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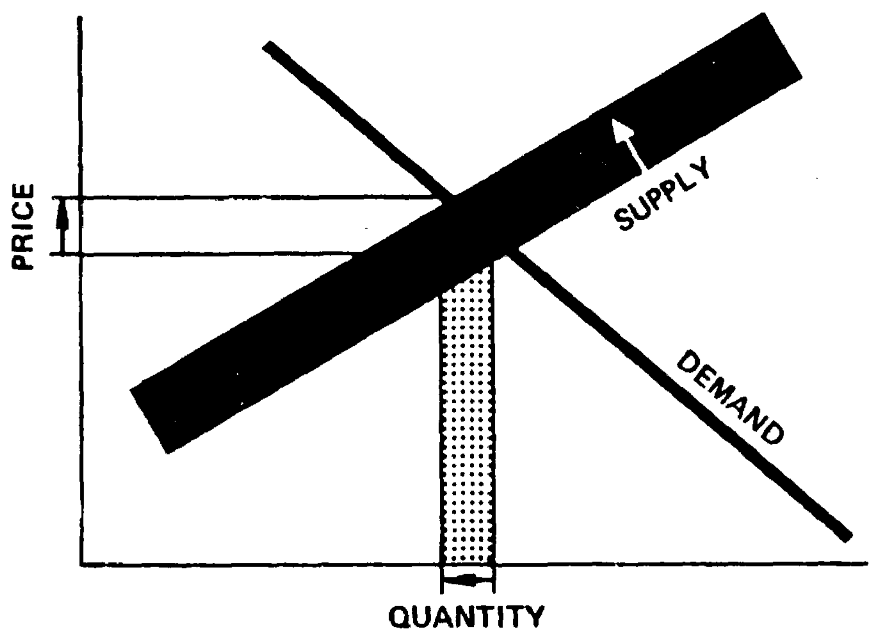
Economic Analysis of Proposed Effluent Limitations and Standards for the Nonferrous Metals Forming Industry



UNITED STATES ENVIRONMENTAL PROTECTION AGENCY

DISTRIBUTION

This document is an economic impact assessment of the effluent limitations guidelines and standards recently proposed for the nonferrous metals forming industry. The report is being distributed to EPA Regional Offices and State pollution control agencies, directed to the staff responsible for writing industrial discharge permits. The report includes information on the costs and economic impacts of various treatment technologies. It should be helpful to permit writers in evaluating the economic impacts on an industrial facility of complying with effluent limitations or water quality standards.

The report is also being distributed by request to parties interested in commenting on the proposed regulation. A limited number of copies of this report are available from:

Economic Analysis Staff (WH-586)
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ECONOMIC ANALYSIS OF PROPOSED EFFLUENT LIMITATIONS AND STANDARDS FOR THE NONFERROUS METALS FORMING INDUSTRY

Environmental Protection Agency
Office of Analysis and Evaluation
Office of Water Regulations and Standards
Washington, D.C. 20460

February 1984

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PREFACE

The attached document is a contractor's study prepared for the Office of Water Regulations and Standards of the Environmental Protection Agency (EPA). The purpose of the study is to analyze the economic impact which could result from the application of alternative BPT, BAT, BCT, PSES, NSPS and PSNS effluent standards and limitations established under the Federal Water Pollution Control Act, as amended.

The study supplements the technical study (EPA Development Document) supporting the proposed regulation. The Development Document surveys existing and potential waste treatment control methods and technology within particular subcategories in the nonferrous metals forming industry and supports certain standards and limitations based upon an analysis of the feasibility of these standards in accordance with the requirements of the Clean Water Act. Presented in the Development Document are the investment and operating costs associated with various control and treatment technologies. The attached document supplements this analysis by estimating the broader economic effects which might result from the application of various control methods and technologies. This study investigates the effect in terms of product price increases, effects upon employment and the continued viability of affected plants, effects upon foreign trade and other competitive effects.

The study has been prepared with the supervision and review of the Office of Analysis and Evaluation of EPA. The work was started under Contract No. 68-01-6348 and completed under Contract No. 68-01-6426 by JRB Associates. The report was prepared by Sidney Wolf and Thong Nguyen of JRB Associates and completed in February 1984.

This report is being released and circulated at approximately the same time as publication in the Federal Register of a notice of proposed rulemaking. It will be considered along with the information contained in the Development Document and any comments received by EPA on either document during the public comment period to establish final regulations.

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INTRODUCTION

Purpose

This report identifies and analyzes the economic impacts which are likely to result from the effluent limitations guidelines and standards on the nonferrous metals forming and iron and steel/copper/aluminum metal powder production and powder metallurgy point source category - referred to here for simplicity as the nonferrous forming industry or category. These regulations include effluent limitations guidelines and standards based on Best Practicable Control Technology Currently Available (BPT), Best Available Technology Economically Achievable (BAT), Best Conventional Pollutant Control Technology (BCT), New Source Performance Standards (NSPS), and Pretreatment Standards for New and Existing Sources (PSNS and PSES, respectively) which are being proposed under authority of Sections 301, 304, 306, 307, 308, and 501 of the Clean Water Act (the Federal Water Pollution Control Act Amendments of 1972, as amended by the Clean Water Act of 1977, P.L. 95-217). The primary economic impact variables assessed in this study include the costs of the regulations and potential for these regulations to cause plant closures, price changes, unemployment, changes in industry profitability, structure and competition, shifts in the balance of foreign trade, industry growth, and impacts on small businesses.

Industry Coverage and Segmentation

Facilities covered under this study include all establishments engaged in the forming of one or more of the pure metals or alloys of the metals listed below:

Beryllium (Be)	Magnesium (Mg)	Tantalum (Ta)
Bismuth (Bi)	Molybdenum (Mo)	Tin (Sn)
Cobalt (Co)	Nickel (Ni)	Titanium (Ti)
Columbium (Niobium) (Cb)(Nb)	Palladium (Pd)	Tungsten (W)
Gold (Au)	Platinum (Pt)	Uranium (U)
Hafnium (Hf)	Rhenium (Re)	Vanadium (V)
Lead (Pb)	Silver (Ag)	Zinc (Zn)
		Zirconium (Zr)

Formers of other nonferrous metals were excluded from regulation because the survey results indicated either that the forming operations for those metals do not generate process wastewater or that the metal is not formed.

The manufacturing operations covered by the proposed regulations include rolling, drawing, extruding, forging, cladding (including bimetallics), and other operations necessary to transform the nonferrous metals into formed products.

Also included in this industry are powder metallurgical (P/M) operations involving iron and steel, aluminum, and copper. These operations include the production of metal powders and the forming of products from the powders.[1/] For brevity, all of the above will be referred to as nonferrous metals forming operations, even though the P/M operations include ferrous metals.

For the purpose of developing effluent limitations guidelines and standards, EPA organized the nonferrous metals forming category into the following 11 metalbased technical subcategories:

- Lead/tin/bismuth forming
- Nickel/cobalt forming

1/ Other forming operations involving iron and steel, copper, and aluminum were the subject of previous regulations. However, powder metallurgy operations for those metals were not included, and hence are covered here for regulatory completeness. Powder metallurgy operations for the 22 nonferrous metals covered in this regulation are regulated in the subcategories for the specific metals.

- Zinc forming
- Beryllium forming
- Precious metals forming (includes gold, silver, platinum, and palladium)
- Iron, copper, and aluminum metal powder production and powder metallurgy (to be referred to as powder metallurgy)
- Titanium forming
- Refractory metals forming (includes tungsten, molybdenum, tantalum, columbium, rhenium, and vanadium)
- Zirconium/hafnium forming
- Magnesium forming
- Uranium forming.

Plants producing in each of these subcategories generally have similar forming and ancillary operations, and generate similar wastewaters.

METHODOLOGY

The approach used to assess the economic impacts likely to occur as a result of the costs of each regulatory option is to (1) develop an operational description of the price and output behavior of the industry and (2) assess the likely plant-specific responses to the incurrence of the compliance costs enumerated in the body of this report. Thus, industry conditions before and after compliance with the regulations are compared. These analyses were performed for three regulatory options considered by EPA. Specifically, the methodology can be divided into nine major steps. Although each step is described independently, there is considerable interdependence among them. The nine steps are described in the following paragraphs.

Step 1: Description of Industry Characteristics

The first step in the analysis is to develop a description of basic industry characteristics such as the determinants of demand, market structure, the degree of intra-industry competition, and financial performance. The resulting observations indicated the type of analysis needed for the industry. The sources for this information include Government reports, trade association data, discussions with various trade associations and industry personnel, and an EPA survey of firms in the industry.

Step 2: Supply - Demand Analysis

The second step in the analysis is a determination of the likely changes in market prices and industry production levels resulting from each regulatory option. The estimates of post-compliance price and output levels are used in the plant-level analysis (Steps 4, 5, and 6) to determine post-compliance revenue and profit levels for specific plants in each group.

A pricing strategy that would maintain the industry-wide initial return on sales is assumed as an approximation of industry-wide price increases. The post-compliance market price levels are used, in a later step, to assess the financial condition of individual nonferrous metals forming facilities.

Step 3: Compliance Cost Estimates

Engineering estimates of investment and annual compliance costs for three alternative treatment technologies were developed for 23 model plants. These cost estimates were extrapolated to obtain compliance cost estimates for the remaining plants in the industry to carry out the impact analysis.

Step 4: Plant-Level Profitability Analysis

Two basic measures of financial performance are used to assess the impact of the regulations on the profitability of individual plants: (1) plant after-compliance return on investment (ROI), and (2) plant after-compliance net present value (NPV). Due to the unavailability of plant-specific baseline financial characteristics for the nonferrous metals forming industry, average industry financial and operating ratios were applied to each plant.

Step 5: Capital Requirements Analysis

In addition to analyzing the potential for plant closures from a profitability perspective, it is also necessary to assess the ability of firms to make the initial capital investment needed to construct and install the required treatment systems. The analysis of capital availability was based on the "fixed charge coverage" ratio which is defined as the ratio of earnings before interest and taxes to interest payments. This ratio was calculated for each plant and compared to a threshold value to help determine the potential for significant plant-level impacts.

Step 6: Plant Closure Analysis

The decision to close a plant, like most major investment decisions, is largely based on financial performance but is ultimately judgmental. This is because the decision involves a wide variety of considerations, many of which cannot be quantified. Assessments of the degree of impacts on individual plants were made by evaluating the above financial variables in conjunction with nonfinancial and nonquantifiable factors, such as substitutability of products, plant and firm integration, the existence of specialty markets, and expected market growth rates.

Step 7: Other Impacts

"Other impacts" which result from the assessment of basic price, production, and plant-level profitability changes include impacts on employment, communities, industry structure, and balance of trade. These impacts are estimated via supplementary analyses that are explained where the results are reported in appropriate portions of the report.

Step 8: New Source Impacts

This step analyzes the effects of NSPS/PSNS guidelines upon new plant construction and substantial modification to existing facilities in the nonferrous metals forming industry. The analysis is based on the incremental compliance costs of the new source treatment technologies relative to those of the selected BAT and PSES treatment options.

Step 9: Small Business Analysis

The Regulatory Flexibility Act requires Federal regulatory agencies to evaluate small entities throughout the regulatory process. This analysis identifies the economic impacts which are likely to result from the proposed effluent regulations on small businesses in the nonferrous metals forming industry.

For purposes of regulation development, a small business definition based on plant output volume was selected. The impacts on small plants were assessed by examining the distribution by plant size of the number of nonferrous metals forming plants, plant revenues, compliance costs, and potential closures resulting from the regulations.

INDUSTRY CHARACTERISTICS

The EPA identified 294 nonferrous metals forming plants in operation in 1983. Total nonferrous metals forming employment of these 294 plants is approximately 35,500 people.

The industry is fairly concentrated. For most nonferrous metal formed products, over 90 percent of production is accounted for by the eight largest firms producing that type of product. A good deal of this concentration is explained by the specialized nature of the products manufactured in this industry.

Most of the nonferrous metals forming plants are small plants with less than $10 million in annual nonferrous metals forming revenues. Furthermore, half of the plants have less than 50 nonferrous metals forming workers. There is a substantial degree of product diversification in the industry, especially among the smaller plants (nonferrous metals forming operations account for less than 10 percent of total revenues of plants with nonferrous metals forming shipments less than $5 million).

Nonferrous metals products are used in a wide variety of end-use markets. For most of the metals, their uses depend on particular properties of the metals and are quite specialized.

BASELINE PROJECTIONS

The growth rate of the demand for nonferrous metals forming products is projected to vary from a fairly stable growth through 1990 for magnesium to 4.5 percent annually for zirconium/hafnium. As a result of existing over-capacity, a significant portion of the increased demand during the 1980s can be met by increasing operating levels at existing facilities.

COST OF COMPLIANCE

EPA identified three alternative technologies that are most applicable for the reduction of the pollutants found in the nonferrous metals forming industry. These treatment technologies are described in detail in the Development Document and are listed below:

- Treatment Option 1: Hexavalent chromium reduction, cyanide removal and chemical emulsion breaking (where applicable); oil skimming; chemical precipitation and sedimentation ("lime and settle")
- Treatment Option 2: Option 1 plus flow reduction by recycle, and countercurrent cascade rinsing
- Treatment Option 3: Option 2 plus filtration

Tables S-1 and S-2 present the estimated investment and annual compliance costs for the existing direct and indirect discharging sources, respectively.

FINDINGS

Plant Closure Impact

Four indirect dischargers (1 nickel, 1 titanium, 1 refractory metals, and 1 zinc plant) are projected to close at each treatment option. The plant closure findings are summarized in Table S-3.

Employment, Community, and Regional Effects

As shown in Table S-3, there is potential for 4 plant closures involving a loss of about 340 jobs. None of these plants accounts for a significant portion of community employment, hence the community and regional impacts appear to be insignificant.

Substitution Effects

The effects of the regulations on substitution potential are insignificant, since the price increases associated with the compliance costs and the corresponding quantity reductions are small.

TABLE S-1. COMPLIANCE COSTS FOR EXISTING DIRECT DISCHARGERS
(in thousands of 1982 dollars)

TECHNICAL SUBCATEGORY	NO. OF LINES	CAPITAL INVESTMENT			ANNUAL COMPLIANCE COSTS		
		OPTION 1	OPTION 2	OPTION 3	OPTION 1	OPTION 2	OPTION 3
Lead/Tin/Bismuth	3	165.5	174.1	225.8	11.0	12.4	35.6
Nickel/Cobalt	14	390.6	429.6	483.5	73.1	84.0	103.9
Zinc	1	13.3	72.1	72.1	27.3	36.8	36.8
Beryllium	1	0	0.4	0.4	15.7	16.0	16.0
Precious Metals	7	95.5	219.9	298.8	93.4	130.7	163.7
Powder Metallurgy	3	189.5	189.5	227.1	122.5	122.5	165.5
Titanium	12	1,385.9	1,420.8	1,535.5	876.0	894.0	948.9
Refractory Metals	8	14.5	89.5	105.5	23.1	41.7	50.1
Zirconium/Hafnium	4	228.1	271.7	289.9	114.0	125.7	132.9
Magnesium	3	71.0	71.0	71.0	44.8	44.8	44.8
Uranium	2	356.3	356.3	356.3	189.9	189.9	189.9
TOTAL NO. OF PLANTS	39[a]	2,910.2	3,294.9	3,665.9	1,590.8	1,698.5	1,888.1

[a] Total is lower than the sum of all subcategories because many plants produce more than one type of metal.

SOURCE: JRB Associates estimates.

TABLE S-2. COMPLIANCE COSTS FOR EXISTING INDIRECT DISCHARGERS
(*in thousands of 1982 dollars*)

TECHNICAL SUBCATEGORY	NO. OF LINES	CAPITAL INVESTMENT			ANNUAL COMPLIANCE COSTS		
		OPTION 1	OPTION 2	OPTION 3	OPTION 1	OPTION 2	OPTION 3
Lead/Tin/Bismuth	18	417.1	442.1	547.4	131.9	139.6	193.5
Nickel/Cobalt	26	1,943.1	2,323.8	2,551.8	968.3	1,091.2	1,197.5
Zinc	2	87.5	89.2	104.7	41.1	46.9	50.2
Beryllium	0	-	-	-	-	-	-
Precious Metals	28	240.6	374.7	716.0	387.8	429.9	562.7
Powder Metallurgy	20	387.8	387.6	440.4	413.9	413.9	450.8
Titanium	16	680.6	838.0	937.5	468.6	529.0	582.1
Refractory Metals	29	968.1	1,304.2	1,417.6	545.2	635.4	686.2
Zirconium/Hafnium	4	19.9	20.3	23.3	2.7	2.8	3.9
Magnesium	2	4.0	4.3	5.3	5.0	5.4	6.1
Uranium	1	118.7	118.7	118.7	63.3	63.3	63.3
TOTAL NO. OF PLANTS	114[a]	4,867.5	5,902.9	6,862.7	3,027.8	3,357.4	3,796.3

[a] Total is lower than the sum of all subcategories because many plants produce more than one type of metal.

SOURCE: JRB Associates estimates.

TABLE S-3. SUMMARY OF POTENTIAL CLOSURES
(all treatment options)

	DIRECT DISCHARGERS	INDIRECT DISCHARGERS
Number of Plants	39[a]	114[a]
Number of closures	0	4
Employment Losses	0	340
Annual Production of Closed Facilities		
- Million lbs.	0	6.3
- % of Industry Total	0	0.9

[a] Includes 7 plants which discharge both directly and indirectly.

SOURCE: JRB Associates estimates.

Foreign Trade Impacts

Since the price increases estimated to result from the regulations are small, such price increases would not alter the trading pattern substantially.

Industry Structure Effects

The impact of the regulations on the industry structure is negligible, since only a small proportion of industry output is accounted for by the plants projected to close.

New Source Impacts

The proposed effluent standards and associated technologies for new sources are identical to those for existing sources. Consequently, the economic impacts for new sources will be similar to those of existing sources and the proposed regulations are not expected to cause barriers to entry.

Impact on Small Entities

The regulations seem to have relatively higher impact on small nonferrous metals forming facilities; the projected closures each have less than 3 million pounds of production annually. Furthermore, annual compliance costs per unit of production for plants with less than 1 million pounds of annual production are substantially higher than those of larger plants.

1. INTRODUCTION

1.1 PURPOSE OF REPORT

This report identifies and analyzes the economic impacts of water pollution control regulations on the nonferrous metals forming and iron and steel/copper/aluminum metal powder production and powder metallurgy point source category - referred to hereafter as the nonferrous forming industry or category. These regulations include effluent limitations and standards based on Best Practicable Control Technology Currently Available (BPT), Best Available Technology Economically Achievable (BAT), Best Conventional Pollutant Control Technology (BCT), New Source Performance Standards (NSPS), and Pretreatment Standards for New and Existing Sources (PSNS and PSES, respectively) which are being proposed under authority of Sections 301, 304, 306, 307, 308, and 501 of the Clean Water Act (the Federal Water Pollution Control Act Amendments of 1972, as amended by the Clean Water Act of 1977, P.L. 95-217). The primary economic impacts assessed in this study include the costs of the regulations and potential for these regulations to cause plant closures, price changes, unemployment, changes in industry profitability, structure and competition, shifts in the balance of foreign trade, and impacts on small businesses.

1.2 INDUSTRY COVERAGE

Facilities covered under this study include all establishments engaged in the forming of one or more of the pure metals or alloys of the metals listed below:

Beryllium (Be)	Magnesium (Mg)	Tantalum (Ta)
Bismuth (Bi)	Molybdenum (Mo)	Tin (Sn)
Cobalt (Co)	Nickel (Ni)	Titanium (Ti)
Columbium (Niobium) (Cb)(Nb)	Palladium (Pd)	Tungsten (W)
Gold (Au)	Platinum (Pt)	Uranium (U)
Hafnium (Hf)	Rhenium (Re)	Vanadium (V)
Lead (Pb)	Silver (Ag)	Zinc (Zn)
		Zirconium (Zr)

Formers of these as well as other nonferrous metals were surveyed by EPA to determine production levels, manufacturing processes, economic characteristics, water use, wastewater characteristics, and treatment-in-place. Following completion of the survey, however, the other nonferrous metals were excluded from regulation because the survey results indicated either that the forming operations for those metals do not generate process wastewater or that the metal is not formed.

For brevity, the 22 metals listed above and their alloys will be referred to hereafter as nonferrous metals.[1/] The manufacturing operations covered by the proposed regulations include rolling, drawing, extruding, forging, cladding (including bimetallics), and other operations necessary to transform the nonferrous metals into formed products. These operations are referred to here as nonferrous metals forming operations. The products formed through these operations include:

- Plate
- Sheet and strip
- Foil and leaf
- Tubing, bar, and rod
- Wire and cable
- Irregular shapes
- Powders
- Others.

Also included in this industry are powder metallurgical (P/M) operations involving iron and steel, aluminum, and copper. These operations include the

[1/] An alloy is classified under EPA regulations according to its major metal; e.g., an alloy that is 40 percent nickel 30 percent iron, and smaller percentages of other metals is considered a nickel alloy.

production of metal powders and the forming of products from the powders.[2/] For brevity, all of the above will be referred to as nonferrous metals forming operations, even though the P/M operations include ferrous metals.

1.3 INDUSTRY SUBCATEGORIZATION

For the purpose of developing effluent limitations guidelines and standards, EPA organized the nonferrous metals forming category into the following 11 metal-based technical subcategories:

- Lead/tin/bismuth forming
- Nickel/cobalt forming
- Zinc forming
- Beryllium forming
- Precious metals forming (includes gold, silver, platinum, and palladium)
- Iron and steel, copper, and aluminum powder production and powder metallurgy (to be referred to as powder metallurgy)
- Titanium forming
- Refractory metals forming (includes tungsten, molybdenum, tantalum, columbium, rhenium, and vanadium)
- Zirconium/hafnium forming
- Magnesium forming
- Uranium forming.

Plants in each of these subcategories generally have similar forming and ancillary operations, and generate similar wastewaters.

2/ Other forming operations involving iron and steel, copper, and aluminum were the subject of previous regulations. However, powder metallurgy operations for those metals were not included, and hence are covered here for regulatory completeness. Powder metallurgy operations for the 22 nonferrous metals covered in this regulation are regulated in the subcategories for the specific metals.

1.4 ORGANIZATION OF REPORT

The remainder of this report consists of eight additional chapters. Chapter 2 presents an overview of the methodology used in the study. Chapters 3 and 4 describe the basic industry characteristics and the markets for nonferrous metal formed products. Chapter 5 projects some of the critical parameters into the future to provide an understanding of the expected characteristics of the industry during the 1985 to 1990 time period, when the primary economic impacts of the proposed regulations will be felt. Chapter 6 describes the pollution control technologies considered by EPA and their associated costs. The information in this chapter is derived primarily from the companion technical study prepared by EPA's Effluent Guidelines Division.[3/] Chapter 7 presents the economic impacts estimated to result from incurring the costs described in Chapter 6. Chapter 8 presents an analysis of the effects of the proposed regulations on small businesses. Finally, Chapter 9 outlines the major limitations of the analysis.

3/ Development Document for Proposed Effluent Limitations Guidelines and Standards for the Nonferrous Metals Forming and Iron and Steel/Copper/ Aluminum Metal Powder Production and Powder Metallurgy Point Source Category (EPA 440/1-84/019-B), February 1984.

2. STUDY METHODOLOGY

2.1 OVERVIEW

Figure 2-1 shows an overview of the analytical approach used to assess the economic impacts likely to occur as a result of the costs of each regulatory option. The approach used in this study is to (1) develop an operational description of the price and output behavior of the industry, and (2) assess the likely plant-specific responses resulting from the compliance costs estimated for each of the three regulatory options enumerated in Chapter 6.

The operational description of the price and output behavior is used, in conjunction with compliance costs estimated by EPA, to determine post-compliance industry price and production levels for each regulatory option and for each of the nonferrous metals forming product groups. Each plant is then subjected to a financial analysis that uses capital budgeting techniques to determine potential closures. If necessary, the industry description is then revised, for each regulatory option, to incorporate the reduced supply into the analysis. Finally, other effects that flow from the basic price, production, and industry structure changes are determined. These include employment, community, and foreign trade impacts. Specifically, the study proceeded in the following nine steps:

1. Description of industry characteristics
2. Industry supply and demand analysis
3. Analysis of compliance cost estimates
4. Plant-level profitability analysis
5. Plant-level capital requirements analysis
6. Assessment of plant closure potential
7. Assessment of other impacts
8. New source impacts
9. Small business analysis.

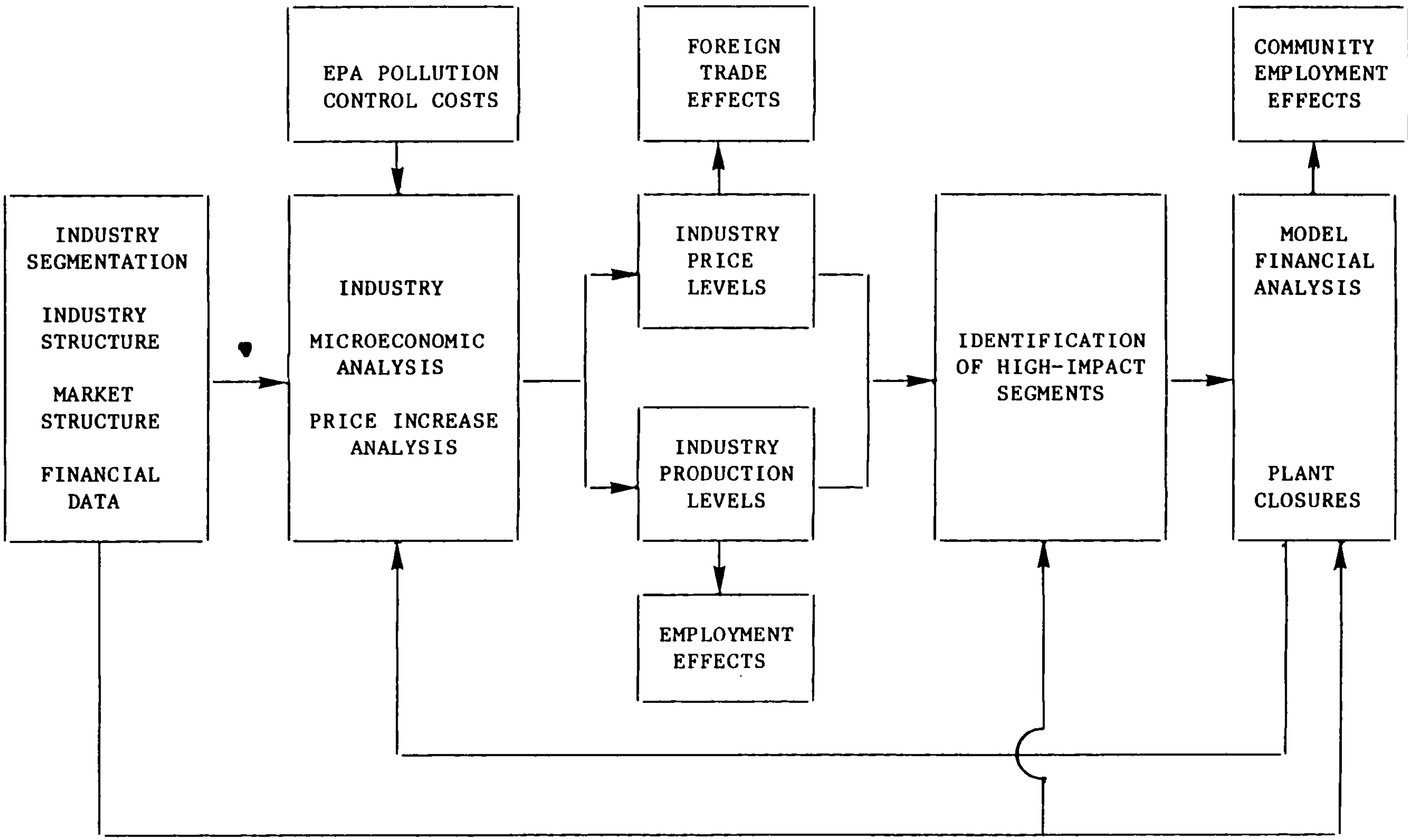

FIGURE 2-1. ECONOMIC ANALYSIS STUDY OVERVIEW

Although each of these steps is described in this section, it is important to realize that there are significant interactions among them, as shown in Figure 2-1.

The major sources of data used in this study are listed below:

- U.S. Environmental Protection Agency: EPA industry survey conducted in 1983 under Section 308 (of particular importance for this study are data on plant production volume and value of shipments); EPA estimates of compliance costs; and the Development Document.
- U.S. Department of Commerce: 1977 Census of Manufactures; Annual Survey of Manufactures (1978-1982).
- U.S. Bureau of Mines: Mineral Facts and Problems; Minerals Yearbook; Mineral Commodity Summaries.
- Federal Trade Commission: Quarterly Financial Report for Manufacturing, Mining and Trade Corporations (1978-1983); Annual Line of Business Report (1974-1976).
- Trade publications such as American Metal Market, Metal Statistics and Modern Metals (various issues, 1978-1983).
- Interviews with industry representatives.
- Corporate annual reports (1982).

2.2 STEP 1: DESCRIPTION OF INDUSTRY CHARACTERISTICS

The first step in this analysis is to describe the basic industry characteristics. These characteristics, which include the determinants of demand, market structure, the degree of intra-industry competition, and financial performance, are described in Chapters 3 and 4 of this report. The sources for this information include those listed above, such as Government reports, trade association data, and discussions with various trade association representatives and individuals associated with the industry.

2.3 STEP 2: SUPPLY-DEMAND ANALYSIS

The purpose of the supply-demand analysis is to determine the likely changes in market prices and industry production levels resulting from each regulatory option. The estimates of post-compliance price and output levels are used in the plant-level analysis to determine post-compliance revenue and profit levels for specific plants in each product group. If prices are raised without significantly reducing product demand and companies are able to maintain their current financial status, the potential for plant closings will be minimal. If prices cannot be raised to fully recover compliance costs because of the potential for a significant decline in product demand or because of significant intra-industry competition, the firms may attempt to maintain their financial status by closing higher-cost/less-efficient plants. The supply-demand analysis was divided into four basic components: determination of industry structure, projection of possible changes in industry structure during the 1980s and 1990s, determination of plant- and firm-specific operational parameters (e.g., production costs, profit rates, etc.), and development of price-quantity algorithms. A separate supply-demand analysis was developed for each of the 11 subcategories.

As described in Chapter 3, the U.S. nonferrous metals forming industry exhibits some characteristics of non-competitive markets such as high concentration ratios, high capital intensity, and high degree of integration. On the other hand, the industry also exhibits some characteristics that are indicative of competitive markets such as generally "normal" profitability and periodic overcapacity resulting from cyclical fluctuations in the economy. Because of the conflicting information regarding the industry's market structure, no single conclusion is drawn regarding an underlying principle or model which could precisely describe the industry's pricing behavior in all market situations. Instead, the magnitude of the price increase is assumed to be at a level which would maintain the industry-wide initial return on sales, i.e., it is assumed that the average price increase in an industry subcategory will equal the ratio of total compliance costs to total production cost of both the discharging and nondischarging plants.[3/] This price behavior is incorporated in the following algorithm:

$$\frac{dP}{P} = \frac{\sum_{i=1}^{n} ACC_i}{\sum_{i=1}^{n} TC_i} \qquad \text{(Equation 1)}$$

where

$$TC_i = R_{1i}\ (1-PM_1) \qquad \text{(Equation 2)}$$

and

$\frac{dP}{P}$ = industry-wide price increase

ACC_i = annual compliance cost of plant i

TC_i = total cost of goods sold for plant i

R_{1i} = pre-compliance sales revenue of plant i

PM_1 = industry average pre-compliance profit margin

n = total number of plants in the product group

The values of R_{1i} were collected in the EPA industry survey, and PM_1 represents an industry average estimate based on a review of corporate annual reports and analysis of industry level data from the Census of Manufactures and the Federal Trade Commission. The methodology for estimating PM_1 is explained in detail in Appendix A.

This price change algorithm implies some important dynamics in the interaction of competing firms in determining prices. Figure 2-2 illustrates how

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3/ Because of variation of unit compliance costs among plants in the industry some plants will be affected more than others by the regulations, as described in Figure 2-2.

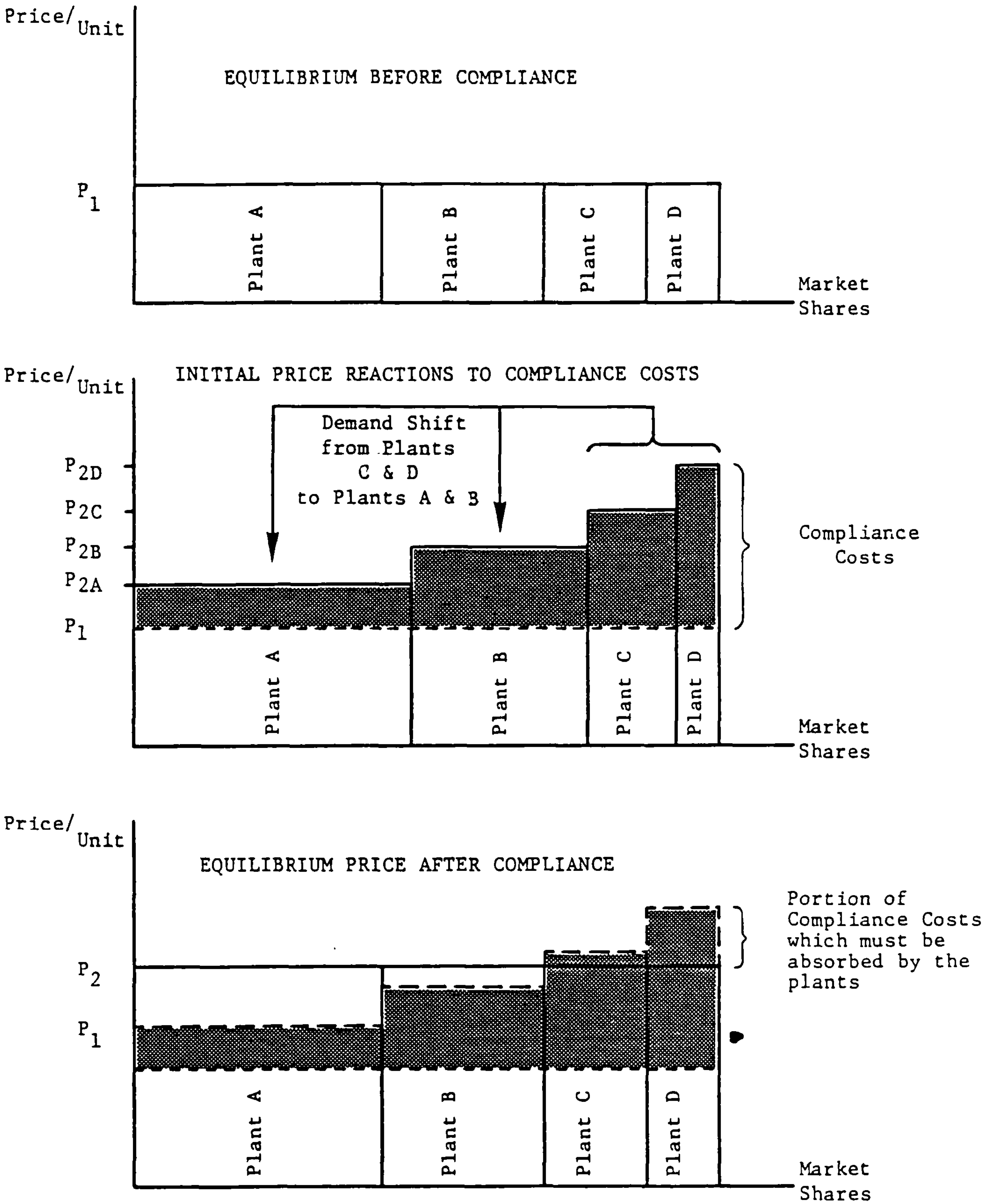

FIGURE 2-2. PRICE AND MARKET SHARE ADJUSTMENTS

the model assimilates the differential compliance costs of four plants producing a similar product. Assume initially that each plant will raise its price from P_1 by an amount equal to its compliance cost per unit of production. Demand would then tend to shift from plants C and D to plants A and B because their prices are now substantially less. As a result of this shift, plants C and D would be under pressure to lower their prices while plants A and B would be able to raise their prices. An equilibrium price, P_2, will be established, with plants C and D absorbing part of their compliance costs. In this manner, the model serves as the basis for estimating the price and production impacts for each product group as well as the basis for identifying plants that may have to absorb a significant portion of their cost of compliance.

Using the definition of price elasticity and the dP/P ratios calculated above, the rate of change in quantity demanded dQ/Q for each product group is determined as follows:

$$E = \frac{dQ}{Q} \div \frac{dP}{P} \qquad \text{(Equation 3)}$$

$$\frac{dQ}{Q} = \frac{dP}{P} \times E \qquad \text{(Equation 4)}$$

where E = Coefficient of price elasticity of demand.

Since all plants in an industry group would raise their prices by the group-wide price increase dP/P, it is initially assumed that each plant in a product group would experience the same proportionate reduction in quantity dQ/Q.

2.4 STEP 3: COST OF COMPLIANCE ESTIMATES

Engineering estimates of investment and annual compliance costs for three alternative treatment technologies were provided for 23 model plants by EPA. These cost estimates were used to estimate compliance costs for the remaining discharging plants in the industry to carry out the impact analysis. A summary description of the control and treatment technologies and assumptions for these compliance cost estimates appears in Chapter 6.

2.5 STEP 4: PLANT-LEVEL PROFITABILITY ANALYSIS

The assessment of the impact of the costs of the regulations on the profitability of individual plants is based on the two following measures:

- Plant after-compliance return on investment (ROI)
- Plant after-compliance net present value (NPV).

The following paragraphs refer to the plant as the decision unit. In fact, the later analyses use the nonferrous forming operations of a plant as a decision unit, since it is assumed that the wastewater from all of the plant's nonferrous metals forming operations will be cotreated in a single system, and therefore the company's assessment of profit impact or closure will relate to the plant's nonferrous metals forming operations. Similarly, instead of plant assets and plant profits, the specific analyses refer to estimated assets used in, and profits of, nonferrous metals forming operations.

2.5.1 Plant After-Compliance Return on Investment

Return on investment is defined as the ratio of annual profits before taxes to the total assets of a plant. This ratio is based on accounting income rather than cash flows and it does not account for the timing of cash flows, thereby ignoring the time value of money. However, this technique has the virtues of simplicity and common usage in comparative profitability analyses of financial entities. Because of lack of data on individual plant profits, and lack of evidence on the difference in profit rate among product groups, a single baseline rate of return on assets is assumed for all plants. Appendix A explains in detail the methodology for estimating the industry baseline profit.

The after-compliance ROI (ROI_{2i}) is estimated for each plant using the following equations:

$$ROI_{2i} = \frac{PROFIT_{2i}}{A_i + CCI_i} \quad \text{(Equation 5)}$$

$$PROFIT_{2i} = PROFIT_{1i} + DPROFIT_i \quad \text{(Equation 6)}$$

where $PROFIT_{1i}$ = Pre-compliance before-tax profit of plant i

$PROFIT_{2i}$ = After-compliance before-tax profit of plant i

$DPROFIT_i$ = Change in before-tax profit of plant i

A_i = Pre-compliance asset value of plant i

CCI_i = Compliance capital investment for plant i

The variables in Equation (6) are further defined as follows:

$$PROFIT_{1i} = R_{1i} \times PM_{1i} \quad \text{(Equation 7)}$$

$$DPROFIT_i = (R_{2i} - a_iP_{1i}Q_{2i} - FC_i - ACC_i) - (R_{1i} - a_iP_{1i}Q_{1i} - FC_i)$$

$$= (R_{2i} - R_{1i}) - (a_i \times E \times \frac{dP}{P} \times R_{1i}) - ACC_i \quad \text{(Equation 8)}$$

$$R_{2i} = R_{1i} \, (1 + \frac{dP}{P}) \, (1 + \frac{dP}{P} E) \quad \text{(Equation 9)}$$

where R_{1i} = Pre-compliance revenue of plant i

R_{2i} = After-compliance revenue of plant i

PM_{1i} = Pre-compliance return on sales of plant i

P_{1i} = Pre-compliance price of plant i

Q_{1i} = Pre-compliance production of plant i

Q_{2i} = After-compliance production of plant i

a_i = Variable cost to pre-compliance price ratio of plant i

FC_i = Fixed cost of production of plant i

ACC_i = Annual compliance cost of plant i

$\frac{dP}{P}$ = Product group price increase

E = Product group price elasticity coefficient of demand.

The values of Q_{1i} and R_{1i} were collected in the EPA industry survey, while dP/P is calculated by Equation (1) presented in Section 2.3. In the absence of plant-specific data, the values of A_i, PM_{1i} and a_i are product group averages estimated from the Census of Manufactures, Federal Trade Commission reports, company published financial data, and various inputs from industry sources. The methodology for estimating A_i and PM_{1i} is explained in detail in Appendix A. Finally, the demand price elasticity E is estimated in Chapter 4.

The estimated after-compliance ROI for a given plant does not, by itself, determine whether this plant is a viable operation and will continue operation or not. However, a plant's change in ROI due to regulation provides a measure of the relative impact and magnitude of the required pollution control expenditures.

2.5.2 Plant After-Compliance Net Present Value

The major measure of profit impact of the regulations is the after-compliance net present value (NPV). The NPV is defined as the plant discounted annual cash flows over a selected period of time less the initial capital investment and can be expressed by the following equation:

$$NPV = \sum_{t=1}^{n} A_t (1 + k)^{-t} + I_n (1 + k)^{-n} - I_o \qquad \text{(Equation 10)}$$

where

A_t = Annual cash flow in year t

I_o = Initial capital investment

I_n = Salvage value of investment at end of discounting period n

k = Discount rate (i.e., cost of capital)

n = Selected discounting period.

The plant NPV represents the excess of the discounted value (i.e., present value) of the projected cash flows from operating the plant over the liquidation value of the plant. A positive NPV indicates that the plant is earning a rate of return greater than its cost of capital and is considered a profitable and viable operation. On the other hand, a negative NPV means that the plant is not earning its cost of capital and should be liquidated.

Plant NPVs are calculated based on the following assumptions:

- Baseline initial capital investment is the liquidation value of plant assets (plant assets defined as net book value of fixed assets plus working capital). Appendix A explains the methodology for estimating the average liquidation value of plant assets.

- Annual cash flows A_t are constant and defined as

  $$A_t = PROFIT_t \times (1 - TAX) + DEP_t + INT_t - CE_t \qquad \text{(Equation 11)}$$

  where:

  $PROFIT_t$ = Before-tax profit in year t

  DEP_t = Annual depreciation (a non-cash expense) in year t

  INT_t = Interest expenses in year t

  CE_t = Annual capital expenditures in year t

  TAX = Tax rate.

- Annual capital expenditures for replacement of productive assets are equal to annual depreciation charges. Thus, the salvage value of productive assets at the end of year n will approximate the initial liquidation value.

- There are no annual investment expenditures for pollution control and the salvage value of the pollution control equipment will be zero at the end of year n.
- Pollution control equipment is financed with debt.
- Interest rate on debt is 12 percent.
- The cost of capital k is defined as the weighted average of cost of equity and cost of debt (before-tax). Assuming the cost of equity is 14 percent and interest rate is 12 percent, the average cost of capital of the nonferrous metals forming industry is estimated to be 12.6 percent (Appendix A).
- The selected discounting period is 10 years.

2.6 STEP 5: CAPITAL REQUIREMENTS ANALYSIS

In addition to analyzing the potential for plant closures from a profitability perspective, it is also necessary to assess the ability of firms to make the initial capital investment needed to construct and install the required treatment systems. Some plants which are not initially identified as potential closures in the profitability analysis may encounter problems raising the amount of capital required to install the necessary treatment equipment. The limit on a given firm's ability to raise capital to finance investment expenditures at a given plant is quite variable, depending upon factors such as the firm's capital structure, profitability, future business prospects, the industry's business climate, the characteristics of the financial markets and the aggregate economy, and the firm management's relationships with the financial community. The precise limit, considering all these factors, is ultimately judgmental. Even given firm-specific data, a limit on a firm's ability (or willingness) to raise funds for capital investment would be difficult to estimate.

In this study, the analysis of capital availability is based on the "fixed charge coverage" ratio which is defined as the ratio of earnings before interest and taxes to interest payments. The assumptions here are the same as those used in the profit impact analysis. The "fixed charge coverage" ratio does not provide precise or universal conclusions regarding a firm's ability to make the investments. However, this ratio provides a good indication of the relative burden created by the compliance requirement, and is often used by lenders to evaluate firm's ability to incur additional debt. Firms with after-compliance fixed charge coverage ratios greater than 2 are generally considered solvent and worthwhile credit risks. While this ratio is generally applied at the firm level, it is applied to individual plants in this study.

2.7 STEP 6: PLANT CLOSURE ANALYSIS

The plant level analysis examined the individual production units in each product group to determine the potential for plant closures and profitability changes. The decision to close a plant, like most major investment decisions, is ultimately judgmental. This is because the decision involves a wide variety of considerations, many of which cannot be quantified. Some of the most important factors are:

- Profitability before and after compliance
- Ability to raise capital
- Market and technological integration
- Market growth rate
- Other pending Federal, state, and local regulations
- Ease of entry into market
- Market share
- Foreign competition
- Substitutability of the product
- Existence of speciality markets.

Many of these factors are highly uncertain, even for the owners of the plants. However, this analysis is structured to make quantitative estimates of the first two factors, as described above, and to qualitatively consider the importance of some others. In this analysis, the first two factors are given the greatest amount of weight while the importance accorded the other factors varies from plant to plant.

2.8 STEP 7: OTHER IMPACTS

"Other impacts" include economic impacts which flow from the basic price, production, and plant level profitability changes. These impacts include impacts on employment, communities, industry structure, and balance of trade.

The estimate of employment effects follows directly from the outputs of the industry level analysis and the plant closure analysis. Employment data for production facilities projected to close are available from the EPA 308 Survey.

The community impacts considered are primarily those resulting from projected employment impacts. The critical variable is the ratio of projected unemployment in the nonferrous metals forming industry caused by the regulations to total employment in the community. Data on community employment are available through the Bureau of the Census and the Bureau of Labor Statistics.

The assessment of changes in industry structure is based on examination of the following, before and after compliance with the regulation:

- Numbers of firms and plants
- Industry concentration ratios
- Effects of plant closures on specialty markets.

A decrease in the first factor and an increase in the second would indicate an increase in industry concentration and could change the pricing behavior of the industry. Such potential changes were qualitatively evaluated.

Imports and exports can be important factors of pricing behavior in the nonferrous metals forming industry. The role of these variables is qualitatively evaluated in Chapter 4 of this report. Basically, impacts on imports and exports are a function of the change in the relative prices charged by domestic versus foreign producers. Therefore, the assessment of foreign trade impacts is based on the relative price effects.

2.9 STEP 8: NEW SOURCE IMPACTS

Newly constructed plants and plants undergoing substantial modifications will be subject to NSPS/PSNS guidelines. The effects these guidelines will have upon new plant construction in the nonferrous metals forming category are analyzed in this step.

For the purpose of evaluating new source impacts, compliance costs of new source standards are defined as incremental costs over the costs of the standards for existing sources. The impacts of new source regulations are then determined by comparing the incremental compliance costs of a model plant to its revenues and profit.

2.10 STEP 9: SMALL BUSINESS ANALYSIS

The Regulatory Flexibility Act (RFA) of 1980, (P.L. 96-354) which amends the Administrative Procedures Act, requires Federal regulatory agencies to consider "small entities" throughout the regulatory process. The RFA requires an initial screening analysis to be performed to determine if a substantial number of small entities will be significantly impacted. If so, regulatory alternatives that eliminate or mitigate the impacts must be considered. These objectives are addressed in this step by identifying the economic impacts which are likely to result from the promulgation of BPT, BAT, BCT, NSPS, PSES, and PSNS regulations on small businesses in the nonferrous metals forming category. The primary economic variables covered are those analyzed in the general economic impact analysis such as plant financial performance, plant closures, and unemployment and community impacts. Most of the information and analytical techniques in the small business analysis are drawn from the general economic impact analysis which is described above and in the remainder of this report. The specific conditions of small firms are evaluated against the background of general conditions in the nonferrous metals forming markets.

A specific problem in the methodology is the development of an acceptable definition of small entities. The Small Business Administration's standard definition of small entities is based on company size, and size is measured by the number of employees. However, alternative definitions can be used if they would be more appropriate. This report uses a definition of small business which is more consistent with the overall economic impact analysis of pollution control requirements, and which uses more readily available data: plants are used as the entities of analysis, rather than companies, and size is measured by production, rather than employees.

More specifically, because of economies of scale in pollution control technologies, unit compliance costs generally increase significantly as plant size decreases. Because the impacts of control requirements are more closely related to plants than companies and closure decisions are generally based on the profitability of a plant and information is collected on a plant basis, the basic analysis of impacts is done on the plant as a unit. In addition, pollutant loadings and the cost of waste treatment facilities tend to be more closely related to production than employment; hence, production is used as a measure of size.

For the nonferrous metals forming industry, several alternative size definitions for plants based on plant output volume are selected for examination. These are: plants with production less than 500,000 pounds, 1 million pounds, 2 million pounds, 3 million pounds, 5 million pounds, and 10 million pounds annually. The use of several different size definitions provides EPA with alternatives in defining small plants for purposes of regulation development.

The impacts on small plants under each definition are assessed by examining the distribution by plant size of the number of nonferrous metals forming plants, plant revenues, compliance costs and potential closures from regulations.

3. INDUSTRY DESCRIPTION

3.1 OVERVIEW

This chapter describes the operational characteristics of plants and firms in the nonferrous metals forming industry which are pertinent to determining behavior when faced with additional pollution control requirements. In subsequent chapters of this report this information is used to project general trends in the industry (Chapter 5) and to assess the potential economic impacts of the proposed regulations (Chapter 7).

The primary economic unit considered in this study is the individual nonferrous metals forming establishment or nonferrous metals forming product lines in a plant. This is the basic unit around which capital budgeting decisions are made. That is, a firm will make decisions regarding opening, closing, or modifying operations on a plant or product line level. In addition, financial and economic characteristics at the company and industry levels must be examined because they affect investment decisions at the plant level. By examining some basic industry parameters such as number, size, and location of plants and firms, employment, and financial characteristics, this chapter provides the basic descriptive information to be used to model the pertinent behavior characteristics which lead to plant closings and other economic impacts.

Nonferrous metals forming operations, as defined by EPA,[1/] are included in the following Standard Industrial Classification (SIC) codes:

3356 Rolling, Drawing, and Extruding of Nonferrous Metals, Except Copper and Aluminum,

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[1/] See Section 1.2 for definition of the category.

3357 Drawing and Insulating of Nonferrous Wire,

3463 Nonferrous Forgings

3497 Metal Foil and Leaf, and

33991 Metal Powders, Paste and Flakes.

With the exception of SIC 3356 and 33991, these Census groupings also include substantial amounts of economic activity not covered under EPA's definition of nonferrous metals forming. SIC 3357, for example, consists primarily of establishments engaged in the production of copper and aluminum wire, which is covered under other EPA categories. SIC 3463 includes aluminum forgings and SIC 3497 consists primarily of products made of aluminum foil; neither of these is covered by the proposed nonferrous metals forming regulations.

3.2 FIRM CHARACTERISTICS

According to the 1977 Census of Manufactures, there are approximately 800 establishments in the five SIC codes of interest. However, the Census data include copper and aluminum forming plants which are not part of this regulation. The EPA Industry Survey (conducted in 1983) identified 294 nonferrous product metals production facilities. Table 3-1 lists the number of firms, and nonferrous forming lines[2/] by technical subcategory and by discharge status.

Firms that perform nonferrous metals forming operations fall into one of three general groups:

- Diversified manufacturing companies such as Allegheny International, Litton Industries, and DuPont where metal forming for own use or sale to others is a small part of the total manufacturing process
- Large metal manufacturing companies such as Alcoa, Reynolds, Inco, Amax, and Asarco that form nonferrous metals as part of a broad line of processed or manufactured metal products offered for sale

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2/ For the purpose of this study, a plant's forming operations in each nonferrous metal forming subcategory are considered a product line.

TABLE 3-1. NUMBER OF NONFERROUS METALS FORMING FIRMS AND NFF* LINES

TECHNICAL SUBCATEGORY	NUMBER OF FIRMS	NUMBER OF NFF LINES	NUMBER OF DISCHARGING NFF LINES		
			TOTAL	DIRECT	INDIRECT
Lead/Tin/Bismuth	54	63	21	3	18
Nickel/Cobalt	56	73	40[c]	14[c]	28[c]
Zinc	10	10	3	1	2
Beryllium	1	1	1	1	0
Precious Metals	44	50	34[b]	7[b]	28[b]
Powder Metallurgy	54	60	23	3	20
Titanium	40	41	27[b]	12[b]	16[b]
Refractory Metals	28	52	35[c]	8[c]	29[c]
Zirconium/Hafnium	10	10	7[b]	4[b]	4[b]
Magnesium	8	8	4[b]	3[b]	2[b]
Uranium	2	2	2[b]	2[b]	1[b]
TOTAL NO. OF NFF LINES		370	197[d]	58[d]	148[d]
TOTAL NO. OF PLANTS[a]		294	146[e]	39[e]	114[e]

* NFF = Nonferrous Metals Forming

[a] Because of the existence of multi-product plants, the total number of plants is lower than the sum of a subcategories.

[b] One NFF line discharges both directly and indirectly.

[c] Two NFF lines discharge both directly and indirectly.

[d] A total of nine NFF lines discharge both directly and indirectly.

[e] Seven plants discharge both directly and indirectly.

SOURCE: EPA Industry Survey

- Specialized metals forming operations such as Kennametal, Driver-Harris, and Handy & Harman that produce a limited number of products, specializing either by metal or by type of product.

As shown in Table 3-2, production of nonferrous metals formed products does not appear highly concentrated at the 4-digit SIC level. At the 5-digit level, however, where products are more narrowly defined, the industry appears highly concentrated, with four-firm concentration ratios of 65 percent or greater in eight of the ten subcategories for which data are available. Eight-firm concentration ratios confirm this observation. In most of the 5-digit categories, over 90 percent of production is accounted for by eight firms. A good deal of this concentration is explained by the specialized nature of the products manufactured in this industry, a point discussed at greater length in Chapter 4.

3.3 FINANCIAL STATUS OF COMPANIES

To assess the financial status of the nonferrous metals forming companies, financial data were obtained for 31 firms whose financial statements are publicly available. Table 3-3 lists these companies, their equity to assets, return on equity and return on assets ratios for the 1980-1982 period. This table shows that firms in the nonferrous metals industry seem to be more debt leveraged than other firms as the majority of the 31 firms have lower equity investment than the all manufacturing average. Also, most of the producers of nonferrous metals forming products appear to be more profitable than other manufacturing companies during 1980-1982.

3.4 PLANT CHARACTERISTICS

EPA identified 294 nonferrous metals forming plants. Total employment for these nonferrous forming operations is estimated to be about 35,500 people.[3/]

[3/] EPA survey data reported total nonferrous forming employment of 201 responding plants to be about 24,300 people.

TABLE 3-2. CONCENTRATION RATIOS FOR NONFERROUS METALS FORMING, 1977

SIC	PRODUCT	TOTAL VALUE OF SHIPMENTS ($ million)	PERCENT ACCOUNTED FOR BY 4 LARGEST COMPANIES	8 LARGEST COMPANIES	20 LARGEST COMPANIES
3356	Nonferrous rolling & drawing, n.e.c.	$2,552.2	43	56	77
33561	Nickel and nickel-base alloy mill shapes	873.2	86	97	(D)
33562	Titanium mill shapes	250.7	82	96	100
33563	Precious metal mill shapes	686.9	79	92	100
33569	Other nonferrous metal mill shapes	662.1	27	43	73
33560	Nonferrous rolling & drawing, n.e.c., n.s.k.	78.8	(X)	(X)	(X)
3357	Nonferrous wire drawing & insulating	6,460.3[a]	37	52	74
33573	Other bare nonferrous metal wire	117.9	82	93	100
33570	Nonferrous wire drawing & insulating, n.s.k.	50.3	(X)	(X)	(X)
3463	Nonferrous forgings	540.4[b]	61	77	90
34635	Hot impression die impact nonferrous forgings	468.1[b]	65	82	95
34636	Cold impression die impact nonferrous forgings	8.5[b]	88	(D)	100
34637	Seamless rolled ring nonferrous forgings	15.9[b]	95	(D)	100

TABLE 3-2. CONCENTRATION RATIOS FOR NONFERROUS METALS FORMING, 1977 (Continued)

SIC	PRODUCT	TOTAL VALUE OF SHIPMENTS ($ million)	PERCENT ACCOUNTED FOR BY 4 LARGEST COMPANIES	8 LARGEST COMPANIES	20 LARGEST COMPANIES
34638	Open die or smith nonferrous forgings	36.8[b]	74	90	100
34630	Nonferrous forgings, n.s.k.	11.1[b]	(X)	(X)	(X)
3497	Metal foil & leaf	1,089.5[c]	43	58	78
34970	Metal foil & leaf, n.s.k.	21.6	(X)	(X)	(X)
3399	Primary Metal Products, n.e.c.	967.5	25	39	58
33991	Metal powders, paste, and flakes	702.2	34	52	76

(D) Withheld to avoid disclosing operations of individual companies.

(X) Not applicable.

n.e.c. Not elsewhere classified.

n.s.k. Not specified by kind.

[a] Most of the $6.4 billion in shipments by this industry are copper or aluminum wire products not covered by this EPA category.

[b] May include aluminum and copper forgings or alloys of aluminum and copper.

[c] Most of the $1.08 billion in shipments by this industry are aluminum foil products not covered by this EPA category.

SOURCE: Concentration Ratios in Manufacturing, 1977 Census of Manufactures. Volume 1.

TABLE 3-3. FINANCIAL CHARACTERISTICS OF SELECTED NONFERROUS METAL FORMING COMPANIES

	EQUITY TO ASSETS RATIO			AFTER-TAX RETURN ON EQUITY (%)			AFTER-TAX RETURN ON ASSETS (%)		
	1982	1981	1980	1982	1981	1980	1982	1981	1980
1. Alcoa	.52	.55	.57	(2.0)	6.6	13.1	(1.0)	4.2	7.5
2. Allegheny International	.34	.32	.35	7.3	10.8	13.9	2.5	3.5	4.9
3. Amax, Inc.	.47	.51	.52	(16.3)	8.2	17.3	(7.7)	4.2	9.0
4. Amsted Industries	.78	.77	.78	4.8	13.4	20.1	3.7	10.3	15.7
5. Asarco, Inc.	.45	.49	.64	(7.7)	4.9	18.1	(3.5)	2.4	11.6
6. Ball Corp.	.45	.42	.42	14.8	14.3	13.6	6.7	6.0	5.7
7. Cabot Corp.	.49	.48	.45	13.7	18.2	29.4	6.7	14.1	13.2
8. Carlisle Corp.	.64	.59	.53	18.2	26.7	24.7	11.6	15.8	13.1
9. Copperweld Corp.	.44	.46	.46	(2.6)	19.6	11.7	(1.1)	9.0	5.4
10. Curtiss-Wright Corp.	.70	.69	.69	9.5	25.2	14.1	6.7	17.4	9.8
11. Dow Chemical Co.	.43	.39	.38	6.8	11.5	18.1	2.9	4.5	6.9
12. Driver-Harris Co.	.15	.17	.34	(16.0)	(80.6)	(8.4)	(2.4)	(13.7)	(2.9)
13. DuPont	.46	.43	.61	8.4	13.7	12.8	3.9	5.9	7.8
14. Engelhard Corp.	.53	.53	.37	15.7	17.7	19.2	8.3	9.4	7.1
15. Federal-Mogul Corp.	.48	.45	.44	10.5	13.6	14.8	5.0	6.1	6.5
16. Handy & Harman	.35	.37	.28	6.6	18.2	24.9	2.3	6.7	6.9
17. Inco	.44	.43	.47	(13.5)	1.2	11.5	(6.0)	.5	5.4
18. Kennametal	.64	.65	.65	13.6	15.7	19.7	8.7	10.2	12.8
19. Litton Industries, Inc.	.44	.39	.36	18.8	21.9	24.9	8.3	8.5	9.0
20. Martin Marietta Corp.	.15	.47	.53	21.0	16.7	17.1	3.2	7.8	9.1
21. The Maytag Co.	.72	.83	.83	17.5	18.3	18.2	12.6	15.2	15.1
22. Olin Corp.	.58	.53	.48	6.6	11.7	4.6	3.8	6.2	2.2
23. Pfizer, Inc.	.53	.47	.46	16.9	7.8	16.2	9.0	3.7	7.5
24. Phelps Dodge Corp.	.49	.51	.49	(7.6)	6.4	8.9	(3.7)	3.3	4.4
25. Pitney Bowes, Inc.	.41	.42	.40	15.2	13.8	16.4	6.2	5.8	6.6
26. H.K. Porter Co., Inc.	.16	.24	.28	(12.4)	10.7	13.3	(2.0)	2.6	3.7
27. Quanex	.27	.47	.43	(38.8)	24.2	20.9	(10.5)	11.4	9.0
28. Reynolds Metals Co.	.41	.41	.42	.6	6.4	13.6	.2	2.6	5.7
29. Roper Corp.	.42	.40	.47	3.8	8.1	8.5	1.6	3.2	4.0
30. Teledyne, Inc.	.64	.59	.55	12.5	24.2	24.5	8.0	14.2	13.5
31. Texas Instruments, Inc.	.52	.55	.48	10.6	8.6	18.2	5.5	4.7	8.7
All Manufacturing Average	.48	.49	.49	(6.2)	10.4	14.0	(3.0)	5.1	6.9
No. of Firms Above All Manufacturing Average	13	12	11	24	21	19	26	18	17

SOURCES: Corporate Annual Reports and Federal Trade Commission, Quarterly Financial Report.

Survey response data obtained from 242 plants as presented in Table 3-4 show that many nonferrous plants (63) produced more than one type of nonferrous metal. The plants with most integration across the subcategories are the nickel/cobalt, titanium, and zirconium/hafnium plants, e.g., of the 66 nickel/ cobalt production lines, most (42) are in plants with two or more nonferrous metals forming lines.

Table 3-5 examines the pattern of integration of the discharging nonferrous metals forming plants. For costing purposes, as discussed in Chapter 6, four of the subcategories are grouped together (nickel/cobalt, titanium, refractory metals, and zirconium/hafnium). This table shows that there is a substantial degree of overlap among these categories; a relatively large number of plants produce a combination of metals from these subcategories. Plants in two other major subcategories--lead/tin/bismuth and powder metallurgy--tend to specialize in the products of a single subcategory.

Table 3-5 also shows the degree of integration of the nonferrous metals forming plants with operations being regulated by other regulations such as iron and steel, copper forming, aluminum forming and nonferrous metals manufacturing. There is a substantial overlap of the nickel/cobalt, titanium, refractory metals and lead/tin/bismuth forming operations with the iron and steel manufacturing, nonferrous metals manufacturing, and copper forming operations.

Plants engaged in forming nonferrous metals range from very small to very large. Table 3-6 presents the distribution of 1981 nonferrous metals forming value of shipments data for 194 plants which responded to the EPA industry survey. At the low end of the range, 31 plants with less than $1 million each in nonferrous forming shipments contributed 0.3 percent of the industry's total. At the other extreme, eight plants with shipments above $100 million provided 39.7 percent of the industry total. The large nonferrous forming plants also tend to be more specialized in the production of nonferrous formed products than the small plants: over 95 percent of the

TABLE 3-4. ANALYSIS OF PLANT INTEGRATION

TECHNICAL SUBCATEGORY	NUMBER OF LINES IN SAMPLE	NUMBER OF LINES IN SAMPLE NFF[a] PLANTS WITH 1 NFF LINE	2 NFF LINES	3 OR MORE NFF LINES
Lead/Tin/Bismuth	50	40	6	4
Nickel/Cobalt	66	24	28	14
Zinc	7	5	0	2
Beryllium	1	0	1	0
Precious Metals	45	25	12	8
Powder Metallurgy	47	37	8	2
Titanium	38	8	21	9
Refractory Metals	52	33	8	11
Zirconium/Hafnium	10	1	4	5
Magnesium	8	5	2	1
Uranium	2	1	0	1
TOTAL LINES IN SAMPLE	326	179	90	57
TOTAL PLANTS IN SAMPLE	242[b]	179	45[b]	18[b]

[a] NFF = Nonferrous Metals Forming.
[b] Because of the existence of multi-product plants, the total number of plants is lower than the sum of all categories.

SOURCE: EPA Industry Survey.

TABLE 3-5. OVERLAP OF NONFERROUS METALS FORMING SUBCATEGORIES - DISCHARGING PLANTS

NUMBER OF LINES	NICKEL/ COBALT	TITANIUM	REFRACTORY METALS	ZIRCONIUM/ HAFNIUM	LEAD/ TIN/ BISMUTH	PRECIOUS METALS	POWDER METAL	ZINC	MAGNESIUM	URANIUM	BERYLLIUM
Number of Lines	40	27	35	7	21	34	23	3	4	2	1
Overlap with other NFF Subcategories:											
Nickel/Cobalt	-	14	10	3	1	6	4	1	1	0	1
Titanium	14	-	6	6	0	1	0	0	3	1	0
Refractory Metals	10	6	-	3	0	8	0	0	1	1	0
Zirconium/Hafnium	3	6	3	-	0	0	0	0	0	0	0
Lead/Tin/Bismuth	1	0	0	0	-	4	0	1	0	0	0
Precious Metals	6	1	8	0	4	-	1	1	0	0	0
Powder Metallurgy	4	0	0	0	0	1	-	0	0	0	0
Zinc	1	0	0	0	1	1	0	-	0	0	0
Magnesium	1	3	1	0	0	0	0	0	-	0	0
Uranium	0	1	1	0	0	0	0	0	0	-	0
Beryllium	1	0	0	0	0	0	0	0	0	0	-
Overlap with Other Categories:											
Iron & Steel	26	12	8	0	3	4	1	1	2	0	0
Copper Forming	9	2	0	1	6	2	0	1	0	1	1
Aluminum Forming	2	3	1	0	2	3	1	0	2	0	1
NFM*	3	4	9	2	6	5	0	0	0	1	1

* NFM - Nonferrous Metals Manufacturing, Phase I and Phase II.

SOURCE: EPA Industry Surveys.

TABLE 3-6. DISTRIBUTION OF PLANTS BY NONFERROUS METALS FORMING VALUE OF SHIPMENTS

PLANTS WITH NFF* VALUE OF SHIPMENTS ($ million)	NUMBER OF PLANTS (NUMBER)	NUMBER OF PLANTS (%)	NFF* VALUE OF SHIPMENTS ($ MILLION)	NFF* VALUE OF SHIPMENTS (%)	TOTAL PLANT VALUE OF SHIPMENTS ($ MILLION)	NFF* TO TOTAL PLANT VALUE OF SHIPMENTS (%)
1 or less	31	16.0	10.3	0.3	301.9	3.4
1 - 2	25	12.9	34.1	0.9	340.3	10.0
2 - 5	31	16.0	109.5	3.0	488.2	7.6
5 - 10	31	16.0	225.0	6.2	672.0	33.5
10 - 20	34	17.5	495.4	13.6	1,077.6	46.0
20 - 50	26	13.4	681.1	18.7	1,469.9	46.3
50 - 100	8	4.1	641.7	17.6	964.3	66.5
100 - more	8	4.1	1,449.3	39.7	1,507.3	96.2
TOTAL	194	100.0	3,646.3	100.0	6,821.5	53.5

*NFF = Nonferrous Metals Forming.

SOURCE: EPA Industry Survey.

revenues of plants with over $100 million in shipments are nonferrous products while nonferrous forming operations account for less than 10 percent of total revenues of plants with nonferrous shipments less than $5 million.

Data showing the distribution of plants by employment categories are presented in Table 3-7. Most of the industry's plants have relatively few employees: of 201 plants with survey response data, 98 (49 percent) and 141 (70 percent) had fewer than 50 and 100 nonferrous metals workers, respectively.

Table 3-8 shows the value of shipments by type of nonferrous product for 179 plants that reported this information in the EPA industry survey.[4/] Titanium, nickel/cobalt, precious metals, and refractory metals are the largest subcategories. They accounted for approximately 80 percent of total value of shipments.

Finally, Table 3-9 presents the geographic distribution of the nonferrous metals forming plants. Production is heavily concentrated in the New England, Middle Atlantic, and East North Central regions where approximately 70 percent of the establishments are located. Furthermore, almost all of the plants in these 3 regions are concentrated in 7 states: Connecticut, Massachusetts, New Jersey, New York, Pennsylvania, Illinois and Ohio. Significant concentration of production facilities is also found in California, where 27 plants are located.

[4/] An additional 15 plants reported plant total nonferrous forming value of shipments; data for these plants are shown in Table 3-6. However, value of shipments for each type of metal produced at these plants was not submitted and these 15 plants are not included in Table 3-8.

TABLE 3-7. DISTRIBUTION OF NONFERROUS METALS FORMING ESTABLISHMENTS BY EMPLOYMENT CATEGORIES, 1981

PLANTS WITH GIVEN NO. OF NFF* EMPLOYEES	NUMBER OF PLANTS		NUMBER OF NFF* EMPLOYEES		NFF* VALUE OF SHIPMENTS	
	(NUMBER)	(%)	(NUMBER)	(%)	($ MILLION)	(%)
1-9	31	15.4	132	0.5	50.0	1.4
10-19	19	9.5	280	1.2	82.6	2.4
20-49	48	23.9	1,558	6.4	334.5	9.6
50-99	43	21.4	3,002	12.3	421.8	12.2
100-199	28	13.9	4,189	17.2	379.4	10.9
200-499	21	10.4	6,213	25.6	647.0	18.6
500 or more	11	5.5	8,943	36.8	1,555.2	44.8
TOTAL	201	100.0	24,317	100.0	3,470.5	100.0

*NFF = Nonferrous Metals Forming.

SOURCE: EPA Industry Survey.

TABLE 3-8. NUMBER OF PRODUCTION FACILITIES, AND VALUE OF SHIPMENTS BY PRODUCT GROUP, 1981

PRODUCT	NUMBER OF PRODUCTION FACILITIES WITH VALUE OF SHIPMENTS DATA[a]	VALUE OF PRODUCT SHIPMENTS[a] ($ million)
Lead/Tin/Bismuth	38	$289.9
Nickel/Cobalt	51	681.1
Zinc	6	33.5
Beryllium	1	(a)
Precious Metals	29	648.5
Powder Metallurgy	35	212.1
Titanium	30	884.1
Refractory Metals	33	480.2
Zirconium/Hafnium	10	126.5
Magnesium	9	44.0
Uranium	1	(a)
	179[b]	$3,429.1

(a) Withheld to avoid disclosure of confidential data.

[a] Includes only plants for which value of shipments are reported by type of metal produced. Hence, the total value of shipments here is less than that reported in Table 3-6.

[b] Because of the existence of multi-products plants, the total number of plants is lower than the sum of all categories.

SOURCE: EPA Industry Survey.

TABLE 3-9. GEOGRAPHIC DISTRIBUTION OF NONFERROUS METALS FORMING PLANTS

GEOGRAPHIC AREA	NO. OF PLANTS	% OF TOTAL
New England		
Connecticut	19	6.5
Maine	1	0.3
Massachusetts	18	6.1
Rhode Island	6	2.0
Middle Atlantic		
New Jersey	29	9.9
New York	23	7.8
Pennsylvania	40	13.6
East North Central		
Illinois	23	7.8
Indiana	5	1.7
Michigan	13	4.4
Ohio	20	6.8
Wisconsin	6	2.0
West North Central		
Missouri	4	1.4
Other*	3	1.0
South Atlantic		
Georgia	4	1.4
North Carolina	7	2.4
Other*	6	2.0
East South Central		
Alabama	3	1.0
Kentucky	7	2.4
Mississippi	1	0.3
Tennessee	5	1.7
West South Central		
Arkansas	3	1.0
Texas	7	2.4
Other*	3	1.0
Mountain	4	1.4
Pacific		
California	27	9.2
Washington	4	1.4
Oregon	2	0.7
Puerto Rico	1	0.3
TOTAL	294	100.0

* Indicates states with one or two plants each.

SOURCE: EPA 308 Industry Survey.

4. MARKET STRUCTURE

The primary determinants influencing the demand for nonferrous metals formed products are described in this chapter. These determinants include the end-use markets, prices, competitive products, price elasticity, and imports and exports. Data are presented in this chapter for each of the eleven subcategories into which the industry has been divided. This information is used in Chapter 5 to project the demand for nonferrous metals formed products and to describe the expected characteristics of the industry in the 1985-1990 period, and in Chapter 7 to estimate the potential economic impacts of the proposed regulation.

Production data for recent years presented below for the individual subcategories show that the downturn in 1981-1982 in the economy had a significant effect on the demand for most of the individual metals. Because this effect was common to so many of the product subcategories, the main emphasis is on examining the end-use markets and making inferences about price elasticity. For most of the metals, their uses depend on particular properties of the metals and are quite specialized; hence, the price elasticities are judged generally to be quite low.

4.1 LEAD/TIN/BISMUTH FORMING

This subcategory includes lead, tin, and bismuth forming. Three major products are formed from these metals: ammunition, solder, and insulated copper cable. Ammunition is made by extrusion and swaging; solder is formed by extrusion and drawing; and insulated cable is made by extruding lead, tin, and bismuth over copper cable. According to the EPA industry survey there are 63 plants owned by 54 companies that produce lead, tin, and bismuth formed products.

4.1.1 Lead Forming

Lead is soft, heavy, malleable, and corrosion-resistant. Lead is produced in several forms, including ingots, pigs, sheet, foil, powder, wool, shot, coatings, pigments, laminates, extrusions, and castings. About 20 percent of the total consumption of lead in 1980 and 1981 was accounted for by lead formed products (see Table 4-1).

Transportation. Lead is used to balance automobile and trailer wheels. Lead alloys are also used for bearings, where their qualities of lubrication and resistance to wear are important.

Construction. This industry segment consumes lead in roofing, flashing, piping, and caulking. Lead sheets are used as a sound barrier in partitions and ceilings of office, school, and hotel buildings. Lead sheets are also used for radiation shielding and vibration dampening. Sheet lead is also used in the chemical industry to provide corrosion protection for process vessels and transportation equipment.

Communication. This industry segment has long used lead cable coverings to protect underground and underwater cables from corrosion or moisture.

Ammunition. Lead ammunition is used in military ordnance and it is a major metal used for sporting ammunition in the form of shot and small-caliber bullets.

Packaging and Canning. Lead foil and sheet are used to package radioactive materials for shipment and storage. The canning industry also uses lead-tin solder for sealing tin-coated steel cans.

The U.S. producer price of lead, which influences the price of lead forming products, has been declining since 1979. Table 4-2 summarizes the trend in the price of lead. The decline in the price of lead from 52.6 cents per pound in 1979 to 27.0 cents per pound in 1982 is the result of

TABLE 4-1. CONSUMPTION OF LEAD
(metric tons)

PRODUCT	1980	1981
Lead Forming Products		
Ammunition	48,662	49,514
Solder	41,366	29,705
Bearing metals	7,808	6,922
Casting metals	19,021	18,582
Extruded products	8,597	8,829
Sheet lead	19,796	19,355
Brass and bronze	13,981	13,306
Cable covering	13,408	12,072
Caulking lead	5,684	5,522
Subtotal	178,323	163,807
Other Lead Products[a]	667,721	789,900
Total Lead Products	846,044	953,707

[a] Products that are not covered in this industry subcategory such as lead storage batteries, leaded gasoline, and lead-based paint.

SOURCE: Compiled from the U.S. Department of Interior, Bureau of Mines, Minerals Yearbook-Lead, 1981.

TABLE 4-2. NEW YORK PRODUCER LEAD PRICES
(cents per pound)

YEAR	PRICE
1975	21.53
1976	23.10
1977	30.70
1978	33.65
1979	52.64
1980	42.46
1981	36.53
1982	27.00

SOURCE: Charles River Associates, Economic and Environmental Analysis of Current OSHA Lead Standards, CRA Project No. 536.60.

the fall in the demand for lead because of the 1981-1982 recession. Prices for lead products are expected to remain low for some time because large inventories of lead exist and because of the fall in demand for lead, resulting from Government regulations which curtail the uses of lead in gasoline and paint.

Table 4-3 shows that the United States exported more lead products than it imported in the period 1979-1981. Exports consist mainly of scrap lead and imports mainly of lead bars and pigs, rather than formed products.

Major substitutes for lead forming products include plastics, galvanized steel, copper, and aluminum. In construction and building equipment uses, copper, plastic, and cement-asbestos piping are substitutes for lead piping. Stainless steel, titanium, plastics, and cement are substitutes for lead in corrosive chemical environments. Steel is, to some degree, being substituted for lead shot in ammunition as an environmental measure to protect waterfowl. Plastics, aluminum, tin, and glass are substitutes for lead in tubes and containers.

The price elasticity of demand for lead forming products is expected to be inelastic (in the short run) even though substitutes for lead products exist.

4.1.2 Tin Forming

In recent years, the consumption of tin has been about 50,000 tons per year. The annual consumption in 1982 decreased about 2 percent from the 1981 level of 54,457 tons. The Bureau of Mines estimated the apparent consumption of tin to be 48,000 tons in 1983.

Tin is used in various industrial applications and fabricated into different forms including worked and other forms, tin plate, tin or tin alloy coatings, and tin alloys (solder). Generally, tin is used in or on a

TABLE 4-3. U.S. EXPORTS AND IMPORTS OF LEAD PRODUCTS BY YEAR
(metric tons)

	1979	1980	1981
Exports:			
Unwrought lead	6,585	147,356	14,484
Unwrought alloys	795	9,144	2,320
Sheet, plates, rods, other forms	2,349	7,522	5,966
Foil, powder, flakes	917	436	550
Scrap	119,748	119,651	59,419
Total Exports	130,394	284,109	82,739
Imports:			
Ore	44,401	29,615	27,206
Base bullion	1,681	296	449
Pigs and bars	182,550	81,300	100,108
Sheet, pipe, and shot	215	950	474
Reclaimed scrap	4,006	2,868	2,661
Total Imports	232,853	115,029	130,898

SOURCE: U.S. Department of Interior, Bureau of Mines, Minerals Yearbook-Lead, 1981.

manufactured product in extremely small amounts. Some of the more important uses of tin forming products include:

Worked and Other Forms. Tin is worked into several forms such as foil, wire, sheet, and tubes. Tin foil is used for electrical condensers, bottle cap liners, gun charges, and wrappings for food. Tin wire is used for fuses and safety plugs. Extruded tin pipe and tin-lined brass pipe are used for conveying drinking water and carbonated beverages. Collapsible tubes, extruded from slugs of tin, are used for packaging pharmaceutical products, food, and artist paints.

Solder. This is generally a tin-lead alloy (or tin-lead-bismuth alloy). The tin composition varies from 2 percent tin and 98 percent lead in container seaming to 63 percent tin and 37 percent lead for most electrical connections. The major uses of solder are in auto radiators, air conditioners, heat exchangers, plumbing and sheet joining, container seaming, and electrical connections in radio and televisions, generating equipment, telephone wiring, electronic equipment, computers, and aerospace equipment. This product group uses substantial amounts of secondary tin and primary tin.

Other major uses of tin are in cans and containers, electrical equipment, construction, and transportation equipment. Table 4-4 summarizes the proportion of tin used by the major end-use markets in 1982.

Table 4-5 shows the trends in the price of tin over the 1970-1982 period. The average New York market price for tin in 1982 was $6.20 per pound, which was down from the 1980 high of $7.86. This price decline was due to the oversupply of tin relative to demand.

Substitutes for tin include steel, plastics, aluminum, lead, bismuth, and nickel. Aluminum has made significant inroads into container markets which traditionally used large amounts of tin. In 1976, tinplated steel cans accounted for 73 percent and aluminum for 27 percent of the total shipments of 83 billion metal cans. However, by 1982, of a total of 89.3 billion cans

TABLE 4-4. TIN FORMING PRODUCTS END-USE MARKETS, 1982

Can and containers	25%
Electrical	17%
Construction	13%
Transportation	13%
Other	32%
	100%

SOURCE: Bureau of Mines, Mineral Commodity Summaries 1983.

TABLE 4-5. TIN PRICE TRENDS (1970-1982)

YEAR	PRICE N.Y. (¢/lb)
1970	174.14
1971	167.37
1972	177.46
1973	227.22
1974	396.26
1975	339.57
1976	374.68
1977	533.26
1978	589.24
1979	707.29
1980	785.73
1981	680.43
1982	620.43

SOURCE: American Metal Market, Metal Statistics 1983, New York.

shipped, tinplated steel cans accounted for only 41 percent and aluminum accounted for 59 percent.

The demand for tin forming products is thought to be price-inelastic. This results even though there are many substitutes for tin, because the price of tin is small relative to the price of the final products. For example, as little as 2 percent tin (98 percent lead) is used in container seaming. Tin alloyed tubes in packaging toothpaste and artist paints also represent a small portion of the cost of the final product. As a result, modest changes in the price of tin would have a very small impact on the total costs of tin alloyed products.

4.1.3 Bismuth Forming

In recent years, the total annual consumption of bismuth has ranged from 1.8 to 2.7 million pounds. The Bureau of Mines estimated that the 1983 consumption of bismuth would be about 2.2 million pounds. The main use in formed products is in fusible alloys (solder) and as a metallurgical additive; these formed products account for one-third to one-half the total consumption (see Table 4-6).

The price of bismuth has continued to remain low. The average price in 1982, according to American Metal Market, was $1.74 per pound and this price fell to $1.33 by December of 1983. Prices are expected to remain low because of the slack demand for bismuth products.

Lead, tin, and bismuth substitute for each other, to some degree, in solder and other alloyed products. Plastics substitute for bismuth alloys in some applications. Tellurium can replace bismuth as a steel additive, and iron, phosphorous, and potassium can be used for bismuth as a catalyst for production of acrylonitrile. However, in general, the demand for bismuth forming products is expected to be price-inelastic because bismuth represents a small portion and cost of the final product.

TABLE 4-6. BISMUTH METAL CONSUMED IN THE U.S., BY USE
(pounds)

USE	1978	1979	1980	1981	1982[a]
Fusible alloys	836,021	721,043	650,895	656,956	470,751
Metallurgical additives	485,284	703,770	467,939	307,028	113,108
Other alloys	21,774	22,029	26,484	25,953	21,384
Pharmaceuticals[b]	1,149,683	1,248,656	1,115,615	1,387,554	1,204,680
Experimental	558	3,153	1,197	214	200
Other	18,556	28,502	26,677	15,004	10,000
Total	2,511,876	2,727,153	2,288,807	2,392,709	1,820,123

[a] Preliminary estimates.

[b] Includes industrial and laboratory chemicals and cosmetics.

SOURCE: American Metal Market, Metal Statistics 1983.

4.2 NICKEL/COBALT FORMING

EPA identified 73 plants owned by 56 companies that produce nickel and cobalt formed products. Nickel and cobalt have similar appearances and both are used in the production of high-temperature alloys and hard alloys resistant to abrasion. Both metals are generally formed at the same plants (19 of the 20 known cobalt plants also form nickel) using identical processes and, very often, the same equiment.

4.2.1 Nickel Forming

The domestic consumption of nickel declined from 197,000 tons in 1981 to 174,000 tons in 1982. This was the third consecutive year that the consumption declined because of depressed end-use markets. The major consumption of nickel is in the production of stainless and alloy steel and nonferrous alloys. The major end-uses of alloys containing nickel are in the transportation, chemical, electrical equipment, and construction industries. Nickel forming products include alloys in ingot, bars, plates, sheets, and tubes. The price of nickel has been falling because of the depressed markets for these products during the 1980 and 1982 recessions. The output and prices of nickel forming products are highly cyclical because nickel formed products are used in highly cyclical industries.

Substitutes for nickel include cobalt, aluminum, coated steel, titanium, and plastics. However, substitution of these products results in increased costs or some sacrifice in the performance of the product. For these reasons, the price elasticity of demand for nickel is fairly low.

4.2.2 Cobalt Forming

In 1981, the value of shipments of cobalt formed products was $30.7 million, and employment totaled 2,777 workers. Since 1979 the domestic consumption of cobalt has been falling. The apparent consumption (i.e., production plus net imports) of cobalt (including alloying applications) dropped to a low of 5,500 tons in 1982, from a high of 9,403 tons in 1979. Domestic consumption decreased, especially in superalloys (i.e., extremely hard alloys) and cutting and wear-resistant materials.

Superalloys, which are used by the aircraft industry, accounted for about 37 percent of the reported cobalt consumption in 1982. Other major end-use markets include the electrical industry sector which accounted for about 16 percent, and the machinery industry sector which consumed about 16 percent of cobalt.

The price of cobalt products has been falling in recent years mainly because of depressed markets. The cobalt cathode price dropped from a high of $25 per pound in 1980 to $12.50 in 1982.

Nickel may be substituted for cobalt in several applications but only with a loss of effectiveness. Other substitutes for cobalt include platinum, tungsten, copper, and chromium. The demand for cobalt is price-inelastic for these reasons.

4.3 ZINC FORMING

According to the EPA industry survey there are 10 zinc forming plants in the U.S. In 1981, the value of shipments of zinc forming products was $33.5 million and these plants employed 424 workers.

Zinc products are used extensively in the transportation and construction industries. Zinc consumption decreased significantly in 1982, because of the decline in construction activity and the lowest level of automobile production in the U.S. in 20 years. Table 4-7 shows the major end-use markets for zinc in 1982.

Construction. This industry is the major market for galvanized steel that is used for structural steel, roofing, siding, guttering, and reinforcing bars. Galvanized sheet is the standard duct material for air conditioning,

TABLE 4-7. ZINC MAJOR END-USE MARKETS, 1982

Construction	40%
Transportation	20%
Machinery	12%
Electrical and Chemical	15%
Other	13%
	100%

SOURCE: Bureau of Mines, Mineral Commodity Summaries 1983.

ventilation, and heating systems, and is used for channels and conduits for electrical and telephone wires in larger buildings. Zinc oxide is used in the production of oil-based paints, and in some latex paints to prevent mildew. Among products that fall under the forming category, zinc dust paints are growing in importance for primers and for structural steel.

Transportation. This industry, which includes automobiles, aircraft, ships, buses, trucks, trailers, motor scooters, bicycles, railway roofing equipment, and massive belt conveyor systems, is an important consumer of zinc products for galvanized steel sheet, zinc oxide, and die-casting alloys. In recent years there has been significant growth in the use of galvanized automobile underbody parts to overcome corrosion problems caused by deicing salts used in winter. About one-half of the total consumption of zinc oxide is for rubber manufacture, which is used in automobile tires. The largest single use of zinc is in die-casting for automobile components, which falls into the forming category.

The machinery, electrical, and chemical industries also are important consumers of zinc forming products. Rolled zinc serves small but important markets for dry cell battery uses, weatherstripping, and lithographic plates. Zinc products are also used as protective coatings for ship hulls, offshore oil drilling and production platforms, and submerged steel work and pipes.

The demand and prices for zinc products correlate with economic activity in the economy. As a result, during periods of economic decline such as the recession of 1981-1982, demand and price for zinc products fell. According to the U.S. Bureau of Mines, the demand for zinc products was expected to increase to about 1 million tons in 1983.

Aluminum and magnesium are the major substitutes for zinc. Plastic coating, paints, electroplated cadmium, and special zinc-aluminum coatings can replace zinc for corrosion protection in some areas. The price of zinc relative to that of aluminum and plastics and the public preference for metal parts because of their durability are major factors affecting the continued use of zinc. The demand for zinc forming products is fairly price-elastic, because several good substitutes exist for this product.

4.4 BERYLLIUM FORMING

Beryllium products are formed by only two firms in the United States: Brush Wellman, Inc., which controls the only domestic deposits from which beryllium-bearing ores are currently mined, and the Cabot Berylco Division of the Cabot Corp., which uses imported beryl ores for its production.

Beryllium is the third lightest metal, with a density two-thirds that of aluminum. Only magnesium and lithium are lighter. Other properties of beryllium include high strength, high thermal conductivity, and neutron moderating and reflecting capability. According to the U.S. Bureau of Mines, major markets for beryllium are:

Metal in nuclear reactors and aerospace applications	38%
Alloy and oxide in electrical equipment	36%
Alloy and oxide in electronic components	17%
Other (compounds and metal)	9%.

Specific uses include military aircraft brake systems, missile re-entry body structures, missile guidance systems, mirrors and optical systems, satellite structures, and X-ray windows.

The total tonnage of beryllium used is quite small; the Bureau of Mines estimates that 325 tons of beryllium oxide, alloy, and metal will be consumed in the United States in 1983. Consumption declined from 1971 to 1976 because of reductions in defense and aerospace demand, but since 1976, consumption has returned to the levels of the late 1960s and early 1970s (see Table 4-8). Prices have also increased since 1976, from $75 to $194 per pound.

Because of beryllium's high price, it tends to be used in products where adequate substitutes are not available. According to the Bureau of Mines,

TABLE 4-8. PRICE AND CONSUMPTION TRENDS FOR BERYLLIUM

YEAR	PRICE ($/lb, domestic, metal)	APPARENT CONSUMPTION (tons)
1969	60	339
1970	60	380
1971	60	415
1972	60	311
1973	70	348
1974	75	209
1975	75	176
1976	75	51
1977	109	67
1978	120	271
1979	120	303
1980	140	321
1981	173	303
1982	194	328

SOURCE: U.S. Bureau of Mines, Mineral Commodity Summaries.

"Steel, titanium, or graphite composites may be substituted for beryllium-copper alloys, but with substantial loss of performance." International trade occurs primarily in beryllium-bearing ores rather than in formed products. Thus, price elasticity of demand is thought to be low.

4.5 PRECIOUS METALS FORMING

The precious metals subcategory includes the forming of gold, silver, and the platinum group metals, all of which are usually formed at any single plant. Precious metal mill shapes were produced by 44 firms at 50 establishments. As Table 4-9 shows, shipments rose from $687 million in 1977 to $1,042 million in 1981, a 52 percent increase. Of the 1977 total, 46 percent was accounted for by gold, 36 percent by silver, and 18 percent by other (Table 4-10).

Most precious metals are easily worked, and are available in a variety of shapes and forms (sheet, foil, wire, gauze, discs, and salts or solutions for plating and coating). They are almost completely resistant to corrosion and are also excellent conductors of electricity.

Because they have a variety of end-uses that differ from one metal to the next, this section will discuss each precious metal (gold, silver, and the platinum group) separately.

4.5.1 Gold

Gold is fabricated by about 3,000 U.S. firms, according to the U.S. Bureau of Mines. Most of these fabricators produce articles for jewelry, art, and dental applications using methods that are not covered by this regulation; it is estimated that only 16 firms carry out gold forming operations covered by the regulation.

TABLE 4-9. PRECIOUS METAL MILL SHAPE SHIPMENTS, 1972-1981

YEAR	VALUE OF SHIPMENTS ($ million)
1972	364.0
1973	487.2
1974	531.7
1975	474.8
1976	529.9
1977	686.9
1978	737.8
1979	959.6
1980	894.7
1981	1,042.3

SOURCES: 1981 Annual Survey of Manufactures and 1977 Census of Manufactures.

TABLE 4-10. NUMBER OF FIRMS AND VALUE OF SHIPMENTS OF PRECIOUS METAL MILL SHAPES, BY METAL, 1977

METAL TYPE	NO. OF FIRMS[a]	VALUE OF SHIPMENTS
Gold	16	$343.7
Silver	15	273.6
Platinum	8	123.9 (Platinum and Other combined)
Other	9	
n.s.k.[b]	NA	10.5

[a] Data not available for firms with shipments below $100,000.

[b] n.s.k. = Not specified by kind.

NA = Not available.

SOURCE: 1977 Census of Manufactures.

Apparent consumption for all uses in 1982 was 3.80 million ounces (237,500 pounds) with a value of $1.5 billion. Major uses were:

Jewelry and arts	61%
Industry (mainly electronics)	29%
Dental	9%
Small bars, etc., mainly for investment	1%1/

Gold is an extremely soft metal. Because of its softness, it is generally alloyed with other metals or used in linings or electrodeposits. The high price of gold encourages its sparing use, and the metal's ability to be worked into extremely thin layers makes economical use of the metal possible (one gram of gold can be worked into leaf covering six square feet).

Gold products have several substitutes, including palladium, platinum and silver. Base metals clad with gold alloys are increasingly used in electrical and electronic applications. Nevertheless, the good substitutes for gold virtually all use gold itself in lesser quantities or some other member of the precious metals group. As a result, producers of formed gold products face low price elasticity of demand.

4.5.2 Silver

Silver is the least expensive of the precious metals. It has the highest thermal and electrical conductivity of all metals. Like other precious metals, it is easily formed and corrosion-resistant.

Reported U.S. industrial consumption of silver in 1982 totaled 125.0 million ounces (7.8 million pounds), valued at $1.0 billion. As Table 4-11 shows, industrial consumption of silver, has declined fairly consistently since 1973. End-uses of silver, according to the U.S. Bureau of Mines, are:

1/ Source: Mineral Commodity Summaries, 1983.

TABLE 4-11. PRICE AND INDUSTRIAL CONSUMPTION OF SILVER, 1978-1982

YEAR	PRICE ($ per oz.)	REPORTED INDUSTRIAL CONSUMPTION (million oz.)
1969	$ 1.79	141.5
1970	1.77	128.4
1971	1.54	129.1
1972	1.68	151.1
1973	2.56	195.9
1974	4.72	177.0
1975	4.42	157.7
1976	4.35	170.6
1977	4.62	153.6
1978	5.50	160.2
1979	11.09	157.3
1980	20.63	124.7
1981	10.52	116.6
1982	8.00	125.0

SOURCE: Mineral Commodity Summaries.

Photography	39%
Electrical and electronic products	29%
Silverware and jewelry	14%
Brazing alloys and solders	7%
Other	11%.

Silver products have many substitutes but silver demand "appears relatively price inelastic" according to the U.S. Bureau of Mines. To a large extent, the low elasticity may be accounted for by two factors: (1) a scarcity of substitutes for most silver uses in photography; and (2) the high value of final products compared to the value of the silver content. Substitutes in forming uses include aluminum and rhodium for reflecting surfaces, tantalum in surgical applications, stainless steel for flatware, and various other metals in batteries and other electrical and electronic applications.

4.5.3 Platinum Group Metals

Six metals make up the platinum group: iridium, osmium, palladium, platinum, rhodium, and ruthenium. These metals are grouped because they occur naturally in the same ore. As shown in Table 4-12, two of the metals (platinum and palladium) account for over 90 percent of U.S. consumption of the group. Only these two will be regulated under the nonferrous metals forming category.

For the group as a whole, the major markets are:

Automotive	32%
Electrical	26%
Dental and Medical	14%
Chemical	12%
Petroleum	6%
Jewelry and Decorative	2%
Glass	2%
Miscellaneous	6%.[2]

[2] 1983 U.S. Industrial Outlook.

TABLE 4-12. PLATINUM-GROUP METALS SOLD TO CONSUMING INDUSTRIES IN THE U.S., 1977-1982
(000 troy ounces)

YEAR	PLATINUM	PALLADIUM	RHODIUM	RUTHENIUM	IRIDIUM	OSMIUM	TOTAL
1977	790	700	55	32	13	0.9	1,592
1978	1,196	918	70	58	17	0.8	2,260
1979	1,409	1,133	83	113	17	0.9	2,756
1980	1,118	912	74	78	24	0.8	2,206
1981	873	889	62	88	8	0.7	1,921
1982	NA	NA	NA	NA	NA	NA	1,510

NA - Not available

SOURCE: U.S. Industrial Outlook 1983.

Platinum and palladium are both silver-white metals that are corrosion-resistant and have applications in electrical or electronics equipment. Of the two, platinum is the most easily worked and is generally the more widely used. In the form of gauze, it is used as a catalyst in air pollution control systems, a use that accounts for more than half of total consumption. It is also used for electrical contacts, resistance wire, and in various chemical and petroleum refining applications, primarily as a catalyst.

Palladium, the other major platinum group metal, resembles and behaves like platinum, but is more difficult to work. Its most important use is in electrical applications: it is easily applied to printed circuit boards as an electrically conductive coating.

Demand for the platinum group metals responds more to the demand for products in which they are used (e.g., automobiles or electronic products) than to the price of the metals. Potential substitutes include other precious metals in most electrical applications. Major changes in automobile engines (e.g., diesel, or CVCC[3/] engines) could reduce the need for platinum as an emission control catalyst.

4.6 IRON AND STEEL, COPPER, AND ALUMINUM METAL POWDER PRODUCTION AND METAL POWDER METALLURGY

Before focusing on the metal powder operations covered by this subcategory, some information is presented on metal powders in general. Metal powders are produced by atomization, pulverization, or chemical decomposition. In powder forms, metals can be used directly or combined with other powders to produce metal parts with unique characteristics of strength, porosity, or tailored variations in composition. Metal powders also eliminate or reduce the necessity for machining, allow the alloying and working of metals that cannot be alloyed or worked by other methods, and allow the mixture of metals

[3/] Controlled vortex combustion cylinder, an engine design capable of meeting motor vehicle emission standards without the use of a catalytic converter.

and non-metals (such as plastics), combining the properties of each. Metal powders have hundreds of uses, ranging from animal feed to welding. A partial list of industries and applications is given in Table 4-13 for all types of metal powders. The value of shipments for all types of metal powders, paste, and flakes (Table 4-14) totaled $1.149 billion in 1981 according to the Census Bureau. A breakdown of the value of metal powder shipments for 1977 indicates that about half are iron and steel, aluminum, and copper, which are included in this subcategory of the regulation, and half are in the remaining nonferrous metal categories.

The iron and steel, copper, and aluminum powder metallurgy subcategory includes about 60 plants that produce metal powders or metal parts from powders. According to the Metal Powder Industries Federation, shipments of iron, copper, and aluminum powders totaled 185,800 tons in 1982. As shown in Table 4-15, shipments of these metal powders showed strong growth in the 1960s and early 1970s peaking at 329,859 tons in 1973. Since then, shipments have declined by 44 percent. The decline has been particularly severe for producers of aluminum powder. Shipments of aluminum powder peaked in 1968 and 1969 at 138,000 tons, and have since fallen nearly 80 percent. The main reason for this decline is that a major use of aluminum powders in the late 1960s and early 1970s was in explosives, pyrotechnics, and bombs, the production of which paralleled the course of American involvement in Vietnam.

Sales of the other metal powders (iron and steel, and copper) have more closely followed the general level of the economy. About 75 percent of all iron powder produced and high percentages of most other metal powders are used to manufacture powder metallurgy (P/M) parts. According to the Metal Powder Industries Federation, about 50 percent of all P/M parts are used in automobiles, primarily in engines and transmissions. The depressed state of the auto industry since 1979 has, in turn, depressed the metal powders industry. A recovery of auto sales should result in increased sales of metal powders.

The cost of metal powders and P/M parts is generally a small percentage of the total cost of the final products in which they are used. There are

TABLE 4-13. MARKETS AND USES FOR METAL POWDERS

INDUSTRY	APPLICATION	TYPE OF POWDER
Agriculture	Animal Feed, Fertilizers	Iron
	Farm Machinery	Iron, Steel, Copper, Bronze
	Food Enrichment	Iron, Copper, Manganese
	Fungicides	Copper
	Seed Coating	Aluminum
	Soil Conditioning	Iron, Copper
Aerospace	Brake Linings	Copper, Lead, Tin, High Nickel Alloys, Graphite, Iron
	Hardware	Aluminum, Beryllium, Titanium, Iron
	Heat Shields	Beryllium, Tungsten
	Rocket Fuels	Aluminum
Automotive	Engines and Related Parts	Iron, Zinc, Stainless Steel, Tool Steels, Platinum Alloy, Copper, Lead, Tin Aluminum, Graphite, Bronze
	Transmissions	Iron, Copper, Steel
	Truck Signal Flares	Aluminum
	Tire Studs	Tungsten Carbide
Chemicals	Catalysts	Platinum, Nickel, Tungsten, Molybdenum, Rhenium, Aluminum, Palladium, Iron, Copper
Coatings	Anti-fouling Paints	Copper
	Corrosion Resistant Paints	Stainless Steel, Aluminum, Zinc, Lead
	Decorative Paints	Aluminum, Brass, Bronze, Zinc, Stainless Steel, Lead, Copper
	Lacquers	Silver, Brass, Bronze, Aluminum
Consumer Products	Cosmetics	Zinc, Aluminum
	Enriched Foodstuffs and Vitamins	Iron
	Flash Bulbs	Zirconium, Cerium
	Floating Soap	Aluminum
	Pen Points	Platinum, Ruthenium, Tungsten, Stainless Steel
Coinage		Nickel, Copper-Nickel
Construction	Caulking Compound	Aluminum
	Linoleum and Decorative Plastics	Iron, Brass, Copper, Aluminum, Stainless Steel
	Pipe Joint Compounds	Zinc, Lead, Copper
	Waterproofing (Concrete and Roof Coatings)	Iron, Aluminum

TABLE 4-13. MARKETS AND USES FOR METAL POWDERS (Continued)

INDUSTRY	APPLICATION	TYPE OF POWDER
Electrical/ Electronic	Batteries	Nickel, Zinc, Silver, Lead, Iron, Graphite, Cadmium
	Contacts	Copper, Silver, Platinum, Tungsten, Others
	Printed Circuits	Copper, Silver, Palladium, Gold, Platinum
	Relays	Iron, Nickel, Molybdenum
	Semiconductors	Lead
Hardware	Lock Components	Brass, Bronze, Iron, Stainless Steel
Lubricants	Greases	Lead, Graphite
	High-temperature Lubricants	Aluminum, Graphite
Medical/Dental	Dental Amalgam	Silver, Gold, Alloys
	Insulin Production	Zinc
	Pharmaceuticals	Stainless Steel
	Prosthetics	Superalloys
Nuclear	Control Rods	Zirconium, Beryllium, Hafnium, Uranium
	Fuel Elements	Iron, Stainless Steel
	Shielding	Aluminum, Tungsten, Lead, Others
Office Equipment	Copiers	Iron, Stainless Steel, Bronze, Aluminum
	Recording Tape	Iron
	Toner	Iron
Ordnance	Ammunition	Graphite
	Anti-personnel Bombs	Iron
	Fuse Parts	Brass, Iron, Steel
	Solid Missile Fuel	Aluminum, Magnesium
Recreation	Fishing Rod Reels	Iron, Brass, Stainless Steel
	Golf Clubs	Tungsten, Iron, Brass
	Hunting Knives	Iron, Stainless Steel, Others
	Shotguns	Iron, Steel

SOURCE: Metal Powder Producers Association.

TABLE 4-14. VALUE OF SHIPMENTS OF METAL POWDERS, PASTE, AND FLAKES, 1972-1981[a]

YEAR	VALUE OF SHIPMENTS ($ million)
1972	322.7
1973	418.3
1974	502.5
1975	394.8
1976	535.1
1977	702.2
1978	813.2
1979	1,085.4
1980	1,214.0
1981	1,149.7

[a] Includes powders, etc., made from all metals.

SOURCES: 1981 Annual Survey of Manufactures and 1977 Census of Manufactures.

TABLE 4-15. U.S. METAL POWDER SHIPMENTS, 1962-1982
(in tons)

YEAR	IRON	COPPER & COPPER BASE	ALUMINUM	TOTAL
1962	51,450	23,792	21,850	97,092
1963	58,400	25,307	22,400	106,107
1964	73,100	28,300	23,100	124,500
1965	86,850	31,000	29,400	147,250
1966	100,000	33,000	60,000	193,000
1967	94,000	28,000	113,000	235,000
1968	112,500	31,100	138,000	281,600
1969	126,900	30,262	138,000	295,162
1970	114,552	23,755	110,000	248,307
1971	127,898	26,000	100,000	253,898
1972	154,355	26,500	90,543	271,398
1973	194,480	32,319	103,060	329,859
1974	178,893	34,183	64,068	277,144
1975	140,375	21,153	34,310	195,838
1976	194,808	32,391	49,483	276,682
1977	199,000	30,000	45,000	274,000
1978	217,000	32,000	51,500	300,500
1979	199,000	33,000	45,500	277,500
1980	152,800	23,500	44,279	220,579
1981	174,374	24,600	39,800	238,774
1982	139,200	18,500p	28,100	185,800p

p - Preliminary

Source: Metal Powder Industries Federation.

few good substitutes for metal powders in most applications. In general, demand for powders is more sensitive to the demand for the final products in which they are used than it is to price. As a result, price elasticity of demand for this subcategory is thought to be low.

4.7 TITANIUM FORMING

Formed titanium products are manufactured at 41 plants. Titanium is lightweight, corrosion-resistant, nonmagnetic, and resistant to metal fatigue. According to the U.S. Bureau of Mines the markets for titanium metal are:

Jet engines, air frames, and space and missile applications	60%
Chemical processing, power generation, and marine and ordinance applications	20%
Steel and other alloys	20%

Titanium alloys are also used in energy and environmental control equipment, and in race car engines and drive train components.

Shipments of titanium mill shapes, which are separately classified in SIC 33562, totaled 25,500 tons valued at $1,052.6 million in 1981. As Table 4-16 shows, this value represented a more than four-fold increase since 1977. While much of this increase represented price increases, there were substantial increases in output as well: net shipments (in tons) rose 75 percent between 1977 and 1980, before declining during the economic downturn in 1981 and 1982.

The United States is the world's third largest producer of titanium sponge metal (the raw material for mill products), after the Soviet Union and Japan. Tariffs on wrought titanium metal are substantial (17 percent for most favored nations, 45 percent for others). As a result, imports of formed products are not a significant factor in the U.S. market. In fact, the United

TABLE 4-16. TITANIUM MILL SHAPE SHIPMENTS AND FOREIGN TRADE, 1977-1982

YEAR	VALUE OF SHIPMENTS ($ million)	NET SHIPMENTS (tons)	IMPORTS (tons)	EXPORTS (tons)	AVERAGE PRICE ($/lb)
1977	250.7	15,466	NA	NA	8.10
1978	326.7	17,648	1,286	2,029	9.26
1979	540.6	23,113	1,280	3,300	11.69
1980	838.8	27,137	946	5,123	15.45
1981	1,052.6	25,500	1,116	6,049	20.64
1982	NA	19,100	850	4,600	NA

NA - Not available

SOURCES: 1981 Annual Survey of Manufactures and 1983 U.S. Industrial Outlook.

States was a net exporter of titanium mill products every year from 1978 to 1982. Furthermore, exports more than doubled during that period, while imports declined by one-third.

Given the nature of titanium's end-use markets, price elasticity of demand for formed products is very low. For the largest market (aircraft and space applications) "there is essentially no substitute for titanium."[4] For other uses, high nickel steel and superalloy metals may be substituted, but in many cases the substitute is less desirable.

4.8 REFRACTORY METALS

Refractory metals, by definition, are metals that have high melting points. Included in this subcategory are molybdenum, tungsten, vanadium,[5] tantalum, rhenium, and columbium. Of the five, vanadium has the lowest melting point (3,452°F), tungsten the highest (6,170°F). Refractory metals and their alloys are formed by 28 firms at 52 plants. Products include various mill forms, screws, bolts, studs, and tubing. The chief uses of formed refractory metals are in high-temperature applications (e.g., electrical, electronic, and aerospace applications), for metal-working and construction machinery, and as alloying agents for steel and titanium.

As shown in Table 4-17, apparent consumption (production plus net imports) of refractory metals totaled $595 million in 1982, more than a 50 percent decline from the peak level reached in 1980. The decline represented decreases in price as well as in quantity of metal consumption. Because of the unique characteristics of these metals, particularly the high melting points, hardness, and resistance to thermal shock, there are few substitutes

4/ U.S. Bureau of Mines, Mineral Commodity Summaries, 1983, p. 165.

5/ Vanadium is not generally considered a refractory metal by the industry but has been grouped with the other four for regulatory purposes.

TABLE 4-17. APPARENT CONSUMPTION OF REFRACTORY METALS, 1974-1982
($ million)

YEAR	MOLYBDENUM	TANTALUM	TUNGSTEN	VANADIUM	COLUMBIUM	TOTAL
1974	176	NA	125	NA	NA	NA
1975	145	135	77	NA	35	NA
1976	207	95	116	NA	22	NA
1977	246	178	188	67	40	719
1978	335	85	181	57	45	703
1979	553	180	191	76	65	1,065
1980	589	320	180	64	70	1,223
1981	519	275	187	75	54	1,110
1982	264	140	91	70	30	595

NA - Not available

SOURCE: U.S. Bureau of Mines.

for them outside of the refractory metal group. As a result price elasticities of demand are low.

4.9 ZIRCONIUM AND HAFNIUM FORMING

According to the EPA industry survey there are 10 plants forming zirconium and hafnium.

4.9.1 Zirconium

Zirconium is used as cladding for nuclear fuel and as a structural material for nuclear reactors employing pressurized water heat exchanges. This is because zirconium has a low thermal neutron absorption cross section, low radioactivity after radiation exposure, and transparency to thermal neutrons. A small quantity of zirconium metal and alloys is used in the chemical industry as components in heat exchangers, acid concentrators, tank shafts, valves, pump housings, fan wheels, high-speed agitators, electrode assemblies, steam jet exhausts, tubing, pipes and pipe fittings, and crucibles.

Approximately 95 percent of all zirconium consumed is in the form of the mineral (zircon), in oxides, and in other compounds.[6/] The remainder of the zirconium is consumed as metal and zirconium-containing alloys. Table 4-18 provides the trend in the consumption of zirconium metal products over the 1969-1979 period.

Production and shipments of zirconium forming products fell in 1981 and 1982 owing to the continued weak demand in nuclear power plant construction, and the decline in production of jet aircraft engines. The imports of zirconium metal and alloys have decreased from 1,000 tons in 1978 to 420 tons in 1982. Exports have also decreased over the same period but not as significantly as imports. Table 4-19 provides information on the import and export of zirconium metal and alloys over the 1973-1982 period.

6/ Zirconium forming products are not included in these uses.

TABLE 4-18. U.S. DEMAND FOR ZIRCONIUM FORMING PRODUCTS
(short tons zirconium contents)

METAL	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979
Fabricated Metal Products	100	110	110	115	100	80	60	80	100	70	80
Photography	10	20	30	50	53	50	78	50	45	40	50
Nuclear Reactors	NA	NA	NA	NA	2,100	NA	NA	NA	NA	2,000[e]	NA
Non-Zr-Base Alloys											
From Zircon	NA	NA	NA	1,500	1,700	800	1,400	900	1,500	1,500	1,500
From Zirconium Scrap	160	170	199	210	200	200	210	260	330	370	500

NA = Not available
e = Estimate

SOURCE: U.S. Department of Interior, Mineral Facts and Problems, 1980 Edition.

TABLE 4-19. IMPORTS AND EXPORTS IN ZIRCONIUM METALS AND ALLOYS (short tons zirconium contents)

YEAR	IMPORTS	EXPORTS
1973	300	500
1974	400	800
1975	500	1,300
1976	500	1,200
1977	600	1,000
1978	1,000	1,000
1979	900	900
1980	721	694
1981	513	681
1982	420	800

SOURCES: U.S. Department of Interior, Mineral Facts and Problems, 1980 Edition for data from 1973 to 1979. U.S. Department of Interior, Mineral Commodity Summaries, 1983, for data after 1979.

Stainless steel is substituted for zirconium as a structural material in nuclear reactors. Aluminum, columbium, and vanadium are substitutes in applications such as fuel containers, tubing, and pipes. Stainless steel, titanium, and tantalum are also substitutes for zirconium in many corrosion-resistant industrial applications. The demand for zirconium is expected to be price-inelastic, because of the relative low unit cost of the metal in relation to the total cost of the final product. In addition, the demand for zirconium would not be very responsive to price changes in the nuclear reactor use because of the product's unique properties.

4.9.2 Hafnium

Two companies produce hafnium sponge and hafnium crystal bar. About half of the hafnium production in 1982 was used for control rods in naval nuclear reactors. Other uses were in alloys, refractory applications, ceramics, and as carbide in cutting tools. According to the Bureau of Mines, the consumption of hafnium in 1982 was 50 short tons. Table 4-20 shows that the U.S. demand for hafnium has been increasing relatively slowly over the last 10 years.

There is no substitute for hafnium in major applications, nuclear reactor control rods, and refractory metal alloys. Zirconium oxide and metal, however, are substituted for hafnium in selected refractories and ceramics. The prices for hafnium products have been increasing since 1979 and will continue to remain high if the demand for hafnium products continues to grow. The price for hafnium sponge was in range of $80-$150 a pound in 1982. There are no exports of hafnium products and imports are negligible.

The demand for hafnium is fairly inelastic with respect to price, because no substitutes exist in major applications.

4.10 URANIUM FORMING

Depleted uranium, which has a low level of radioactivity, is generated by the U.S. Department of Energy as a by-product of the uranium enrichment

TABLE 4-20. U.S. HAFNIUM DEMAND
(short tons)

YEAR	U.S. DEMAND
1973	35
1974	32
1975	30
1976	28
1977	35
1978	40
1979	45
1980	45
1981	45
1982	50

SOURCES: U.S. Department of Interior, Mineral Facts and Problems, 1980 Edition, for data from 1973 to 1979. U.S. Department of Interior Mineral Commodity Summaries, 1983, for data after 1979.

process. For every ton of uranium that has been enriched for nuclear applications, about 4.5 tons of depleted uranium are produced. The uranium subcategory in the regulation refers to the forming of depleted uranium.

As Table 4-21 shows, production of depleted uranium far exceeds apparent consumption and exports. At the end of 1980, the Department of Energy held an inventory of approximately 300,000 tons of the metal. The Department was conducting research and encouraging development of nonenergy applications.

The principal use developed thus far is in ordnance. Uranium is an extremely dense metal (2.5 times the density of iron). This quality makes the metal ideal for armor-piercing shells and projectiles. According to the Bureau of Mines, use of the metal for ordnance, which first became significant in 1976, accounts for about 90 percent of total depleted uranium use.

Other uses include shielding for X-rays, shipping casks for nuclear waste, and counterweights in commercial aircraft. None of these markets is sensitive to price changes.

4.11 MAGNESIUM FORMING

Magnesium is the lightest structural metal available (only two-thirds the weight of aluminum) and is easily formed into shapes. It is also one of the more abundant metals. World resources are "virtually unlimited" according to the U.S. Bureau of Mines, since it can be extracted from seawater, brines, or any of several magnesium-bearing minerals.

The United States is the world's largest producer of magnesium: the U.S. total of 125,000 tons accounted for 40 percent of the world total in 1982. The Soviet Union and Norway accounted for another 29 percent and 17 percent, respectively.

Most of the metal produced is used for aluminum-based alloys. Magnesium castings and wrought products consume only 17 percent of total production.

TABLE 4-21. PRODUCTION, CONSUMPTION, PRICES, AND EMPLOYMENT IN THE DEPLETED URANIUM SECTOR

YEAR	PRODUCTION (tons)	EXPORTS (tons)	APPARENT CONSUMPTION[a] (tons)	PRICE (per lb.)	EMPLOYMENT
1976	17,591	341	1,700	$2.00	250
1977	11,822	273	2,000	2.50	325
1978	15,763	590	2,200	2.50	450
1979	15,116	1,531	2,500	3.25	525
1980	18,000[e]	7,000[e]	3,500[e]	4.50[e]	600[e]

[a] Production plus net imports.

[e] Estimated.

SOURCE: U.S. Bureau of Mines, Mineral Commodity Summaries. The Bureau stopped reporting data for this metal in 1980.

Uses include aircraft engine components, wheels for racing and sports cars, power tool housings, and luggage frames.

Table 4-22 summarizes ten years of data for magnesium mill products, including shipments, exports, and imports. U.S. production of mill shapes peaked in 1979 at 44 million pounds. Consumption in 1980 and 1981 was at or below the levels of the early 1970s.

In recent years, the United States has exported between 10 and 40 percent of its magnesium mill shape production. The substantial swings in U.S. production over the period 1977-1981 were largely the result of sharp increases or decreases in U.S. exports.

The demand for magnesium forming products is relatively price-elastic, because both zinc and aluminum are good substitutes for magnesium.

TABLE 4-22. NET SHIPMENTS, EXPORTS, IMPORTS, AND APPARENT CONSUMPTION OF MAGNESIUM MILL PRODUCTS: 1972 TO 1981

YEAR	VALUE OF SHIPMENTS ($000)	MANUFACTURERS' NET SHIPMENTS (000 lbs)	EXPORTS OF DOMESTIC MERCHANDISE		PERCENT EXPORTS TO MANUFACTURERS' NET SHIPMENTS (quantity)	IMPORTS FOR CONSUMPTION		APPARENT CONSUMPTION (000 lbs)	PERCENT IMPORTS TO APPARENT CONSUMPTION (quantity)
			QUANTITY (000 lbs)	ESTIMATED PRODUCERS' VALUE ($000)		QUANTITY (000 lbs)	VALUE ($000)		
1972	(Y)	31,297	1,640	1,402	5	15	36	29,672	(Z)
1973	(Y)	31,535	2,435	2,141	8	22	103	29,122	(Z)
1974	(Y)	28,732	2,310	3,229	8	22	103	26,444	(Z)
1975	(Y)	26,141	2,136	3,341	8	5	22	24,010	(Z)
1976	(Y)	27,181	2,323	4,591	9	7	24	24,865	(Z)
1977	(Y)	32,020	3,293	6,484	10	94	123	28,821	(Z)
1978	(Y)	40,131	6,583	9,892	16	9	39	33,557	(Z)
1979	(Y)	44,465	12,271	21,196	28	59	134	32,557	(Z)
1980	61,735	34,981	13,853	21,946	40	95	132	21,223	(Z)
1981	69,114	32,625	3,367	8,805	10	63	130	29,321	(Z)

(Y) Data not collected prior to 1980.

(Z) Less than one-half percent.

SOURCE: U.S. Department of Commerce, Current Industrial Reports - Magnesium Mill Products, 1981.

5. BASELINE PROJECTIONS OF INDUSTRY CONDITIONS

This chapter provides projections of conditions in the nonferrous metals forming industry segments to 1990 under the assumption that there would be no water pollution control requirements resulting from the Clean Water Act. These projections are used together with estimated costs and other information to assess the effects of the effluent control requirements on future industry conditions.

The baseline projections in this report provide a general point of reference for the analysis and are not intended to be a comprehensive, authoritative forecast of future industry conditions. These projections provide a plausible picture of future developments, and thus can be used as a benchmarck for comparison. Although minor changes to the baseline may result from a more comprehensive treatment of forecasting techniques, they are not likely to significantly alter the study's overall conclusions regarding the extent of the economic impacts of the effluent guidelines.

The basic approach followed in developing the projections is to begin with a forecast of demand-related factors, such as GNP or defense outlays. Then, using the resulting initial projection of product volume for a metal, industry supply factors are assessed to determine if there would be any significant change in the number of plants.

5.1 DEMAND FACTORS

The primary reason for beginning the baseline projections with the demand analysis is based on the hypothesis that the nonferrous metals forming industry segments' supply factors will adjust to demand conditions. This results from two factors: (1) the industry segments are a small proportion of the total economic activity in the U.S. and, therefore, are more likely to react to general trends rather than influence them; and (2) the demand for nonferrous metals forming products is a derived demand, depending on the sales and use of thousands of products, such as automobiles, nuclear reactors, and electrical products, that use nonferrous metals components.

The forecasts of demand for the various nonferrous metals forming subcategories are derived primarily from forecasts from sources such as the U.S. Bureau of Mines (USBM) and the Department of Commerce. These sources are supplemented by the analyses of recent trends in nonferrous metals production, consumption and markets. Table 5-1 summarizes the demand forecasts for each of the eleven subcategories.

These forecasts involved a number of assumptions and adjustments to the information in the original sources shown in the table. First, for those subcategories that are composed of more than one metal (e.g., lead/tin/bismuth) weighted average growth rates were developed from forecasts of each individual metal. Second, some of the outside forecasts, such as those prepared by the USBM Minerals Commodities Summaries, are based on long-term trends and do not capture cyclical variations. Since the base year for the forecasts shown in the table, 1981, is a year of low production, the application of the long-term growth rates to these data may result in underestimates of future demand. However, it is not certain that the original trend lines are still valid, because the speed of recovery from the 1982 recession is uncertain and because the markets for a number of the products may have undergone significant shifts in end-use patterns in recent years. For example the price of gold in constant dollars has multiplied over 4 times over the past 12 years and consumption has dropped by more than half. Moreover, the price of gold has been quite erratic over the past five years. Shifting materials usage in the automobile and electrical and electronics industries is another cause of this uncertainty. These industries have been increasing the use of plastics relative to other materials. Given these uncertainties, where the published sources used a long-run trend, the rate of growth of the trend line was applied to the low production year of 1981. This assumption represents a conservative approach to the forecast, since a rapid economic recovery over the mid-1980s could accelerate

TABLE 5-1. BASE CASE PRODUCTION GROWTH PROJECTIONS

TECHNICAL SUBCATEGORY	REAL HISTORICAL RATE OF GROWTH	PROJECTIONS: ANNUAL RATE 1981 - 1990	PROJECTIONS: GROWTH 1981-1985	PROJECTIONS: GROWTH 1981-1990	SOURCE/COMMENT
1. Lead/Tin/Bismuth	[a]	1.7%	+7%	+16%	Bureau of Mines, <u>Mineral Commodity Summaries</u>, 1983.
2. Nickel/Cobalt	1.5%[b]	2.3%	+10%	+23%	Bureau of Mines, <u>Mineral Commodity Summaries</u>, 1983.
3. Zinc	0%[c]	1.1%	+4%	+9%	Bureau of Mines, <u>Mineral Commodity Summaries</u>, 1983.
4. Beryllium	[a]	4% to 1985 0% 1985-1990	+17%	+17%	1. Major markets are defense and aerospace. There are no adequate substitutes. Growth rate for GNP was applied to 1981 data growth. 2. Approximately same result could be achieved using growth rate of defense budget (see uranium). 3. Real defense expenditures are assumed to level off after 1985.
5. Precious Metals	-2.0%[d]	2.5%	+10%	+25%	Bureau of Mines, <u>Mineral Commodity Summaries</u>, 1983.
6. Powder Metallurgy	-1.3%[e]	2% to 1985 3% 1985-1990	+8%	+25%	Negative historical rate of growth reflects war-related use of aluminum powders. Civilian uses are widespread. Assumed growth equal to growth of GNP over the 1982-1990 period.

[a] Time series has been erratic; no discernible trend.
[b] 1960-1981 average annual rate.
[c] 1977-1981 average annual rate.
[d] 1971-1981 average annual rate.
[e] 1972-1981 average annual rate.

TABLE 5-1. BASE CASE PRODUCTION GROWTH PROJECTIONS (Continued)

TECHNICAL SUBCATEGORY	REAL HISTORICAL RATE OF GROWTH	PROJECTIONS ANNUAL RATE 1981 - 1990	GROWTH 1981-1985	GROWTH 1981-1990	SOURCE/COMMENT
7. Titanium	12%[f]	2.7%	+11%	+27%	U.S. Department of Commerce, U.S. Industrial Outlook, 1983. (Based on estimate that mill products production will increase from 2,500 S.T. in 1981 to 30,000 S.T. in 1987.)
8. Refractory Metals	NA	2% to 1985 3% 1985-1990	+8%	+25%	1. Because of varied uses (electrical, aerospace metal-working, construction), assumed growth equal to growth of GNP. 2. U.S. Industrial Outlook projects tungsten demand will grow faster than GNP, but so will imports.
9. Zirconium/Hafnium	[a]	4.5%	+19%	+49%	Bureau of Mines, Mineral Commodity Summaries, 1983.
10. Uranium	14%[g]	4%	+17%	+42%	1. Assumed growth equal to defense budget growth (CBO estimates 5% real growth FY81-88). 2. DRI projects real annual growth rate for ordnance of 3.7%, 1981-1995, but says defense spending will rise faster than GNP to the late 1980's before trailing off in the late 1980's to 1995.
11. Magnesium	-0.1%[h]	0%	0%	0%	U.S. consumption and manufacturers' shipments were both virtually unchanged over the period 1972-1981. Therefore, no growth assumed.

[f] 1976-1981, annual rate.
[g] 1976-1979, annual rate.
[h] 1972-1981, annual rate.

SOURCE: JRB Associates estimates.

this growth. That is, this approach is more likely to underestimate industry growth than to overestimate it. It is important not to overstate baseline conditions, since an overstatement of industry baseline performance can lead to an understatement of economic impacts due to the proposed regulation.

For some subcategories demand forecasts are based on the growth rates of the major end-use sectors or the expected rate of growth of the overall economy. Subcategories analyzed in this manner include beryllium, refractory metals, uranium, powder metallurgy, and zirconium/hafnium. The reasoning for these forecasts are listed in the last column of the table.

The demand forecasts are summarized in Table 5-1. Included in the table are historical rates of growth for each of the eleven subcategories and baseline growth projections in three forms: (1) an annual percentage rate or rates; (2) cumulative growth in the 1981-1985 period; and (3) cumulative growth in the 1981-1990 period. A final column lists sources of projections or reasoning used to derive them.

The highest rates of growth in demand over the 1983-1990 period are expected in the zirconium/hafnium subcategory. The demand for both of these products is expected to be about 4.5 percent annually over the forecast period. The demand growth rates for the other products range between 0 and 4 percent annually.

5.2 SUPPLY FACTORS

Questions relevant to this study are the number of baseline closures and new sources that might be expected during the 1980s. The above forecasted increase in demand through the 1980s can be supplied by (a) increasing capacity utilization at current plants, (b) modifying current plants to increase their capacity, (c) constructing new plants, and (d) increasing imports. Since aggregate industry output is expected to increase, baseline closures are not likely to result.

During the 1980-1982 period, capacity utilization rates for the plants in the nonferrous metals forming industry segments have been low. As a result, a significant portion of the increased demand during the 1980s can be met by increasing operating levels at existing facilities. Therefore, it is unlikely that a substantial number of new plants will be opened during the 1980s. There may, however, be modifications at existing plants. There is insufficient information available to determine the number of modifications that will be substantial enough to be subject to new source standards.

6. COST OF COMPLIANCE

6.1 OVERVIEW

Alternative water treatment control systems, costs, and effluent limitations for the nonferrous metals forming category are enumerated in the Development Document cited earlier. That document identifies various characteristics of the industry, including the manufacturing processes; products manufactured; volume of output; raw waste characteristics; supply, volume, and discharge destination of water used in the production processes; sources of wastewaters; and the constituents of wastewaters. Using the data in the Development Document, pollutant parameters requiring limitations or standards of performance were selected by EPA.

The EPA Development Document also identifies and assesses the range of control and treatment technologies within each industry subcategory. The assessment procedure involved an evaluation of both in-plant and end-of-pipe technologies that could be designed for each subcategory. Information about these technologies for existing surface water industrial dischargers was evaluated to determine the effluent limitations required for the Best Practical Control Technology Currently Available (BPT), and the Best Available Technology Economically Achievable (BAT). A similar evaluation was performed for existing dischargers to publicly owned treatment works (POTWs) to develop Pretreatment Standards for Existing Sources (PSES). Finally, New Source Performance Standards (NSPS) and Pretreatment Standards for New Sources (PSNS) were developed. The identified technologies were analyzed to estimate cost and performance of each. Cost data were expressed in terms of investment, operating and maintenance costs, depreciation, and interest expense. The waste streams associated with each of the production processes were studied to determine the identity and mass of pollutants discharged and volume of wastewater discharged per unit of production.

6.2 POLLUTANT PARAMETERS

The selection of pollution parameters for the application of effluent limitations guidelines and standards was primarily based on a review of laboratory analyses of wastewater samples from 17 nonferrous metals forming plants and responses to a mail survey conducted by EPA in 1983. This information was used to estimate the concentration of each of the 129 priority pollutants as well as the conventional and nonconventional pollutants. The specific approach to selecting pollutant parameters is presented in Sections V and VI of the Development Document.

6.3 CONTROL AND TREATMENT TECHNOLOGIES

Based on the analysis of the significant pollutant parameters and treatment-in-place in the nonferrous metals forming category, EPA identified three treatment technologies that are most applicable for the reduction of the selected pollutants. These treatment technologies are described in detail in the Development Document and are listed below:

- Treatment Option 1: Hexavalent chromium reduction, cyanide removal and chemical emulsion breaking (where applicable); oil skimming; chemical precipitation and sedimentation ("lime and settle")
- Treatment Option 2: Option 1 plus flow reduction by recycle, and countercurrent cascade rinsing
- Treatment Option 3: Option 2 plus filtration.

6.4 COMPLIANCE COST ESTIMATES

6.4.1 Cost Factors, Adjustments, and Assumptions

In developing the compliance cost estimates, a number of critical factors were estimated, and adjustments and assumptions were made by EPA. These assumptions, as outlined in the Development Document, are:

- All costs are expressed in first quarter of 1982 dollars.
- Capital and annual cost data for the selected treatment processes were obtained from equipment manufacturers, literature data, and cost data from existing plants.
- The cost of electricity used is 4.8 cents per kilowatt hour, which is based on the electricity charge rate for March 1982 reported in the Department of Energy's Monthly Energy Review.
- Capital costs are amortized at 10 years and 12 percent interest.
- Sludge disposal costs are included in the cost estimates, where applicable. A rate of $0.40 per gallon is assumed for nonhazardous wastes, and $0.80 per gallon for hazardous wastes.
- A labor rate of 21 dollars per person-hour, including fringe benefits and plant overhead was used to convert the person-hour requirements into annual costs.
- Where a batch, continuous, or haul-away treatment system was possible, the system with the lowest life cycle cost (over a 10-year period) was selected for presentation in the system cost table.
- The treatment system costs refer to a separate system designed to treat all of the nonferrous metals forming wastes, even though the plant may be carrying out other operations requiring similar treatment.
- In many instances, in-process flow reduction controls are relatively inexpensive and the cost savings from a smaller-sized end-of-pipe treatment result in lower annual compliance costs for Treatment Option 2 than for Treatment Option 1. In such cases, it is assumed that Treatment Option 2 would be installed instead of Treatment Option 1, even when the regulation would only require the smaller removals resulting from implementation of Option 1.

6.4.2 Compliance Costs of Existing Sources

EPA has identified 294 nonferrous metals forming plants. However, the regulation only affects 146 plants discharging wastes: 32 plants discharging to surface waters (direct dischargers), 107 discharging to publicly owned treatment works (indirect dischargers), and 7 discharging both to surface waters and POTWs.

Plant-specific compliance costs were estimated for 23 plants that represent 22 relatively homogeneous groups of plants in terms of wastewater characteristics, wastewater flow, and treatment-in-place. Two plants were selected to represent the powder metallurgy group because of the large number of plants in that group. Table 6-1 lists the 22 plant groups. For costing purposes, a plant is classified here according to the major nonferrous metal that it forms.

The selection of representative plants for compliance cost estimation is explained in the Development Document (Section VIII). Plants which have flows close to the group averages were selected for costing. An attempt was also made to choose plants with treatment-in-place typical of their groups. In many cases, plants in a same product group have similar levels of treatment-in-place. For example, the bullet manufacturers all have lime-and-settle treatment. Because of the high degree of integration, plants with major production in the nickel/cobalt, titanium, refractory metals, and zirconium/hafnium subcategories were grouped together although these plants have different levels of treatment-in-place. The diversity of treatment-in-place was taken into account by subdividing the plants into two groups--plants with treatment-in-place and plants without, as shown in Table 6-1. In addition, five size-categories for each of the "with" and "without" treatment groups were established to account for different wastewater flows. Ten representative plants were selected to represent these costing groups.

The engineering cost estimates for the 23 representative plants take into consideration detailed information on the production processes, flows and treatment-in-place. These cost estimates were the bases for projecting costs for the remaining plants in the costing groups. It was determined that plant compliance costs would be better estimated based on nonferrous metals forming process wastewater flow than based on nonferrous forming production volume.

TABLE 6-1. NONFERROUS METALS FORMING COSTING GROUPS

SUBCATEGORY	COSTING GROUP	NUMBER OF DISCHARGING PLANTS
1. Lead/Tin/Bismuth	Bullet Manufacturers	4
	Solder Manufacturers	5
	Other Products	10*
2. Beryllium		1
3. Uranium		2
4. Magnesium		1
5. Zinc		2
6. Powder Metallurgy	Metal Powder Production	6
	Production of Metal Parts from Powder	18
7. Zirconium/Hafnium, Nickel/Cobalt, Refractory Metals Titanium		
With Treatment	Extra Small	14
	Small	7
	Medium	8
	Large	9
	Extra Large	1
Without Treatment	Extra Small	9
	Small	4
	Medium	12
	Large	8
	Extra Large	1
8. Precious Metals	Small	10
	Medium	8
	Large	6
		146

* Five plants are nonferrous metals forming operations of battery manufacturing plants. The wastewaters of the nonferrous metals forming operations can be treated together with the battery manufacturing wastewaters, thus there will be no incremental compliance costs.

SOURCE: EPA, Development Document.

Based on wastewater flow rate data available for 65 plants, compliance costs were estimated for these plants using the cost estimates of the 23 representative plants.[1/] For an additional 24 plants, nonferrous metals forming production data were available and compliance costs were estimated for these plants using the same approach described in the footnote but substituting plant production for flow. Finally, compliance costs were projected for the remaining 34 discharging plants by assuming for each plant the average compliance costs per plant of its costing group.

Tables 6-2, 6-3, and 6-4 present the industry compliance costs by technical subcategory for all plants and for the direct and indirect discharging plants, respectively. Because many plants form more than one type of nonferrous metal, compliance costs for these plants were allocated to the corresponding technical subcategories based on production volume. In a few cases, production data were not available by type of metal produced at the plant,

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1/ Compliance costs of individual plants in each costing group were estimated as follows:

$$CCI_{ij} = CCI_i \times \left[\frac{Flow_{ij}}{Flow_i}\right]^{.6}$$

$$ACC_{ij} = ACC_i \times \left[\frac{Flow_{ij}}{Flow_i}\right]^{.6}$$

where: CCI_{ij} = Compliance capital investment of plant j in costing group i

CCI_i = Compliance capital investment of the representative plant of costing group i

ACC_{ij} = Annual compliance cost of plant j in costing group i

ACC_i = Annual compliance cost of the representative plant of costing group i

$Flow_{ij}$ = Flow rate of plant j in costing group i

$Flow_i$ = Flow rate of the representative plant of costing group i

TABLE 6-2. TOTAL INDUSTRY COMPLIANCE COSTS FOR EXISTING SOURCES
(in thousands of 1982 dollars)

TECHNICAL SUBCATEGORY	NO. OF LINES	CAPITAL INVESTMENT			ANNUAL COMPLIANCE COSTS		
		OPTION 1	OPTION 2	OPTION 3	OPTION 1	OPTION 2	OPTION 3
Lead/Tin/Bismuth	21	582.6	616.2	773.2	142.9	152.0	229.1
Nickel/Cobalt	40	2,333.7	2,753.4	3,035.3	1,041.4	1,175.2	1,301.4
Zinc	3	100.9	161.3	176.8	68.4	83.7	87.0
Beryllium	1	0	0.4	0.4	15.7	16.0	16.0
Precious Metals	34	336.1	594.6	1,014.8	481.2	560.6	726.4
Powder Metallurgy	23	577.3	577.1	667.5	536.4	536.4	616.3
Titanium	27	2,066.5	2,258.8	2,473.0	1,344.6	1,423.0	1,531.0
Refractory Metals	35	982.6	1,393.7	1,523.1	568.3	677.1	736.3
Zirconium/Hafnium	7	248.0	292.0	313.2	116.7	128.5	136.8
Magnesium	4	75.0	75.3	76.3	49.8	50.2	50.9
Uranium	2	475.0	475.0	475.0	253.2	253.2	253.2
TOTAL NO. OF PLANTS	146[a]	7,777.7	9,197.8	10,528.6	4,618.6	5,055.9	5,684.4

[a] Total is lower than the sum of all subcategories because many plants form more than one type of metal.

SOURCE: JRB Associates estimates.

TABLE 6-3. COMPLIANCE COSTS FOR EXISTING DIRECT DISCHARGERS
(in thousands of 1982 dollars)

TECHNICAL SUBCATEGORY	NO. OF LINES	CAPITAL INVESTMENT			ANNUAL COMPLIANCE COSTS		
		OPTION 1	OPTION 2	OPTION 3	OPTION 1	OPTION 2	OPTION 3
Lead/Tin/Bismuth	3	165.5	174.1	225.8	11.0	12.4	35.6
Nickel/Cobalt	14	390.6	429.6	483.5	73.1	84.0	103.9
Zinc	1	13.3	72.1	72.1	27.3	36.8	36.8
Beryllium	1	0	0.4	0.4	15.7	16.0	16.0
Precious Metals	7	95.5	219.9	298.8	93.4	130.7	163.7
Powder Metallurgy	3	189.5	189.5	227.1	122.5	122.5	165.5
Titanium	12	1,385.9	1,420.8	1,535.5	876.0	894.0	948.9
Refractory Metals	8	14.5	89.5	105.5	23.1	41.7	50.1
Zirconium/Hafnium	4	228.1	271.7	289.9	114.0	125.7	132.9
Magnesium	3	71.0	71.0	71.0	44.8	44.8	44.8
Uranium	2	356.3	356.3	356.3	189.9	189.9	189.9
TOTAL NO. OF PLANTS	39[a]	2,910.2	3,294.9	3,665.9	1,590.8	1,698.5	1,888.1

[a] Total is lower than the sum of all subcategories because many plants form more than one type of metal.

SOURCE: JRB Associates estimates.

TABLE 6-4. COMPLIANCE COSTS FOR EXISTING INDIRECT DISCHARGERS
(in thousands of 1982 dollars)

TECHNICAL SUBCATEGORY	NO. OF LINES	CAPITAL INVESTMENT			ANNUAL COMPLIANCE COSTS		
		OPTION 1	OPTION 2	OPTION 3	OPTION 1	OPTION 2	OPTION 3
Lead/Tin/Bismuth	18	417.1	442.1	547.4	131.9	139.6	193.5
Nickel/Cobalt	28	1,943.1	2,323.8	2,551.8	968.3	1,091.2	1,197.5
Zinc	2	87.6	89.2	104.7	41.1	46.9	50.2
Beryllium	0	-	-	-	-	-	-
Precious Metals	28	240.6	374.7	716.0	387.8	429.9	562.7
Powder Metallurgy	20	387.8	387.6	440.4	413.9	413.9	450.8
Titanium	16	680.6	838.0	937.5	468.6	529.0	582.1
Refractory Metals	29	968.1	1,304.2	1,417.6	545.2	635.4	686.2
Zirconium/Hafnium	4	19.9	20.3	23.3	2.7	2.8	3.9
Magnesium	2	4.0	4.3	5.3	5.0	5.4	6.1
Uranium	1	118.7	118.7	118.7	63.3	63.3	63.3
TOTAL NO. OF PLANTS	114[a]	4,867.5	5,902.9	6,862.7	3,027.8	3,357.4	3,796.3

[a] Total is lower than the sum of all subcategories because many plants form more than one type of metal.

SOURCE: JRB Associates estimates.

in these cases, compliance costs were equally distributed to each of the metals. Similarly, treatment costs for plants discharging both directly and indirectly were apportioned equally to the direct and indirect cost totals. Table 6-2 shows that total industry capital investment ranges between $7.8 million for Treatment Option 1 and $10.5 million for Treatment Option 3. Annual compliance costs vary between $4.6 million for Treatment Option 1 and $5.7 million for Treatment Option 3.[1/]

6.5 ANALYSIS OF TREATMENT-IN-PLACE

To gain an understanding of factors that have influenced the installation of treatment and to get a general idea of the potential impacts of the regulations, EPA industry survey data were reviewed to examine the level of treatment already in place among the nonferrous metals forming plants.

Even though no guidelines have specifically been issued for the nonferrous metals forming category, compliance with current NPDES permit limitations generally requires treatment of wastewaters discharged by the direct dischargers. Review of survey data on the 146 discharging plants in the nonferrous metals forming industry as well as more detailed analysis of the 23 representative plants bears this out. Table 6-5 indicates that approximately 90 percent of the direct dischargers already have some treatment-in-place. On the other hand, pretreatment requirements for indirect dischargers have been applied less broadly, and it is estimated that only 50 percent of the indirect dischargers have any treatment-in-place.

1/ The BAT limitations proposed in the Federal Register notice are Option 3 for nine subcategories and Option 2 for the lead/tin/bismuth and powder metallurgy subcategories; for PSES the option choices are the same except that the zinc indirect dischargers are excluded from the regulation.

Cost estimates for the proposed limitations based on the above figures are (in millions): BPT - $2.9 capital and $1.6 annual; BAT - $3.6 capital and $1.8 annual; PSES - $6.6 capital and $3.7 annual. Total cost for the proposed regulation is $10.2 capital and $5.5 annual.

TABLE 6-5. SUMMARY OF TREATMENT-IN-PLACE

	DIRECT DISCHARGERS	INDIRECT DISCHARGERS
All Dischargers		
Number of Plants[a]	39 (100%)	114 (100%)
Number of Plants with Treatment-in-place		
Some Treatment	34 (87%)	58 (51%)
L&S[b]	24 (62%)	17 (15%)
L&S+[c]	10 (26%)	3 (3%)
23 Representative Plants		
Number of Plants	8 (100%)	15 (100%)
Number of Plants with Treatment-in-place	7 (88%)	5 (33%)

[a] Includes 7 plants that are both direct and indirect dischargers.

[b] L&S = Lime and settle; technology basis for Option 1.

[c] L&S+ = Lime, settle and filter (in place at 1 direct plant and one direct/indirect plant) and lime and multi-stage settling (in place at 8 direct plants and 2 indirect plants).

SOURCE: EPA Industry Survey.

Although most direct dischargers have some treatment to meet permit limits, there are exceptions. Table 6-5 indicates that of the 8 representative direct discharging plants, one has no treatment-in-place. This plant, which discharges to the Ohio River, currently contract-hauls its dirtiest waste streams (acid baths) and discharges rinse streams which have been mixed with cooling water. Among the 15 representative indirect dischargers, only five have treatment-in-place while 10 have none. Review of discharge flow data for the nonferrous metals forming waste streams of these plants shows that the indirect dischargers with treatment generally have larger flows than the indirect dischargers without treatment. Therefore, even in the absence of across-the-board pretreatment programs, it appears that municipalities have tended to require treatment of their largest dischargers.

Finally, it should be noted that plants which already have in place some of the technology on which the regulatory limits are based may still incur substantial costs in complying with the regulation, because of the need for various types of preliminary treatment, upgrading, etc. For example, of the 12 representative plants with some treatment-in-place, the cost credited to the treatment in operation averages only 40 percent of the total costs for Treatment Option 1.

7. ECONOMIC IMPACT ANALYSIS

This section provides an assessment of the economic impacts which are likely to occur as a result of the imposition of the costs of the effluent treatment technologies described in Chapter 6. It is based upon an examination of the estimated compliance costs and other economic, technical, and financial characteristics of 105 discharging plants for which compliance cost estimates and plant revenues are available. The analytical methodology used is described in Chapter 2. The primary economic impacts discussed include changes in industry profitability, plant closures, substitution effects, changes in employment, shifts in imports and exports, and industry structure effects.

7.1 PRICE AND QUANTITY CHANGES

Table 7-1 shows the industry-wide price increases and the resulting changes in quantity of production for each compliance option estimated from the pricing model described in Chapter 2. The price increases are generally small, not exceeding one-quarter of a percent for all product groups except uranium.1/ Similarly, the production quantity changes are also very small. The small changes in production costs and quantity demanded suggest that the major impacts, to the extent they exist, will be intra-industry. That is, the degree to which the unit compliance costs are unequally distributed across the industry will determine the extent of the impacts.

1/ One reason for the high expected price increase for the uranium subcategory is that, since the companies do not own the uranium, the measure of output submitted in the survey is value added, rather than shipments. Hence, the price increase is taken relative to a smaller base here than in the other subcategories.

TABLE 7-1. ESTIMATED PRODUCT PRICE AND PRODUCTION CHANGES
(in percent)

PRODUCT GROUP	OPTION 1		OPTION 2		OPTION 3	
	dP/P	dQ/Q	dP/P	dQ/Q	dP/P	dQ/Q
Lead/Tin/Bismuth	0.04	-0.02	0.05	-0.03	0.07	-0.04
Nickel/Cobalt	0.13	-0.07	0.15	-0.08	0.17	-0.09
Zinc	0.21	-0.16	0.23	-0.17	0.23	-0.17
Beryllium	0.09	-0.02	0.10	-0.03	0.10	-0.03
Precious Metals	0.05	-0.03	0.06	-0.03	0.08	-0.04
Powder Metallurgy	0.20	-0.10	0.20	-0.10	0.23	-0.12
Titanium	0.14	-0.07	0.15	-0.08	0.16	-0.08
Refractory Metals	0.10	-0.05	0.12	-0.06	0.13	-0.07
Zirconium/Hafnium	0.07	-0.05	0.07	-0.05	0.08	-0.06
Magnesium	0.12	-0.09	0.12	-0.09	0.12	-0.09
Uranium	2.38	-0.60	2.38	-0.60	2.38	-0.60

dP/P = Change in price.
dQ/Q = Change in quantity of production.

SOURCE: JRB Associates estimates.

7.2 MAGNITUDE OF COMPLIANCE COSTS

To evaluate the magnitude of the costs of the regulations, the ratios of annual compliance costs to revenues (ACC/R) and compliance capital investment to revenues (CCI/R) are calculated for each plant. Tables 7-2 and 7-3 present the distribution of the ACC/R and CCI/R ratios, respectively, for the 105 nonferrous metals forming sample discharging plants. These tables indicate that the costs of the proposed regulations seem to be relatively low as 90 plants have annual compliance costs less than 1 percent of revenues and 95 plants have compliance capital investment less than 2 percent of revenues at Treatment Option 3. Only 5 plants (1 nickel/cobalt, 1 zinc, 1 titanium, 1 refractory metals, and 1 uranium) have annual compliance costs greater than 2 percent of revenues. A detailed impact analysis which determines potential plant closures and other impacts is presented in the following sections.

7.3 PROFIT IMPACT ANALYSIS

As indicated in Chapter 2, the impact of the regulations on plant profitability is measured by (1) the change in plant ROI, and (2) the plant after-compliance net present value (NPV).

7.3.1 Changes in Plant ROI

Plant baseline and after-compliance ROI calculations are based on the algorithm shown in Section 2.5 combined with the key financial and economic parameters shown in Table 7-4. These parameters represent average industry ratios. These ratios are imputed to each plant because plant-specific baseline financial characteristics (e.g., plant profit margin, asset value, variable, and fixed costs of production) are not available. The differences in profitability among the various product groups are due primarily to different asset turnover (i.e., assets to sales) ratios across product groups. Appendix A describes the methodology for estimating the baseline values for the key financial variables. The price elasticity estimates are based on the qualitative assessment in Chapter 4.

TABLE 7-2. DISTRIBUTION OF ANNUAL COMPLIANCE COST TO REVENUE RATIOS AT TREATMENT OPTION 3

PRODUCT GROUP	NUMBER OF DISCHARGERS[a]	NUMBER OF DISCHARGING PLANTS WITH ACC/R (in percent)					
		0-0.5	0.5-1	1-2	2-5	>5	NA
Lead/Tin/Bismuth	22	12	2	1			7
Nickel/Cobalt	29	17	4	3	1		4
Zinc	2	1			1		
Beryllium	1	1					
Precious Metals	24	13		1			10
Powder Metallurgy	21	11	2	3			5
Titanium	13	9	1	1		1	1
Refractory Metals	29	12	3		1		13
Zirconium/Hafnium	1	1					
Magnesium	2	1		1			
Uranium	2				1		1
TOTAL	146	78	12	10	4	1	41

[a] Many plants form more than one nonferrous metal. Each of these plants is classified in a single nonferrous metals product group that accounts for most of its total nonferrous metals forming.

NA: Data not available.

SOURCE: JRB Associates estimates.

TABLE 7-3. DISTRIBUTION OF COMPLIANCE CAPITAL INVESTMENT TO REVENUE RATIOS AT TREATMENT OPTION 3

PRODUCT GROUP	NUMBER OF DISCHARGERS[a]	NUMBER OF DISCHARGING PLANTS WITH CCI/R (in percent)					
		0-1	1-2	2-5	5-10	>10	NA
Lead/Tin/Bismuth	22	12	2			1	7
Nickel/Cobalt	29	20	2	2		1	4
Zinc	2	1			1		
Beryllium	1	1					
Precious Metals	24	13	1				10
Powder Metallurgy	21	15		1			5
Titanium	13	11				1	1
Refractory Metals	29	14	1		1		13
Zirconium/Hafnium	1	1					
Magnesium	2	1		1			
Uranium	2			1			1
TOTAL	146	89	6	5	2	3	41

[a] Many plants form more than one nonferrous metal. Each of these plants is classified in a single nonferrous metals product group that accounts for most of its total nonferrous metals forming.

NA: Data not available.

SOURCE: JRB Associates estimates.

TABLE 7-4. BASELINE CHARACTERISTICS OF THE NONFERROUS METALS FORMING INDUSTRY

PRODUCT GROUP	PRICE ELASTICITY	BEFORE-TAXES RETURN ON SALES (%)	RATIO OF VARIABLE COST TO TOTAL COST	ASSETS TO REVENUES RATIO
Lead/Tin/Bismuth	-.50	4.5	.80	0.56
Nickel/Cobalt	-.50	4.0	.80	0.50
Zinc	-.75	4.5	.80	0.56
Beryllium	-.25	4.5	.80	0.56
Precious Metals	-.50	3.7	.80	0.46
Powder Metallurgy	-.50	4.6	.80	0.58
Titanium	-.50	4.6	.80	0.57
Refractory Metals	-.50	4.5	.80	0.56
Zirconium/Hafnium	-.75	4.5	.80	0.56
Magnesium	-.75	4.5	.80	0.56
Uranium	-.25	4.5	.80	0.56

SOURCE: JRB Associates estimates (see Appendix A).

Table 7-5 presents the distribution of changes in plant ROI as a result of the proposed regulations. The regulations seem to affect the nickel/cobalt forming plants most, as 4 plants have ROI reductions greater than 2 percent at Treatment Option 3.

7.3.2 Plant After-Compliance Net Present Value

The impact of the proposed regulations on plant profitability is measured by the plant after-compliance net present value (NPV) as described in Section 2.5. The plant NPV represents the difference between the present value of the projected cash flows from operating the plant and the liquidation value of the plant. A negative NPV indicates that the plant is not earning its cost of capital and, consequently, can be considered a potential closure.

Table 7-6 summarizes the results of the NPV analysis and shows that 4 plants (1 nickel/cobalt, 1 zinc, 1 titanium and 1 refractory metal) have a negative NPV at all treatment options.

7.4 CAPITAL REQUIREMENT ANALYSIS

As presented in Chapter 2, the "fixed charge coverage" ratio is used to evaluate a firm's ability to raise the capital necessary to install the proposed pollution control systems. The "fixed charge coverage" ratio is defined as the ratio of earnings before interest and taxes to all fixed charge obligations (i.e., interest payments). This ratio is often used by lenders to evaluate firms' ability to incur additional debt. In this analysis, the ratio is applied to individual plants. Firms or plants with fixed charge coverage ratios greater than 2 are generally considered solvent and will not encounter unusual difficulty obtaining additional loans. Table 7-7 presents the results of the capital availability analysis. At Treatment Option 3, 10 plants have fixed charge coverage ratios less than 2. These plants include all 4 plants that have negative after-compliance NPV's.

TABLE 7-5. DISTRIBUTION OF CHANGE IN ROI AT TREATMENT OPTION 3

PRODUCT GROUP	NUMBER OF DISCHARGERS[a]	NUMBER OF DISCHARGING PLANTS WITH ROI REDUCTION (in percent)					
		<1	1-2	2-3	3-4	>4	NA
Lead/Tin/Bismuth	22	12	2		1		7
Nickel/Cobalt	29	17	4	2	1	1	4
Zinc	2	1				1	
Beryllium	1	1					
Precious Metals	24	12	1	1			10
Powder Metallurgy	21	12	2	1	1		5
Titanium	13	10	1			1	1
Refractory Metals	29	13	2			1	13
Zirconium/Hafnium	1	1					
Magnesium	2	1		1			
Uranium	2	1					1
TOTAL	146	81	12	5	3	4	41

[a] Many plants form more than one nonferrous metal. Each of these plants is classified in a single nonferrous metal product group that accounts for most of its total nonferrous metals forming.

NA: Data not available.

SOURCE: JRB Associates estimates.

TABLE 7-6. SUMMARY OF NET PRESENT VALUE ANALYSIS

PRODUCT GROUP	NUMBER OF DISCHARGING PLANTS [a]	NUMBER OF PLANTS WITH NPV <0		
		OPTION 1	OPTION 2	OPTION 3
Lead/Tin/Bismuth	22	0	0	0
Nickel/Cobalt	29	1	1	1
Zinc	2	1	1	1
Beryllium	1	0	0	0
Precious Metals	24	0	0	0
Powder Metallurgy	21	0	0	0
Titanium	13	1	1	1
Refractory Metals	29	1	1	1
Zirconium/Hafnium	1	0	0	0
Magnesium	2	0	0	0
Uranium	2	0	0	0
TOTAL	146	4	4	4

[a] Many plants form more than one nonferrous metal. Each of these plants is classified in a single nonferrous metal product group that accounts for most of its total nonferrous metals forming.

SOURCE: JRB Associates estimates.

TABLE 7-7. SUMMARY OF CAPITAL REQUIREMENT ANALYSIS

PRODUCT GROUP	NUMBER OF DISCHARGING PLANTS [a]	NUMBER OF PLANTS WITH FCC* RATIO <2		
		OPTION 1	OPTION 2	OPTION 3
Lead/Tin/Bismuth	22	1	1	1
Nickel/Cobalt	29	3	3	3
Zinc	2	1	1	1
Beryllium	1	0	0	0
Precious Metals	24	0	0	1
Powder Metallurgy	21	1	1	1
Titanium	13	1	1	1
Refractory Metals	29	1	1	1
Zirconium/Hafnium	1	0	0	0
Magnesium	2	1	1	1
Uranium	2	0	0	0
TOTAL	146	9	9	10

[a] Many plants form more than one nonferrous metal. Each of these plants is classified in a single nonferrous metal product group that accounts for most of its total nonferrous metals forming.

* FCC = Fixed charge coverage ratio.

SOURCE: JRB Associates estimates.

7.5 PLANT CLOSURE ANALYSIS

While financial parameters are the main determinants of plant closures, nonfinancial factors are also important and may influence the decision process. Some of these nonfinancial factors are market growth potential, contribution to total firm's product line, diversification, integration, intra-industry competition, and substitution potential for the products. Very often, these nonfinancial factors cannot be quantified. Therefore, the plant closure decision, like most investment decisions, ultimately involves managerial judgment.

In this analysis, the relevant investment decision factors are combined in a summary table to model the investment decision-making process, thereby facilitating estimates of plant closures. This information is shown in Table 7-8 for the 10 potentially impacted nonferrous metals forming plants in the sample identified in the above profit impact and capital requirements analyses. The table shows that 4 plants (all indirect dischargers and with negative NPVs) are projected to have high probability of closure at each treatment option.

Table 7-9 summarizes the results of the plant closure analysis. Other impacts of the regulations such as employment, community, and regional effects, substitution effects, foreign trade impacts, and industry structure effects are examined in Section 7.6.

7.6 OTHER IMPACTS

7.6.1 Employment, Community, and Regional Effects

As shown in Table 7-9, there is judged to be a potential for 4 plant closures at each of the three treatment options, involving a loss of about 340 jobs. The plants projected to close are located in large metropolitan/industrial areas and do not account for a significant portion of community employment; hence there are no significant community or regional impacts likely.

TABLE 7-8. SUMMARY OF PLANT CLOSURE ANALYSIS

PLANT	METAL(S) PRODUCED	ANNUAL PRODUCTION (mil/lbs)	PLANT DIVERSIFICATION/ INTEGRATION	TREATMENT OPTION	ACC/R (%)	AFTER-COMPLIANCE NPV ($000)	CCI/R (%)	FCC RATIO	POTENTIAL FOR CLOSURE
Plant A	Nickel	1-3	Moderate	1	1.7	-108	2.9	1.7	High
				2	1.9	-180	3.5	1.6	High
				3	2.0	-215	3.7	1.6	High
Plant B	Titanium	<1	Low	1	9.2	-418	15.0	-0.1	High
	Nickel	<1		2	10.2	-467	18.3	-0.2	High
				3	10.7	-493	19.4	-0.2	High
Plant C	Refractory	<1	Low	1	3.3	-253	5.5	1.3	High
	Nickel	<0.1		2	3.7	-322	6.7	1.2	High
				3	4.0	-459	7.3	1.2	High
Plant D	Zinc	1-3	Low	1	3.4	-35	6.9	1.3	High
				2	3.5	-38	7.0	1.3	High
				3	4.1	-55	8.0	1.2	High
Plant E	Nickel	<0.1	High. NFF production accounts for 1% of total plant revenues	1	0.9	23	20.1	1.6	Low
				2	0.9	33	20.1	1.6	Low
				3	1.0	32	21.6	1.6	Low
Plant F	Powder Metallurgy	1-3	Low	1	1.6	116	4.1	1.8	Low
				2	1.6	116	4.1	1.8	Low
				3	1.7	110	4.2	1.8	Low
Plant G	Magnesium	<1	Low	1	1.4	83	2.1	1.9	Low
				2	1.4	83	2.1	1.9	Low
				3	1.4	83	2.1	1.9	Low

SOURCE: JRB Associates estimates.

TABLE 7-8. SUMMARY OF PLANT CLOSURE ANALYSIS (Continued)

PLANT	METAL(S) PRODUCED	ANNUAL PRODUCTION (mil/lbs)	PLANT DIVERSIFICATION/ INTEGRATION	TREATMENT OPTION	ACC/R (%)	AFTER-COMPLIANCE NPV ($000)	CCI/R (%)	FCC RATIO	POTENTIAL FOR CLOSURE
Plant H	Lead	1-3	High. NFF production accounts for 1% of total revenues	1	0.4	59	8.8	1.9	Low
				2	0.4	59	8.8	1.9	Low
				3	1.8	26	11.6	1.6	Low
Plant I	Nickel	<1	Moderate	1	1.0	35	0.4	2.0	Low
				2	1.4	7	1.1	1.9	Low
				3	1.4	2	1.1	1.9	Low
Plant J	Precious Metals	<1	Low	1	0.8	19	1.1	2.0	Low
				2	0.9	55	1.6	2.0	Low
				3	1.0	7	1.7	1.9	Low

SOURCE: JRB Associates estimates.

TABLE 7-9. SUMMARY OF POTENTIAL CLOSURES
(all treatment options)

	DIRECT DISCHARGERS	INDIRECT DISCHARGERS
Number of Plants	39[a]	114[a]
Number of Closures	0	4
Employment Losses	0	340
Annual Production of Closed Facilities		
- Million lbs.	0	6.3
- % of Industry Total	0	0.9

[a] Includes 7 plants which discharge both directly and indirectly.

SOURCE: JRB Associates estimates.

The industry price increases due to the regulations would result in less than one percent reduction in the quantity of nonferrous metals forming products demanded (see Table 7-1). Such small quantity reductions would have minor effects on plant employment levels.

7.6.2 Substitution Effects

The price increases due to regulatory compliance costs will frequently lead to substitution by other products and materials which, in turn, results in a decrease in the quantity of product demanded.

However, the compliance costs of the regulations for the nonferrous metals forming industry are relatively small, and the price increases due to compliance are projected to be less than one-quarter of 1 percent for all subcategories except uranium. As shown in Table 7-1, such low price increases will result in less than 1 percent reduction in quantity demanded. Thus, the regulations will cause insignificant shifts to the use of other materials.

7.6.3 Foreign Trade Impacts

As shown in Table 7-1, the price increases estimated to result from the regulations are quite small, amounting to fractions of a percent for all product groups but uranium. The regulations would raise the prices of uranium products by approximately 2.5 percent; however, the primary application of uranium is for armor-piercing shells for which demand is presumably very price inelastic. Thus, the proposed regulations are expected to have very little impact on foreign trade patterns.

7.6.4 Industry Structure Effects

As shown in Table 7-8, the 4 potential closures each have less than 3 million pounds annual production. Total production of these plants accounts for less than 1 percent of industry output; their closures, therefore, are not expected to significantly change the industry structure.

7.7 NEW SOURCE IMPACTS

The proposed effluent standards and associated technologies for new sources are identical to those for existing sources. It is believed that compliance costs could be lower for new sources than for the corresponding options for existing sources because there would be no costs associated with retrofitting the in-process controls. Since the new source limitations would not create an additional cost for prospective new plants or major modifications, the proposed regulations would not cause barriers to entry.

8. SMALL BUSINESS ANALYSIS

The Regulatory Flexibility Act (RFA) of 1980 (P.L. 96-354), which amends the Administrative Procedures Act, requires Federal regulatory agencies to consider "small entities" throughout the regulatory process. The RFA requires an initial screening analysis to be performed to determine if a substantial number of small entities will be significantly impacted. If so, regulatory alternatives that eliminate or mitigate the impacts must be considered. This analysis addresses these objectives by identifying and evaluating the economic impacts of these regulations on small nonferrous metals forming plants. As described in Chapter 2, the small business analysis is developed as an integral part of the general economic impact analysis and is based on the examination of the distribution by plant size of the number of nonferrous metals forming plants, plant revenues, wastewater volumes, compliance costs, and potential closures from the regulations.

As explained in Section 2.11, rather than define small business in terms of firm total employment (i.e., the SBA definition), "small business" is defined more appropriately for the present analysis in terms of plant size, with size measured by rate of production. Several plant-size definitions based on plant annual production of nonferrous metals forming products were considered as alternative definitions:

- Plants with less than 500,000 pounds in production
- Plants with less than 1 million pounds in production
- Plants with less than 2 million pounds in production
- Plants with less than 3 million pounds in production
- Plants with less than 5 million pounds in production
- Plants with less than 10 million pounds in production.

Table 8-1 shows the distribution of 190 nonferrous metal forming sample plants with production data (including nondischarging plants) by size categories as well as the distribution of potential plant closures due to regulations. This table indicates that the majority of the plants in the nonferrous metals forming industry are small plants with less than 1 million pounds in annual production. A total of 4 plants are projected to close at each treatment option. Two of these plants have production less than 1 million pounds annually and the other two have 2-3 million pounds of production annually.

Table 8-2 presents the distribution of plant production and compliance costs by plant size. This table shows that annual compliance costs per unit of production for plants with less than 1 million pounds of annual production are substantially higher than those of larger plants.

TABLE 8-1. DISTRIBUTION OF NONFERROUS METALS FORMING PLANTS BY PRODUCTION VOLUME

	TOTAL NUMBER OF SAMPLE PLANTS	NUMBER OF SAMPLE PLANTS WITH NFF* PRODUCTION (in million pounds)						
		<0.5	0.5-1	1-2	2-3	3-5	5-10	>10
Lead/Tin/Bismuth								
- Total	34	7	4	3	3	3	8	6
- Dischargers	15	3	1	2	0	2	4	3
- Nondischargers	19	4	3	1	3	1	4	3
- Potential Closures	0	0	0	0	0	0	0	0
Nickel/Cobalt								
- Total	38	19	5	4	4	2	0	4
- Dischargers	24	11	4	2	3	0	0	4
- Nondischargers	14	8	1	2	1	2	0	0
- Potential Closures	1	0	0	0	1	0	0	0
Zinc								
- Total	5	1	0	1	1	0	1	1
- Dischargers	2	0	0	0	1	0	0	1
- Nondischargers	3	1	0	1	0	0	1	0
- Potential Closures	1	0	0	0	1	0	0	0
Beryllium								
- Total	1	1	0	0	0	0	0	0
- Dischargers	1	1	0	0	0	0	0	0
- Nondischargers	0	0	0	0	0	0	0	0
- Potential Closures	0	0	0	0	0	0	0	0
Precious Metals								
- Total	20	17	1	1	1	0	0	0
- Dischargers	14	11	1	1	1	0	0	0
- Nondischargers	6	6	0	0	0	0	0	0
- Potential Closures	0	0	0	0	0	0	0	0
Powder Metallurgy								
- Total	38	12	5	5	3	3	3	7
- Dischargers	16	3	3	4	1	2	1	2
- Nondischargers	22	9	2	1	2	1	2	5
- Potential Closures	0	0	0	0	0	0	0	0
Titanium								
- Total	19	9	2	3	0	2	1	2
- Dischargers	11	3	1	3	0	1	1	2
- Nondischargers	8	6	1	0	0	1	0	0
- Potential Closures	1	0	1	0	0	0	0	0

* Nonferrous metals forming.

TABLE 8-1. DISTRIBUTION OF NONFERROUS METALS FORMING PLANTS BY PRODUCTION VOLUME (Continued)

	TOTAL NUMBER OF SAMPLE PLANTS	NUMBER OF SAMPLE PLANTS WITH NFF* PRODUCTION (in million pounds)						
		<0.5	0.5-1	1-2	2-3	3-5	5-10	>10
Refractory Metals								
- Total	26	21	0	3	0	1	1	0
- Dischargers	17	13	0	2	0	1	1	0
- Nondischargers	9	8	0	1	0	0	0	0
- Potential Closures	1	1	0	0	0	0	0	0
Zirconium/Hafnium								
- Total	2	0	2	0	0	0	0	0
- Dischargers	1	0	1	0	0	0	0	0
- Nondischargers	1	0	1	0	0	0	0	0
- Potential Closures	0	0	0	0	0	0	0	0
Magnesium								
- Total	6	3	0	0	0	1	1	1
- Dischargers	2	2	0	0	0	0	0	0
- Nondischargers	4	1	0	0	0	1	1	1
- Potential Closures	0	0	0	0	0	0	0	0
Uranium								
- Total	1	0	0	0	0	0	1	0
- Dischargers	1	0	0	0	0	0	1	0
- Nondischargers	0	0	0	0	0	0	0	0
- Potential Closures	0	0	0	0	0	0	0	0
Total Industry								
- Total	190	90	19	20	12	12	16	21
- Dischargers	104	47	11	14	6	6	8	12
- Nondischargers	86	43	8	6	6	6	8	9
- Potential Closures	4	1	1	0	2	0	0	0

* Nonferrous metals forming.

SOURCE: EPA Industry Survey

TABLE 8-2. DISTRIBUTION OF COMPLIANCE COSTS BY PRODUCTION VOLUME

	SAMPLE PLANTS WITH ANNUAL NFF* PRODUCTION (in million pounds)					
	<0.5	0.5-1	1-2	2-3	3-5	>5
Direct Dischargers						
Number of Plants	8	2	4	2	2	8
Production - 10^6 x lbs	1.5	1.2	7.2	5.3	8.2	166.3
Potential Closures						
Number	0	0	0	0	0	0
Employment	0	0	0	0	0	0
Production - 10^6 x lbs	0	0	0	0	0	0
Treatment Option 1						
Investment - $000	201.8	162.7	152.1	207.8	22.2	1,533.2
Annual - $000	91.7	93.5	59.1	60.7	50.3	854.6
- ¢/lb	6.1	7.5	0.8	1.1	0.6	0.5
Treatment Option 2						
Investment - $000	269.1	195.5	152.9	278.7	84.8	1,591.9
Annual - $000	111.7	102.3	60.3	81.4	72.5	864.7
- ¢/lb	7.5	8.2	0.8	1.5	0.9	0.5
Treatment Option 3						
Investment - $000	297.2	208.5	211.8	341.5	95.6	1,721.3
Annual - $000	121.8	109.8	91.7	103.4	79.0	946.3
- ¢/lb	8.2	8.8	1.3	2.0	1.0	0.6

* Nonferrous metals forming.

TABLE 8-2. DISTRIBUTION OF COMPLIANCE COSTS BY PRODUCTION VOLUME (Continued)

	SAMPLE PLANTS WITH ANNUAL NFF* PRODUCTION (in million pounds)					
	<0.5	0.5-1	1-2	2-3	3-5	>5
Indirect Dischargers						
Number of Plants	34	9	10	4	4	11
Production - 10^6 x lbs	4.3	6.1	14.6	9.4	16.0	208.8
Potential Closures						
Number	1	1	0	2	0	0
Employment	a	a	0	a	0	0
Production - 10^6 lbs	a	a	0	5.4	0	0
Treatment Option 1						
Investment - $000	770.0	579.4	451.3	698.9	82.4	1,259.2
Annual - $000	528.7	367.5	573.9	356.1	109.5	376.2
- ¢/lb	12.4	6.0	3.9	3.8	0.7	0.2
Treatment Option 2						
Investment - $000	1,029.6	884.1	474.4	798.9	92.7	1,303.1
Annual - $000	623.4	455.4	602.8	383.7	112.7	387.4
- ¢/lb	14.6	7.4	4.1	4.1	0.7	0.2
Treatment Option 3						
Investment - $000	1,122.0	968.3	786.6	848.1	110.3	1,494.6
Annual - $000	672.2	496.2	732.8	410.3	124.4	469.5
- ¢/lb	15.7	8.1	5.0	4.4	0.8	0.2

* Nonferrous metals forming.

[a] Withheld to avoid disclosure of confidential data.

SOURCE: EPA Industry Survey.

9. LIMITATIONS OF THE ANALYSIS

This section discusses the major limitations of the economic impact analysis. It focuses on the limitations of the data, methodology, assumptions, and estimations made in this report.

9.1 DATA LIMITATIONS

The accuracy of the conclusions of this report depends largely on the accuracy of the data used in the analyses, especially that of the estimated compliance costs, and plant financial and economic characteristics.

One important limitation to this study results from the fact that engineering cost estimates were developed for only 23 representative plants. These engineering cost estimates were the basis for extrapolating the costs to the remaining plants in the industry, as explained in Section 6.4. It is likely that the extrapolated costs are less accurate than the engineering estimates, since less information was taken into consideration regarding the specific waste streams needing treatment and the extent of treatment-in-place. Further analysis of compliance costs is therefore planned.

In the absence of a detailed financial survey for the nonferrous metals forming industry, a financial profile of the nonferrous metals forming industry was developed based on extensive review of trade literature and published financial reports. This financial profile is subject to the following major assumptions and limitations:

- Lacking plant-specific operating ratios such as profit margin, assets value, fixed and variable costs of production industry average estimates were applied to the plants. The methodology for estimating these financial variables are explained in Appendix A.

- Only a single year's plant production and value of shipments data (1981) were collected in the EPA industry survey. Multiple years production data would have enabled a more in-depth analysis, encompassing the cyclical nature of the industry. However, the 1981 period was neither a peak nor a trough for the industry and the general economy and is, therefore, considered to be representative of average conditions in the industry over the long run.

9.2 METHODOLOGY LIMITATIONS

In addition to the data limitations described above, this study is also subject to limitations of the methodology used. These limitations are related to critical assumptions on price increase, profit impact, and capital availability.

9.2.1 Price Increase Assumptions

Because the nonferrous metals forming industry exhibits characteristics of both competitive and noncompetitive market behavior, it is assumed that the industry's pricing behavior will follow a strategy that will maintain the industry-wide initial return on sales. This assumption appears to be fairly reasonable since the demand for nonferrous metals forming products is relatively inelastic with respect to price.

9.2.2 Profit Impact Assumptions

The basic measure of profit impact used in this study is the after-compliance net present value. Due to the difficulty and uncertainties of forecasting the fluctuation in annual cash flows, it is assumed that annual cash flows remain constant over the period of the analysis. The rationale for this assumption is that while cash flows vary from year to year, they would tend to average around a normal level over a period of time. The assumption of constant cash flow is believed to have little effect on the accuracy of the analysis.

Another limitation relates to the ability of the profit impact methodology to assess the combined effects of the business cycle and the timing of the effective date of the regulation. As previously mentioned, portions of the study rely on inferences from only one or a few years of data. Where this occurred, care was taken to insure that any point estimate was not taken for an extreme year, such as a trough of a recession or a peak of an expansion. The 1981 time period was neither a peak nor a trough for the industry or the general economy, and is, therefore, considered to be representative of average conditions in the industry over a long period of time.

9.2.3 Capital Availability Assumptions

The capital investment requirements analysis was assessed through an evaluation of the "fixed charge coverage" ratio. Although this technique does not provide a precise conclusion on a firm's ability to make the investment, it does provide a good indication of the relative burden of the requirement.

9.3 SUMMARY OF LIMITATIONS

Although the above factors may affect the quantitative accuracy of the impact assessments on specific nonferrous metals forming plants , it is believed that the results of this study represent a valid industry-wide assessment of the economic impacts likely to be associated with effluent guideline control costs.

For the purpose of this study, the focus of the analysis is on the impacts of the regulations on the nonferrous metals forming operations of a plant. As a result, when a plant includes manufacturing activities other than nonferrous metals forming, only the nonferrous metals forming operations of that plant were evaluated. That is, the economic impact analysis is focused on the compliance costs and revenues of the nonferrous metals forming operations of the plant.

APPENDIX A

ESTIMATION OF PLANT ASSET VALUE, BASELINE RETURN ON SALES, AND COST OF CAPITAL

APPENDIX A

ESTIMATION OF PLANT ASSET VALUE, BASELINE RETURN ON SALES AND COST OF CAPITAL

This appendix described the methodology for estimating three critical financial parameters of the economic impact analysis. These parameters are:

- Plant asset value
- Plant baseline return on sales, and
- Industry cost of capital (i.e., discount rate).

Data for the above estimations are obtained from the 1977 Census of Manufactures, the Federal Trade Commission's Quarterly Financial Report for Manufacturing, Mining and Trade Corporations, and various corporate annual reports.

A.1 ESTIMATION OF PLANT ASSET VALUE

Plant assets are defined in this study as plant property and equiment net of depreciation, plus inventories and other current assets (i.e., cash, short-term investments, receivables, etc.). The individual plant asset values are estimated based on asset to value of shipment (A/VS) ratios calculated for each nonferrous metals forming group as follows:

$$A/VS = \frac{GBFA - DEP}{VS} + \frac{INV}{VS} + \frac{OCA}{VS}$$

$$= \frac{GBFA}{VS}\left(1 - \frac{DEP}{GBFA}\right) + \frac{INV}{VS} + \frac{OCA}{VS}$$

$$= \frac{GBFA}{VA} \times \frac{VA}{VS} \times \left(1 - \frac{DEP}{GBFA}\right) + \frac{INV}{VS} + \frac{OCA}{VS}$$

where:

GBFA/VA	=	Gross book value of fixed assets to value added ratio
VA/VS	=	Value added to value of shipment ratio
DEP/GBFA	=	Accumulated depreciation to gross book value of fixed assets ratio
INV/VS	=	Inventories to value of shipments ratio
OCA/VS	=	Other current assets to value of shipment ratio.

Table A-1 presents the steps and assumptions for estimating the nonferrous metals forming plant asset values.

As indicated in Section 2.5, the assessment of potential for plant closure is based on the comparison of the present value of the plant's projected annual cash flows and its liquidation value. Table A-2 summarizes the estimation of the liquidation value of plant assets for each nonferrous metals forming group. Plant liquidation value is estimated to vary from 68 percent of book value for the metal powders group to 76 percent of book value for the precious metals forming group, respectively. These estimates are based on the following assumptions:

- Liquidation value of inventories is 85 percent of book value,
- Liquidation value of other current assets (i.e., cash, short-term securities, and receivables) is 90 percent of book value, and
- Salvage value of fixed assets is zero, however, assuming a 40 percent corporate tax rate, the liquidation value of fixed assets will be 40 percent of book value as the result of tax-writeoff benefit.

A.2 ESTIMATION OF BASELINE RETURN ON SALES

In the absence of plant-specific data, industry average baseline profit margins (PM_1) are estimated for each nonferrous metals forming group. A

TABLE A-1. ESTIMATION OF PLANT ASSETS VALUE

PRODUCT GROUP	a/ GBFA/VA (1)	b/ VA/VS (2)	c/ DEP/GBFA (3)	d/ INV/VS (4)	e/ OCA/VS (5)	f/ A/VS (6)
Nickel Forming (SIC 33561)	1.25	0.21	0.41	0.18	0.17	0.50
Titanium Forming (SIC 33562)	1.25	0.30	0.41	0.18	0.17	0.57
Precious Metals Forming (SIC 33563)	1.25	0.15	0.41	0.18	0.17	0.46
Other Nonferrous Metals Forming (SIC 33569)	1.25	0.28	0.41	0.18	0.17	0.56
Metal Powders (SIC 33991)	1.17	0.34	0.41	0.18	0.17	0.58

a/ 1977 4-digit SIC gross book value of fixed assets to value added ratio. (SOURCE: 1977 Census of Manufactures.)

b/ 1977 5-digit SIC value added to value of shipment ratio. (SOURCE: 1977 Census of Manufactures.)

c/ 1982 accumulated asset depreciation to gross book value of fixed assets ratio of Nonferrous Metals industry. (SOURCE: Federal Trade Commission, Quarterly Financial Report.)

d/ 1977 4-digit SIC inventories to value of shipments. (SOURCE: 1977 Census Manufactures.)

e/ 1982 other current assets to sales ratio of Nonferrous Metals industry. (SOURCE: Federal Trade Commission, Quarterly Financial Report.)

f/ Equals [(1) x (2)] x [1 - (3)] + (4) + (5).

SOURCE: JRB Associates estimates.

TABLE A-2. ESTIMATION OF SALVAGE VALUE OF PLANT ASSETS

PRODUCT GROUP	BOOK VALUE OF ASSETS (% OF TOTAL ASSETS)			SALVAGE VALUE OF ASSETS (% OF BOOK VALUE OF TOTAL ASSETS)			
	a/ INVENTORIES	b/ CURRENT ASSETS	c/ FIXED ASSETS	d/ INVENTORIES	e/ CURRENT ASSETS	f/ FIXED ASSETS	TOTAL
Nickel Forming	36	34	30	31	31	12	74
Titanium Forming	31	30	39	26	27	16	69
Precious Metals Forming	39	37	24	33	33	10	76
Other Nonferrous Metals Forming	32	31	37	27	28	15	70
Metal Powders	31	29	40	26	26	16	68

a/ Equal to INV/VS ÷ A/VS (estimated in Table A-1).

b/ Equal to OCA/VS ÷ A/VS (estimated in Table A-1).

c/ Equal to GVFA/VA x VA/VS x (1 - DEP/GBFA) ÷ A/VS (estimated in Table A-1).

d/ Salvage value of inventories is estimated to be 85 percent of book value.

e/ Salvage value of other current assets is estimated to be 90 percent of book value.

f/ Liquidation value of fixed assets is assumed to be 40 percent of book value.

SOURCE: JRB Associates estimates.

impact analysis estimated the baseline before-tax return on assets (ROI) of the nonferrous metals forming industry to be approximately 8 percent.[1] In addition, the Federal Trade Commission's Quarterly Financial Report for Manufacturing, Mining, and Trade Corporations also reported that before-tax ROI in the nonferrous metals forming industry averaged about 8 percent during 1978-1982. Finally, annual reports of over 50 nonferrous metals formers were reviewed. Most of these companies are highly diversified and their nonferrous metals forming operations represent a relatively small portion of their total business; however, 15 companies report financial data on their nonferrous metals forming lines of business. Table A-3 lists the before-taxes ROIs of the nonferrous metals forming line of business for these 15 companies for the period 1978-1982. The mean ROI for these companies during that period range from 3.7 percent in 1982 to 16.4 percent in 1980, averaging 12 percent over the five-year period. The 1978-1982 average ROI is believed to represent the industry's future normal profit level because it includes periods of both industry expansion and slowdown.

For the purpose of this analysis, it is assumed that the nonferrous metals forming industry baseline ROI would average 8 percent. This is believed to represent a conservative estimate. Based on asset-turnover ratios estimated in Table A-1, the industry baseline return on sales PM_1 is estimated to range from 3.7 percent for the precious metals forming plants to 4.6 percent for the metal powder plants, respectively. Table A-4 summarizes the baseline return on sales estimated for the nonferrous metals forming groups.

A.3 ESTIMATION OF INDUSTRY COST OF CAPITAL

As described in Section 2.5, the discount rate for present value calculations is defined as the weighted average of cost of equity and cost of debt, that is:

$$k = \frac{(i \times D) + (e \times E)}{D + E}$$

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[1] EPA, Economic Impact Analysis of Effluent Limitations Guidelines and Standards for the Aluminum Forming Industry, September 1983.

TABLE A-3. ESTIMATION OF NONFERROUS METALS FORMING BASELINE RETURN ON ASSETS

COMPANY	BEFORE-TAXES RETURN ON ASSETS (in percent)				
	1982	1981	1980	1979	1978
1. Allegheny International	2.3	14.1	13.7	8.5	2.2
2. Amax, Inc.	(13.2)	4.4	15.7	18.0	10.8
3. Amsted Industries	13.4	22.7	23.9	24.3	28.3
4. Cabot Corp.	(3.4)	2.9	12.6	8.8	3.3
5. Carlisle Corp.	16.2	38.4	36.8	22.5	23.8
6. Curtiss-Wright Corp.	3.9	7.6	18.6		
7. Driver-Harris Co.	(0.8)	(5.4)	(1.9)	5.8	(0.9)
8. Engelhard Corp.	5.0	9.7	12.0	4.2	9.5
9. Federal-Mogul Corp.	13.5	16.6	18.2	20.6	21.1
10. Handy & Harman	4.3	12.3	13.6		
11. Inco	(8.0)	(1.3)	8.1		
12. Kennametal	15.2	17.2	23.8	29.2	23.4
13. Olin Corp.	13.6	14.6	8.8	1.6	4.0
14. H.K. Porter Co., Inc.	13.4	20.2	27.5		
15. Quanex	(20.1)	20.3	14.3	16.8	20.2
AVERAGE	3.7	13.0	16.4	14.6	13.2

TABLE A-4. ESTIMATION OF NONFERROUS METALS FORMING BASELINE RETURN ON SALES

PRODUCT GROUP	BASELINE ROI (%)	ASSET TURNOVER RATIO	BASELINE PM_1 (%)
Nickel Forming	8.0	0.50	4.0
Titanium Forming	8.0	0.57	4.6
Precious Metals Forming	8.0	0.46	3.7
Other Nonferrous Metals Forming	8.0	0.56	4.5
Powder Metallurgy	8.0	0.58	4.6

SOURCE: JRB Associates estimates.

where:

- k = Discount rate
- i = Interest rate of debt capital
- e = Cost of equity capital
- D = Debt capital
- E = Equity capital.

Interest rates on commercial loans are generally 1 to 2 percentage points above prime interest rates (i.e., interest rates that banks usually charge their best, most credit-worthy customers). Data Resources, Inc. forecasted that prime rates between 1985 and 1995 would average about 10.5 percent.2/ Assuming a premium of 1.5 percent, it is projected that interest rates on debt would average about 12 percent over that period of time.

For this study, cost of equity is defined as the rate of return on a risk-free investment such as the U.S. Treasury Bond plus a risk premium factor. DRI forecasts show that 10-year U.S. Treasury Bond yields would average about 9 percent over the 1985-1995 time period.3/ In the financial literature, the long-run normal risk premium on stock investment is estimated to be 5 percent.4/ As the result, the cost of equity is expected to average around 14 percent.

Finally, the Federal Trade Commission's Quarterly Financial Report indicates that book values of debt and equity in the nonferrous metals forming industry each average approximately 50 percent of total capital during 1978-1982. As indicated in Table A-2, the salvage values of assets average approximately 70 percent of book value. Since debt is due in full at liquidation of the plant, it actually represents about 71 percent of the plant liquidation value (50 ÷ 70 = 0.71), and equity accounts for 29 percent. Thus, the cost of capital of the nonferrous metals forming industry is estimated to be 12.6 percent ([12 x 0.71] + [14 x 0.29]).

2/ Data Resources, Inc., U.S. Long-term Review, Winter 1982-1983.

3/ Ibid.

4/ Alfred Rappaport, "Strategic Analysis for More Profitable Acquisitions," Harvard Business Review, July-August 1979.