BACKGROUND REPORT

AP-42 SECTION 12.17

MISCELLANEOUS LEAD PRODUCTS

Prepared for

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

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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 (the 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 information from process information obtained from industry comment and two test reports to support revision of emission factors for miscellaneous lead.

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

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 a data gap analysis.

2.0 INDUSTRY DESCRIPTION

2.1 GENERAL[8]

In 1989 the following categories (in decreasing order of lead usage) were significant in the miscellaneous lead products group: ammunition, cable covering, solder, and type metal. However, in 1992, U.S. can manufacturers and the electronics industry discontinued the use of lead solder, replacing it with tin solder. Therefore, solder will not be included as a miscellaneous lead product in this section. Lead used in ammunition (bullets and shot) and for shot used at nuclear facilities in 1989 was 62,940 megagrams (69,470 tons)[8]. The use of lead sheet in construction and lead cable sheathing in communications also increased to a combined total of 43,592 megagrams (48,115 tons)[8].

2.2 PROCESS DESCRIPTION

Ammunition and Metallic Lead Products

Lead is consumed in the manufacture of ammunition, bearing metals, and other lead products, with subsequent lead emissions. Lead used in the manufacture of ammunition is melted and alloyed before it is cast, sheared, extruded, swaged, or mechanically worked. Some lead is also reacted to form lead azide, a detonating agent. Lead is used to a lesser extent in bearing manufacture by alloying it with copper, bronze, antimony, and tin.

Other lead products include terne metal (a plating alloy), weights and ballasts, caulking lead, plumbing supplies, roofing materials, casting metal foil, collapsible metal tubes, and sheet lead. Lead is also used for galvanizing, annealing, and plating. In all of these cases lead is usually melted and cast prior to mechanical forming operations.

Cable Covering[9]

About 90 percent of the lead cable covering produced in the United States is lead-cured jacketed cables, the remaining 10 percent being lead sheathed cables. In preparation of the former type an unalloyed lead cover applied in the vulcanizing treatment during the manufacture of rubber-insulated cable must be stripped from the cable and remelted.

Lead coverings are applied to insulated cable by hydraulic extrusion of solid lead around the cable. Extrusion rates of typical presses average 3,000 to 15,000 lb/hr[9]. The molten lead is

continuously fed into the extruder or screw press, where it solidifies as it progresses. A melting kettle supplies lead to the press.

Type Metal Production

Lead type, used primarily in the letterpress segment of the printing industry, is cast from a molten lead alloy and remelted after use. Linotype and monotype processes produce a mold, while the stereotype process produces a plate for printing. All type is an alloy consisting of 60 to 85 percent recovered lead, with antimony, tin, and a small amount of virgin metal.

2.3 EMISSIONS AND CONTROLS

Emission factors for miscellaneous lead products are presented in Table 2.3-1. Emissions and controls for ammunition and metallic lead products, cable covering, and type metal production are discussed below.

Ammunition and Metallic Lead Products[6,3]

Little or no air pollution control equipment is currently used by manufacturers of metallic lead products. Emissions from bearing manufacture are negligible, even without controls.

Cable Covering[4,3,5]

The melting kettle is the only source of atmospheric lead emissions and is generally uncontrolled. Average particle size is approximately 5 microns, with a lead content of about 70 to 80 percent.

Cable covering processes do not usually include particulate collection devices. However, fabric filters, rotoclone wet collectors, and dry cyclone collectors can reduce lead emissions at control efficiencies of 99.9 percent, 75 to 85 percent, and greater than 45 percent, respectively. Lowering and controlling the melt temperature, enclosing the melting unit and using fluxes to provide a cover on the melt can also minimize emissions.

TABLE 2.3-1 (METRIC UNITS)
EMISSION FACTORS FOR MISCELLANEOUS SOURCES
All Emission Factors are in kg/Mg of Lead Processed
Ratings (A-E) Follow Each Factor

Process	Particulate		Lead		Reference
Metallic Lead Products					
Ammunition (SCC# 304-041-01)			≤ to 0.5	E	3,7
Bearing Metals (SCC# 304-042-01)			negligible		3,7
Other Sources of Lead (SCC# 304-042-02)			0.8	E	3,7
Cable Covering (SCC# 304-040-01)	0.3[a]	E	0.25	E	3,5,7
Type Metal Production (SCC# 360-001-01)	0.4[b]	E	0.13	E	2,7

[a] Reference 7, p. 4-301.
[b] Calculated on the basis of 35% of the total (Reference 1).

TABLE 2.3-1 (ENGLISH UNITS)
EMISSION FACTORS FOR MISCELLANEOUS SOURCES
All Emission Factors are in lb/ton of Lead Processed
Ratings (A-E) Follow Each Factor

Process	Particulate		Lead		Reference
Metallic Lead Products					
Ammunition (SCC# 304-041-01)			≤ to 1.0	E	3,7
Bearing Metals (SCC# 304-042-01)			negligible		3,7
Other Sources of Lead (SCC# 304-042-02)			1.5	E	3,7
Cable Covering (SCC# 304-040-01)	0.6[a]	E	0.5	E	3,5,7
Type Metal Production (SCC# 360-001-01)	0.7[b]	E	0.25	E	2,7

[a] Reference 7, p. 4-301.
[b] Calculated on the basis of 35% of the total (Reference 1).

Type Metal Production[1,2]

The melting pot is again the major source of emissions, containing hydrocarbons as well as lead particulate. Pouring the molten metal into the molds involves surface oxidation of the metal, possibly producing oxidized fumes, while the trimming and finishing operations emit lead particles. It is estimated that 35 percent of the total emitted particulate is lead.

Approximately half of the current lead type operations control lead emissions, by approximately 80 percent. The other operations are uncontrolled. The most frequently controlled sources are the main melting pots and drossing areas. Linotype equipment does not require controls when operated properly. Devices in current use on monotype and stereotype lines include rotoclones, wet scrubbers, fabric filters, and electrostatic precipitators, all of which can be used in various combinations.

Additionally, the VOC/PM Speciation Database has identified phosphorus, chlorine, chromium, manganese, cobalt, nickel, arsenic, selenium, cadmium, antimony, mercury, and lead as occurring in emissions from type metal production and lead cable coating operations. All of these metals/chemicals are listed in CAA Title III as being hazardous air pollutants (HAPs) and should be the subject of air emissions testing by industry sources.

2.4 REVIEW OF SPECIFIC DATA SETS

Pacific Environmental Services (PES) contacted the following sources to obtain the most up-to-date information on process descriptions and emissions for this industry:

1) Alpha Metals, Jersey City, NJ
2) American National Can Co., Chicago, IL
3) Brockway Standard Inc., Atlanta, GA
4) Can Manufacturers Institute, Washington, DC
5) Federated Fry Metals, Altoona, PA
6) Institute for Interconnecting & Packaging Electrical Circuits, Chicago, IL 7) Illinois EPA, Springfield, IL
8) Lead Industries Association (LIA), New York, NY
9) National Electric Manufacturer's, Washington, DC

Responses were received from Sources 1, 2, 4, and 8. No responses were received from the remaining sources. Source #1 indicated in a telephone conversation that they test for lead emissions at their Jersey City plant and would have a plant engineer contact PES with additional information. However, PES has not received any information to date. Source #2 sent a letter stating that they no longer use lead solder. This letter is discussed as Reference 10 below. Source #4 sent a letter indicating that it would not be necessary to include can manufacturing in Section 12.17 because can manufacturers have completely eliminated the use of lead solder from all domestic food can production. This letter is discussed as Reference 11 below. Source #8 indicated in a telephone conversation that they have member companies in various lead-use industries and that they would distribute a request for information to those members. However, PES has not received that information to date.

References 1 through 7 were cited in the previous version of Section 12.17 (July 1979) and were also used in this revision. References 8 through 11 are new references and are discussed below.

Reference 8. Minerals Yearbook, Volume 1. Metals and Minerals, U.S. Department of the Interior, Bureau of Mines. 1989.

This reference provided statistical information about miscellaneous lead products in the general section.

Reference 9. Air Pollution Emission Test, General Electric Company, Wire and Cable Department. Report No. 73-CCC-1.

This reference provided a process description and emissions information for cable covering operations.

Reference 10. Personal communication with R.M. Rivetna, Director, Environmental Engineering, American National Can Co., April 1992.

This reference provided support for the removal of the can soldering discussion and emission factors from Section 12.7.

Reference 11. Personal communication with R. R. Budway, General Counsel, Can Manufacturers Institute, May 1992.

This reference provided support for the removal of the can soldering discussion and emission factors from Section 12.7.

2.5 REFERENCES FOR CHAPTER 2

1. N.J. Kulujian. Inspection Manual for the Enforcement of New Source Performance Standards: Portland Cement Plants, EPA Contract No. 68-02-1355, PEDCo-Environmental Specialists, Inc., Cincinnati, OH. January 1975.

2. Atmospheric Emissions from Lead Typesetting Operation Screening Study, EPA Contract No. 68-02-2085. PEDCo-Environmental Specialists, Inc., Cincinnati, OH. January 1976.

3. W.E. Davis, Emissions Study of Industrial Sources of Lead Air Pollutants, 1970, EPA Contract No. 68-02-0271. W. E. Davis Associates. Leawood, KS. April 1973.

4. R.P. Betz, et al., Economics of Lead Removal in Selected Industries, EPA Contract No. 68-02-0611. Battelle Columbus Laboratories. Columbus, OH. August 1973.

5. E.P. Shea. Emissions from Cable Covering Facility, EPA Contract No. 68-02-0228. Midwest Research Institute. Kansas City, Mo. June 1973.

6. Mineral Industry Surveys: Lead Industry in May 1976, Bureau of Mines, U.S. Department of the Interior, Washington, DC. August 1976.

7. Control Techniques for Lead Air Emissions, EPA-450/2-77-012A. U.S. Environmental Protection Agency, Research Triangle Park, NC. December 1977.

8. Minerals Yearbook, Volume 1. Metals and Minerals, U.S. Department of the Interior, Bureau of Mines. 1989.

9. Air Pollution Emission Test, General Electric Company, Wire and Cable Department. Report No. 73-CCC-1.

10. Personal communication with R.M. Rivetna, Director, Environmental Engineering, American National Can Co., April 1992.

11. Personal communication with R. R. Budway, General Counsel, Can Manufacturers Institute, May 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 miscellaneous lead. This search involved the following references:

AP-42 background files maintained by the Emission Factor and Methodologies Section. PES attempted to obtain the EPA Background File for Section 12.7. Unfortunately, this file was unavailable at the time of this revision. Thus, none of the references cited in the previous version of 12.17 were available and no verification of the emission factors could be performed.

The EPA databases, including but not limited to the VOC/Particulate Matter (PM) Speciation Database Management System (SPECIATE), the Crosswalk/Air Toxic Emission Factor Data Base Management System (XATEF), and the Emission Measurement Technical Information Center's Test Methods Storage and Retrieval System (TSAR). The VOC/PM Speciation Database (SPECIATE) identified phosphorus, chlorine, chromium, manganese, cobalt, nickel, arsenic, selenium, cadmium, antimony, mercury, and lead as occurring in emissions from type metal production and lead cable coating operations. All of these metals/chemicals are listed in CAA Title III as being hazardous air pollutants (HAPs). Lead is discussed in Section 4.1 Criteria Pollutant Emission Data. No quantitative data for the remaining HAPs were found from which to develop emission factors.

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 was found and the previous update utilized secondary data, this secondary data was 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 4.0.

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 (i.e., 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 either the inhalable particulate (IP) protocol documents or the EPA reference test methods, although these documents and 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, October, 1986.

4.0 POLLUTANT EMISSION FACTOR DEVELOPMENT

4.1 CRITERIA POLLUTANT EMISSIONS DATA

No data on emissions of volatile organic compounds (VOCs), nitrogen oxides, sulfur dioxide nor carbon monoxide were found for the manufacture of miscellaneous lead products. Emission data for the remaining criteria pollutants, lead and particulate matter, are discussed below.

Lead.

The lead emission factors in this revision were obtained from the previous version of Section 12.17 (July 1979.) The references cited in the emission factor Table 2.3-1 were not available for this revision; therefore, a verification of the factors could not be performed. Due to the unavailability of the references, coupled with the fact that these references are almost 20 years old, PES has downgraded all of the emission factors from "C" to "E" for this revision. As discussed in Section 2.4, PES received documentation that can manufacturers no longer use lead solder in can manufacturing. Therefore, the can manufacturing industry was deleted from the miscellaneous lead products section of AP-42.

Three metallic lead products have been assigned SCC codes in this revision, they are as follows;

Ammunition - SCC# 3-04-041-01 in units lb/ton of lead processed

Bearing metals - SCC# 3-04-042-01 in units lb/ton of lead processed

Other sources of lead - SCC# 3-04-042-02 in units lb/ton of lead processed.

Particulate Matter .

The particulate emission factors in this revision were obtained from the previous revision of Section 12.17 (July 1979.) The references cited in the emission factor Table 2.3-1 were not available for this revision, therefore, a verification of the factors could not be performed. Due to the unavailability of the references, coupled with the fact that these references are almost 20 years old, PES has downgraded all of the emission factors from "C" to "E" for this revision. As discussed in Section 2.4, PES received documentation that can manufacturers no longer use lead solder in can manufacturing. Therefore, the can manufacturing industry was deleted from the miscellaneous lead products section of AP-42.

4.2 NONCRITERIA POLLUTANT EMISSION DATA

Hazardous Air Pollutants.

Hazardous Air Pollutants (HAPs) are defined in the 1990 Clean Air Act (CAA) Amendments. The VOC/PM Speciation Database (SPECIATE) identifies phosphorus, chlorine, chromium, manganese, cobalt, nickel, arsenic, selenium, cadmium, antimony, mercury, and lead as occurring in emissions from type metal production and lead cable coating operations. All of these metals/chemicals are listed in CAA Title III as being HAPs. Lead is discussed in Section 4.1 Criteria Pollutant Emission Data. No quantitative data for the remaining HAPs were found from which to develop emission factors.

Global Warming Gases.

Pollutants such as methane, carbon dioxide, and N_2O have been found to contribute to overall global warming. No data on emissions of these pollutants were found for miscellaneous lead manufacturing processes.

Ozone Depletion Gases.

Chlorofluorocarbons have been found to contribute to ozone depletion. No data on emissions of these pollutants were found for the miscellaneous lead manufacture processes.

4.3 REVIEW OF SPECIFIC DATA SETS

The emission factors in this revision were obtained from the previous version of Section 12.17 (July 1979.) The references cited in the emission factor Table 2.3-1 were not available for this revision, precluding a review of specific data sets. As discussed in Section 2.4, PES received documentation that can manufacturers no longer use lead solder in can manufacturing. Therefore, the can manufacturing industry was deleted from the miscellaneous lead products section of AP-42.

4.4 DATA GAP ANALYSIS

The emission factors in this revision were obtained from the previous version of Section 12.17 (July 1979.) The references cited in the emission factor Table 2.3-1 were not available for this revision, precluding a verification of the emission factors. Due to the unavailability of the references, coupled with the fact that these references are almost 20 years old, PES has downgraded all of the emission factors from "C" to "E" for this revision.

Because of the age of the available data and the low ratings of the current emission factors, PES suggests obtaining more recent source test reports from the industries comprising the miscellaneous lead category of AP-42. Like can manufacturers, other industries are most likely reducing or eliminating the use of lead in the manufacturing of miscellaneous lead products. Current source tests will provide a more accurate assessment of lead use in the manufacturing of miscellaneous lead products.

TABLE 4.4-1
LIST OF CONVERSION FACTORS

Multiply:	**by:**	**To obtain:**
mg/dscm	4.37×10^{-4}	gr/dscf
m^2	10.764	ft^2
acm/min	35.31	acfm
M^3	3.281	ft^3
kg	2.205	lb
kPa	1.45×10^{-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:

$$°F = 1.8(°C) + 32$$

4.5 REFERENCES FOR CHAPTER 4

1. N.J. Kulujian. Inspection Manual for the Enforcement of New Source Performance Standards: Portland Cement Plants, EPA Contract No. 68-02-1355, PEDCo-Environmental Specialists, Inc., Cincinnati, OH. January 1975.

2. Atmospheric Emissions from Lead Typesetting Operation Screening Study, EPA Contract No. 68-02-2085. PEDCo-Environmental Specialists, Inc., Cincinnati, OH. January 1976.

3. W.E. Davis, Emissions Study of Industrial Sources of Lead Air Pollutants, 1970, EPA Contract No. 68-02-0271. W. E. Davis Associates. Leawood, KS. April 1973.

4. E.P. Shea. Emissions from Cable Covering Facility, EPA Contract No. 68-02-0228. Midwest Research Institute. Kansas City, Mo. June 1973.

5. Control Techniques for Lead Air Emissions, EPA-450/2-77-012A. U.S. Environmental Protection Agency, Research Triangle Park, NC. December 1977.

6. Compliance Stack Testing Report for Lead Emissions from the Kester Solder Plant, Brantford, Ontario, performed by The Environmental Applications Group, Ltd., July, 1991.

7. Stack Test Report for Electrum Recovery Works, Rahway, NJ, performed by Trace Technologies, Inc., September 1990.