# BACKGROUND REPORT

# AP-42 SECTION 12-11

## SECONDARY LEAD PROCESSING

**Prepared for**

**U.S. Environmental Protection Agency**
**OAQPS/TSD/EIB**
**Research Triangle Park, NC 27711**

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# 1-103

# AP-42 Background Report

## TECHNICAL SUPPORT DIVISION

**U.S. ENVIRONMENTAL PROTECTION AGENCY**
Office of Air Quality Planning and Standards
Research Triangle Park, NC  27711

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# 1.0 INTRODUCTION

The document "Compilation of Air Pollutant Emission Factors" (AP-42) has been published by the U.S. Environmental Protection Agency (EPA) since 1972. Supplements to AP-42 have been routinely published to add new emission source categories and to update existing emission factors. AP-42 is routinely updated by the EPA to respond to new emission factor needs of the EPA, State and local air pollution control programs, and industry.

An emission factor relates the quantity (weight) of pollutants emitted to a unit of activity of the source. The uses for the emission factors reported in AP-42 include:

1. Estimates of area-wide emissions;
2. Emission estimates for a specific facility; and
3. Evaluation of emissions relative to ambient air quality.

The purpose of this report is to provide background documentation of process information obtained from industry comment and 9 test reports to support revision of emission factors for the secondary lead processing industry.

Including the introduction (Chapter 1), this report contains four chapters. Chapter 2 gives a description of the secondary lead processing industry. It includes a characterization of the industry, an overview of the different process types, a description of emissions, and a description of the technology used to control emissions resulting from secondary lead processing.

Chapter 3 is a review of emissions data collection and analysis procedures. It describes the literature search, the screening of emission data reports, and the quality rating system for both emission data and emission factors. Chapter 4 details criteria and noncriteria pollutant emission factor development. It includes the review of specific data sets and the results of data analyses. Particle size determination and particle size data analysis methodology are described when applicable.

# 2.0 INDUSTRY DESCRIPTION

## 2.1 GENERAL

Secondary lead smelters produce elemental lead and lead alloys from lead-bearing scrap material. More than 60 percent of all secondary lead is derived from scrap automobile batteries. Each battery contains approximately 11.8 kg (26 lbs) of lead, consisting of 40 percent lead alloys and 60 percent lead oxide.[21] Other raw materials used in secondary lead smelting include wheel balance weights, pipe, solder, drosses, and lead sheathing. Lead produced by secondary smelting accounts for half of the lead produced in the U.S. As of 1989, there were 42 companies operating 50 plants with individual capacities ranging from 900 Mg (992 tons) to 110,000 Mg (121,000 tons) per year.[21]

## 2.2 PROCESS DESCRIPTION

Secondary lead smelting includes three major operations: scrap pretreatment, smelting, and refining. These are shown schematically in Figures 2.2-1A, 2.2-1B, and 2.2-1C, respectively.

### 2.2.1 Scrap Pretreatment

Scrap pretreatment is the partial removal of metal and nonmetal contaminants from lead-bearing scrap and residue. Processes used for scrap pretreatment include battery breaking (SCC# 3-04-004-10), crushing (SCC# 3-04-004-11), and sweating (SCC# 3-04-004-12). Battery breaking is the draining and crushing of batteries, followed by manual separation of the lead from nonmetallic materials. Lead plates, posts, and intercell connectors are collected and stored in a pile for subsequent charging to the furnace. Oversized pieces of scrap and residues are usually put through jaw crushers. This separated lead scrap is then sweated in a gas- or oil-fired reverberatory (SCC# 3-04-004-05) or rotary furnace (SCC# 3-04-004-04). The sweating process separates lead from metals with higher melting points. Rotary furnaces are usually used to process low lead

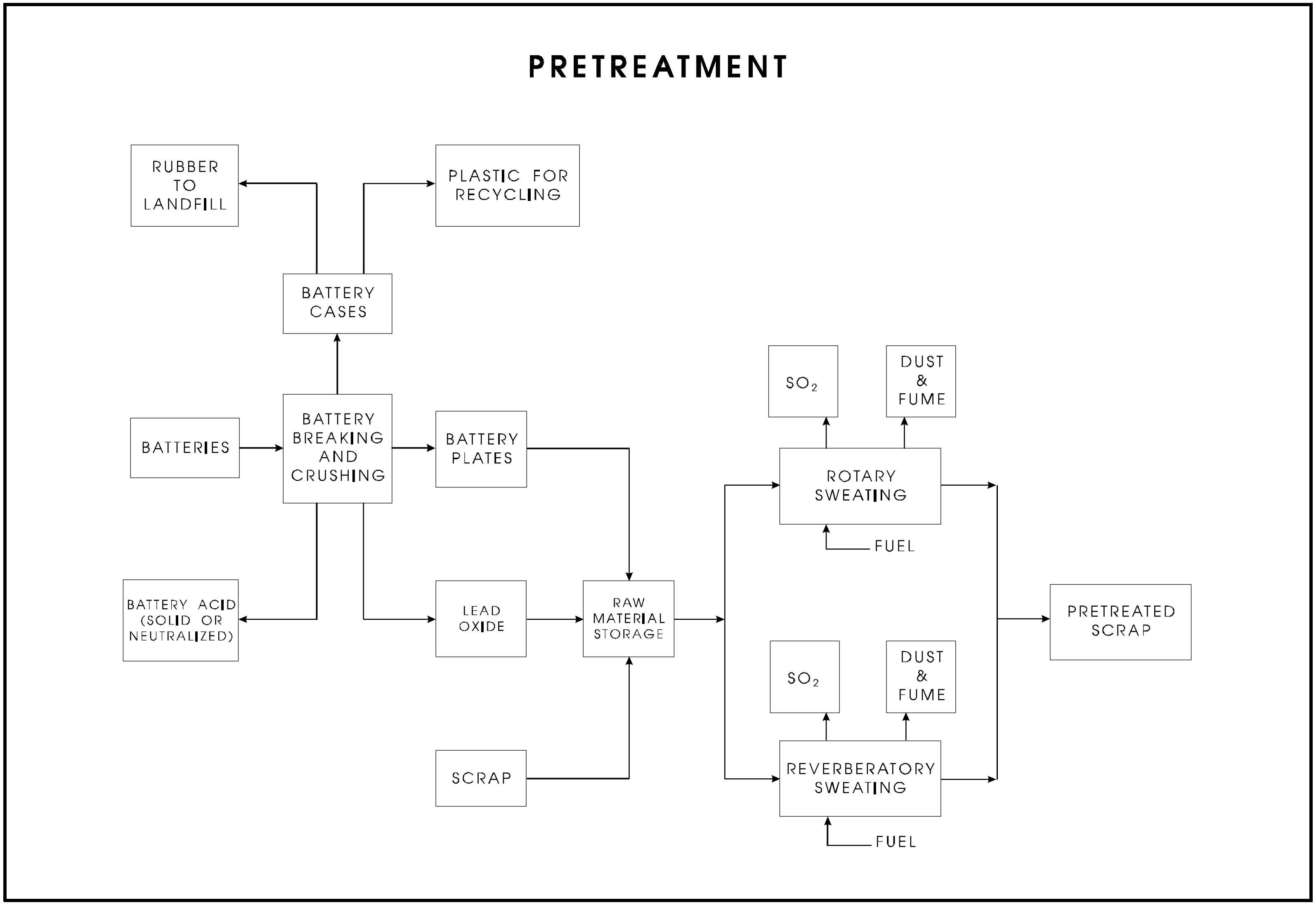

Figure 2.2-1A Generalized process flow for secondary lead processing

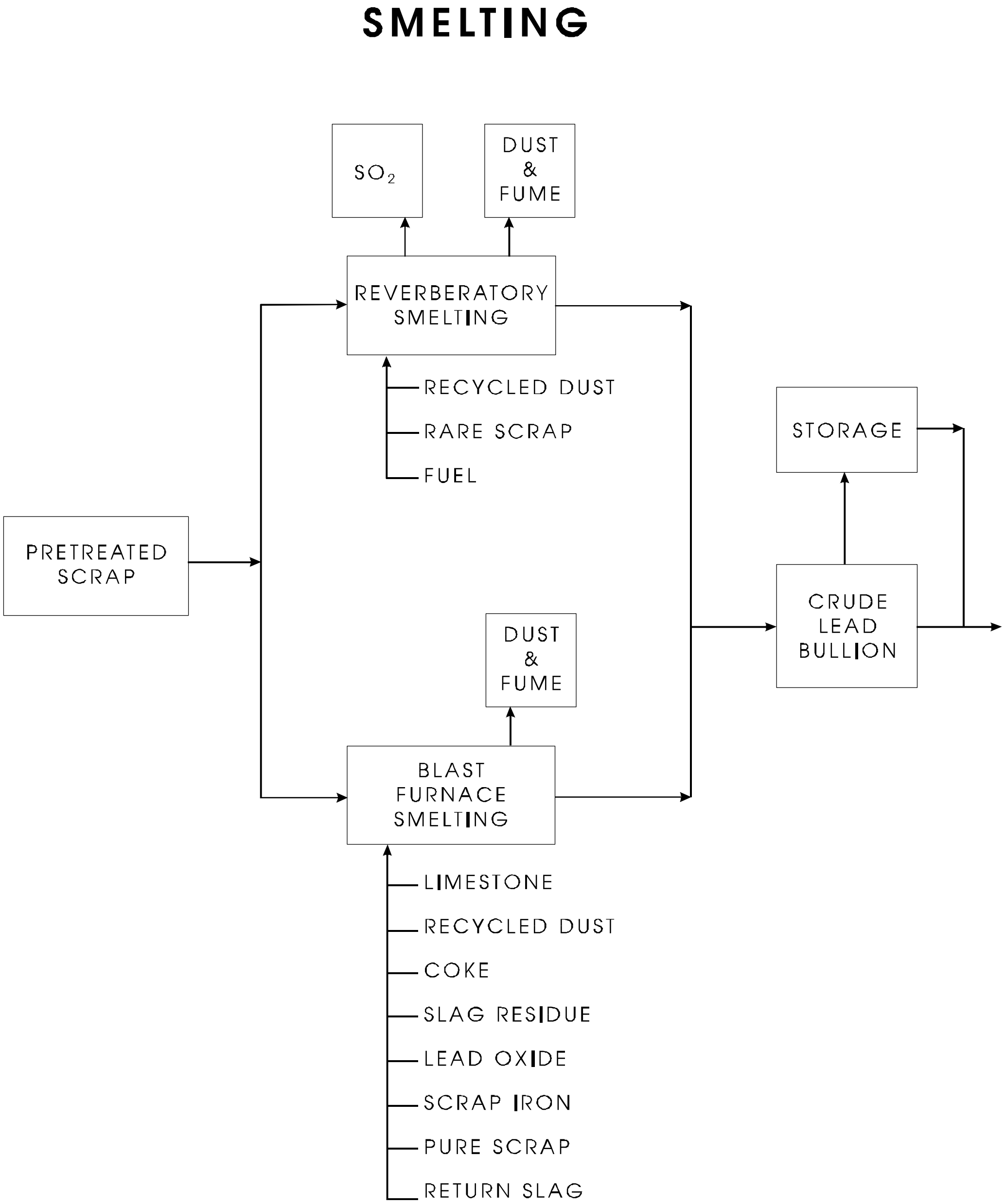

Figure 2.2-1B Generalized process flow for secondary lead processing (cont.)

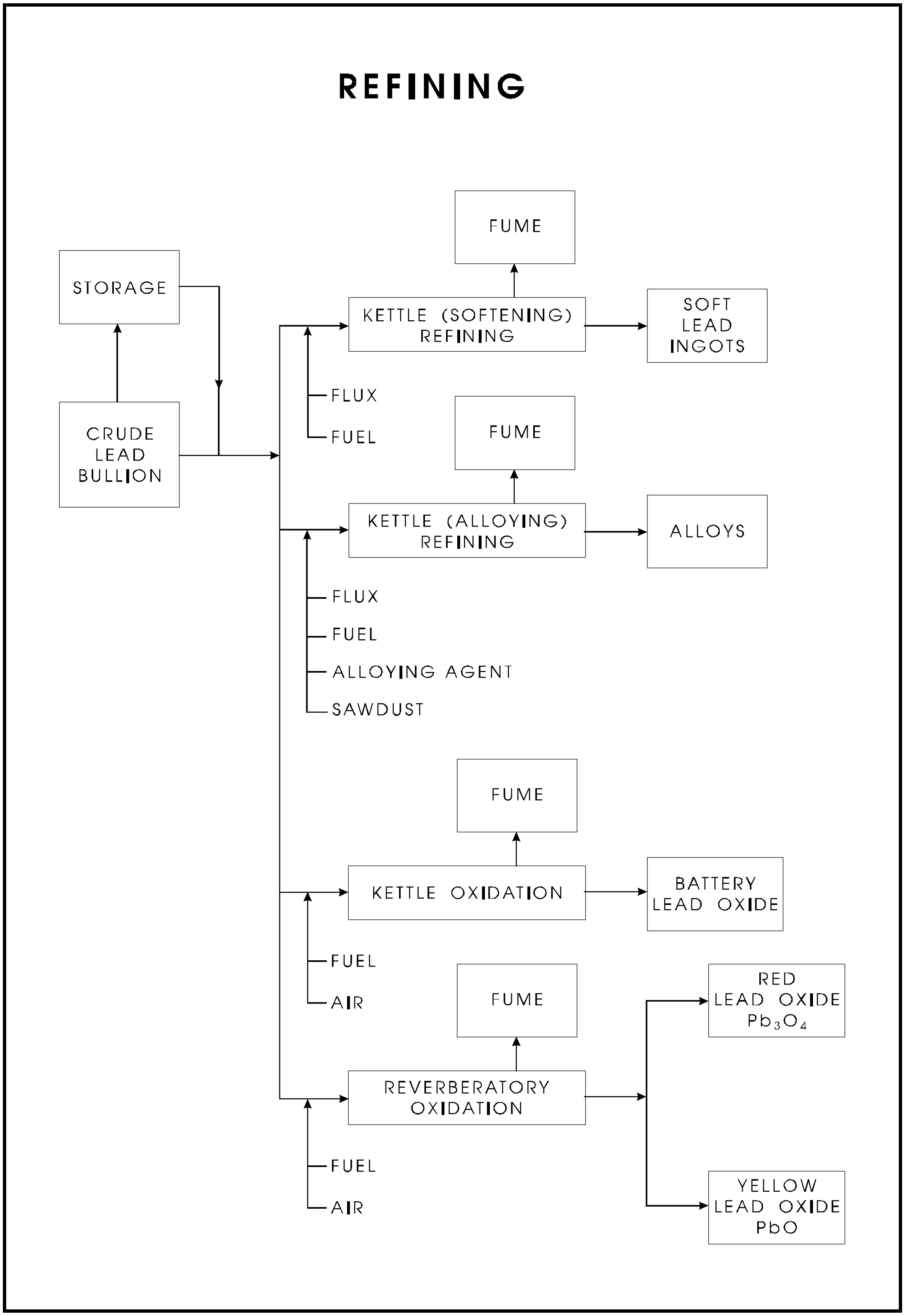

Figure 2.2-1C  Generalized process flow for secondary lead processing (cont.)

content scrap and residue, while reverberatory furnaces are used to process high lead content scrap. The partially purified lead is periodically tapped from these furnaces for further processing in smelting furnaces or pot furnaces.

### 2.2.2 Smelting

Smelting produces lead by melting and separating the lead from metal and nonmetallic contaminants and by reducing oxides to elemental lead. Smelting is carried out in blast (SCC# 3-04-004-03), reverberatory (SCC# 3-04-004-02), and rotary kiln (SCC# 3-04-004-99) furnaces. Blast furnaces produce hard or antimonial lead containing about 10 percent antimony. Reverberatory and rotary kiln furnaces are used to produce semisoft lead containing three to four percent antimony; however, rotary kiln furnaces are rarely used in the U.S. and will not be discussed in detail.

In blast furnaces pretreated scrap metal, rerun slag, scrap iron, coke, recycled dross (as byproduct waste or impurities), flue dust, and limestone are used as charge materials to the furnace. The process heat needed to melt the lead is produced by the reaction of the charged coke with blast air that is blown into the furnace. Some of the coke combusts to melt the charge, while the remainder reduces lead oxides to elemental lead. The furnace is charged with combustion air at 3.4 to 5.2 kPa (0.5 to 0.75 psi) with an exhaust temperature ranging from 650 to 730°C (1200 to 1350°F).

As the lead charge melts, limestone and iron float to the top of the molten bath and form a flux that retards oxidation of the product lead. The molten lead flows from the furnace into a holding pot at a nearly continuous rate. The product lead constitutes roughly 70 percent of the charge. From the holding pot, the lead is usually cast into large ingots called pigs or sows. About 18 percent of the charge is recovered as slag, with about 60 percent of this being a sulfurous slag called matte. Roughly 5 percent of the charge is retained for reuse, and the remaining 7 percent of the charge escapes as dust or fumes. Processing capacity of the blast furnace ranges from 18 to 73 megagrams per day (20 to 80 tons per day).

The reverberatory furnace used to produce semisoft lead is charged with lead scrap, metallic battery parts, oxides, drosses, and other residues. The charge is heated directly to a temperature of 1260°C (2300°F) using either natural gas, oil, or coal. The average furnace capacity is about 45 megagrams (50 tons) per day. About 47 percent of the charge is recovered as lead product and is periodically tapped into molds or holding pots. Forty-six percent of the charge is removed as slag and is later processed in blast furnaces. The remaining seven percent of the furnace charge escapes as dust or fumes.

### 2.2.3 Refining

Refining (SCC# 3-04-004-14) and casting (SCC# 3-04-004-09) the crude lead from the smelting furnaces consists of softening, alloying, and oxidation depending on the degree of purity or alloy type desired. These operations are batch processes requiring from two hours to three days. These operations can be performed in reverberatory furnaces; however, kettle-type furnaces are most commonly used. The remelting process is usually applied to lead alloy ingots that require no further processing before casting. Kettle furnaces used for alloying, refining and oxidizing are usually oil- or gas-fired (SCC# 3-04-004-06 and 3-04-004-07, respectively) and have typical capacities of 23 to 136 megagrams (25 to 150 lbs) per day. Refining and alloying operating temperatures range from 320 to 700°C (600 to 1300°F). Alloying furnaces simply melt and mix ingots of lead and alloy materials. Antimony, tin, arsenic, copper, and nickel are the most common alloying materials.

Refining furnaces are used to either remove copper and antimony for soft lead production or to remove arsenic, copper, and nickel for hard lead production. Sulfur may be added to the molten lead bath to remove copper. Copper sulfide skimmed off as dross may subsequently be processed in a blast furnace to recover residual lead. Aluminum chloride flux may be used to remove copper, antimony, and nickel. The antimony content can be reduced to about 0.02 percent by bubbling air through the molten lead. Residual antimony can be removed by adding sodium nitrate and sodium hydroxide to the bath and skimming off the resulting dross. Dry drossing consists of adding sawdust to the agitated mass of molten metal. The sawdust supplies carbon to help separate globules of lead suspended in the dross and to reduce some of the lead oxide to elemental lead.

Oxidizing furnaces, either kettle or reverberatory units, are used to oxidize lead and to entrain the product lead oxides in the combustion air stream for subsequent recovery in high efficiency baghouses.

## 2.3 EMISSIONS AND CONTROLS

Emission factors for controlled and uncontrolled processes and for fugitive particulate matter are given in Tables 2.3-1 and 2.3-2, respectively. Particulate emissions from most processes were obtained from the previous AP-42 section (October 1986) which were based on accumulated test data. Process fugitive emissions presented in Table 2.3-2 were also derived from the previous AP-42 document except for the smelting operation lead emission factor. The smelting operation fugitive lead emission factor was developed from a recent source test received for the industry, and the remaining fugitive emissions presented in Table 2.3-2 were based on the assumption that 5 percent of uncontrolled stack emissions are released as fugitive emissions.

Reverberatory and blast furnaces account for the vast majority of the total lead emissions from the secondary lead industry. The lead blast furnace is also referred to as cupola. The relative quantities emitted from these two smelting processes cannot be specified, because of a lack of complete information. Most of the remaining processes are small emission sources with undefined emission characteristics.

Emissions from battery breaking are mainly of sulfuric acid mist and dusts containing dirt, battery case material, and lead compounds. Emissions from crushing are also mainly dusts.

Emissions from sweating operations are fumes, dust, soot particles, and combustion products, including sulfur dioxide ($SO_2$). The $SO_2$ emissions come from combustion of sulfur compounds in the scrap and fuel. Dust particles range in size from 5 to 20 micrometers (µm) and unagglomerated lead fumes range in size from 0.07 to 0.4 µm, with an average diameter of 0.3 µm. Baghouses are usually used to control sweating emissions, with removal efficiencies exceeding 99 percent. The emission factors for lead sweating in Table 2.3-1 are based upon measurements at similar sweating furnaces in other secondary metal processing industries, not on measurements at lead sweating furnaces.

Reverberatory smelting furnaces emit particulate and oxides of sulfur and nitrogen. Particulate consists of oxides, sulfides and sulfates of lead, antimony, arsenic, copper, and tin, as well as unagglomerated lead fumes. Emissions are generally controlled with settling and cooling chambers, followed by a baghouse. Control efficiencies generally exceed 99 percent. Wet scrubbers are sometimes used to reduce $SO_2$ emissions. However, because of

## TABLE 2.3-1. (METRIC UNITS)
## EMISSION FACTORS FOR SECONDARY LEAD PROCESSING

All Emission Factors are in kg/Mg of Product, Unless Noted
Ratings (A-E) Follow Each Factor

| | Particulate | | | | Lead | | | | $SO_2$ | |
|---|---|---|---|---|---|---|---|---|---|---|
| Process | Uncontrolled | | Controlled | | Uncontrolled | | Controlled | | Uncontrolled | |
| Sweating[a] (kg/Mg charge)<br>(SCC# 3-04-004-04 and 3-04-004-05) | 16-35 | E | | | 4-8[b] | E | | | | |
| Reverberatory smelting<br>(SCC# 3-04-004-02) | 162<br>(87-242)[c] | E | 0.50<br>(0.26-0.77)[d] | E | 32<br>(17-48)[e] | E | | | 40<br>(36-44)[d] | E |
| Blast (cupola) smelting[f]<br>(SCC# 3-04-004-03) | 153<br>(92-207)[g] | E | 1.12<br>(0.11-2.49)[h] | E | 52<br>(31-70)[i] | E | 0.15<br>(0.02-0.32)[j] | E | 27<br>(9-55)[c] | E |
| Kettle refining<br>(SCC# 3-04-004-99) | 0.02[k] | E | | | 0.006[k] | E | | | | |
| Kettle Oxidation<br>(SCC# 3-04-004-08) | ≤ 20[l] | E | | | | | | | | |
| Casting<br>(SCC# 3-04-004-09) | 0.02[k] | E | | | 0.007[k] | E | | | | |

[a] Reference 1. Estimated from sweating furnace emissions from nonlead secondary nonferrous processing industries. Based on quantity of material charged to furnace.

[b] References 3, 5. Based on assumption that uncontrolled reverberatory furnace flue emissions are 23% lead.

[c] References 8-11.

[d] References 6, 8-11.

[e] Reference 13. Uncontrolled reverberatory furnace flue emissions assumed to be 23% lead. Blast furnace emissions have lead content of 34%, based on single uncontrolled plant test.

[f] Blast furnace emissions are combined flue gases and associated ventilation hood streams (charging and tapping).

[g] References 8, 11-12.

[h] References 6, 8, 11-12, 14-15.

[i] Reference 13. Blast furnace emissions have lead content of 26%, based on single controlled plant test.

[j] Based on quality of material charged to furnace.

[k] Reference 13. Lead content of kettle refining emissions is 40% and of casting emissions is 36%.

[l] References 1-2. Essentially all product lead oxide is entrained in an air stream and subsequently recovered by baghouse with average collection efficiency >99%. Factor represents emissions of lead oxide that escape a baghouse used to collect the lead oxide product. Represents approximate upper limit for emissions.

## TABLE 2.3-1. (ENGLISH UNITS)
## EMISSION FACTORS FOR SECONDARY LEAD PROCESSING

All Emission Factors are in lb/ton of Product, Unless Noted
Ratings (A-E) Follow Each Factor

| | Particulate | | | | Lead | | | | $SO_2$ | |
|---|---|---|---|---|---|---|---|---|---|---|
| Process | Uncontrolled | | Controlled | | Uncontrolled | | Controlled | | Uncontrolled | |
| Sweating[a] (lb/ton charged)<br>(SCC# 3-04-004-04 and 3-04-004-05) | 32-70 | E | | | 7-16[b] | E | | | | |
| Reverberatory smelting<br>(SCC# 3-04-004-02) | 323<br>(173-483)[c] | E | 1.01<br>(0.53-1.55)[d] | E | 65<br>(35-97)[e] | E | | | 80<br>(71-88)[d] | E |
| Blast (cupola) smelting[f]<br>(SCC# 3-04-004-03) | 307<br>(184-413)[g] | E | 2.24<br>(0.22-4.88)[h] | E | 104<br>(64-140)[i] | E | 0.29<br>(0.03-0.64)[j] | E | 53<br>(18-110)[c] | E |
| Kettle refining<br>(SCC# 3-04-004-99) | 0.03[k] | E | | | 0.01[k] | E | | | | |
| Kettle Oxidation<br>(SCC# 3-04-004-08) | ≤ 40[l] | E | | | | | | | | |
| Casting<br>(SCC# 3-04-004-09) | 0.04[k] | E | | | 0.01[k] | E | | | | |

[a] Reference 1. Estimated from sweating furnace emissions from nonlead secondary nonferrous processing industries. Based on quantity of material charged to furnace.

[b] References 3, 5. Based on assumption that uncontrolled reverberatory furnace flue emissions are 23% lead.

[c] References 8-11.

[d] References 6, 8-11.

[e] Reference 13. Uncontrolled reverberatory furnace flue emissions assumed to be 23% lead. Blast furnace emissions have lead content of 34%, based on single uncontrolled plant test.

[f] Blast furnace emissions are combined flue gases and associated ventilation hood streams (charging and tapping).

[g] References 8, 11-12.

[h] References 6, 8, 11-12, 14-15.

[i] Reference 13. Blast furnace emissions have lead content of 26%, based on single controlled plant test.

[j] Based on quality of material charged to furnace.

[k] Reference 13. Lead content of kettle refining emissions is 40% and of casting emissions is 36%.

[l] References 1-2. Essentially all product lead oxide is entrained in an air stream and subsequently recovered by baghouse with average collection efficiency >99%. Factor represents emissions of lead oxide that escape a baghouse used to collect the lead oxide product. Represents approximate upper limit for emissions.

## TABLE 2.3-2 (METRIC UNITS)
## FUGITIVE EMISSION FACTORS FOR SECONDARY LEAD PROCESSING[a]

All Emission Factors are in kg/Mg of Product
Ratings (A-E) Follow Each Factor

| Operation | Particulate | | Lead | |
|---|---|---|---|---|
| Sweating<br>(SCC# 3-04-004-12) | 0.8-1.8[b] | E | 0.2-0.9[c] | E |
| Smelting<br>(SCC# 3-04-004-13) | 4.35-12.1 | E | 0.1-0.3[d] | D |
| Kettle refining<br>(SCC# 3-04-004-14) | 0.001 | E | 0.0003[e] | E |
| Casting<br>(SCC# 3-04-004-99) | 0.001 | E | 0.0004[e] | E |

[a] Reference 16. Based on amount of lead product, except for sweating, which is based on quantity of material charged to furnace. Fugitive emissions estimated to be 5 percent of uncontrolled stack emissions.
[b] Reference 1. Sweating furnace emissions estimated from nonlead secondary nonferrous processing industries.
[c] References 3, 5. Assumes 23 percent lead content of uncontrolled blast furnace flue emissions.
[d] Reference 24.
[e] Reference 13.

## TABLE 2.3-2 (ENGLISH UNITS)
## FUGITIVE EMISSION FACTORS FOR SECONDARY LEAD PROCESSING[a]

All Emission Factors are in lb/ton of Product
Ratings (A-E) Follow Each Factor

| Operation | Particulate | | Lead | |
|---|---|---|---|---|
| Sweating<br>(SCC# 3-04-004-12) | 1.6-3.5[b] | E | 0.4-1.8[c] | E |
| Smelting<br>(SCC# 3-04-004-13) | 8.7-24.2 | E | 0.2-0.6[d] | D |
| Kettle refining<br>(SCC# 3-04-004-14) | 0.002 | E | 0.0006[e] | E |
| Casting<br>(SCC# 3-04-004-99) | 0.002 | E | 0.0007[e] | E |

[a] Reference 16. Based on amount of lead product, except for sweating, which is based on quantity of material charged to furnace. Fugitive emissions estimated to be 5 percent of uncontrolled stack emissions.

[b] Reference 1. Sweating furnace emissions estimated from nonlead secondary nonferrous processing industries.

[c] References 3, 5. Assumes 23 percent lead content of uncontrolled blast furnace flue emissions.

[d] Reference 24.

[e] Reference 13.

the small particles emitted from reverberatory furnaces, baghouses are used more often than scrubbers for particulate control.

Two chemical analyses by electron spectroscopy have shown the particulate to consist of 38 to 42 percent lead, 20 to 30 percent tin, and about 1 percent zinc.[17] Particulate emissions from reverberatory smelting furnaces are estimated to contain 20 percent lead.

Particle size distributions for blast furnace flue gases are presented in Table 2.3-3 and Figure 2.3-1. Similarly, Table 2.3-4 and Figure 2.3-2 present particle size distributions for the blast furnace charging and tapping operations. Emissions from blast furnaces occur at charging doors, the slag tap, the lead well, and the furnace stack. The emissions are combustion gases (including carbon monoxide, hydrocarbons, and oxides of sulfur and nitrogen) and particulate matter. Emissions from the charging doors and the slag tap are hooded and routed to the control devices treating the furnace stack emissions. Blast furnace particulate is smaller than that emitted from reverberatory furnaces and is suitable for control by scrubbers or fabric filters downstream of gas cooling equipment. Efficiencies for various control devices are shown in Table 2.3-5. In one application, fabric filters alone captured over 99 percent of the blast furnace particulate emissions.

Particulate recovered from the uncontrolled flue emissions at six blast furnaces had an average lead content of 23 percent. Particulate recovered from the uncontrolled charging and tapping hoods at one blast furnace had an average lead content of 61 percent. Based on these concentrations and relative emission rates, lead comprises 34 percent of uncontrolled blast furnace emissions. Emission testing downstream of control equipment at the same blast furnace revealed lead contents of 33 percent in the flue gas, 22 percent in the offgas from charging and tapping operations, and a weighted average of 26 percent lead content. Particulate recovered from another blast furnace contained 80 to 85 percent lead sulfate and lead chloride, 4 percent tin, 1 percent cadmium, 1 percent zinc, 0.5 percent antimony, 0.5 percent arsenic, and less than 1 percent organic matter. The above lead concentration information was obtained from the previous AP-42 document (October 1986) from References 13 and 18. Reference 18 could not be obtained, and Reference 13 had several deficiencies which are discussed later in Section 4.3. For these reasons, the above information should be used for background information only.

# TABLE 2.3-3

# EMISSION FACTORS AND PARTICLE SIZE DISTRIBUTION FOR UNCONTROLLED BLAST FURNACE VENTILATION[a]

## EMISSION FACTOR RATING: D

| Particle size[b] (um) | Cumulative mass % ≤ stated size | | Cumulative emission factors | | | |
|---|---|---|---|---|---|---|
| | | | Uncontrolled | | Controlled | |
| | Uncontrolled | Controlled | kg/Mg | lb/ton | kg/Mg | lb/ton |
| 15 | 40.5 | 88.5 | 25.7 | 51.4 | 0.41 | 0.83 |
| 10 | 39.5 | 83.5 | 25.1 | 50.2 | 0.39 | 0.78 |
| 6 | 39.0 | 78.0 | 24.8 | 49.5 | 0.36 | 0.73 |
| 2.5 | 35.0 | 65.0 | 22.2 | 44.5 | 0.30 | 0.61 |
| 1.25 | 23.5 | 43.5 | 14.9 | 29.8 | 0.20 | 0.41 |
| 1.00 | 16.5 | 32.5 | 10.5 | 21.0 | 0.15 | 0.30 |
| 0.625 | 4.5 | 13.0 | 2.9 | 5.7 | 0.06 | 0.12 |
| Total | 100.0 | 100.0 | 63.5 | 127.0 | 0.47 | 0.94 |

[a] Based on lead, as produced. Includes emissions from charging, metal and slag tapping.
[b] Expressed as equivalent aerodynamic particle diameter.

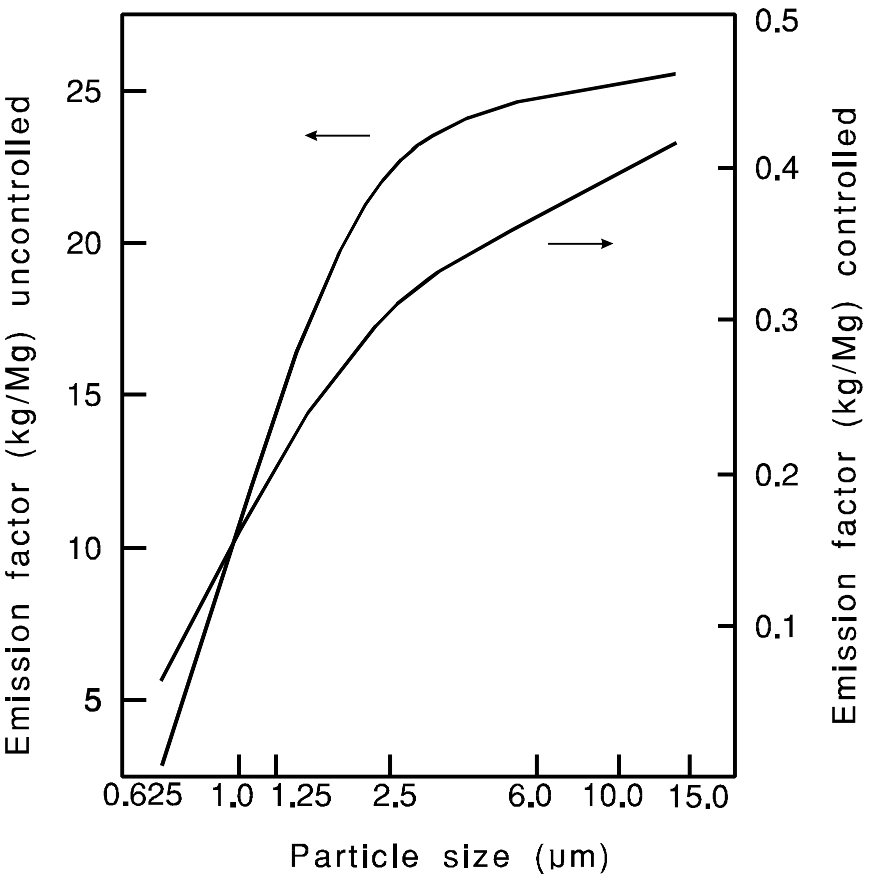

Figure 2.3-1. Emission factors less than stated particle size for uncontrolled and baghouse controlled blast furnace ventilation.

## TABLE 2.3-4

## EMISSION FACTORS AND PARTICLE SIZE DISTRIBUTION FOR BAGHOUSE CONTROLLED BLAST FURNACE FLUE GASES[a]

### EMISSION FACTOR RATING: D

| Particle size[b] (um) | Cumulative mass % ≤ stated size | Cumulative emission factors | |
|---|---|---|---|
| | | Uncontrolled | |
| | Uncontrolled | kg/Mg | lb/ton |
| 15 | 93.0 | 0.22 | 0.45 |
| 10 | 89.0 | 0.21 | 0.43 |
| 6 | 83.5 | 0.20 | 0.40 |
| 2.5 | 71.0 | 0.17 | 0.34 |
| 1.25 | 44.5 | 0.11 | 0.21 |
| 1.00 | 33.0 | 0.08 | 0.16 |
| 0.625 | 14.5 | 0.03 | 0.07 |
| Total | 100.0 | 0.24 | 0.48 |

[a] Units are for lead, as produced.

[b] Expressed as equivalent aerodynamic particle diameter.

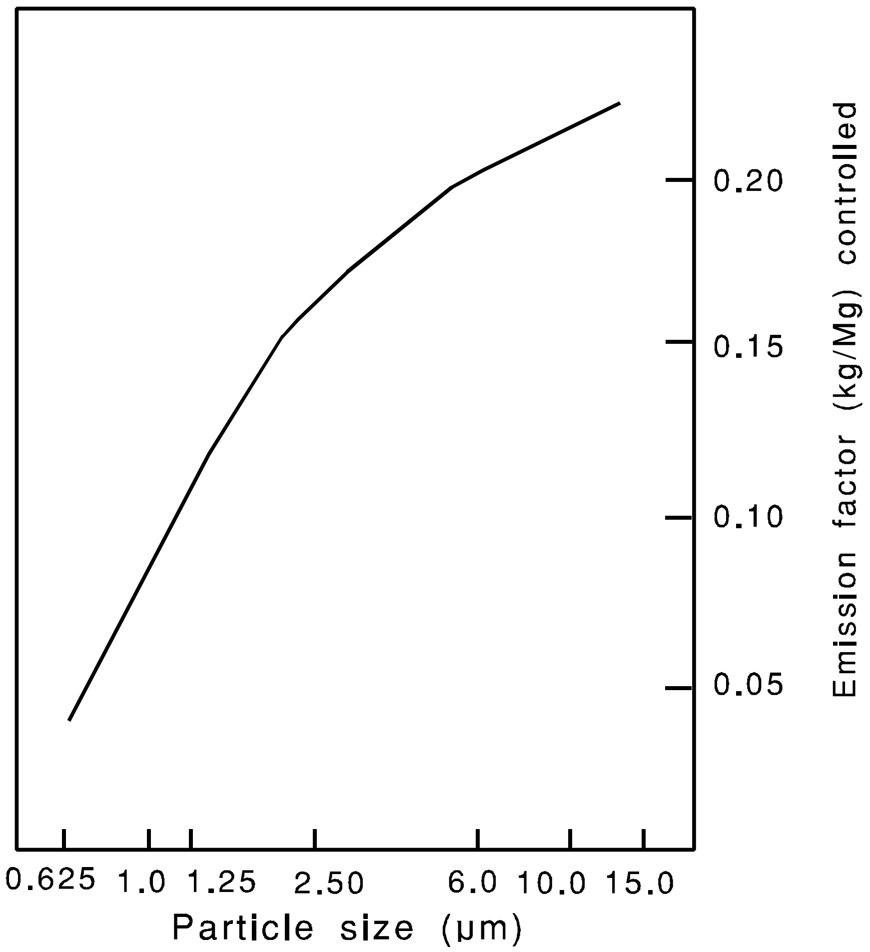

Figure 2.3-2. Emission factors less than stated particle size for baghouse controlled blast furnace flue gases.

## TABLE 2.3-5

## EFFICIENCIES OF PARTICULATE CONTROL EQUIPMENT ASSOCIATED WITH SECONDARY LEAD SMELTING FURNACES

| Control Equipment | Furnace type | Control efficiency (%) |
|---|---|---|
| Fabric filter[a] | Blast<br>Reverberatory | 98.4<br>99.2 |
| Dry cyclone plus fabric filter[a] | Blast | 99.0 |
| Wet cyclone plus fabric filter[b] | Reverberatory | 99.7 |
| Settling chamber plus dry cyclone plus fabric filter[c] | Reverberatory | 99.8 |
| Venturi scrubber plus demister[d] | Blast | 99.3 |

[a] Reference 8.
[b] Reference 9.
[c] Reference 10.
[d] Reference 14.

Kettle furnaces for melting, refining, and alloying are relatively minor emission sources. The kettles are hooded, with fumes and dusts typically vented to baghouses and recovered with efficiencies exceeding 99 percent. Twenty measurements of the uncontrolled particulate from kettle furnaces showed a mass median aerodynamic particle diameter of 18.9 micrometers, with particle size ranging from 0.05 to 150 micrometers. Three chemical analyses by electron spectroscopy showed the composition of particulate to vary from 12 to 17 percent lead, 5 to 17 percent tin, and 0.9 to 5.7 percent zinc.[16]

Emissions from oxidizing furnaces are economically recovered with baghouses. The particulates are mostly lead oxide, but they also contain amounts of lead and other metals. The oxides range in size from 0.2 to 0.5 µm. Controlled emissions have been estimated to be 0.1 kilograms per megagram (0.2 pounds per ton) of lead product, based on a nominal 99 percent efficiency for baghouses.

## 2.4 REVIEW OF SPECIFIC DATA SETS

Pacific Environmental Services (PES) contacted the following sources to obtain the most up-to-date information on processes, emissions, and control techniques for this industry.

1) Alabama Department of Environmental Mangement, Air Division, Montgomery AL;
2) Association of Battery Recyclers, Washington, DC;
3) Dellate Metals, Ponchatoula, LA;
4) East Penn Manufacturing Co. Inc., Lyon Station, PA;
5) Exide Corporation, Muncie, IN;
6) Federated Fry Metals, Altoona, PA;
7) Florida Department of Environmental Regulation, Tallahassee, FL;
8) Georgia Department of Natural Resources, Atlanta, GA;
9) Indiana Air Pollution Control Bureau, Indianapolis, IN;
10) Jefferson County Department of Health, Birmingham, AL;
11) Kansas Department of Health and Environment, Topeka, KS;
12) Master Metals, Inc., Cleveland, OH;
13) Michigan Department of Natural Resources, Lansing, MI;
14) Missouri Department of Natural Resources, Jefferson City, MO;
15) Pennsylvania Department of Environmental Resources, Harrisburg, PA;
16) RSR Corporation, Dallas, TX;
17) Sanders Lead Company, Inc., Troy, AL;
18) Schuylkill Metals Corporation, Forest City, MO;
19) Shelby County Air Pollution Control Bureau, Shelby County, TN; and
20) U.S. Department of the Interior, Bureau of Mines, Washington, DC.

Responses were received from eight sources, contacts 2, 4, 9, 10, 12, 18, 19, and 20. The data received from contact 2, Association of Battery Recyclers (Reference 24), consisted of a source test conducted to quantify fugitive blast furnace emissions from smelting operations. PES modified the previous AP-42 fugitive emission factors to reflect the results of this test. General process information and a description of control devices employed were received from contact 4, East Penn Manufacturing, Inc. (Reference 25). A process emission list without any primary sources (i.e., source tests) was also included in the information received from contact 4. PES was unable to use the emission data included; however, general process information was included in the section revision. Three source tests were received from contact 9, Indiana Air Pollution Control Bureau (References 30, 31, and 32); one source test was received from contact 10, Jefferson County Department of Health (Reference 29); one source test from contact 12, Master Metals (Reference 28); and one source test from contact 18, Schuylkill Metals Corporation (Reference 27). All six tests were missing process information needed for emission factor development. Therefore, PES was unable to use these sources in the emission factor revision. Information received from contact 19, Shelby County Air Pollution Control Bureau (Reference 26), consisted of a source test conducted on a blast furnace process baghouse. Information obtained from this source test is discussed later in this section and in Section 4.3 of this background report. Finally, a list of the current secondary smelters operating in the U.S. with production capacity of at least 6,000 tons/yr was received from contact 20, Bureau of Mines. References 20, 21, 22, 23, and 33 were obtained from a literature search conducted by PES pursuant to the update of AP-42 Section 12.11. References 1 through 19 were the cited references in the previous AP-42 section (October 1986). Only six references were found, and one of them was missing process information needed to develop emission factors. As a result, the emission factors obtained from the previous AP-42 document were downrated (from a "C" rating to an "E" rating) and are presented unverified and unchanged. The OAQPS emission factor rating system is discussed in Chapter 3 of this background report.

A brief discussion of the references used in revising the AP-42 section is given below.

<u>Reference 20</u>

Detailed descriptions of each process in the secondary lead processing industry were given in Reference 20, *Control of Arsenic Emissions from the Secondary Lead Smelting Industry*. PES has incorporated this information when applicable, along with the identification of the control devices used for each process, and their corresponding efficiencies when available.

<u>Reference 21</u>

Reference 21, *Minerals Yearbook*, included annual production capacity of refined lead and lead alloys from secondary lead smelters. Amount of lead recovered from scrap processed in the

U.S. by kind of scrap and form of recovery were presented. Also, total number of plants, individual production range, lead consumption levels, and U.S. lead pricing trends were discussed.

Reference 22

Reference 22, *AIRS Facility Subsystem Source Classification Codes and Emission Factors*, was used to verify emission factors for the secondary lead processing industry, and to identify process SCC codes. Two discrepancies were found for the presented emission factors. Both discrepancies corresponded to lead smelting emission factors for both the reverberatory and blast furnaces. This is discussed further in Section 3.1 of this background report, "Literature Search And Screening."

Reference 23

Reference 23, *Inspection and Operating and Maintenance Guidelines for Secondary Lead Smelters Air Pollution Control*, was used in updating the process description. Detailed process flow operations were discussed, and equipment operating parameters were presented. Process fugitive emission factors for particulate matter, lead, and sulfur dioxide were provided. The emission data presented were in close agreement to the AP-42 emission factors.

Reference 24

Reference 24, *Association of Battery Recyclers*, included comments on the previous AP-42 section and a source test conducted by Lake Engineering to develop fugitive blast furnace emissions. Test results reflected a significantly lower emission factor for lead than the lowest end of the range previously cited in the AP-42 document (October 1986). PES reviewed the process description comments and incorporated the information in the document revision when applicable. Also, the blast furnace fugitive emission factor was modified to represent the source test result obtained by Lake Engineering. This is discussed in Section 4.1 of this background report.

Reference 33

Reference 33 is a source test performed for General Motors on their lead reclaiming operations. PES received this test from a separate project which is not linked to the AP-42 document revision. Emission data from this source could not be used in the section revision, because the exhaust stack tested contained the effluent of multiple processes, and it was impossible to estimate individual process emissions.

## 2.5 REFERENCES FOR CHAPTER 2

1. William M. Coltharp, et al., Multimedia Environmental Assessment of the Secondary Nonferrous Metal Industry (Draft), Contract No. 68-02-1319, Radian Corporation, Austin, TX, June 1976.

2. H. Nack, et al., Development of an Approach to Identification of Emerging Technology and Demonstration Opportunities, EPA-650/2-74-048, U.S. Environmental Protection Agency, Cincinnati, OH, May 1974.

3. J. M. Zoller, et al., A Method of Characterization and Quantification of Fugitive Lead Emissions from Secondary Lead Smelters, Ferroalloy Plants and Gray Iron Foundries (Revised), EPA-450/3-78-003 (Revised), U.S. Environmental Protection Agency, Research Triangle Park, NC, August 1978.

4. Air Pollution Engineering Manual, Second Edition, AP-40, U.S. Environmental Protection Agency, Research Triangle Park, NC, May 1973. Out of Print.

5. Control Techniques for Lead Air Emissions, EPA-450/2-77-012, U.S. Environmental Protection Agency, Research Triangle Park, NC, January 1978.

6. Background Information for Proposed New Source Performance Standards, Volumes I and II: Secondary Lead Smelters and Refineries, APTD-1352a and b, U.S. Environmental Protection Agency, Research Triangle Park, NC, June 1973.

7. J. W. Watson and K. J. Brooks, A Review of Standards of Performance for New Stationary Source - Secondary Lead Smelters, Contract No. 68-02-2526, Mitre Corporation, McLean, VA, January 1979.

8. J. E. Williamson, et al., A Study of Five Source Tests on Emissions from Secondary Lead Smelters, County of Los Angeles Air Pollution Control District, Los Angeles, CA, February 1972.

9. Emission Test No. 72-CI-8, Office of Air Quality Planning and Standards, U.S. Environmental Protection Agency, Research Triangle Park, NC, July 1972.

10. Emission Test No. 72-CI-7, Office of Air Quality Planning and Standards, U.S. Environmental Protection Agency, Research Triangle Park, NC, August 1972.

11. A. E. Vandergrift, et al., Particulate Pollutant Systems Study, Volume I: Mass Emissions, APTD-0743, U.S. Environmental Protection Agency, Research Triangle Park, NC, May 1971.

12. Emission Test No. 71-CI-34, Office of Air Quality Planning and Standards, U.S. Environmental Protection Agency, Research Triangle Park, NC, July 1972.

13. Emission and Emission Controls at a Secondary Lead Smelter (Draft), Contract No. 68-03-2807, Radian Corporation, Durham, NC, January 1981.

14. Emission Test No. 71-CI-33, Office of Air Quality Planning and Standards, U.S. Environmental Protection Agency, Research Triangle Park, NC, August 1972.

15. Secondary Lead Plant Stack Emission Sampling at General Battery Corporation, Reading, Pennsylvania, Contract No. 68-02-0230, Battelle Institute, Columbus, OH, July 1972.

16. Technical Guidance for Control of Industrial Process Fugitive Particulate Emissions, EPA-450/3-77-010, U.S. Environmental Protection Agency, Research Triangle Park, NC, March 1977.

17. E. I. Hartt, An Evaluation of Continuous Particulate Monitors at A Secondary Lead Smelter, M. S. Report No. O. R. -16, Environment Canada, Ottawa, Canada. Date unknown.

18. J. E. Howes, et al., Evaluation of Stationary Source Particulate Measurement Methods, Volume V: Secondary Lead Smelters, Contract No. 68-02-0609, Battelle Laboratories, Columbus, OH, January 1979.

19. Silver Valley/Bunker Hill Smelter Environmental Investigation (Interim Report), Contract No. 68-02-1343, Pedco, Inc., Cincinnati, OH, February 1975.

20. Rives, G.D. and A.J. Miles, Control of Arsenic Emissions from the Secondary Lead Smelting Industry, Technical Document. Prepared under EPA contract No. 68-02-3816. Office of Air Quality Planning and Standards, U.S. Environmental Protection Agency, Research Triangle Park, NC, May 1985.

21. W.D. Woodbury, "Lead," Minerals Yearbook. United States Department of the Interior, Bureau of Mines, Washington, DC, 1989.

22. AIRS Facility Subsystem Source Classification Codes and Emission Factor Listing for Criteria Air Pollutants, EPA 450/4-90-003, U.S. Environmental Protection Agency, Research Triangle Park, NC, March 1990.

23. F. Hall, et al. Inspection and Operating and Maintenance Guidelines for Secondary Lead Smelter Air Pollution Control. Pedco-Environmental, Inc., Cincinnati, OH, 1984.

24. Quantification of Fugitive Lead Emissions from Smelter and Oxide Plant Sources for GNB Inc., preformed by Lake Engineering, Inc., Atlanta, GA, April 1992.

25. Letter from R. A. Leiby, Jr. of East Penn Manufacturing Co., Inc., to B. Richani of Pacific Environmental Services, Inc., RTP, NC, June 1992.

26. Report of Particulate/Lead/$SO_2$ Emission Tests for Refined Metals Corporation, performed by Environmental Monitoring Laboratories, Ridgeland, MS, July 1991.

27. Source Test Report for Schuylkill Metals Corporation at Cannon Hollow Facility, Forest City, MO, performed by Burnes & McDonnell Engineering Company, Kansas City, MO, November 1990.

28. Source Evaluation Results at Master Metals, Inc., prepared by Envisage Environmental, Inc., Richfield, OH, March 1991.

29. Particulate, Lead, & $SO_2$ Emission Tests Conducted on the Refinery, Blast Furnace, and Reverberatory Ventilation Systems in Leeds, AL, for Interstate Lead Company, Inc., performed by Guardian Systems, Inc., Leeds, AL, June 1987.

30. Report on Compliance Testing, Performed for RSR Corporation, Dallas, TX, Conducted at Quemetco, Inc., Indianapolis, IN, performed by Clean Air Engineering, Palatine, IL, May 1991.

31. Report of Particulate/Lead Emissions Test for Refined Metals Corporation Secondary Lead Smelter, Beech Grove, IN, performed by Environmental Monitoring Laboratories, Ridgeland, MS, June 1989.

32. Source Emission Survey of Quemetco Inc., Indianapolis, IN, performed by Metco Environmental, Addison, TX, October 1988.

33. Stack Emissions from a Baghouse Serving Scrap Lead Reclaiming Operations at Delco-Remy Division, GM Corporation, New Brunswick, New Jersey, performed by RMC Environmental Services, Inc., Spring City, PA, March 1992.

# 3.0 GENERAL EMISSION DATA REVIEW AND ANALYSIS PROCEDURES

## 3.1 LITERATURE SEARCH AND SCREENING

The first step of this investigation involved a search of available literature relating to criteria and noncriteria pollutant emissions associated with the secondary lead processing industry. This search included the following references:

*AP-42 background files* maintained by the Emission Factor and Methodologies Section. Some of the references used to develop the emission factors presented in the 1986 version were missing. Therefore, PES could not redevelop the previous emission factors, and they are presented unverified and unchanged except for the blast furnace fugitive emission factor which was developed from a recent source test received from the Association of Battery Recyclers. See Section 4.3 of this background report for a more detailed discussion.

*"Locating and Estimating" reports* published by the Emission Factor and Methodologies Section. PES obtained one report, "Locating and Estimating Air Emissions From Sources of Polycyclic Organic Matter (POM)" (EPA-450/4-84-007p). PES did not obtain any original information from this source.

*$PM_{10}$ "gap filling" documents* such as, "$PM_{10}$ Emission Factor Listing Developed by Technology Transfer" (EPA-450/4-89-022), "Gap Filling $PM_{10}$ Emission Factors for Selected Open Area Dust Sources" (EPA-450/88-003), and "Generalized Particle Size Distributions for Use in Preparing Size Specific Particulate Emission Inventories" (EPA-450/4-86-013). PES found applicable emission factors which were developed on assumptions and not source test results. The accuracy of the assumed $PM_{10}$ data is in doubt.

Information in the *Air Facility Subsystems* (AFS) of the EPA *Aerometric Information Retrieval System* (AIRS). PES compared data in the AIRS to the AP-42 Section (October 1986). Two discrepancies were found for the presented emission factors. Both discrepancies corresponded to lead smelting emission factors for the reverberatory and blast furnaces. In both cases, the AIRS emission factor was lower than the lowest end of the range cited in the previous AP-42 document. Also, it was noticed that the emissions presented in the AIRS document were for uncontrolled processes. Therefore, PES recommends that the blast and reverberatory furnaces emission factor in AIRS document be corrected to coincide with the AP-42 section, and that the AIRS be updated to represent both controlled and uncontrolled emission factors whenever possible. Also, note that the emission factors presented for $PM_{10}$ in the AIRS were obtained based on assumptions and not source test results; therefore, PES recommends modifying AIRS to reflect the changes made to the emission factors per this revision, and the $PM_{10}$ emission factors for the industry be verified.

EPA databases including *Clearinghouse for Inventories and Emission Factors* (CHIEF), the *National Air Toxics Information Clearinghouse* (NATICH), the *VOC/Particulate Matter* (PM) *Speciation Database Management System* (SPECIATE), and the *Crosswalk/Air Toxic Emission Factor Data Base Management System* (XATEF). PES did not obtain any origional information from these sources for the secondary lead processing industry.

To reduce the amount of literature collected to a final group of references pertinent to this report, the following general criteria were used:

1. Emissions data must be from a primary reference; i.e., the document must constitute the original source of test data. For example, a technical paper was not included if the original study was contained in the previous document.
2. The referenced study must contain test results based on more than one test run.
3. The report must contain sufficient data to evaluate the testing procedures and source operating conditions (e.g., one-page reports were generally rejected).

If no primary data were found and the previous update utilized secondary data, these secondary data were still used and the Emission Factor Rating lowered, if needed. A final set of reference materials was compiled after a thorough review of the pertinent reports, documents, and information according to these criteria. The final set of reference materials is given in Chapter 4 of this background report.

## 3.2 EMISSION DATA QUALITY RATING SYSTEM

As part of Pacific Environmental Services' analysis of the emission data, the quantity and quality of the information contained in the final set of reference documents were evaluated. The following data were always excluded from consideration.

1. Test series averages reported in units that cannot be converted to the selected reporting units;
2. Test series representing incompatible test methods (e.g., comparison of the EPA Method 5 front-half with the EPA Method 5 front- and back-half);

3. Test series of controlled emissions for which the control device is not specified;
4. Test series in which the source process is not clearly identified and described; and
5. Test series in which it is not clear whether the emissions were measured before or after the control device.

Data sets that were not excluded were assigned a quality rating. The rating system used was that specified by the OAQPS for the preparation of AP-42 sections. The data were rated as follows:

**A**

Multiple tests performed on the same source using sound methodology and reported in enough detail for adequate validation. These tests do not necessarily conform to the methodology specified in the EPA reference test methods, although these methods were certainly used as a guide for the methodology actually used.

**B**

Tests that were performed by a generally sound methodology but lack enough detail for adequate validation.

**C**

Tests that were based on an untested or new methodology or that lacked a significant amount of background data.

**D**

Tests that were based on a generally unacceptable method but may provide an order-of-magnitude value for the source.

The following criteria were used to evaluate source test reports for sound methodology and adequate detail:

1. Source operation. The manner in which the source was operated is well documented In the report. The source was operating within typical parameters during the test.
2. Sampling procedures. The sampling procedures conformed to a generally acceptable methodology. If actual procedures deviated from accepted methods, the deviations are well documented. When this occurred, an evaluation was made of the extent such alternative procedures could influence the test results.

3. Sampling and process data. Adequate sampling and process data are documented in the report. Many variations can occur unnoticed and without warning during testing. Such variations can induce wide deviations in sampling results. If a large spread between test results cannot be explained by information contained in the test report, the data are suspect and were given a lower rating.
4. Analysis and calculations. The test reports contain original raw data sheets. The nomenclature and equations used were compared to those (if any) specified by the EPA to establish equivalency. The depth of review of the calculations was dictated by the reviewer's confidence in the ability and conscientiousness of the tester, which in turn was based on factors such as consistency of results and completeness of other areas of the test report.

## 3.3 EMISSION FACTOR QUALITY RATING SYSTEM

The quality of the emission factors developed from analysis of the test data was rated utilizing the following general criteria:

**A (Excellent)**

Developed only from A-rated test data taken from many randomly chosen facilities in the industry population. The source category is specific enough so that variability within the source category population may be minimized.

**B (Above average)**

Developed only from A-rated test data from a reasonable number of facilities. Although no specific bias is evident, it is not clear if the facilities tested represent a random sample of the industries. As in the A-rating, the source category is specific enough so that variability within the source category population may be minimized.

**C (Average)**

Developed only from A- and B-rated test data from a reasonable number of facilities. Although no specific bias is evident, it is not clear if the facilities tested represent a random sample of the industry. As in the A-rating, the source category is specific enough so that variability within the source category population may be minimized.

**D (Below average)**

The emission factor was developed only from A- and B-rated test data from a small number of facilities, and there is reason to suspect that these facilities do not represent a random sample of the industry. There also may be evidence of variability within the source category population. Limitations on the use of the emission factor are noted in the emission factor table.

**E (Poor)**

The emission factor was developed from C- and D-rated test data, and there is reason to suspect that the facilities tested do not represent a random sample of the industry. There also may be evidence of variability within the source category population. Limitations on the use of these factors are always noted.

The use of these criteria is somewhat subjective and depends to an extent on the individual reviewer.

## 3.4 REFERENCES FOR CHAPTER 3

1. Technical Procedures for Developing AP-42 Emission Factors and Preparing AP-42 Sections. U.S. Environmental Protection Agency, Emissions Inventory Branch, Office of Air Quality Planning and Standards, Research Triangle Park, NC, 27711, April 1992. [Note: this document is currently being revised at the time of this printing.]

2. AP-42, Supplement A, Appendix C.2, "Generalized Particle Size Distributions." U.S. Environmental Protection Agency, Research Triangle Park, NC, October 1986.

3. AIRS Facility Subsystem Source Classification Codes and Emission Factor Listing for Criteria Air Pollutants, EPA 450/4-90-003, U.S. Environmental Protection Agency, Research Triangle Park, NC, March 1990.

# 4.0 POLLUTANT EMISSION FACTOR DEVELOPMENT

## 4.1 CRITERIA POLLUTANT EMISSIONS DATA

### Lead

Lead is the main pollutant tested for in the secondary lead processing industry. The industry applies various control techniques including fabric filters, cyclones, settling chambers, venturi scrubbers, and mist separators. PES obtained a total of nine source tests (References 24, and 26 through 33) for emissions from the secondary processing industry. Emission data from six source tests (References 27 through 32) could not be used because of missing process information necessary to develop emission factors. Reference 33 could not be used because the stack tested vents control emissions from multiple sources (two scrap pots, a reverberatory furnace, a drying oven, and associated conveyors), making it was impossible to determine separate process emissions. Reference 24 was conducted to determine fugitive emissions from a blast furnace smelting operation. Reported results indicated blast furnace fugitive emissions of 0.0067 kg/Mg (0.0133 lb/ton) (on a controlled basis). Assuming the plant's existing hooding is 97 percent effective in capturing fugitive emissions, yields an uncontrolled lead emission factor of 0.2 kg/Mg (0.4 lb/ton). Test results reflected a significantly lower lead emission factor than the lowest end of the range previously cited in the AP-42 document (October 1986). Normally, one source test is not sufficient to justify a change in emission factors; however, because the previous fugitive emission factors are based on an assumption and not a stack test, PES chose to use the information presented from this source in updating the blast furnace fugitive lead emission factor. This is further discussed in Section 4.3, "Review of Specific Data Sets."

Controlled blast furnace smelting process emissions were presented in Reference 26. The developed lead emission factor is lower than the current emission factor in the AP-42 section. Since the AP-42 emission factor was developed from several source tests performed on the industry, the emission data from Reference 26 are not sufficient to justify a change in the AP-42 emission factors. Emission data developed from References 24 and 26 are presented in Table 4.1-1.

The remaining data presented in Tables 2.3-1, 2.3-2, and 2.3-4 were obtained from the previous AP-42 document (October 1986). PES was not able to develop the

## TABLE 4.1-1 (METRIC UNITS)
## LEAD

| Source Test # | Test Rating | Test Method | Run # | Production Rate[a] | Emission Rate[b] | Emission Factor[c] |
|---|---|---|---|---|---|---|
| Control device: Sanitary Hooding (97 % effective) | | | | | | |
| **1**<br>24<br>Blast Furnace Fugitive | A | * | 1 | 2,721 | 0.023 | 0.0084 |
| | | | 2 | 2,721 | 0.010 | 0.0037 |
| | | | **Average** | 2,721 | 0.017 | 0.0061 |
| Control device: None | | | | | | |
| **1**<br>24<br>Blast Furnace Fugitive | A | * | 1 | 2,721 | 0.767 | 0.282 |
| | | | 2 | 2,721 | 0.333 | 0.122 |
| | | | **Average** | 2,721 | 0.550 | 0.202 |
| Control device: Baghouse | | | | | | |
| **2**<br>26<br>Blast Furnace | A | 12 | 1 | 4,637 | 0.059 | 0.013 |
| | | | 2 | 4,637 | 0.041 | 0.0090 |
| | | | 3 | 4,637 | 0.027 | 0.0058 |
| | | | **Average** | 4,637 | 0.042 | 0.0093 |

[a] Units in kg/hr
[b] Units in kg/hr
[c] Units in kg/Mg
[*] See Section 4.3

## TABLE 4.1-1 (ENGLISH UNITS)
## LEAD

| Source Test # | Test Rating | Test Method | Run # | Production Rate[a] | Emission Rate[b] | Emission Factor[c] |
|---|---|---|---|---|---|---|
| Control device: Sanitary Hooding (97 % effective) | | | | | | |
| **1**<br>24<br>Blast Furnace Fugitive | A | * | 1 | 6,000 | 0.051 | 0.017 |
| | | | 2 | 6,000 | 0.023 | 0.0080 |
| | | | **Average** | 6,000 | 0.037 | 0.013 |
| Control device: None | | | | | | |
| **1**<br>24<br>Blast Furnace Fugitive | A | * | 1 | 6,000 | 1.70 | 0.567 |
| | | | 2 | 6,000 | 0.767 | 0.256 |
| | | | **Average** | 6,000 | 1.23 | 0.411 |
| Control device: Baghouse | | | | | | |
| **2**<br>26<br>Blast Furnace | A | 12 | 1 | 10,225 | 0.13 | 0.025 |
| | | | 2 | 10,225 | 0.090 | 0.018 |
| | | | 3 | 10,225 | 0.060 | 0.012 |
| | | | **Average** | 10,225 | 0.090 | 0.018 |

[a] Units in lb/hr
[b] Units in lb/hr
[c] Units in lb/ton
[*] See Section 4.3

presented emission factors in these tables because some of the references could not be obtained, and some were missing necessary information for emission factor development such as production data (Reference 13). Only References 8, 9, 10, 13, and 15 were obtained from the previous AP-42 section.

### Sulfur dioxide.

Not enough information was received from the sources that PES contacted to justify a change in the sulfur dioxide emission factors for this industry. Necessary information needed to develop $SO_2$ process emission factors were included in Reference 26 only. Reference 26 corresponded to the controlled blast furnace smelting operation, and the developed $SO_2$ emission factors are presented in Table 4.1-2.

As discussed earlier in the lead emission section, the current AP-42 $SO_2$ emission factors could not be verified because of missing references. Note that the emission factors presented in the AP-42 section correspond to uncontrolled processes. Currently, all of the secondary lead facilities are required to meet stringent $SO_2$ levels set by the U.S. Environmental Protection Agency. Therefore, it is expected that all secondary lead facilities employ control devices to limit $SO_2$ emissions, and that the $SO_2$ emission factors presented in the AP-42 section are not representative of the current industry emission levels.

### Particulate Matter

Particulate emission factors were developed from Reference 26 only. The blast furnace controlled particulate emission factor was determined to be lower than the current emission factor in the AP-42 section. As discussed earlier in the lead section, emission data from one source test is not sufficient to justify a change in the AP-42 emission data. The data obtained from Reference 26 are presented in Table 4.1-3.

Again, the current AP-42 emission factors for the secondary lead processing industry were obtained from the previous AP-42 section (October 1986), and are presented unverified and unchanged for reasons discussed earlier in this chapter.

## TABLE 4.1-2 (METRIC UNITS)
## SULFUR DIOXIDE

| Source Test # | Test Rating | Test Method | Run # | Production Rate[a] | Emission Rate[b] | Emission Factor[c] |
|---|---|---|---|---|---|---|
| Control device: Baghouse | | | | | | |
| **1**<br>26<br>Blast<br>Furnace | A | 6 | 1 | 4,637 | 91.16 | 19.66 |
| | | | 2 | 4,637 | 73.47 | 15.84 |
| | | | 3 | 4,637 | 86.17 | 18.58 |
| | | | **Average** | 4,637 | 83.60 | 18.03 |

[a] Units in kg/hr.
[b] Units in kg/hr.
[c] Units in kg/Mg.

## TABLE 4.1-2 (ENGLISH UNITS)
## SULFUR DIOXIDE

| Source Test # | Test Rating | Test Method | Run # | Production Rate[a] | Emission Rate[b] | Emission Factor[c] |
|---|---|---|---|---|---|---|
| Control device: Baghouse | | | | | | |
| **1**<br>26<br>Blast<br>Furnace | A | 6 | 1 | 10,225 | 201 | 39.32 |
| | | | 2 | 10,225 | 162 | 31.69 |
| | | | 3 | 10,225 | 190 | 37.16 |
| | | | **Average** | 10,225 | 184 | 36.06 |

[a] Units in lb/hr.
[b] Units in lb/hr.
[c] Units in lb/ton.

## TABLE 4.1-3 (METRIC UNITS)
## TOTAL SUSPENDED PARTICULATE

| Source Test # | Test Rating | Test Method | Run # | Production Rate[a] | Emission Rate[b] | Emission Factor[c] |
|---|---|---|---|---|---|---|
| Control device: Baghouse | | | | | | |
| **1**<br>26<br>Blast<br>Furnace | A | 5 | 1 | 4,637 | 0.38 | 0.082 |
| | | | 2 | 4,637 | 0.11 | 0.024 |
| | | | 3 | 4,637 | 0.19 | 0.041 |
| | | | **Average** | 4,637 | 0.23 | 0.049 |

[a] Units in kg/hr.
[b] Units in kg/hr.
[c] Units in kg/Mg

## TABLE 4.1-3 (ENGLISH UNITS)
## TOTAL SUSPENDED PARTICULATE

| Source Test # | Test Rating | Test Method | Run # | Production Rate[c] | Emission Rate[b] | Emission Factor[c] |
|---|---|---|---|---|---|---|
| Control device: Baghouse | | | | | | |
| **1**<br>26<br>Blast<br>Furnace | A | 5 | 1 | 10,225 | 0.83 | 0.16 |
| | | | 2 | 10,225 | 0.25 | 0.049 |
| | | | 3 | 10,225 | 0.43 | 0.084 |
| | | | **Average** | 10,225 | 0.50 | 0.098 |

[a] Units in lb/hr.
[b] Units in lb/hr.
[c] Units in lb/ton.

Other Criteria Pollutants

No data on emissions of nitrogen oxides, carbon monoxide, or non-methane organic compounds, all of which are criteria pollutants, were found for the secondary lead processing industry.

## 4.2 NONCRITERIA POLLUTANT EMISSION DATA

Hazardous Air Pollutants.

Hazardous Air Pollutants (HAPs) are defined in the 1990 Clean Air Act Amendments. Lead compounds are identified as HAPs. Lead emissions were previously discussed in Section 4.1.

Chlorofluorocarbons have been found to contribute to stratospheric ozone depletion. No data on emissions of these pollutants were found for the secondary lead processing industry.

Global Warming Gases.

Pollutants such as methane ($CH_4$), carbon dioxide ($CO_2$), and nitrous oxide ($N_2O$) have been found to contribute to overall global warming. Carbon dioxide emissions were documented in Reference 26 for the blast furnace outlet. The reaction of blast air (sometimes oxygen-enriched) with coke in the charge produces $CO_2$, and the reaction of carbon and carbon monoxide with lead sulfates, oxides, and carbonates in the furnace tuyeres forms $CO_2$.

For source testing purposes, the concentration of $CO_2$ in the stack gas being tested is measured in order to approximate the molecular weight of the stack gas. The $CO_2$ concentration measurement is performed in such a way that its level of accuracy is less than that of the primary pollutants of interest. It is for this reason that the concentration for $CO_2$ is usually undocumented as shown in this industry. The emission rate of a gas such as carbon dioxide can readily be calculated, given the volumetric rate of the stack gas at standard conditions and the concentration of carbon dioxide in the stack gas, and using ideal gas laws. The carbon dioxide emission data obtained from Reference 26 are summarized in Table 4.2-1.

## TABLE 4.2-1 (METRIC UNITS)
## GLOBAL WARMING GASES

| Source Test # | Test Rating | Test Method | Run # | $CO_2$ Concentration[a] | Volumetric Flow Rate[b] | Process Rate[c] | Emission Factor[d] |
|---|---|---|---|---|---|---|---|
| Control device: Baghouse | | | | | | | |
| **26** | A | 12 | 1 | 0.5 | 1,690 | 4,637 | 214 |
| | | | 2 | 0.5 | 1,702 | 4,637 | 216 |
| | | | 3 | 0.5 | 1,601 | 4,637 | 203 |
| | | | **Average** | 0.5 | 1,664 | 4,637 | 211 |

[a] Concentration in percent.
[b] Units in dry standard cubic meters per minute.
[c] Units in kg/hr.
[d] Units in kg/Mg.

## TABLE 4.2-1 (ENGLISH UNITS)
## GLOBAL WARMING GASES

| Source Test # | Test Rating | Test Method | Run # | $CO_2$ Concentration[a] | Volumetric Flow Rate[b] | Process Rate[c] | Emission Factor[d] |
|---|---|---|---|---|---|---|---|
| Control device: None | | | | | | | |
| **26** | A | 12 | 1 | 0.5 | 59,701 | 10,225 | 429 |
| | | | 2 | 0.5 | 60,105 | 10,225 | 432 |
| | | | 3 | 0.5 | 56,566 | 10,225 | 407 |
| | | | **Average** | 0.5 | 58,791 | 10,225 | 423 |

[a] Concentration in percent.
[b] Units in dry standard cubic feet per minute.
[c] Units in lb/hr.
[d] Units in lb/ton.

## 4.3 REVIEW OF SPECIFIC DATA SETS

A total of nine source tests were received for the secondary lead processing industry. Only two of these sources contained all necessary information for developing emission factors. These sources are References 24 and 26, which correspond to blast furnace fugitive and process emissions, respectively. The data obtained from Reference 24 were used in updating the AP-42 emission factors, while the results of Reference 26 were insufficient to justify a change in the AP-42 emission factors. This was discussed earlier in Section 4.1. Therefore, the current AP-42 emission factors were obtained from the previous AP-42 document (October 1986) except for the fugitive blast furnace lead emissions.

PES could not verify the current AP-42 emission factors, because of missing sources used in developing these emission factors. Only References 8, 9, 10, 13, and 15 were obtained. Validation of these references showed that Reference 13 has several deficiencies which would make it unacceptable for emission factor development. These deficiencies are discussed below. No other deficiencies were found in any of the reviewed sources.

The following section provides a more detailed discussion of the source tests used in developing and verifying the current AP-42 emission factors.

### Reference 13: A Domestic Lead Smelter, January, 1981

Reference 13 is a source test report that presents results of an interagency control technology demonstration and research study conducted at a domestic secondary lead smelter. In the previous AP-42 document (October 1986) several emission factors were referenced to Reference 13. Test results included lead emission rates, and did not document any production information. Therefore, emission factors from this reference could not be developed. This report contained other deficiencies: the test report stated that Method 12 and modified Method 12 were the sampling procedures utilized without presenting any documentation or explanation of these methods; no documentation of sampling Methods 1 through 4 were found; and the test stated that all the runs were sampled isokinetically, but did not include any data to verify this. Emission factors obtained from this reference were downgraded to "E".

Reference 24: GNB, Inc., Columbus, GA, April 1992

This test was conducted by Lake Engineering, Inc. to quantify the blast furnace fugitive emissions. The area tested included two conventional blast furnaces, and the plant existing sanitary hooding was assumed to be 97 percent effective in capturing fugitive emissions. The lead fugitive emission factor (controlled) was determined to be 0.0133 lb/ton, which yields an uncontrolled emission factor of 0.4 lb/ton. This is significantly lower than the lowest end of the range previously cited in the AP-42 document. The lead emission factor was developed according to the following concept:

Lead Emission Factor = Indoor Air Concentration of lead x Exhaust Air Flow Rate,

where the air velocity was measured using a hand-held velometer. The concept and procedures were approved by the Georgia Environmental Protection Division, and the test included a detailed description of the suggested method and included all necessary data needed to quantify emission factors. The test is rated "A"; however, since this is the only source test available for this emission source, the developed emission factor is rated "D".

Reference 26: Refined Metals Corporation, Memphis, TN, July 1991

This test was conducted to quantify particulate, lead, and sulfur dioxide emissions from a blast furnace baghouse. The baghouse was tested twice, once under normal operation and another during an accelerated mode. For the purpose of this report, only the normal mode data were used. The test was conducted using EPA Methods 1 through 4. Sulfur dioxide concentrations were determined according to Method 6, while particulate and lead emissions were determined according to Methods 5 and 12, respectively. Carbon dioxide ($CO_2$) concentrations in the flue gases, calibration, and field data were documented. The test was performed by Environmental Monitoring Laboratories, and the emission factors developed from this reference are rated "A".

## 4.4 DATA GAP ANALYSIS

The secondary lead processing industry consists of several processes. PES received only two source tests that contained sufficient information for emission factor development. Data from these source tests reflected considerably lower emission factors than those previously documented in the AP-42 section, especially for fugitive emissions. Recall that the current fugitive emissions were determined based on the assumption that 5 percent of process uncontrolled emissions exists as fugitive emissions. Also, note that new regulations are currently in effect for $SO_2$ emissions; therefore, PES suspects that the current emission factors presented in the AP-42 section are not an accurate representation of the industry emissions. In conclusion, more source tests for all processes and better estimation for fugitive emissions (or source tests as in Reference 24) are needed for the secondary lead processing industry.

## 4.5 REFERENCES FOR CHAPTER 4

1. William M. Coltharp, et al., Multimedia Environmental Assessment of the Secondary Nonferrous Metal Industry (Draft), Contract No. 68-02-1319, Radian Corporation, Austin, TX, June 1976.

2. H. Nack, et al., Development of an Approach to Identification of Emerging Technology and Demonstration Opportunities, EPA-650/2-74-048, U.S. Environmental Protection Agency, Cincinnati, OH, May 1974.

3. J. M. Zoller, et al., A Method of Characterization and Quantification of Fugitive Lead Emissions from Secondary Lead Smelters, Ferroalloy Plants and Gray Iron Foundries (Revised), EPA-450/3-78-003 (Revised), U.S. Environmental Protection Agency, Research Triangle Park, NC, August 1978.

4. Air Pollution Engineering Manual, Second Edition, AP-40, U.S. Environmental Protection Agency, Research Triangle Park, NC, May 1973. Out of Print.

5. Control Techniques for Lead Air Emissions, EPA-450/2-77-012, U.S. Environmental Protection Agency, Research Triangle Park, NC, January 1978.

6. Background Information for Proposed New Source Performance Standards, Volumes I and II: Secondary Lead Smelters and Refineries, APTD-1352a and b, U.S. Environmental Protection Agency, Research Triangle Park, NC, June 1973.

7. J. W. Watson and K. J. Brooks, A Review of Standards of Performance for New Stationary Source - Secondary Lead Smelters, Contract No. 68-02-2526, Mitre Corporation, McLean, VA, January 1979.

8. J. E. Williamson, et al., A Study of Five Source Tests on Emissions from Secondary Lead Smelters, County of Los Angeles Air Pollution Control District, Los Angeles, CA, February 1972.

9. Emission Test No. 72-CI-8, Office of Air Quality Planning and Standards, U.S. Environmental Protection Agency, Research Triangle Park, NC, July 1972.

10. Emission Test No. 72-CI-7, Office of Air Quality Planning and Standards, U.S. Environmental Protection Agency, Research Triangle Park, NC, August 1972.

11. A. E. Vandergrift, et al., Particulate Pollutant Systems Study, Volume I: Mass Emissions, APTD-0743, U.S. Environmental Protection Agency, Research Triangle Park, NC, May 1971.

12. Emission Test No. 71-CI-34, Office of Air Quality Planning and Standards, U.S. Environmental Protection Agency, Research Triangle Park, NC, July 1972.

13. Emission and Emission Controls at a Secondary Lead Smelter (Draft), Contract No. 68-03-2807, Radian Corporation, Durham, NC, January 1981.

14. Emission Test No. 71-CI-33, Office of Air Quality Planning and Standards, U.S. Environmental Protection Agency, Research Triangle Park, NC, August 1972.

15. Secondary Lead Plant Stack Emission Sampling at General Battery Corporation, Reading, Pennsylvania, Contract No. 68-02-0230, Battelle Institute, Columbus, OH, July 1972.

16. Technical Guidance for Control of Industrial Process Fugitive Particulate Emissions, EPA-450/3-77-010, U.S. Environmental Protection Agency, Research Triangle Park, NC, March 1977.

17. E. I. Hartt, An Evaluation of Continuous Particulate Monitors at A Secondary Lead Smelter, M. S. Report No. O. R. -16, Environment Canada, Ottawa, Canada. Date unknown.

18. J. E. Howes, et al., Evaluation of Stationary Source Particulate Measurement Methods, Volume V: Secondary Lead Smelters, Contract No. 68-02-0609, Battelle Laboratories, Columbus, OH, January 1979.

19. Silver Valley/Bunker Hill Smelter Environmental Investigation (Interim Report), Contract No. 68-02-1343, Pedco, Inc., Cincinnati, OH, February 1975.

20. Rives, G.D. and A.J. Miles, Control of Arsenic Emissions from the Secondary Lead Smelting Industry, Technical Document. Prepared under EPA contract No. 68-02-3816. Office of Air Quality Planning and Standards, U.S. Environmental Protection Agency, Research Triangle Park, NC, May 1985.

21. W.D. Woodbury, "Lead," Minerals Yearbook. United States Department of the Interior, Bureau of Mines, Washington, DC, 1989.

22. AIRS Facility Subsystem Source Classification Codes and Emission Factor Listing for Criteria Air Pollutants, EPA 450/4-90-003, U.S. Environmental Protection Agency, Research Triangle Park, NC, March 1990.

23. F. Hall, et al. Inspection and Operating and Maintenance Guidelines for Secondary Lead Smelter Air Pollution Control. Pedco-Environmental, Inc., Cincinnati, OH, 1984.

24. Quantification of Fugitive Lead Emissions from Smelter and Oxide Plant Sources for GNB Inc., preformed by Lake Engineering, Inc., Atlanta, GA, April 1992.

25. Letter from R. A. Leiby, Jr. of East Penn Manufacturing Co., Inc., to B. Richani of Pacific Environmental Services, Inc., RTP, NC, June 1992.

26. Report of Particulate/Lead/$SO_2$ Emission Tests for Refined Metals Corporation, performed by Environmental Monitoring Laboratories, Ridgeland, MS, July 1991.

27. Source Test Report for Schuylkill Metals Corporation at Cannon Hollow Facility, Forest City, MO, performed by Burnes & McDonnell Engineering Company, Kansas City, MO, November 1990.

28. Source Evaluation Results at Master Metals, Inc., prepared by Envisage Environmental, Inc., Richfield, OH, March 1991.

29. Particulate, Lead, & $SO_2$ Emission Tests Conducted on the Refinery, Blast Furnace, and Reverberatory Ventilation Systems in Leeds, AL, for Interstate Lead Company, Inc., performed by Guardian Systems, Inc., Leeds, AL, June 1987.

30. Report on Compliance Testing, Performed for RSR Corporation, Dallas, TX, Conducted at Quemetco, Inc., Indianapolis, IN, performed by Clean Air Engineering, Palatine, IL, May 1991.

31. Report of Particulate/Lead Emissions Test for Refined Metals Corporation Secondary Lead Smelter, Beech Grove, IN, performed by Environmental Monitoring Laboratories, Ridgeland, MS, June 1989.

32. Source Emission Survey of Quemetco Inc., Indianapolis, IN, performed by Metco Environmental, Addison, TX, October 1988.

33. Stack Emissions from a Baghouse Serving Scrap Lead Reclaiming Operations at Delco-Remy Division, GM Corporation, New Brunswick, New Jersey, performed by RMC Environmental Services, Inc., Spring City, PA, March 1992.

## TABLE 4.5-1

## LIST OF CONVERSION FACTORS

| Multiply: | by: | To obtain: |
|---|---|---|
| mg/dscm | $4.37 \times 10^{-4}$ | gr/dscf |
| $m^2$ | 10.764 | $ft^2$ |
| $m^3$ | 35.31 | $ft^3$ |
| m | 3.281 | ft |
| kg | 2.205 | lb |
| kPa | $1.45 \times 10^{-1}$ | psia |
| kg/Mg | 2.0 | lb/ton |
| Mg | 1.1023 | ton |

**Temperature conversion equations:**

Fahrenheit to Celsius:

$$°C = \frac{(°F - 32)}{1.8}$$

Celsius to Fahrenheit:

$$°F = 1.8(°C) + 32$$