BACKGROUND REPORT

AP-42 SECTION 12.12

SECONDARY MAGNESIUM SMELTING

Prepared for

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

1-103

Pacific Environmental Services, Inc.
P.O. Box 12077
Research Triangle Park, NC 27709

919/941-0333

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
This report has been reviewed by the Technical Support Division of the Office of Air Quality Planning and Standards, EPA. Mention of trade names or commercial products is not intended to constitute endorsement or recommendation for use. Copies of this report are available through the Library Services Office (MD-35), U.S. Environmental Protection Agency, Research Triangle Park, NC 27711.

TABLE OF CONTENTS

LIST OF TABLES

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 EPA to respond to new emission factor needs of 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 a test report to support revision of the process description and emission factors for secondary magnesium smelting.

Including the introduction (Chapter 1), this report contains four chapters. Chapter 2 gives a description of the secondary magnesium smelting 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 magnesium smelting. Chapter 2 also presents a list of industry contacts from whom source tests or general industry information was solicited, along with a synopsis of data PES received. A review of references from which general or process information was obtained is included in Chapter 2.

Chapter 3 is a review of emissions data collection and analysis procedures. It describes the literature search and the screening of emission data reports. The rating system for both emission data and emission factors is also presented. Chapter 4 discusses criteria and noncriteria pollutants emitted from secondary magnesium smelting. Particle size determination and particle size data analysis methodology are described. A review of the references from which emission factor information was obtained is included in Chapter 4.

2.0 INDUSTRY DESCRIPTION

2.1 GENERAL[1,2]

Secondary metal recovery (SCC code 3-04-999-99) involves melting scrap metals to recover a pure form of the sought metal. The main sources for magnesium scrap recycling are automotive components (primarily Volkswagen crankcase and transmission housings), etched photoengraving sheets, chainsaw housings, scrap from wrought product manufacture and fabrication, general die-cast scrap, magnesium turnings, and sludges from various magnesium-melting operations. If the magnesium content is less than 15 to 20 percent, recovery is not economical.

In 1983, only 13 percent of the U.S. magnesium supply came from secondary production; in 1991, this number increased to 30 percent. This increase is partially a result of increased in recycling of used beverage cans fabricated from aluminum-magnesium alloys.

Secondary magnesium production requires less energy than primary production. Approximately 6.7 MJ/kg (2,865 Btu/lb) is needed to melt and cast recycled magnesium, as compared to 267 MJ/kg (115,000 Btu/lb) to produce primary magnesium.

There are three secondary magnesium smelters in the U.S.: Garfield Alloys in Ohio, Inco Recycling in Oklahoma, and Halaco Engineering in California. Approximately 27,000 megagrams (30,000 tons) of magnesium were recovered from secondary sources in 1991.

2.2 PROCESS DESCRIPTION[3,4]

The secondary magnesium recovery steps include: scrap sorting and melting, the addition of flux layer and additives; melt transfer and molding. These steps are discussed below.

Scrap is sorted according to the desired composition of the finished metal. The sorted piles are charged into a fabricated steel crucible heated to 675°C (1247°F) by natural gas. The charge temperature must be carefully maintained to avoid the following problems: 1) oxidation, which reduces metal recovery, 2) increased danger of "spit back," 3) reduced alloying efficiency, 4) burning of the metal, and 5) the crucible itself may oxidize and flake off into the melt.

The lower castings begin to burn within 30 minutes of charging. This must be controlled with flux or inhibitive gas. As the castings melt, the pile of metal lowers, allowing more castings to be added. Keeping the bottom molten and the top solid prevents "shooting," a reaction any metal has when cold solids are placed into hot liquids.

While castings continue to be added to the melt, care must be taken to control any burning

with the use of flux. Flux usually contains chloride salts of potassium, magnesium, barium and magnesium and calcium chloride. The flux is floated on top of the molten metal in the open pots or crucibles to prevent contact with air. Magnesium chloride is a basic constituent of the fluxes used with the open pot crucible. Slight magnesium oxide and hydrochloric acid (HCl) are formed when magnesium chloride is in contact with moisture from the air.

Magnesium and barium-free flux have nearly the same specific gravity, making the process of separating flux from liquid metal the most difficult part of any melt. An experienced furnace operator is able to clean the metal until impurities settle at the bottom of the crucible.

When the charge is entirely melted, a crusting flux must be added to inhibit surface burning. Adjustments to the final composition can be made by adding pure magnesium or alloying elements such as aluminum, zinc, or manganese. These additions can only be done after careful preheating.

When the melt reaches the required specifications, it can be transferred to ingot molds. The molds must be preheated, because any moisture in the molds will turn to steam and "shoot" molten metal. Melt transfer can be accomplished by pumping, tilt pouring, and manual ladling. Pumping provides the greatest production capacity, but is time-intensive due to high maintenance requirements. Tilt pouring sacrifices some metal recovery as it sinks to the bottom of the melt, but works well for large ingots that will undergo further refining. Hand ladling is slower than mechanical methods but results in less downtime.

2.3 EMISSIONS AND CONTROLS[3,4]

Magnesium chloride is a basic constituent of the flux used to inhibit oxidation. Slight hydrochloric acid (HCl) has been found in the air. Hydrochloric acid is emitted when magnesium chloride vapor is in contact with the moisture from the air during the fluxing process. Particulate magnesium, in the form of oxidized magnesium (MgO), is emitted during the melting process. Nitrogen oxide emissions result from the fixation of atmospheric nitrogen, which occurs at normal furnace operation temperatures. Carbon monoxide and nonmethane hydrocarbons emissions have also been detected.

Typical control devices for a secondary magnesium smelter include a baghouse to control particulate matter. Particulate occurs in the form of oxidized magnesium, which comes from the melt and from the magnesium chloride flux used to control metal oxidation. No information about control devices for hydrochloric acid or nitrogen oxide was found.

2.4 REVIEW OF REFERENCES FOR CHAPTER 2

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) Alabama Air Division, Montgomery, AL.

2) Florida Department of Environmental Regulation, Tallahassee, FL.

3) Garfield Alloys, Cleveland, OH.

4) Georgia Department of Natural Resources, Division of Environmental Quality, Atlanta, GA.

5) Halaco Engineering, Oxnard, CA.

6) Inco Recycling, Sapulpa, OK.

7) Kansas Department of Health and Environment, Topeka, KS.

8) Michigan Department of Natural Resources, Lansing, MI.

9) Missouri Department of Natural Resources, Division of Environmental Quality, Jefferson City, MO.

10) Pennsylvania Department of Environmental Resources, Harrisburg, PA.

11) Ventura County Air Pollution Control District, Ventura, CA.

The Ventura County Air Pollution Control District (APCD), Source number 11, was the only source that responded, sending a summary of an emission source test conducted at Halaco Engineering, located in Oxnard, California. No responses were received from the remaining sources.

The test summary received from Ventura County APCD reports the emission factors for volatile organic compounds, nitrogen oxide, carbon monoxide, hydrogen chloride and particulate (the only emission factor currently reported in AP-42). There are only three secondary magnesium plants in the U.S. Therefore, Halaco Engineering represents 33 percent of the secondary magnesium smelters. However, the source test summary alone is not sufficient to revise or add to the current emission factors since it does not have any information concerning how the test was performed. Therefore, the source test summary is given an "E" rating. Pacific Environmental

Services used this test summary as background information only (discussed further in Chapter 4). Pacific Environmental Services made an attempt to obtain the complete test report directly from Halaco Engineering, however, no response was received.

The previous secondary magnesium section in AP-42 had not been updated since 1972. Furthermore, the process was not described in detail in the existing chapter. Therefore, PES used Reference 1, a 1992 journal paper, to incorporate an in-depth, current process description into this revision of the AP-42 section.

A 1981 chemical encyclopedia (Reference 2) was used to gather current statistics on secondary production of magnesium.

2.5 REFERENCES FOR CHAPTER 2

1. Kirk-Othmer Encyclopedia of Chemical Technology, 3rd ed., vol. 14, John Wiley and Sons, Canada, 1981.

2. Mineral Commodity Summaries 1992, Bureau of Mines.

3. "Recycling: The Catchword of the '90s," Light Metal Age, vol. 50, Nos. 1,2, Feb. 1992.

4. National Emission Inventory of Sources and emissions of Magnesium, EPA-450/3-74-010, U.S. Environmental Protection Agency, Research Triangle Park, NC, May 1973.

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 secondary magnesium production. This search included, but was not limited to, the following reference:

1) AP-42 background files maintained by the Emission Factor and Methodologies Section.
2) Files maintained by the Emission Standards Division.
3) "Locating and Estimating" reports (as applicable) published by the Emission Factor and Methodologies Section.
4) PM_{10} "gap filling" documents as listed below (if applicable).
5) "PM_{10} Emission Factor Listing Developed by Technology Transfer" (EPA-450/4-89-022).
6) "Gap Filling PM_{10} Emission Factors for Selected Open Area Dust Sources" (EPA-450/88-003).
7) "Generalized Particle Size Distributions for Use in Preparing Size Specific Particulate Emission Inventories" (EPA-450/4-86-013).
8) Background Information Documents for NSPS and NESHAPS.
9) Publications generated by and available through the EPA Control Technology Center (CTC).
10) Reports and project summaries from the EPA Office of Research and Development Standards Division.
11) Information in the *Air Facility Subsystems* (AFS) of the EPA *Aerometric Information Retrieval System* (AIRS).
12) References in the National Technical Information Service (NTIS).
13) Handbook of Emission Factors, Parts I and II, Ministry of Health and Environmental Protection, The Netherlands, 1980/1983.
14) The EPA *Clearinghouse for Inventories and Emission Factors* (CHIEF) and *National Air Toxics Information Clearinghouse* (NATICH).
15) 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).

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.
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.

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 EPA Method 5 front-half with 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 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. Details of the rating of each candidate emission factor are provided in Chapter 4 of this report.

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, Emission 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. Compilation of Air Pollutant Emission Factors, Volume I: Stationary Sources, Supplement A, Appendix C.2, "Generalized Particle Size Distributions." U.S. Environmental Protection Agency, Office of Air Quality Planning and Standards, Research Triangle Park, NC, October 1986.

4.0 POLLUTANT EMISSION FACTOR DEVELOPMENT

4.1 CRITERIA POLLUTANT EMISSIONS DATA

Volatile organic compounds.

Nonmethane volatile organic compounds are emitted during secondary magnesium smelting. A source test summary from the Ventura County Air Pollution Control District for Halaco Engineering Company (Reference 3) cannot be used to revise the existing emission factors. Therefore, this summary test data is used for background information only. No data was available to develop emission factors for uncontrolled nonmethane VOCs. The test data was given in pounds of pollutant per hour. Therefore, the test data was divided by the production rate expressed in pounds of product per hour. This result was multiplied by 2000 to obtain an emission factor in pounds of pollutant per ton of product. For example, given an average for VOC emissions of 0.54 pound (0.25 kg) per hour and a production rate of 6300 pounds (2858 kg) per hour, the calculations yield:

$$(0.25/2858) \times 1000 = 0.09 \text{ kg/Mg (Metric units)}$$

$$(0.54/6300) \times 2000 = 0.17 \text{ lb/ton (English units)}$$

A summary of VOC emission factors from Reference 3 is shown in Table 4.1-1. Due to lack of complete source test information, the test data is rated E. Thus, the emission factors derived from this data are given an "E" rating.

Lead

No data on emissions of lead were found for the secondary magnesium smelting process.

Sulfur dioxide

No data on emissions of lead were found for the secondary magnesium smelting process.

TABLE 4.1-1 (METRIC UNITS)
VOLATILE ORGANIC COMPOUNDS

Source Test #	Test Rating	Test Method	Run #	Production Rate[a]	Emission Rate[a]	Emission Factor[b]
Control device: baghouse						
1	E	Unknown	1	2858	0.42	0.15
			2	2858	0.13	0.04
			3	2858	0.19	0.07
			Average	2858	0.25	0.09

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

TABLE 4.1-1 (ENGLISH UNITS)
VOLATILE ORGANIC COMPOUNDS

Source Test #	Test Rating	Test Method	Run #	Production Rate[a]	Emission Rate[a]	Emission Factor[b]
Control device: baghouse						
1	E	Unknown	1	6300	0.93	0.30
			2	6300	0.28	0.09
			3	6300	0.42	0.13
			Average	6300	0.54	0.17

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

Nitrogen oxides.

Controlled emission factor for NO_x was derived from the Ventura County Air Pollution Control District's source test for Halaco Engineering Company (Reference 3). This factor is not used to revise the existing emission factor. Therefore, this test data is used for background information only. The test data was given in pounds of pollutant per hour. Therefore, the test data was divided by the production rate expressed in pounds of product per hour. This result was divided by 2000 to obtain an emission factor in pounds of pollutant per ton of product. For example, given an average for NO_x emissions of 1.16 pound (0.53 kg) per hour and a production rate of 6300 pounds (2858 kg) per hour, the calculations yield:

$$(0.53/2858) \times 1000 = 0.19 \text{ kg/Mg} \quad \text{(Metric units)}$$

$$(1.17/6300) \times 2000 = 0.37 \text{ lb/ton} \quad \text{(English units)}$$

Data for uncontrolled emission factors were unavailable. Table 4.1-2 presents a summary of emission factors for these pollutants. Due to lack of complete source test information, the test data is rated E. Thus, the emission factors derived from this data are given an "E" rating.

TABLE 4.1-2 (METRIC UNITS)
NITROGEN OXIDES

Source Test #	Test Rating	Test Method	Run #	Production Rate[a]	Emission Rate[a]	Emission Factor[b]
Control device: baghouse						
1	E	Unknown	1	2858	0.35	0.12
			2	2858	0.70	0.25
			Average	2858	0.53	0.19

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

TABLE 4.1-2 (ENGLISH UNITS)
NITROGEN OXIDES

Source Test #	Test Rating	Test Method	Run #	Production Rate[a]	Emission Rate[a]	Emission Factor[b]
Control device: baghouse						
1	E	Unknown	1	6300	0.78	0.25
			2	6300	1.55	0.49
			Average	6300	1.17	0.37

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

Carbon monoxide.

Uncontrolled emission factor for CO was derived from Halaco Engineering's source test (Reference 3). This factor is not used to revise the existing emission factor. The test data is used for background information only. The test data was given in pounds of pollutant per hour. Therefore, the test data was divided by the production rate expressed in pounds of product per hour. This result was multiplied by 2000 to obtain an emission factor in pounds of pollutant per ton of product. For example, given an average for CO emissions of 4.41 pound (2.00 kg) per hour and a production rate of 6300 pounds (2858 kg) per hour, the calculations yield:

$$(2.00/2858) \times 1000 = 0.70 \text{ kg/Mg} \quad \text{(Metric units)}$$

$$(4.41/6300) \times 2000 = 1.40 \text{ lb/ton} \quad \text{(English units)}$$

Factors are presented in Table 4.1-3. Due to lack of complete source test information, the test data is rated E. Thus, the emission factors derived from this data are given an "E" rating.

TABLE 4.1-3 (METRIC UNITS)
CARBON MONOXIDE

Source Test #	Test Rating	Test Method	Run #	Production Rate[a]	Emission Rate[a]	Emission Factor[b]
Control device: none						
1	E	Unknown	1	2858	2.50	0.87
			2	2858	1.50	0.53
			Average	2858	2.00	0.70

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

TABLE 4.1-3 (ENGLISH UNITS)
CARBON MONOXIDE

Source Test #	Test Rating	Test Method	Run #	Production Rate[a]	Emission Rate[a]	Emission Factor[b]
Control device: none						
1	E	Unknown	1	6300	5.51	1.75
			2	6300	3.31	1.05
			Average	6300	4.41	1.40

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

Total Suspended Particulate & PM_{10}.

PM_{10} is a subset of Total Suspended Particulate (TSP). There is no single method which is universally accepted for the determination of particle size. A number of different techniques can be used which measure the size of particles according to their basic physical properties. Since there is no "standard" method for particle size analysis, a certain degree of subjective evaluation was used to determine if a test series was performed using a sound methodology for particle sizing.

For pollution studies, the most common types of particle sizing instruments are cyclones, rotoclones, and cascade impactors. Traditionally, cyclones and rotoclones have been used as a preseparator ahead of a cascade impactor to remove the larger particles. These devices are of the standard reverse-flow design whereby the flue gas enters the cyclone through a tangential inlet and forms a vortex flow pattern. Particles move outward toward the cyclone wall with a velocity that is determined by the geometry and flow rate in the device and by their size. Large particles reach the wall and are collected. A series of cyclones with progressively decreasing cut-points can be used to obtain particle size distributions.

Controlled and uncontrolled particulate emission factors in the existing AP-42 were taken from References 4 and 5. A detailed derivation of the emission factors is presented in Section 4.3. Controlled particulate matter emission factor from Halaco Engineering test summary (Reference 3) is not used to revise the existing emission factor. The test data is used for background information only. No data for uncontrolled emission factors have been found at this time. The test data was given in pounds of pollutant per hour. Therefore, the test data was divided by the production rate expressed in pounds of product per hour. This result was multiplied by 2000 to obtain an emission factor in pounds of pollutant per ton of product. For example, given an average for particulate emissions of 1.56 pound (0.71 kg) per hour and a production rate of 6300 pounds (2858 kg) per hour, the calculations yield:

$$(0.71/2858) \times 1000 = 0.25 \text{ kg/Mg} \quad \text{(Metric units)}$$

$$(1.56/6300) \times 2000 = 0.50 \text{ lb/ton} \quad \text{(English units)}$$

No tests were found for uncontrolled emission factor data. These factors are given in Table 4.1-4. Due to lack of complete source test information, the test data is rated E. Thus, the emission factors derived from this data are given an "E" rating.

TABLE 4.1-4 (METRIC UNITS)
TOTAL SUSPENDED PARTICULATE AND PM_{10}

Source Test #	Test Rating	Test Method	Run #	Production Rate[a]	Emission Rate[a]	Emission Factor[b]
Control device: baghouse						
1	E	Unknown	1	2858	0.64	0.22
			2	2858	0.61	0.21
			3	2858	0.88	0.31
			Average	2858	0.71	0.25

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

TABLE 4.1-4 (ENGLISH UNITS)
TOTAL SUSPENDED PARTICULATE AND PM_{10}

Source Test #	Test Rating	Test Method	Run #	Production Rate[a]	Emission Rate[a]	Emission Factor[b]
Control device: baghouse						
1	E	Unknown	1	6300	1.40	0.44
			2	6300	1.34	0.43
			3	6300	1.94	0.62
			Average	6300	1.56	0.50

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

4.2 NONCRITERIA POLLUTANT EMISSIONS DATA

Hazardous Air Pollutants.

Hazardous Air Pollutants (HAPs) are defined in the 1990 Clean Air Act Amendments. The available source test (Reference 3) shows hydrochloric acid (HCl), a HAP, to be present in the secondary magnesium smelting process. This test data is not used to revise the existing emission factors; it is used for background information only. A controlled emission factor for HCl is given in Table 4.2-1. The test data was given in pounds of pollutant per hour. Therefore, the test data was divided by the production rate expressed in pounds of product per hour. This result was multiplied by 2000 to obtain an emission factor in pounds of pollutant per ton of product. For example, given an average for hydrogen chloride emissions of 1.97 pound (0.90 kg) per hour and a production rate of 6300 pounds (2858 kg) per hour, the calculations yield:

$$(0.90/2858) \times 1000 = 0.31 \text{ kg/Mg} \quad \text{(Metric units)}$$

$$(1.97/6300) \times 2000 = 0.63 \text{ lb/ton} \quad \text{(English units)}$$

No tests for uncontrolled HCl emissions have been found. Computed controlled emission factors are given in Table 4.2-1. Due to lack of complete source test information, the test data is rated E. Thus, the emission factors derived from this data are given an "E" rating.

Global Warming Gases.

Pollutants such as methane, carbon dioxide, and nitrous oxide have been found to contribute to overall global warming. No data on emissions of these pollutants were found for the secondary magnesium smelting process.

Ozone Depletion Gases.

Chlorofluorocarbons and nitric oxide have been found to contribute to depletion of the ozone layer. No data on emissions of these pollutants were found for the secondary magnesium smelting process.

TABLE 4.2-1 (METRIC UNITS)
HAZARDOUS AIR POLLUTANTS: HYDROGEN CHLORIDE

Source Test #	Test Rating	Test Method	Run #	Production Rate[a]	Emission Rate[a]	Emission Factor[b]
Control device: baghouse						
1	E	Unknown	1	2858	0.69	0.24
			2	2858	0.54	0.19
			3	2858	1.46	0.51
			Average	2858	0.90	0.31

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

TABLE 4.2-1 (ENGLISH UNITS)
HAZARDOUS AIR POLLUTANTS: HYDROGEN CHLORIDE

Source Test #	Test Rating	Test Method	Run #	Production Rate[a]	Emission Rate[a]	Emission Factor[b]
Control device: baghouse						
1	E	Unknown	1	6300	1.51	0.48
			2	6300	1.19	0.38
			3	6300	3.21	1.02
			Average	6300	1.97	0.63

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

4.3 REVIEW OF SPECIFIC DATA SETS

The emission factors in the existing AP-42 chapter were derived from data dating from 1966 and 1970. Thus, a revision was necessary, as any changes in processes or controls can make emission factor data obsolete. A single source test report was received from Pacific Environmental Service's industry contact. The report contains the summary of the source test only and is not sufficient to revise current emission factors. Therefore, the current emission factors in the AP-42 will remain unchanged until a complete source test report is received and further determinations are made. A discussion of specific references used in the current emission factors in the updated AP-42 is presented below.

Reference #4: Control of Metallurgical and Mineral Dusts and Fumes in Los Angeles County

Table 1 in this document contains controlled emission summaries from pot furnaces during the magnesium smelting process. The document does not provide any description of the test method. The summary shows that the test was performed at a temperature of 1,425°F for 36 minutes. The existing controlled particulate emission factor was calculated by averaging the emission factor for magnesium smelting and averaged emission factor for light metals alloys.

The upper limit of the emission factor was calculated from magnesium smelting test. The throughput of the test is 217 lb/hr, and the particulate emission is 0.05 lb/hr. The emission factor was calculated by dividing the emission rate by the throughput rate:

$$(0.05/217) \times 2000 = 0.46 \text{ lb/ton}$$

The lower limit of the emission factor was calculated from light metal alloys smelting test. The emission factor for this alloys is 0.38 lb/ton. The controlled particulate emission factor in the existing AP-42 is thus

$$(0.46 + 0.38)/2 = 0.42 \text{ lb/ton}$$

Reference #5: Data on Non-Ferrous Metallurgical Operations. Los Angeles County Air Pollution Control District

Uncontrolled particulate emission factors were referenced from this document. Pacific Environmental Service was unable to find this document from AP-42 files. Therefore, PES was unable to determine how the uncontrolled emission factor was derived from.

4.4 DATA GAP ANALYSIS

Since there are only three magnesium smelters in operation in the U.S., the one source test summary that PES received represents one-third of the magnesium smelting facilities. The source test summary received shows that there are VOC, NO, CO, and hydrogen chloride (HCl) emitted during secondary magnesium smelting process. However, the test summary does not describe how the test was performed. Pacific Environmental Services gave an "E" rating to this test summary until the complete report is received and further determinations are made. The remaining two smelters PES contacted gave no indication as to whether source tests have been done at their facilities. Pacific Environmental Services recommends that further testing be strongly encouraged for secondary magnesium smelters.

4.5 REFERENCES FOR CHAPTER 4

1. Kirk-Othmer Encyclopedia of Chemical Technology, 3rd ed., vol. 14, John Wiley and Sons, Canada, 1981.

2. "Recycling: The Catchword of the '90s," Light Metal Age, vol. 50, Nos., 1,2, Feb. 1992.

3. Summary of stack test results: Halaco Engineering Company, Oxnard, california, January 1990. Provided by Ventura County Air Pollution Control District.

4. Allen, G.L. et al. Control of Metallurgical and Mineral Dusts and Fumes in Los Angeles County. Department of the Interior, Bureau of Mines. Washington, D.C. Information Circular Number 7627. April 1952.

5. Hammond, W.F. Data on Non-Ferrous Metallurgical Operations. Los Angeles County Air Pollution Control District. November 196

TABLE 4.5-1

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/s	3.281	ft/s
kg/hr	2.205	lb/hr
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:

$$°F = 1.8(°C) + 32$$