mills with EAFs, steel mills with BOFs, and nonferrous metal recovery facilities.

The ferrous scrap stream from facilities shredding ELVs is sent to steel mills with EAFs or BOFs. Some fraction of ELVs may be flattened but not shredded, and ELVs that are not shredded are sent directly to steel mills. No data were available for this fraction.

Facilities with EAFs are covered by NAICS 3311114 - Iron and Steel Mills - Nonintegrated. EAFs utilize electricity to melt and refine scrap in a batch process to make steel products. To aid in scrap processing in EAFs, fluxes and other additives such as fluorspar, dolomite, and alloying agents such as aluminum and manganese are added (U.S. EPA, 1995). During melting, impurities in the scrap such as carbon, manganese, phosphorus, silicon, and other materials are oxidized. This results in the formation of a slag containing these oxidized materials on top of the molten metal. Other byproducts of the EAF process include metal dusts and gases. Since EAFs use scrap metal instead of molten iron, there are no coke-making or iron-making processes associated with this form of steel production.

Facilities with BOFs are covered by NAICS 3311111 - Steel Mills with Blast Furnaces, Coke oven and blast furnace products, made in steel mills. BOFs combine molten iron from blast furnaces with scrap steel to produce steel. BOFs utilize 25 percent to 35 percent steel scrap on average while EAFs utilize over 90 percent steel scrap on average. In addition, data indicate EAFs processed approximately 70 percent of total post-consumer scrap steel while BOFs processed approximately 30 percent of total post-consumer scrap steel (Steel Recycling Institute, 2004).

Gases and particulate matter from EAFs are conveyed into either a wet or dry gas cleaning system. Particulate matter removed from the gas cleaning system is a listed hazardous waste (RCRA K061) called EAF dust if it is from a dry system or EAF sludge if it is from a wet system. The composition of EAF dust or sludge varies greatly, depending on the scrap composition and furnace additives. A pollutant found in the dust/sludge is lead. Some EAFs use briquettes made from EAF dust to charge the furnace, and this practice may further increase lead stack emissions from these EAFs. (Ecology Center et al, 2001)

The nonferrous metal separation and recovery facilities covered are Secondary Smelting, refining and alloying of non-ferrous metal (except copper and aluminum) NAICS- 331492. The nonferrous streams from facilities shredding ELVs are sent to nonferrous metal separation and recovery facilities. The nonferrous stream is between 6 to 8 percent of the dismantled weight of the ELV and primarily includes lead, aluminum, stainless steel, copper, brass, bronze, magnesium, nickel, and zinc (Ecology Center et al, 2001). This nonferrous stream may be contaminated with lead wheel weights released from the shredding process. Because lead tends to form amalgams with many nonferrous metals, it is likely that some lead from ELVs is contained in the nonferrous fraction during shredding and subsequently released into the environment during nonferrous metal separation and recovery. Approximately 50 percent of the nonferrous fraction received by recovery facilities is a nonmetallic residue which is currently landfilled in the United States (Ecology Center et al, 2001). Like steel mills, nonferrous smelting facilities use high temperature processes to melt nonferrous scrap, and some lead may be volatilized from these processes and emitted to air. Some lead may also be in nonferrous facilities' waste streams.

2.5.3.1 Numbers of Workers, Facilities, and Operating Days

There are 95 facilities utilizing EAFs in the United States (U.S. EPA, 2005a). Regarding facilities with BOFs, the 2002 Economic Census reports there are 16 facilities in the United States with 4,933 employees, of which there are 4,167 production employees (U.S. Census Bureau, 2004b).

Regarding nonferrous recovery facilities, several key metal types are included to demonstrate potential numbers of facilities and workers. For secondary smelting, the 2002 Economic Census reports there are 236 facilities in the United States with 9,939 employees, of which there are 6,987 production employees (U.S. Census Bureau, 2004c). Another source reported 23 lead smelting facilities (Rice, 2005). Another source reported 26 secondary lead smelting facilities in the U.S. (Kirk-Othmer, 1996).

The number of workers exposed to lead originating from wheel weights in ELVs in these facilities cannot be determined. Operating days for these industrial facilities could be expected to range up to 365 days/yr. Appendix A contains a list of facilities that have EAFs, along with their locations and capacities.

2.5.3.2 Workplace Exposures

Occupational exposures to lead from wheel weights in ELVs at metal separation and recovery facilities may include primarily lead from the furnaces and the presence and handling of lead-contaminated dusts or sludges.

Workers may be exposed to fugitive emissions of lead particles from lead wheel weights. The lead may be vented through exhaust stacks. Inhalation exposures to lead would be expected to be below the Occupational Safety and Health Administration (OSHA) 8-hour Permissible Exposure Limit (PEL) for lead of 0.04 mg/m³ time weighted average (TWA). No monitoring data was found for workers exposures to lead in metal separation and recovery facilities.

Exposure to lead in dust may be due to dust from exhaust stacks and from handling dusts. The OSHA 8-hour Permissible Exposure Level (PEL) for total particulate not otherwise regulated is 15 mg dust/m³ air time-weighted average (TWA). It is possible that worker exposures to dust would be kept below this OSHA PEL. The percent of lead contained in the dust will vary depending on the process, the type of control equipment used, and the scrap processed. No monitoring data were available for lead in dusts in nonferrous recovery or in facilities with BOFs and EAFs.

Additionally, in the absence of actual monitoring data, exposures are sometimes estimated based on monitoring data of other similarly handled operations. A 1994 study reports an average inhalation exposure of 49 µg/m³ (2 samples) for lead pot tenders (SIC 3949: Fishing Lure and sinker manufacturers). This exposure results in potential exposure dose rates of 0.49 mg/day, assuming a breathing rate of 1.25 m³/hr and 8-hr/day. This estimate assumes that the exposures of lead pot tenders would be comparable to the exposures for workers at metal separation and recovery facilities. Another study on worker exposure to lead in Korea (Donguk & Namwon,

2004) reported geometric mean values for total airborne lead concentrations of 758 $\mu\text{g}/\text{m}^3$ in secondary smelting furnace operations and 436 $\mu\text{g}/\text{m}^3$ in scrap and furnace operations. This may produce lead exposures of 7.58 mg/day and 4.36 mg/day respectively (assuming an inhalation rate of 1.25 m^3 and an 8-hour shift).

Workers may be exposed to lead in these facilities for up to 250 days/yr.

Workers handling dusts or sludges in these metal recovery facilities may be exposed to lead during processing and cleanup activities. Dermal exposure to solids (dust) and liquids containing lead could occur but cannot be quantified. Workers wearing appropriate gloves and protective clothing when handling lead or lead containing materials may have reduced potential for dermal exposure to lead.

2.5.3.3 Workplace Releases

There are no data to determine the distribution of lead between ferrous and non-ferrous scrap.

There was 2003 TRI data reported for SIC 3341 (Secondary Smelting and Refining of Nonferrous Metals) includes releases from operations other than secondary lead smelting and other sources of lead other than lead wheel weights. The releases reported covers more than secondary lead smelting. There was no data available to segment the data to just secondary lead smelters. The air releases for SIC 3341 were 2,791,163 lbs (fugitive) and 5,590,402 lbs (stack). The reported water releases were 278,304 lbs (surface water) and 101,281 lbs (POTW). Land releases were 1,612,807,619 lbs. There were 1,945,230,974 lbs transfers off-site for further waste management.

3.0 Data Gaps/Uncertainties

In general, there is limited data for estimating occupational exposures and environmental releases during various stages of the lifecycle of lead wheel balancing weights. The table that follows list the data gaps and uncertainties in estimating occupational exposures and environmental releases for lead wheel balancing weights.

TABLE 3.0 Summary of Estimates, Uncertainties and Data Gaps

INDUSTRY SECTOR	ASSESSMENT TYPE	ESTIMATED QUANTITY	SOURCE	UNCERTAINTIES AND DATA GAPS
Tire Weight Manufacturing [5 facilities]: Halko (Clayton, DE & Woodbury, TN); Perfect (Spraks, NV & Murfreesboro, TN) Hennesy (Bowling Green, KY)	Air Release	None for 3 sites reporting None for 3 sites reporting 5 lbs (Perfect-NV) 5 lbs (Perfect-TN) NA (Hennesy and Halko-TN)	TRI (2003) TRI (2002) TRI (2001) TRI (2001)	No TRI data was found for the Hennesy site and the Halko site in Woodbury, TN.
	Water Release	None for 3 sites reporting None for 3 sites reporting None for 3 sites reporting NA (Hennesy and Halko-TN)	TRI (2003) TRI (2002) TRI (2001)	Not known where the off-site transfers (reported in TRI) go.
	Land Release	None for 3 sites reporting None for 3 sites reporting None for 3 sites reporting NA (Hennesy and Halko-TN)	TRI (2003) TRI (2002) TRI (2001)	
	Transfers Off-site for Further Waste Management	18,775 lbs (Halko-DE) 455,929 lbs (Perfect-NV) 391,746 lbs (Perfect-TN) NA (Hennesy and Halko-TN)	TRI (2003)	
	Number of Workers	307 (Total for 5 facilities)	Dun & Bradstreet Industry contacts	

INDUSTRY SECTOR	ASSESSMENT TYPE	ESTIMATED QUANTITY	SOURCE	UNCERTAINTIES AND DATA GAPS
	Inhalation Exposure	0.5 mg/day (fume and dust) 0.49 mg/day (8-hr TWA personal breathing zone sample)	OSHA PEL (lead) = 400 $\mu\text{m}/\text{m}^3$ (max permissible limit) OSHA (1994) Avg = 49 $\mu\text{m}/\text{m}^3$ (2 samples) for lead pot tenders of fishing lure and sinker manufacturers (SIC 3949)	No monitoring data was found. Estimate based on assumption of compliance with OSHA PEL. The OSHA data from pot tenders of fishing lure and sinker manufacturers may or may not be applicable to the manufacture of lead wheel balancing weights.
	Dermal Exposure	Unknown	NA	No data was found. Assumptions that no contact will occur with molten lead. Specific information pertaining to worker activity is needed to needed to assess dermal exposures.
Installation onto Wheels <u>OEM:</u> 176 auto facilities 95 light truck & utility vehicle facilities <u>Aftermarket:</u> 5,500 facilities	Air Release	Unknown	NA	Loss fraction due to disposal of off-spec or damaged tire weights is unknown. Media of release. Amount of lead wheel weights used (the quantities reported are inconsistent).
	Water Release	Unknown	NA	
	Land Release	Unknown	NA	
	Transfers Off-site for Further Waste Management	Unknown	Tire Industry Association survey	
	Number of Workers	<u>OEM:</u> Automobile 85,845 (total) 75,114 (production) Light truck & utility: 107,237 (total) 96,856 (production) <u>Aftermarket:</u> 22,000 (total at 5,500 facilities) 81,500 to 86,000	2002 Economic Census Tire Industry, 2005 Dept. of Labor	Number of workers directly installing lead wheel weights. Hours per day workers may be exposed to lead wheel weights. Number of days per year workers may be exposed to lead wheel weights.
	Inhalation Exposure	Unknown	NA	No monitoring data was found.
	Dermal Exposure	Unknown	NA	No data was found. Specific information pertaining to worker activity is needed to needed to assess dermal exposures.

INDUSTRY SECTOR	ASSESSMENT TYPE	ESTIMATED QUANTITY	SOURCE	UNCERTAINTIES AND DATA GAPS
Automobile Use	Air Release	8,800,000-11,000,000 lbs	(Lohse, 2001) and Root study (2000)	Validity of extrapolating Root study to the entire United States is unknown. Initial releases from automobiles is to land; however, environmental fate and partitioning to other media is unknown.
	Water Release	10,000,000-15,000,000 lbs	(EPAB, 2005) and Root study (2000)	
	Land Release	(specific media of release are known)		
	Transfers Off-site for Further Waste Management	Unknown	NA	Quantity of weights collected (recycled) for personal use is unknown (fishing weights, lures, ammunition, etc).
Automobile Disposal (Salvage Yards)	Air Release	Unknown	NA	Media of release uncertain. Fate uncertain - amount of wheel weights in landfill and junkyards. Number of cars in the US disposed of in US. Fraction of wheel weights recycled.
	Water Release	Unknown		
	Land Release	Unknown		
	Transfers Off-site for Further Waste Management	Unknown	NA	Transfers off-site is unknown. No data was found.
	Number of Workers	Unknown	NA	No data was located on number of workers.
	Inhalation Exposure	Unknown	NA	No data was found on occupational exposures to lead from lead wheel weights in salvage yards.
	Dermal Exposure	Unknown	NA	
Automobile Disposal (~200 shredders in US based on ISRI, 2005 & Great Lakes Institute, 1998)	Air Release	Unknown	NA	1) Fraction of lead wheel weights removed during dismantling, prior to transfer to shredders; and 2) The amount of lead wheel weights that may be shredded; 3) The amount of lead from wheel weights in waste streams and in product streams.
	Water Release	Unknown		
	Land Release	Unknown		
	Transfers Off-site for Further Waste Management	Unknown		
	Number of Workers	Unknown	NA	Reference source did not have information on number of workers per facilities.
	Inhalation Exposure	Unknown	NA	No monitoring data was found.

INDUSTRY SECTOR	ASSESSMENT TYPE	ESTIMATED QUANTITY	SOURCE	UNCERTAINTIES AND DATA GAPS
	Dermal Exposure	Unknown	NA	No data exist.
Automobile Disposal (Steel Mills - EAFs or BOFs) 95 facilities utilizing EAFs (EPA, 2005a) 16 facilities with BOFs (2002 Economic Census)	Air Release (stack & fugitive)	48,550 kg/yr	TRI (2003 data) for SIC 3312	1) TRI data could not be segregated to quantify the amount of lead from lead wheel weights. 2) Cannot directly separate emissions specifically associated with EAFs and BOFs containing lead from lead wheel weights. 3) Automobile scrap sent to steel mills with EAFs and BOFs containing lead wheel weights. Number of workers exposed to lead from lead wheel weights is not known. Inhalation and dermal exposures attributed to lead wheel weights is not known.
	Water Release (surface water & POTW)	6,570 kg/yr	TRI (2003 data) for SIC 3312	
	Land Release	4,012,060 kg/yr	TRI (2003 data) for SIC 3312	
	Transfers Off-site for Further Waste Management	6,659,870 kg/yr	TRI (2003 data) for SIC 3312	
	Number of Workers	4,933 (employees) 4,167 (production employees)	2002 Economic Census Manufacturing Industry Series: Iron and Steel Mills	
	Inhalation Exposure	Unknown	NA	
	Dermal Exposure	Unknown	NA	

INDUSTRY SECTOR	ASSESSMENT TYPE	ESTIMATED QUANTITY	SOURCE	UNCERTAINTIES AND DATA GAPS
<p>Secondary Smelting</p> <p>Potentially up to 236 secondary smelting facilities in US (2002 Economic Census, US Census Bureau, Dept. of Commerce)</p> <p>Potentially 23 lead smelting facilities (Rice, 2005)</p> <p>Potentially 26 secondary lead smelting facilities in U.S. (Kirk-Othmer, 1996)</p>	Air Release	2,791,163 lbs (fugitive) 5,590,402 lbs (stack)	TRI (2003 for SIC 3341)	<p>TRI data reported for SIC 3341 (Secondary Smelting and Refining of Nonferrous Metals) includes releases from operations other than secondary lead smelting and other sources of lead other than lead wheel weights.</p> <p>Destination of off-site transfers is unknown. The lead content in these transfers from lead wheel weights is unknown.</p>
	Water Release	278,304 lbs (surface) 101,281 lbs (POTW)	TRI (2003 for SIC 3341)	
	Land Release	1,612,807,619 lbs	TRI (2003 for SIC 3341)	
	Transfers Off-site for Further Waste Management	1,945,230,974 lbs	TRI (2003 for SIC 3341)	
	Number of Workers	9,931 (all employees) 6,987 (production workers) (NAICS 331492). 1,600 workers	2002 Economic Census (US Dept of Commerce) Rice, 2005	This data could not be partitioned to reflect actual number of workers exposed to lead from lead wheel weights.

INDUSTRY SECTOR	ASSESSMENT TYPE	ESTIMATED QUANTITY	SOURCE	UNCERTAINTIES AND DATA GAPS
	Inhalation Exposure	<p>0.5 mg/day (fume and dust)</p> <p>0.49 mg/day (8-hr TWA personal breathing zone sample)</p> <p>4.4 - 7.6 mg/day</p>	<p>OSHA PEL (lead) = 400 $\mu\text{m}/\text{m}^3$ max permissible limit</p> <p>OSHA (1994) Avg = 49 $\mu\text{m}/\text{m}^3$ (2 samples) for lead pot tenders of fishing lure and sinker manufacturers (SIC 3949)</p> <p>Korean data in scrap and furnace operations (436 $\mu\text{g}/\text{m}^3$) and in secondary smelting furnace operations (758 $\mu\text{g}/\text{m}^3$) [J. Occup. Health, 2004]</p>	<p>No monitoring data exist. Estimate based on assumption of compliance with OSHA PEL.</p> <p>The OSHA data may or may not be comparable to the potential workers exposures for operation being assessed.</p> <p>This data from a Korean study may or may not be comparable to those for the operation being reviewed.</p>
	Dermal Exposure	Unknown (Worker contact to molten lead is not likely to occur)	NA	Dermal exposure data for workers in secondary lead smelting was not found.

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Appendix A

Steel Plants with Electric Arc Furnaces^a

Facility Name	City	State	Number of Furnaces	Type(s) of Steel Produced ^b	Capacity (1,000 tpy)
AK Steel Corp/Butler Operations	Butler	PA	3	S	960
AK Steel Corp/Mansfield Operations	Mansfield	OH	2	S	700
Allegheny Technologies Inc.	Brackenridge	PA	4	S	496
Allegheny Technologies Inc./Birmingham	Birmingham	AL	5	C	588
Arkansas Steel Associates	Newport	AR	1	C	130
Bayou Steel Corp./LaPlace	LaPlace	LA	2	C	683
BetaSteel Corp.	Portage	IN	1	C	500
Border Steel Mills, Inc.	El Paso	TX	2	C	250
Carpenter Technology Corp./Reading Plant	Reading	PA	6	H, S	450
Cascade Steel Rolling Mills, Inc	McMinnville	OR	1	C	700
Champion Steel Co.	Orwell	OH	1	C, H, S	6
Charter Manufacturing Co., Inc/Charter Steel	Saukville	WI	1	C	515
CitiSteel USA Inc.	Claymont	DE	1	C	400
CMC Steel Group/SMI Steel South Carolina	Cayce	SC	1	C	1,089
CMC Steel Group/SMI Steel, Inc.	Birmingham	AL	1	S, C	1,855
CMC Steel Group/Structural Metals, Inc.	Seguin	TX	1	C	339
Corus Tuscaloosa	Tuscaloosa	AL	1	C	870
Crucible Materials Corp	Syracuse	NY	1	H, S	50
Electralloy	Oil City	PA	1	C	90
Ellwood Quality Steels Co.	New Castle	PA	1	C, H, S	410
Erie Forge and Steel Inc.	Erie	PA	3	C, H, S	385
Finkl, A., & Sons	Chicago	IL	2	C	90
Gallatin Steel Co.	Ghent	KY	1	C	1,500
Gerdau Ameristeel - Cartersville Division	Cartersville	GA	1	C	658
Gerdau Ameristeel - Charlotte Steel Mill	Charlotte	NC	1	C	622
Gerdau Ameristeel - Jacksonville Steel Mill	Baldwin	FL	1	C	330
Gerdau Ameristeel - Knoxville Steel Mill	Knoxville	TN	1	C	515
Gerdau Ameristeel - Raritan	Perth Amboy	NJ	1	C	800
Gerdau Ameristeel - Sayreville	Sayreville	NJ	1	C	750
Gerdau Ameristeel - Tennessee Steel Mill	Jackson	TN	1	C	892
Haynes International, Inc.	Kokomo	IN	2	H, S	20
Hoeganeas Corp./Gallatin	Gallatin	TN	1	C	500
Hoeganeas Corp./Riverton	Riverton	NJ	1	C	112
Inmetco	Ellwood City	PA	1	S	28
Ipsco Inc./Mobile Steel Works	Axis	AL	1	C	674
Ipsco Inc./Montpelier	Muscatine	IA	1	H, C	317
International Steel Group (ISG)	Cleveland	OH	2	C	396

ISG (formerly Bethlehem Steel).	Coatsville	PA	1	C, H, S	880
ISG (formerly Bethlehem Steel).	Steelton	PA	1	C	1,100
ISG (formerly Georgetown Steel)	Georgetown	SC	2	C	1,000
Ispat Inland, Inc./Ispat Inland Bar Prods.	East Chicago	IN	1	C	500
J&L Specialty Steel, Inc.	Midland	PA	2	S	400
K.O. Steel Foundry & Machine	San Antonio	TX	1	C	18
Keystone Steel & Wire Co	Peoria	IL	1	C	1,000
Kobelco Metal Powder of America, Inc.	Seymore	IN	1	C	63
LeTourneau Inc.	Longview	TX	2	C, H	124
Lone Star Steel Inc.	Lone Star	TX	2	C	265
MACSTEEL Arkansas Div.	Fort Smith	AR	2	C	607
MACSTEEL Michigan Div.	Jackson	MI	2	C	725
Marion Steel Co.	Marion	OH	1	C	400
National Forge Co.	Irvine	PA	1	C, H, S	58
North American Stainless	Ghent	KY	1	S	800
North Star BHP Steel L.L.P.	Delta	OH	1	C	1,800
North Star Steel/Iowa Div.	Wilton	IA	1	C	917
North Star Steel/Kingman	Kingman	AZ	1		500
North Star Steel/Michigan Div.	Monroe	MI	1	C	600
North Star Steel/Minnesota Div.	St. Paul	MN	1	C	843
North Star Steel/Texas Div.	Beaumont	TX	1	C	1,002
Northwestern Steel & Wire Co.	Sterling	IL	2	C	2,070
NS Group Inc./Koppel Steel Corp.	Beaver Falls	PA	1	C	550
Nucor Bar Mill Group	Birmingham	AL	1	C	500
Nucor Bar Mill Group	Kankakee	IL	1	C	800
Nucor Bar Mill Group/Nucor Steel Jackson Inc.	Jackson	MS	1	C	500
Nucor Bar Mill Group/Nucor Steel Seattle Inc.	Seattle	WA	1	C	840
Nucor Corp./Berkeley County Plant	Berkeley County	SC	2	C	2,359
Nucor Corp./Crawfordsville Plant	Crawfordsville	IN	2	H, C	224
Nucor Corp./Darlington Plant	Darlington	SC	1	H, C	872
Nucor Corp./Hertford Plant	Cofield	NC	1	H, C	171
Nucor Corp./Hickman Plant	Hickman	AR	2	C, H, S	1,200
Nucor Corp./Jewett Plant	Jewett	TX	3	C	460
Nucor Corp./Norfolk Plant	Norfolk	NE	1	C	1,103
Nucor Corp./Plymouth Plant	Plymouth	UT	2	C	1,111
Nucor Steel - Auburn	Auburn	NY	1	C	550
Nucor Steel - Decatur LLC	Decatur	AL	2	C	2,000
Nucor-Yamato Steel Co.	Blytheville	AR	2	C	3,277
Oregon Steel Mills, Inc./Portland	Portland	OR	1	C	499
Oregon Steel Mills/Rocky Mountain Steel Mills	Pueblo	CO	2	C	1,200
Republic Engineered Steels, Inc./Canton Plant	Canton	OH	1	C	1,050
Roanoke Electric Steel Corp.	Roanoke	VA	2	C	710
Sheffield Steel Corp.	Sand Springs	OK	2	C	600

Standard Steel/Burnham Plant	Burnham	PA	3	C, H, S	231
Standard Steel/Latrobe Plant	Latrobe	PA	1	C, H	59
Steel Dynamics Inc./Butler	Butler	IN	2	C	3
Steel Dynamics Inc./Whitley County	Whitley County	IN	2	C, H	800
Steel of West Virginia, Inc.	Huntington	WV	2	C	100
TAMCO	Rancho	CA	1	C	750
Timken Co., The/Faircrest Plant	Canton	OH	1	C	415
Timken Co., The/Harrison Plant	Canton	OH	3	S	358
Timken Co., The/Latrobe Steel Co.	Latrobe	PA	2	C, H	60
TXI Chaparral Steel/Dinwiddie	Dinwiddie	VA	1	C, H, S	1,200
TXI Chaparral Steel/Midlothian	Midlothian	TX	2	C, H, S	2,000
Union Electric Steel Corp.	Carnegie	PA	1	C, H	
Universal Stainless & Alloy Products, Inc.	Bridgeville	PA	1	H, S	105
V&M Star	Youngstown	OH	1	C, H	650
Wheeling-Pittsburgh Steel	Mingo Junction	OH	1	C	500
TOTAL			144		63,149

Source: U.S. EPA 2005a.

^a Compiled from Roundup (May 2003), an OAQPS survey of minimills in 2004, and news releases. Also updated to include ownership changes and recent shutdowns. Does not include EAFs used at iron and steel foundries (some were listed in Roundup)

^b S = stainless, H = high alloy, C = carbon (or low alloy)