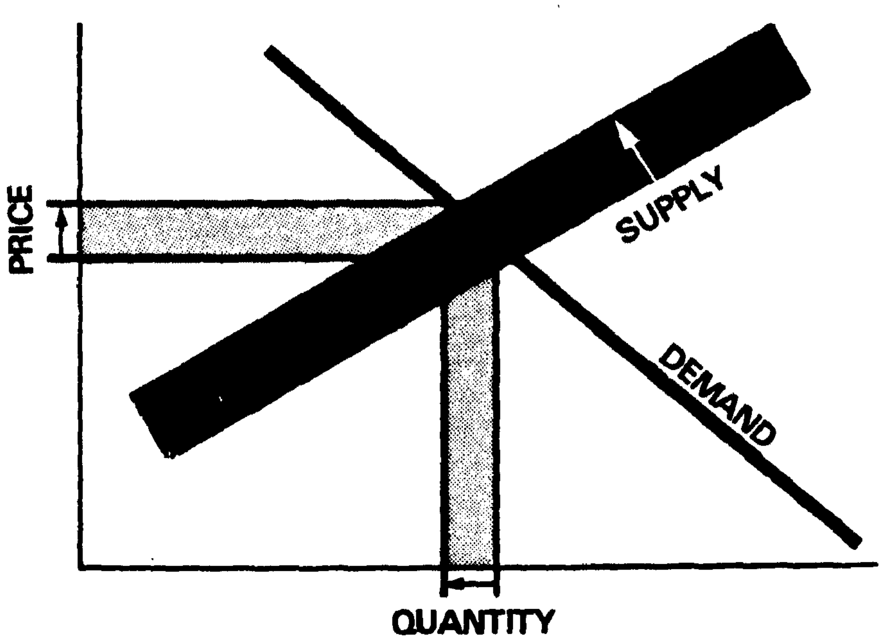
United States
Environmental Protection
Agency

Office of Water Regulations
and Standards
Washington, DC 20460

EPA 440/2-82-005
November 1982

Water

Economic Impact Analysis of Effluent Limitations and Standards for the Porcelain Enameling Industry



ECONOMIC IMPACT ANALYSIS OF
EFFLUENT LIMITATIONS AND STANDARDS
FOR THE PORCELAIN ENAMELING INDUSTRY

Submitted to:

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

November 1982

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
WASHINGTON, D.C. 20460

This document is an economic impact assessment of the recently-issued effluent guidelines. The report is being distributed to EPA Regional Offices and state pollution control agencies and directed to the staff responsible for writing industrial discharge permits. The report includes detailed information on the costs and economic impacts of various treatment technologies. It should be helpful to the permit writer in evaluating the economic impacts on an industrial facility that must comply with BAT limitations or water quality standards.

The report is also being distributed to EPA Regional Libraries, and copies are available from the National Technical Information Service (NTIS), 5282 Port Royal Road, Springfield, Virginia 22161 (703/487-4600).

If you have any questions about this report, or if you would like additional information on the economic impact of the regulation, please contact the Economic Analysis Staff in the Office of Water Regulations and Standards at EPA Headquarters:

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PREFACE

This 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 effluent standards and limitations issued under Sections 301, 304, 306, 307, and 501 of the Clean Water Act to the porcelain enameling industry.

The study supplements the technical study (EPA Development Document) supporting the issuance of these regulations. The Development Document surveys existing and potential waste treatment control methods and technology within particular industrial source categories 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 effects 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 Water Regulations and Standards of EPA. This report was submitted in accordance with Contract No. 68-01-6348, Work Assignment 14, by JRB Associates, and was completed in November, 1982.

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INTRODUCTION

Purpose

This report provides an identification and analysis of the economic impacts which are likely to result from the promulgation of EPA's effluent regulations on the Porcelain Enameling Industry. These regulations include effluent limitations and standards based on Best Practicable Control Technology Currently Available (BPT), Best Available Technology Economically Achievable (BAT), New Source Performance Standards (NSPS), and Pretreatment Standards for New and Existing Sources (PSNS and PSES) which are being proposed under authority of Section 301, 304, 306, 307, and 501 of the Federal Water Pollution Control Act, as amended by the Clean Water Act of 1977 (Public Law 92-500). The primary economic impact variables assessed in this study include the costs of the proposed 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, new source impacts, and impacts on small businesses.

Industry Coverage and Segmentation

Porcelain enameling is a metal finishing process performed by appliance, plumbing fixture, job shops and other product manufacturers. It involves the application of a glass coating called frit to steel, cast iron, aluminum, or copper. The purpose of the coating is to improve resistance to chemical abrasion and corrosion, and to improve thermal stability, electrical insulation, and appearance. The porcelain enameling process involves the preparation of the enamel slip (ball milling)*, the surface preparation of the base metal, application of the enamel, and the drying and firing to permanently fuse the coating to the metal. These processes comprise the focus of this study.

For regulatory purposes, EPA divided the porcelain enameling industry into the following four technical subcategories based on basis material coated:

- Porcelain enamel on steel
- Porcelain enamel on cast iron
- Porcelain enamel on aluminum
- Porcelain enamel on copper.

Since the pollutants generated in the surface preparation of the metal vary by type of metal enameled, this subcategorization scheme was chosen to subdivide the industry into groups of plants with similar pollution profiles. However, from an economic viewpoint, it is expected that the economic and financial impacts of the regulations will vary with the type of product enameled. This is because product market strength, pricing latitude, and the ability of manufacturers to substitute alternative materials for porcelain enameling vary by end product. Therefore, in order to develop a basis for assessing economic impacts, these four subcategories were subdivided into the following major end product groups:

- Ranges
- Home Laundry
- Hot Water Heaters
- Dishwashers
- Refrigerators
- Steel Sanitary Ware

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* The slip is a suspension of ceramic material in either water or oil. Ball milling is the process for grinding enamels utilizing vitreous china balls in a rotating cylindrical mill.

- Cast Iron Sanitary Ware
- Cookware
- Architectural Panels.

In addition, while job shops do not represent a single end-product, they are included as a separate economic group.

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. Supplemental analyses are used to assess linkages of the porcelain enameling industry's price, production, and profitability changes to employment, community, industry structure, and balance of trade impacts. These analyses were performed for each of five regulatory options considered by EPA. The methodology of the study includes nine major steps. Although each step is described independently, there is considerable interdependence among them. Specifically, the study proceeded using the following nine steps:

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 (Step 4) to determine post-compliance revenue and profit levels for specific plants in each group.

A pricing strategy which would maintain the industry's initial return on sales is assumed as an approximation of industry-wide price increases. However, due to weak market conditions and declining demand for porcelain enameled architectural panels, it was assumed that architectural panel producers will not be able to raise their prices and, therefore, will have to absorb the compliance costs. Industry-wide quantity reductions are also estimated.

Step 3: Cost of Compliance Estimates

Investment and annual compliance costs of five treatment options were estimated for each porcelain enameling facility. These cost estimates form the basis for the economic impact analysis.

Step 4: Plant-Level Profitability Analysis

The basic measure of profitability used to assess the impact of the regulations on individual plants is return on investment (ROI). Plants with after-compliance ROI below a threshold value of 7 percent are considered potential plant closures. The 7 percent ROI threshold value is estimated to correspond to a 12 percent after-tax return on equity which is assumed to be the minimum return for a business to continue operation. Due to the unavailability of plant-specific baseline financial characteristics for the porcelain enameling industry, average industry financial and operating ratios for each product group was applied to each plant.

Step 5: Capital Requirements Analysis

In addition to analyzing the potential for plant closures from a profitability perspective, the ability of firms to make the initial capital investment needed to construct and install the required treatment systems is also assessed. The analysis of capital availability is based on the ratio of "compliance capital investment requirements to plant revenues" (CCI/R). This ratio was calculated for each plant and compared to a threshold value to indicate the potential for plant closure as a result of not being able to raise sufficient capital.

Step 6: Plant Closure Analysis

For this analysis, plant closure estimates are based primarily on the quantitative estimates of post-compliance profitability and the ability to raise capital developed in Steps 4 and 5, respectively. Although the decision to close a plant, like most major investment decisions, is largely based on financial performance, it is ultimately judgmental. This is because the decision involves a wide variety of considerations, many of which are highly uncertain and cannot be quantified. Thus, the identification of plants as potential closures is interpreted as an indication of the extent of plant impact rather than as a prediction of certain closure.

Step 7: Other Impacts

Other impacts evaluated include impacts on employment, communities, industry structure, and balance of trade. These are assessed through supplementary analyses on the basis of the findings of Steps 2, 4, 5, and 6.

Step 8: New Source Impacts

This step analyzes the effects of NSPS/PSNS guidelines. The analysis is based on model plants developed for each technical subcategory and the corresponding compliance costs of the alternative treatment technologies. The impacts of new source regulations are determined by a comparison of estimated compliance costs to expected revenues for the model plants.

Step 9: Small Business Analysis

This analysis identifies the economic impacts which are likely to result from the promulgation of the regulations on small businesses in the porcelain enameling industry. The primary economic variables covered are those analyzed in the general economic impact analysis such as plant closures and unemployment. Most of the information and analytical techniques in the small business analysis are drawn from the general economic impact analysis. The specific conditions of small firms are evaluated against the background of general conditions in the porcelain enameling markets.

The impacts on small plants were assessed by examining the distribution, by plant size, of the number of porcelain enameling plants, plant revenues, wastewater volumes, compliance costs and potential closures from regulations.

INDUSTRY CHARACTERISTICS

EPA has identified 116 plants in the U.S. that perform porcelain enameling operations. Porcelain enameling plants can be subcategorized into two basic types -- captive operations within an integrated manufacturing facility, and independent job shops. Captive operations comprise about 80 percent of the plants and 92-95 percent of the industry production, whereas job shops represent about 20 percent of the plants and 5 to 8 percent of the industry production.

In 1976, the annual production rates of 108 plants (those which reported production data in an EPA industry survey) ranged from 25,000 square feet (of exposed surface area enameled) for a small job shop to 62,190,000 square feet (of exposed surface area enameled) for an integrated appliance manufacturer, totaling 775 million square feet for the industry. Also, approximately 50 percent of the plants are middle sized, with an employment of between

50 to 500 workers; and while many plants were built before 1950, most plants have had recent modification.

Industry competition among firms that manufacture products with porcelain enamel finishes appears to be rather intense. Manufacturers appear to be quite competitive in attempts to maintain and improve their brand names' market share as well as maintaining or improving their private-label production. There is evidence of a trend toward increasing market share among the large manufacturers for most home appliance product groups.

Except for the cookware group, foreign competition is not significant for the porcelain enameling industry.

In most of its major applications, porcelain enamel faces strong competition from alternative materials or finishing techniques such as plastic, fiberglass, cultured marble, stainless steel, coated coil, and paint. Over the last two decades, porcelain enamel use declined, the number of production facilities decreased, and production capacity was reduced. However, most of the substitution seems to have already taken place, and the substitution pattern away from porcelain enamel appears to have leveled off in recent years.

The demand for porcelain enameled products is dependent on two factors: (1) the market strength of the various end products which contain porcelain enamel, and (2) the availability of substitute materials for porcelain enameling finishes. Generally, the competition from alternative finishes appears to affect the demand for porcelain enameled products more than from end product competition. The responsiveness of demand factors to price changes is reflected in the measure of price elasticity. Inelastic coefficients were assigned to each major product group (varying from -.3 to -.9) except architectural panels, which proved to be elastic and assigned the coefficient -1.2.

BASE CASE ANALYSIS

Baseline conditions in the porcelain enameling industry were projected for the 1983-1987 period to assess the industry's status in the absence of this regulation. These projections form the basic background for the economic impact conclusions. In particular, it is projected that demand will remain stable and there will be no baseline closures.

WATER POLLUTION CONTROL OPTIONS AND COSTS

Based on the analysis of the potential pollutant parameters and treatment in place in the porcelain enameling industry, EPA identified five treatment technologies that are applicable for the existing sources in the industry:

- Treatment Level 1: Settling sump plus chemical treatment
- Treatment Level 2: Physical and chemical treatment (lime and settle)
- Treatment Level 3: In-process flow reduction plus physical and chemical treatment (lime and settle plus flow reduction)
- Treatment Level 4: Physical and chemical treatment plus filtration (lime and settle plus filtration)
- Treatment Level 5: In-process flow reduction, physical and chemical treatment plus filtration (lime and settle, filtration and flow reduction).

For new sources, two alternative treatment technologies were examined:

- Treatment Level 1: Lime and settle, flow reduction
- Treatment Level 2: Lime and settle, flow reduction plus filtration and 3-stage countercurrent cascade rinse to further reduce wastewater flow.

Table S-1 presents the estimated total industry investment and annual compliance costs of these technologies for the existing sources, and Table S-2 summarizes the compliance cost estimates of the new source treatment alternatives for model plants.

FINDINGS

Plant Closure Impact

Table S-3 summarizes the estimated number of closures among existing sources as the result of the alternative treatment levels. Twenty-one plants or production lines (10 job shops, 4 architectural panels, 4 cookware, 1 range, 1 hot water heater, and 1 steel sanitary ware) are estimated to close at Treatment Levels 2 to 5. Nineteen of these closures were below the ROI threshold and above the capital requirements threshold. Two facilities (both job shops) were estimated to close solely on the basis of capital availability. At Treatment Level 1, only one job shop is projected to close.

Industry Structure Impact

The impact of the regulations on industry structure and competition is assessed via a review of post-compliance market concentration. For Treatment Levels 2 to 5, significant increases in product group concentration could occur in the job shop (10 closures), architectural panels (4 closures), and cookware (4 closures) subcategories.

Substitution Effects

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

TABLE S-1. ESTIMATED COMPLIANCE COSTS FOR PORCELAIN ENAMELING INDUSTRY EXISTING SOURCES (1978 DOLLARS)

Product Groups	No. of Plants	Annual Production (10^3 sq.ft.)	Total Compliance Capital Investment ($ Thousand)					Total Annual Cost of Compliance ($ Thousand)				
			Level 1	Level 2	Level 3	Level 4	Level 5	Level 1	Level 2	Level 3	Level 4	Level 5
Ranges	25	215,533	1,435.2	4,991.9	5,340.4	6,690.0	7,036.0	371.4	3,031.7	3,108.3	3,504.8	3,580.9
Home Laundry	9	181,720	1,004.0	1,771.2	1,900.6	3,293.3	3,421.4	259.8	2,141.1	2,170.1	2,560.9	2,589.7
Dishwashers	4	48,060	341.8	1,429.3	1,507.4	1,909.9	1,987.8	88.5	692.3	709.3	824.0	841.0
Hot Water Heaters	9	75,211	179.2	1,309.6	1,385.7	1,418.4	1,494.3	46.4	536.3	553.1	565.7	589.9
Refrigerators	2	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)
Steel Sanitary Ware	9	58,255	416.8	2,296.9	2,384.5	2,807.8	2,895.3	107.9	960.9	980.4	1,100.7	1,120.2
Cast Iron Sanitary Ware	2	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)
Cookware	11	50,982	434.3	2,526.0	2,681.5	3,136.0	3,291.1	112.4	846.0	880.1	1,011.7	1,045.7
Architectural Panels	11	35,552	221.9	1,464.9	1,532.8	1,590.6	1,658.4	57.6	597.1	612.2	629.5	644.5
Job Shops	23	52,310	613.4	4,452.4	4,674.8	5,018.8	5,240.9	158.7	1,649.5	1,698.4	1,802.2	1,850.9
Barbecues	1	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)
Total for Sample Plants	106	774,628	4,931.7	21,450.3	22,673.9	27,498.1	28,716.0	1,276.5	11,097.7	11,367.6	12,760.5	13,036.4
Indirect Dischargers	82	556,389	3,780.9	17,326.3	18,300.8	21,866.8	22,837.3	978.7	8,671.6	8,886.0	9,911.7	10,132.5
Direct Dischargers	24	218,240	1,150.8	4,124.0	4,373.0	5,631.2	5,878.7	297.8	2,426.1	2,481.4	2,848.9	2,903.9
Total for Industry	116	851,700	5,170.4	23,242.8	24,544.8	29,487.3	30,783.6	1,338.3	11,803.5	12,090.6	13,520.3	13,813.5
Indirect Dischargers	88	597,100	3,912.8	18,529.3	19,565.8	23,143.9	24,176.2	1,012.8	9,105.1	9,333.2	10,364.4	10,599.0
Direct Dischargers	28	254,000	1,257.6	4,713.4	4,979.0	6,343.4	6,607.3	325.5	2,698.4	2,757.4	3,155.9	3,214.6

(a)Withheld to avoid disclosure of confidential data.

NA: Not available.

Source: EPA.

TABLE S-2. ESTIMATED COMPLIANCE COSTS FOR A MODEL NEW SOURCE

	Technical Subcategory			
	Steel	Aluminum	Cast Iron	Copper
Average Annual Production per Plant* (thousand sq ft)	6,610	1,380	4,280	280
Treatment Level 1 Compliance Costs per Plant ($ thousand)				
Capital Investment	247.8	183.0	72.0	72.0
Annual Costs	80.6	61.6	22.1	22.1
Treatment Level 2 Compliance Costs per Plant ($ thousand)				
Capital Investment	259.8	195.0	82.0	84.0
Annual Costs	83.6	63.5	24.0	24.1

*One side of metal

Source: EPA

TABLE S-3. SUMMARY OF ESTIMATED FACILITY CLOSURES FOR EXISTING SOURCES

	Treatment Level 1			Treatment Levels 2 to 5		
	All Plants	Direct	Indirect	All Plants	Direct	Indirect
Potential Closures						
Line Closures	1	0	1	12	2	10
Plant Closures	0	0	0	9	1	8
All Closures	1	0	1	21	3	18
Employment at						
Line Closures	2	0	2	185	51	134
Plant Closures	0	0	0	303	8	295
All Closures	2	0	2	488	59	429
Market Share of Closures (%)	*	0	*	2.4	0.2	2.2

*Less than 0.05 percent

SOURCE: JRB Associates estimates.

Community and Employment Impacts

The 21 porcelain enameling plants and lines projected to close are all located in different localities/municipalities. Total employment affected by these closures are 488 employees. The largest employment impact to a single locality is 55 employees; thus, community impact seems to be insignificant.

Foreign Trade Impacts

Except for the cookware group, where a significant level of import competition already exists, the regulations will have no foreign trade impacts. For the cookware manufacturers, the price increase due to regulations is less than 1 percent; such a price increase would not alter the trading pattern substantially.

New Source Impacts

Two treatment alternatives are considered for newly constructed facilities and existing facilities that are substantially modified. For the purpose of evaluating the new source impacts, compliance costs of new source standards are defined as incremental costs over the costs of selected standards for existing sources.

New source Treatment Level 1 is similar to the selected treatment technology for existing sources, and there is no additional incremental compliance cost for this alternative.

The costs of new source Treatment Level 2 are also low (annual compliance costs are less than 1 percent of revenues) and are not expected to deter new entry.

Impacts on Small Entities

Economic impacts, as indicated by plant closures and unemployment, are highest among the smaller plants:

- 17 of the 21 projected plant closures are among small businesses as defined by the Small Business Administration's employment levels
- All 21 projected closures have less than $5 million in plant revenues
- 14 projected closures are indirect dischargers with flow rate less than 60,000 l/day and production rate less than 1600 m^2 per day.

1. INTRODUCTION

1.1 PURPOSE

This report identifies and analyzes the economic impacts which are likely to result from the promulgation of EPA's effluent regulations on the Porcelain Enameling Industry. These regulations include effluent limitations and standards based on Best Practicable Control Technology Currently Available (BPT), Best Available Technology Economically Achievable (BAT), New Source Performance Standards (NSPS), and Pretreatment Standards for New and Existing Sources (PSNS and PSES) which are being proposed under authority of Section 301, 304, 306, 307, and 501 of the Federal Water Pollution Control Act, as amended by the Clean Water Act of 1977 (Public Law 92-500). The primary economic impact variables assessed in this study include the costs of the proposed 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, new source impacts, and impacts on small businesses.

1.2 INDUSTRY COVERAGE

Porcelain enameling is a metal finishing process performed by appliance, plumbing fixture, job shops and other product manufacturers. It involves the application of a glass coating called frit to steel, cast iron, aluminum, or copper. The purpose of the coating is to improve resistance to chemical abrasion and corrosion, and to improve thermal stability, electrical insulation, and appearance. The porcelain enameling process involves the preparation of the enamel slip (ball milling)*, the surface preparation of the base metal, application of the enamel, and the drying and firing to permanently fuse the coating to the metal. The focus of this study is on the ball milling, metal preparation, and process application stages of porcelain enameling.

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*The slip is a suspension of ceramic material in either water or oil. Ball milling is the process for grinding enamels utilizing vitreous china balls in a rotating cylindrical mill.

1.3 INDUSTRY SEGMENTATION

For regulatory purposes, EPA divided the porcelain enameling industry into four technical subcategories based on basis material coated. These subcategories are:

- Porcelain enamel on steel
- Porcelain enamel on cast iron
- Porcelain enamel on aluminum
- Porcelain enamel on copper.

Since the pollutants generated in the surface preparation of the metal vary by type of metal enameled, this subcategorization scheme was chosen to subdivide the industry into groups of plants with similar wastewater profiles. While this scheme may be appropriate from a technical viewpoint, it is expected that the economic and financial impacts of the regulations will vary with the type of product enameled. This is because product market strength, pricing latitude, and the ability of manufacturers to substitute alternative materials for porcelain enameling vary by end product. Therefore, subdividing these four subcategories into end product groups is required to develop a basis for assessing economic impacts. The major end products which contain porcelain enamel are:

- Ranges
- Home Laundry
- Hot Water Heaters
- Dishwashers
- Refrigerators
- Steel Sanitary Ware
- Cast Iron Sanitary Ware
- Cookware
- Architectural Panels.

In addition, while job shops do not represent a single end-product, they are included as a separate economic group.

1.4 ORGANIZATION OF REPORT

The remainder of this report consists of seven chapters. Chapter 2 describes the analytical methodology, Chapter 3 provides the basic industry characteristics, and Chapter 4 projects some of the critical parameters into the future to enable an understanding of the expected characteristics of the industry during the 1982 to 1987 time period, when the primary economic impacts of the proposed regulations will be felt. Chapter 5 describes the pollution control technologies considered by EPA and their associated costs. The information in Chapter 5 is derived primarily from the technical Development Document prepared by EPA's Effluent Guidelines Division. Chapter 6 describes the economic impacts estimated to result from the cost estimates that are presented in Chapter 5. Chapter 7 presents an analysis of the effects of the proposed regulations on small business, and Chapter 8 outlines the major limitations of the analysis and discusses the possible effects of the limitations on the study's major conclusions.

2. STUDY METHODOLOGY

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 proposed regulatory option. For the Porcelain Enameling industry, five regulatory options are considered in the economic impact study. 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 effects of the compliance costs enumerated in Chapter 5.

The operational description of the price and output behavior is used, in conjunction with compliance cost estimates, to determine new post-compliance industry price and production levels for each regulatory option and for each of the Porcelain Enameling product groups. Individual plants are then subjected to a financial analysis that uses capital budgeting techniques to determine potential plant closures. Effects on employment, community, foreign trade and industry structure are also determined. Specifically, the study proceeded in the following nine steps:

1. Description of industry characteristics
2. Industry supply and demand analysis
3. Analysis of cost of compliance 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.

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

2.1 STEP 1: DESCRIPTION OF INDUSTRY CHARACTERISTICS

The first step in the analysis is to describe the basic industry characteristics. These characteristics, which include number and type of

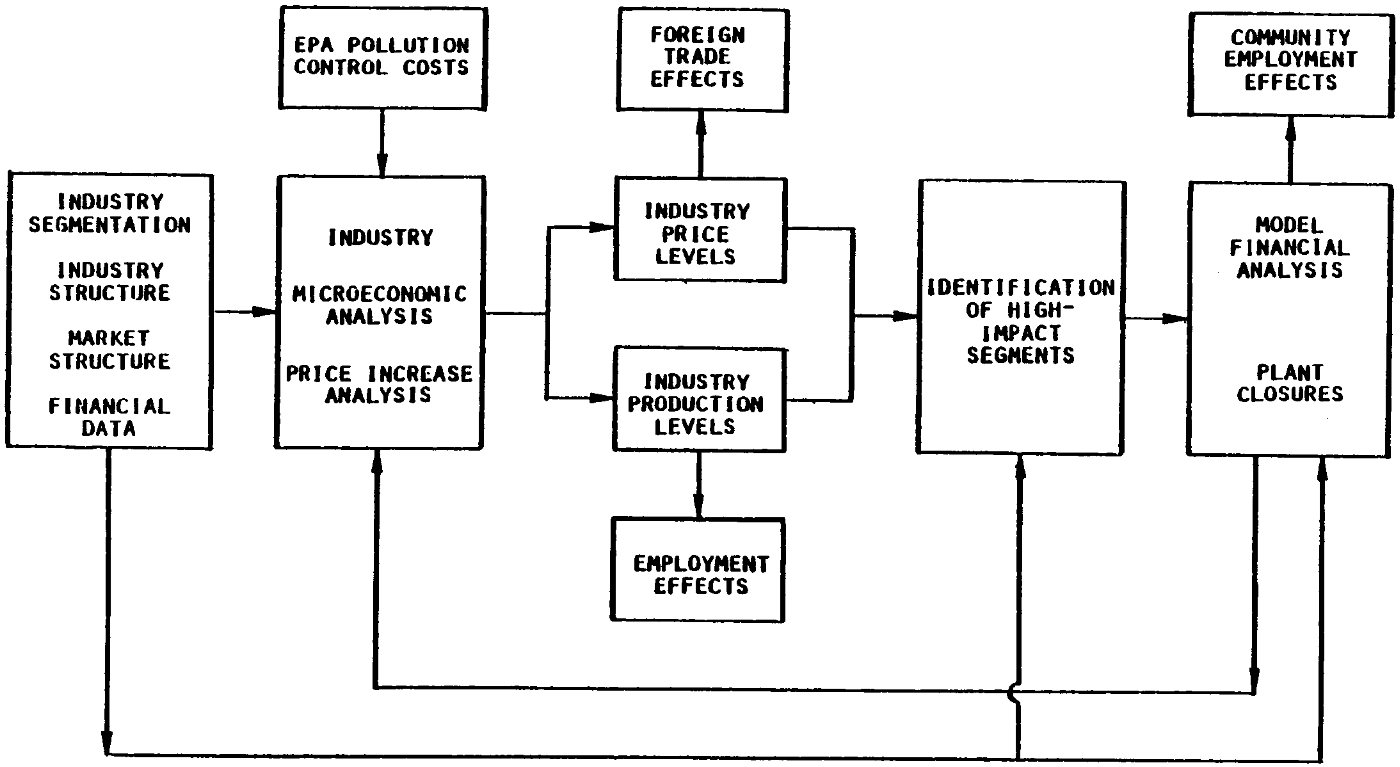

FIGURE 2-1. ECONOMIC ANALYSIS STUDY OVERVIEW

plants, the determinants of demand, market structure, the degree of intra-industry competition, and financial performance, are presented in Chapter 3 of this report.

It was also necessary to determine if, in the absence of effluent regulations, the key parameters in industry structure would change significantly during the 1980's. Projections of industry conditions begin with a demand forecast. The demand during the 1980's is estimated via trend analysis and market research analysis. The potential for change in porcelain enameling prices and number of facilities is also assessed.

The sources for this information include government reports, trade association data, discussions with various trade association representatives and individuals associated with the industry, and an EPA industry survey.

2.2 STEP 2: SUPPLY-DEMAND ANALYSIS

The purpose of the supply-demand analysis, step 2 of the study approach, 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 successfully raised without significantly reducing product demand and companies are able to maintain their current financial status, the potential for plant closings resulting from the regulation 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 to 1984 (the expected effective date for the regulation), determination of plant- and firm-specific operational parameters (e.g., production costs, profit rates), and development of price-quantity algorithms.

Short run pricing behavior depends upon the market structure of the industry, which can range from competitive to monopolistic competition, to oligopoly, and to monopoly situations. Many economic impact studies begin by assuming perfect competition. However, the product groups covered in this study exhibit some characteristics that are indicative of non-competitive pricing mechanisms.

The perfectly competitive market structure is one in which there are many buyers and sellers and the actions of any one of these do not significantly affect the market. Firms in a competitive market generally earn a "normal" rate of return on their assets. If it is assumed that (1) the market for a competitive good is currently at equilibrium, or will be when the regulations become effective, and (2) firms will attempt to maintain their current financial status by passing through industry-wide cost increases in the form of higher prices (to the extent the market will allow), the post-compliance equilibrium price and quantity level can be derived from the interaction of the elasticities of supply and demand.

The high concentration ratios for some of the product groups and the existence of specialty markets suggest the possibility of non-competitive pricing behavior. The oligopolistic pricing scheme is applicable for those product categories which exhibit characteristics of oligopoly markets, such as:

- Few firms in the product group
- High industry concentration
- Low degree of foreign competition
- Abnormally high profitability
- Low demand elasticities
- Highly capital intensive
- Large degree of integration of production, marketing, and distribution
- Large degree of specialized knowledge.

Industries which exhibit the first three of these characteristics are those in which the pricing and output actions of one firm will directly affect those of other firms in the industry. While these conditions do not guarantee oligopolistic behavior, they are necessary conditions and good indicators that oligopolistic behavior exists. Abnormally high profits in an industry would, in time, normally attract new entrants to the industry, thereby increasing price competition (because there are more competitors) and industry marginal cost (to the extent that new entrants have higher costs). However, very high profits over long periods of time which are not explained by such factors as excess risk, unusual amounts of technological innovation, or firm size may be an indicator that an imperfect market structure exists. Such conditions may occur when entry into an industry is difficult. The last three of the above points are indicators of difficulty of entry into the market.

There is conflicting information regarding the pricing mechanism that explains the industry's behavior. On one hand, the domestic industry exhibits some of the above characteristics of non-competitive markets. On the other hand, the existence of periodic price pressures caused by wide cyclical swings in the industry are indicative of competitive pricing behavior. Because of this conflicting information, the pricing strategy of individual producers is indeterminate. Instead, the analysis assumes an industry-wide price increase which would maintain the industry's initial return on sales for each product group. This pricing strategy is incorporated in the following algorithm:

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

where

$$TC_i = P_1 Q_{1i} \, (1-PM_1) \qquad (2)$$

where

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

ACC_i = annual compliance cost of plant i

TC_i = total cost of goods sold for plant i

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

P_1 = pre-compliance product price

PM_1 = industry average pre-compliance profit margin

n = total number of plants in the product group

The values of Q_{1i} were obtained for the 1976-1977 period in an industry survey conducted by EPA, and P_1 and PM_1 were estimated based on discussions with industry representatives, analysis of industry level data from Census of Manufactures, the Federal Trade Commission and Robert Morris Associates Statement Studies, and review of corporate annual reports.

This price change algorithm implies some important dynamics in the interaction of competing firms in determining prices. Figure 2-2 illustrates how 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 to an amount equaling the compliance cost per unit of its 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.

For all product groups except architectural panels, equation (1) above is used to calculate the percentage price increase resulting from compliance costs. Because of weak market conditions and declining demand for porcelain enameled architectural panels (as discussed in Section 3.4 and 4.2), it was assumed that architectural panel producers will not be able to raise their prices and, therefore, will have to absorb the compliance costs.

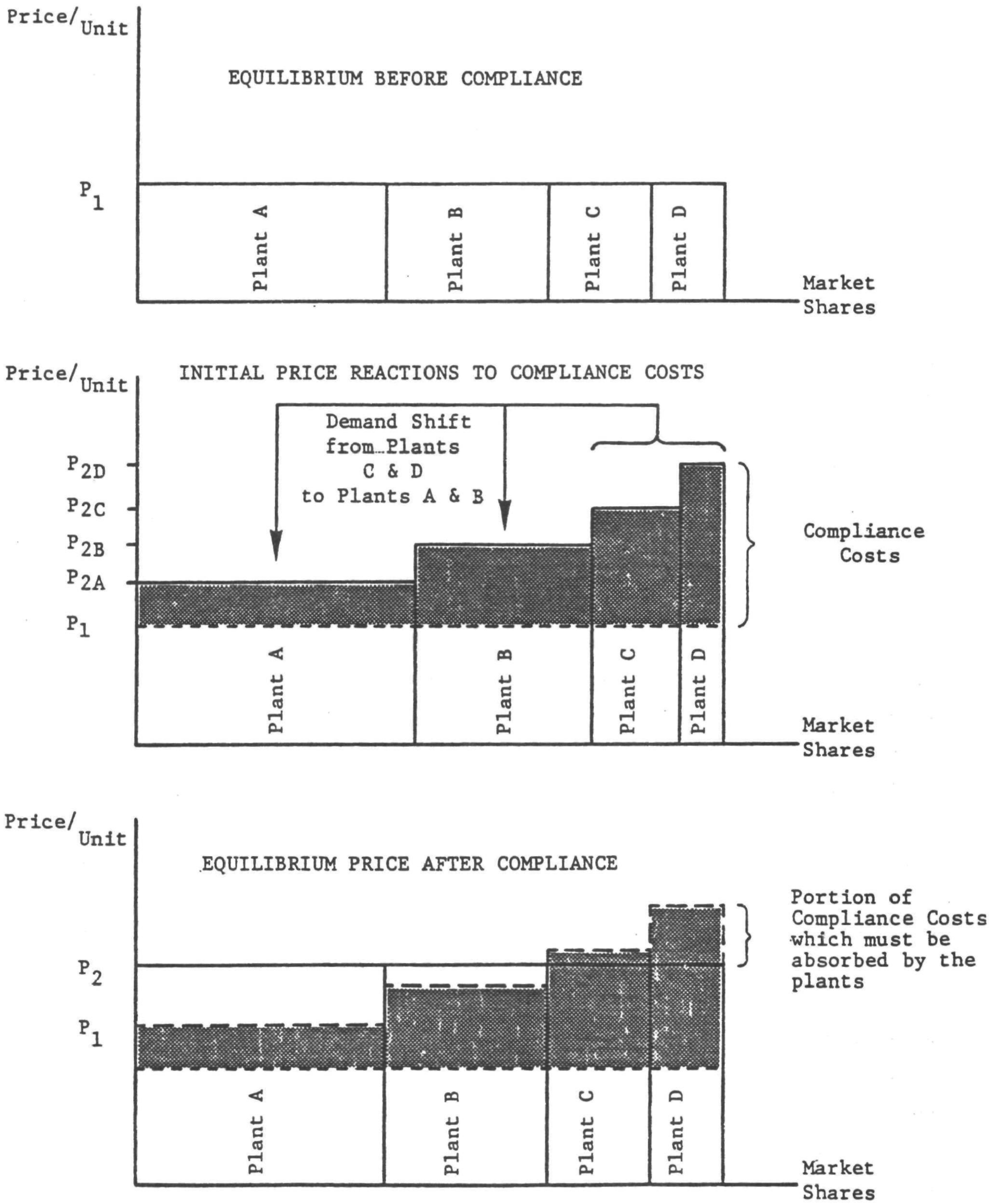

FIGURE 2-2. PRICE AND MARKET SHARE ADJUSTMENTS

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

$$E = \frac{dQ}{Q} \div \frac{dP}{P} \tag{3}$$

$$\frac{dQ}{Q} = \frac{dP}{P} \times E \tag{4}$$

where E = Coefficient of price elasticity of demand (estimated in Section 3.4)

The post-compliance price and quantity levels are used, in a later step, to assess the financial condition of individual porcelain enameling facilities.

2.3 STEP 3: COST OF COMPLIANCE ESTIMATES

The estimated investment and annual compliance costs for five treatment options, summary descriptions of the control and treatment technologies, and the assumptions for the compliance cost estimates appear in Chapter 5.

2.4 STEP 4: PLANT-LEVEL PROFITABILITY ANALYSIS

The basic measure of profitability used to assess the impact of the proposed regulations on individual plants is return on investment (ROI). The use of this technique involves a comparison of the measure after compliance with a minimum required return on investment.

The return on investment is defined as the ratio of annual profits before taxes to the total assets of a plant. This technique has the virtues of simplicity and common usage in comparative analyses of the profitabilities of financial entities. Discounted cash flow capital budgeting techniques were also considered in this analysis, but the data were insufficient for implementation of this technique.

The profit impact assessment is determined by calculating the after-compliance ROI for each plant. Plants with after-compliance ROI below the threshold value are considered potential plant closures. The underlying assumption is that plants cannot continue to operate as viable concerns if they are unable to generate a return on investment that is at least equal to the opportunity cost of other lower risk investment alternatives.

The critical value for ROI used in the analysis is 7 percent. Plants with after-compliance ROI less than 7 percent are considered likely plant closures. The 7 percent ROI threshold level is based on the condition that plants cannot continue to operate as a viable concern if they are unable to generate for the owners/stockholders an after tax return on their investments (i.e., stockholder equity) equal to the opportunity cost of other investment alternatives, which in this case is defined as the U.S. Treasury bond yield expected to be in effect when the regulation is implemented. Data Resources, Inc. forecasts that interest rates on long-term U.S. Treasury bonds will be about 12 percent in 1983-1984*, which is approximately the time when the plants will have to make investment decisions on the treatment facilities. It was determined that a before tax ROI of 7 percent would yield a 12 percent after-tax return on the liquidation value of the equity given the following assumptions:

- Stockholders' equity of porcelain enameling firms represents about 50 percent of total assets (based on published financial data for selected appliance manufacturers). However, for the job shops and architectural panels product groups, the stockholders' equity is estimated to be 65 percent based on survey data of small porcelain enameling companies provided by the Porcelain Enamel Institute (PEI).
- The average corporate tax rate is 40 percent**, except for job shops and architectural panels which are 35 percent according to PEI data.
- The average liquidation value of the plants is 85 percent of their book values. Because job shop and architectural panel plants are generally older (see Section 3.2), the liquidation value is assumed to be 75 percent.

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*Data Resources, Inc., U.S. Long Term Review, Summer 1981

**Average for Fabricated Metal Products Industry group as reported in the Federal Trade Commission's Quarterly Financial Report for Manufacturing, Mining and Trade Corporations, Second Quarter 1981.

Appendix A describes the methodology that led to this ROI threshold level.

The after compliance ROI (ROI_2) was estimated for each plant using the following equations:

$$ROI_{2i} = \frac{PROFIT_{1i} + DPROFIT_i}{A_i + CCI_i} \qquad (5)$$

where $PROFIT_{1i}$ = Pre-compliance profit of plant i
$DPROFIT_i$ = Change in profit of plant i
A_i = Pre-compliance assets value of plant i
CCI_i = Compliance capital investment for plant i

The variables in Equation (5) were further defined as follows:

$$PROFIT_{1i} = R_{1i} \times PM_{1i} \qquad (6)$$

$$\begin{aligned} DPROFITi &= (R_{2i} - a_i P_{1i} Q_{2i} - FC_i - ACC_i) - (R_{1i} - a_i P_{1i} Q_{1i} - FC_i) \\ &= (R_{2i} - R_{1i}) - (a_i \times E \times \frac{dP}{P} \times R_{1i}) - ACC_i \qquad (7) \end{aligned}$$

$$R_{2i} = R_{1i} \left(1 + \frac{dP}{P}\right)\left(1 + \frac{dP}{P} E\right) \qquad (8)$$

where R_{1i} = Pre-compliance revenue of plant i
R_{2i} = After-compliance revenue of plant i
PM_{1i} = Pre-compliance profit margin of plant i (gross profits as a percent of sales)
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
$\frac{dP}{P}$ = Industry-wide price increase
E = Price elasticity coefficient of demand

The values of Q_{1i} and R_{1i} were collected in an industry survey by EPA, while dP/P was calculated by equation (1) presented in Section 2.3 and A_i, PM_{1i}, a_i and E were estimated based on Census of Manufactures, Federal Trade Commission, company published financial data, and various inputs from industry sources.

As discussed in Section 2.6, actual plant closure decisions made by individual companies are usually based on many factors. However, the profitability ratio (ROI) relates profits to plant total assets, and provides a means of evaluating the attractiveness of the plant as an investment opportunity compared to other opportunities that may be available to stockholders and potential lenders. For purposes of this analysis (Section 2.6) the profitability impact is one of the major decision criteria for projecting closure. All other things being equal, if the threshold value is violated, then the plant is projected as a closure.

2.5 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 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 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 difficult to determine.

Because firm-specific data is scarce, the analysis of capital availability was based on the ratio of "compliance capital investment requirements to plant revenues" (CCI/R). This ratio provides an indication of the relative magnitude of the compliance capital investment requirements.

The ratio CCI/R was calculated for each plant and compared to a threshold value. Assuming that re-investment in plant and equipment equals depreciation, the plant's net after-tax profit margin is a measure of the internally generated funds available for pollution control investment and is used as the threshold value. For example, if the before-tax profit margin is 6 percent of revenues and the corporate tax rate is 40 percent, 3.6 percent (60 percent of 6 percent) of revenues is taken to be the capital availability threshold. If a plant's CCI/R ratio is less than the threshold value, the investment may be financed out of a single year's cash flow, without additional debt. The actual threshold values vary among product groups because of variation in pre-compliance profit rate.

Although this ratio provides a good indication of the relative burden created by the compliance requirement, it does not provide precise or universal conclusions regarding a firm's ability to make the investments. For purposes of this analysis, a plant that exceeds the capital availability threshold value is identified as a potential closure with the following exception. Some plants that exceed the threshold value belong to larger firms, and the required pollution control capital investments represent a relatively small proportion of total firm revenues. This analysis assumes that plants in this situation would have the required capital available to them and would not close on the sole basis of capital requirements.

2.6 STEP 6: PLANT CLOSURE ANALYSIS

The plant level analysis examines the individual production units in each product group to determine the potential for plant or production line closures. The term "plant closure" refers to a porcelain enameling facility projected to close as a result of incurring compliance costs. For these facilities, porcelain enameling is the major production activity. The term "production line closure" or "line closure" refers to the porcelain enameling component within an establishment that has other production activities. For example, a job shop may do both electroplating and porcelain enameling. The analysis of porcelain enameling compliance costs for this job shop may indicate that the job shop would cease porcelain enameling operations, but not close the entire job shop. In this case, a line closure would be projected.

For this analysis, plant closure estimates are based primarily on the quantitative estimates of post-compliance profitability and ability to raise capital developed in Steps 4 and 5, respectively.

The decision by a company to close a plant also involves consideration of other factors such as market and technological integration, and the existence of speciality markets. Many of these factors are highly uncertain and cannot be quantified. Situations in which information on the other factors significantly affected the estimates of plant closure are noted in Chapter 6. Nevertheless, because of the general uncertainty regarding the factors the identification of plants as potential closures in this step is interpreted as an indication of the extent of plant impact rather than as a prediction of certain closure.

2.7 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 flows directly from the outputs of the industry level analysis and the plant closure analysis. Employment estimates for production facilities that are projected to close are taken from the EPA 308 data collection portfolios (obtained in EPA industry survey conducted under authority of Section 308 of the Clean Water Act).

Community impacts result primarily from employment impacts. The critical variable is the ratio of porcelain enameling industry unemployment 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 industry structure changes 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.

Decreases in the first factor and increases in the second factor would indicate an increase in industry concentration and may change the pricing behavior of the industry. Such potential changes are qualitatively evaluated in Section 6.5.

Except for the cookware subcategory, foreign competition is not an important factor in the porcelain enameling industry. The role of imports and exports is qualitatively evaluated in Chapter 3 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. In this study, the price changes due to the regulations are estimated to be small. Therefore the resulting changes in imports and exports of porcelain enameled products are estimated to be small.

2.8 STEP 8: NEW SOURCE IMPACTS

This step in the study estimates the economic impacts of NSPS and PSNS guidelines. The analysis is based on model plants developed for each technical subcategory and the corresponding compliance costs of the treatment technologies. The analysis covers both existing facilities undergoing major modifications and greenfield (new) sites; costs of pollution control and financial characteristics are estimated to be similar for both types of new sources. For the purpose of evaluating new source impacts, compliance costs of new source standards are defined as incremental costs over the costs of selected standards for existing sources. The impacts of new source regulations are then determined by comparing compliance costs to expected plant revenues.

2.9 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. An initial screening analysis is performed to determine if a substantial number of small entities will be significantly affected. If so, regulatory alternatives that eliminate or mitigate the impacts must be considered. This step in the study addresses these objectives by identifying the economic impacts which are likely to result from the promulgation of regulations on small businesses in the porcelain enameling industry. The primary economic variables covered are those analyzed in the general economic impact analysis such as compliance costs, plant closures, and unemployment. 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 porcelain enameling markets.

The impacts on small plants were assessed by examining the distribution, by plant size, of the number of porcelain enameling plants, plant revenues, wastewater volumes, compliance costs and potential closures due to the regulations.

3. INDUSTRY CHARACTERISTICS

3.1 OVERVIEW

As indicated in Chapter 1, porcelain enameling is a metal finishing process performed by appliance, plumbing fixture, miscellaneous product manufacturers, and job shops. It consists of the application of a glass coating called frit to steel, cast iron, aluminum, strip steel, or copper. The purpose of the coating is to improve resistance to chemical abrasion and corrosion, and to improve thermal stability, electrical insulation, and appearance. The liquid enamel applied to the metal workpiece is called a "slip" and is composed of one of many combinations of frits, clays, coloring oxides, water, and special additives such as suspending agents. This vitreous inorganic coating is applied to the metal by a variety of methods such as spraying, dipping, electrostatic deposition, and flow coating, and is bonded to the base metal at temperatures in excess of 500 degrees centigrade (about 1,000 degrees Fahrenheit). At these temperatures, the finely ground enamel frit particles fuse and flow together to form the permanently bonded hard porcelain coating.

3.1.1 <u>Industry Coverage</u>

Regardless of the base metal being enameled, the porcelain enameling process involves the preparation of the enamel slip (ball milling), the surface preparation of the base metal, application of the enamel, and the drying and firing to permanently fuse the coating to the metal. There are a few porcelain enameling facilities that also manufacture their own frit. The focus of this study is on the ball milling, metal preparation, and process application stages of porcelain enameling. Figure 3-1 depicts the porcelain enamel manufacturing process. The major end products which contain porcelain enamel are listed in Table 3-1.

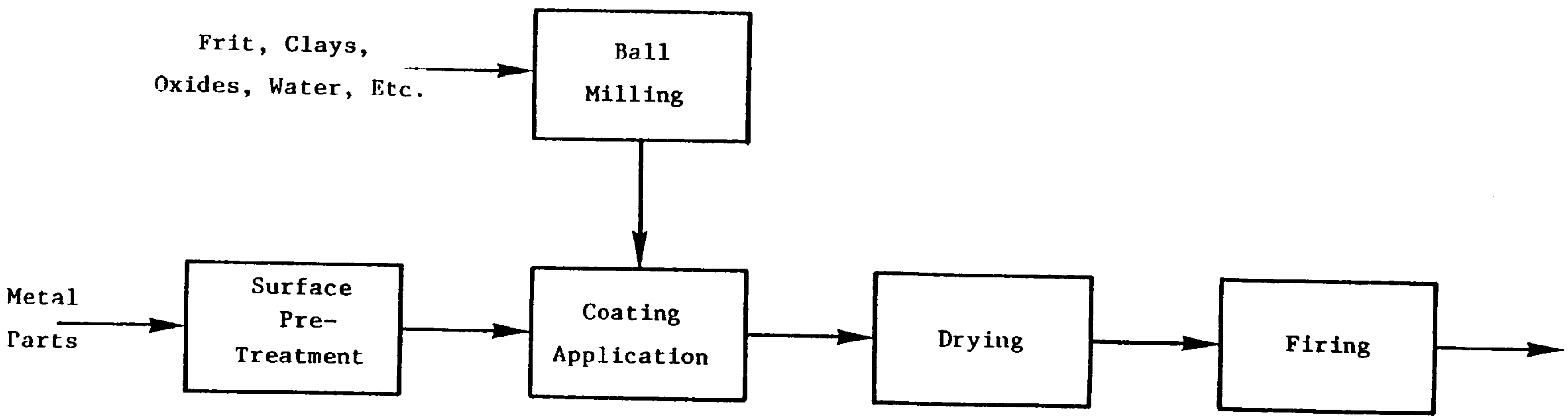

FIGURE 3-1 · TYPICAL PORCELAIN ENAMELING PROCESS SEQUENCE

TABLE 3-1. MAJOR END-USE PRODUCTS CONTAINING PORCELAIN ENAMEL BY TECHNICAL SUBCATEGORY

Technical Subcategory	End-Use Products
Steel	Ranges Home laundry Hot water heaters Bathtubs, sinks Dishwashers Architectural panels Cookware Refrigerators Chalkboards
Cast Iron	Bathtubs Range parts
Aluminum	Architectural panels Cookware
Copper	Meter dials Miscellaneous products

3.1.2 Industry History

The basic porcelain enameling process has been in existence for thousands of years. The first use of the process was for coating jewelry and other decorative and ornamental items. However, commercial enameling did not begin until about 1830 in Czechoslovakia, when the Bartelmes family began porcelain enameling cast iron for cooking utensils. In 1859, this same family started to enamel sheet iron. From these activities grew the great enamel industry of Central Europe.

Porcelain enameling began in the United States around 1867 when two cooking utensil plants began to enamel. Shortly afterward, one of the first plants to enamel cast iron tubs, the Kohler Company, began operation in Kohler, Wisconsin. Next came the first porcelain enameled stove (1890), followed by refrigerators, washtubs, and many other products. The first washing machine enameling plant was built by the A.B.C. Washer Company in 1927.

Probably one of the greatest early technical advances in enameling was the discovery of the use of clay to keep the powdered enamel frit suspended in water, making it adhere better to the metal before firing. The suspended enamel and clay in water was called slip, and was painted or poured on the metal, dried, and then fired in a furnace. At a much later date, the spray gun was developed, greatly facilitating the uniform application of frit, especially on large pieces.

The use of enamel slips became known as the wet process, and the powdering-on as the dry process. Both are in use at the present time--the dry process being used primarily for cast iron, while the wet process is used both for cast iron and steel enameling.

By 1930, porcelain enamel was used for signs, table tops, restaurant equipment, automobile manifolds, and wall tile. Following the Depression, the manufacture of porcelain enamel refrigerators, stoves, and washing machines, as well as other household items, expanded many times. New products such as automatic hot water heaters and architectural panels added to the growth.

In 1941, when war was declared, porcelain enameling production all but stopped as the industry put its efforts into war production. After World War II, application techniques changed greatly. Before the war and a short time afterwards, porcelain enamel thicknesses were up to 40 mm. Today, with improved application and coating technologies, the thickness of coatings has been reduced to 8 mm. Despite the elimination of porcelain enamel use from many products following World War II (i.e., table tops, restaurant and service station equipment, automobile manifolds, hospital bed pans, etc.), overall porcelain enamel use increased as the demand for housing grew, resulting in increased demand for sanitary ware and home appliances. The demand for porcelain enamel products and finishes remained at a peak until the early 1960's, when substitute finishes began to supplant many uses of the more costly enamel surfaces.

3.2 FIRM AND PLANT CHARACTERISTICS

EPA has identified 116 plants in the United States that perform porcelain enameling operations, and collected annual production rate data on 108 of these plants from an industry survey. In 1976, the annual production rates of these plants ranged from 25,000 square feet (of exposed surface area enameled) for a small job shop to 62,190,000 square feet (of exposed surface area) for an integrated appliance manufacturer. In total these 108 plants enameled 775 million square feet of exposed metal surface area.*

EPA estimated the costs of complying with this effluent regulation for all 116 identified plants. However, for two of the 108 plants with production data, there was insufficient product and price data available to include them in the economic impact analysis sample. Therefore, the remaining 106 plants form the nucleus of the economic analyses presented in this report. Chapter 6 contains the results of the plant-by-plant economic analyses performed in this report. Impacts for the remaining ten plants are discussed qualitatively in Section 6.4.

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*Even though both sides of the metal workpiece are enameled when the dip process is used, only the exposed surface is important for end-product use. This number is generally equal to one side of the metal that is enameled.

Table 3-2 lists, by product group, the 106 sample plants and the 10 (116 minus 106) missing plants.

3.2.1 Types of Plants

Table 3-3 presents a summary of the plant profile characteristics by product group for the 106 plants. In the analysis of discharger status, it was found that approximately 77 percent of the plants are indirect dischargers. Also, most of the plants (about 50 percent) employ between 50 to 500 workers; and, while many plants were built before 1950, most plants have had recent modifications.

3.2.2 Company Organization

Porcelain enameling plants can be subcategorized into two basic types--captive operations within an integrated manufacturing facility and independent job shops. Job shops are defined as plants that perform porcelain enamel operations on a contract basis and are not part of an integrated appliance, sanitary ware, or other product manufacturing facility. Of the 116 porcelain enamel plants in the United States, approximately 25 are porcelain enamel job shops. Job shops represent about 20 percent of the plants but only about 5 to 8 percent of the production in the porcelain enamel industry. A job shop may perform other operations such as metal stamping, welding, or spray paint finishing. However, almost all job shops have at least limited fabrication capabilities and many of them make direct purchases of metal from metal producers. Most do not market proprietary items, nor have a research department to develop products. Practically all of the job shops are family or privately owned and closely held. This factor hinders financial and market data collection for this group.

The range of items which are enameled by job shops includes appliance parts, sanitary ware, free-standing fireplaces, lanterns, hog feeders, shower stalls, heat exchangers, architectural items, gauges, dials, pumps, cast iron gates, and signs, as well as other miscellaneous items.

TABLE 3-2. PLANTS IDENTIFIED FROM EPA DATA COLLECTION PORTFOLIOS

Industry	No. of Plants Included in Economic Impact Analysis Sample	No. of Plants Identified by EPA but Having Insufficient Data for Economic Analysis	Total Number of Identified Plants
Ranges	25	2	27
Job Shops	23	-	23
Cookware	11	-	11
Home Laundry	9	-	9
Hot Water Heaters	9	1	10
Steel Sanitary Ware	9	-	9
Architectural Panels	11	-	11
Dishwashers	4	-	4
Cast Iron Sanitary Ware	2	1	3
Refrigerators	2	-	2
Barbecues	1	-	1
Other Products[a/]	0	6	6
Total	106	10	116

[a/] Includes heat exchangers, pipes, iron parts, copper enameling, etc., as well as plants for which products were not known.

Source: Responses to EPA industry survey, conducted under authority of Section 308 of the Clean Water Act.

TABLE 3-3. SUMMARY OF PLANT PROFILES

Products Groups	Total Number of Sample Plants	Employment: Total Plant	Employment: Porcelain Enamel Operations	Number of Plants by[1/] Plant Age: Built Before 1950	Plant Age: Built After 1965	Plant Modification: Last Modification Before 1965	Plant Modification: Last Modification After 1970	Plant Size: Employ Less Than 50 Employees	Plant Size: Employ More Than 500 Employees	Discharge Status: Indirect	Discharge Status: Direct
Home Laundry	9	16,255	1,095	3	1	0	6	0	8	7	2
Ranges	25	19,496[3/]	1,751[2/]	12	3	1	15	1	14	18	7
Hot Water Heaters	9	4,669	269	5	1	2	6	0	4	8	1
Dishwashers	4	5,998	220	2	1	0	3	0	4	4	0
Steel Sanitary Ware	9	2,225	711	3	2	3	5	0	0	8	1
Job Shops	23	2,866[2/]	1,116[2/]	16	1	6	11	7	0	17	6
Cookware	11	7,676	323	5	3	2	7	0	7	9	2
Architectural Panels	11	1,134	174	4	2	4	3	3	0	7	4
Cast Iron[3/] Sanitary Ware	2										
Refrigerators[3/]	2	9,763	476	3	2	2	3	0	2	4	1
Barbecues[3/]	1										
TOTAL	106	70,082	6,135	53 (50)	16 (15)	20 (19)	59 (56)	11 (10)	39 (37)	82 (77)	24 (23)

1/ Numbers in parentheses represent percent of plants.

2/ Employment was not available for one of the plants.

3/ Cast Iron, refrigerators, and Barbecues product groups have two or less plants; therefore, plant data are combined to avoid releasing company confidential information.

Source: Environmental Protection Agency

The vast majority of porcelain enamel plants are owned by large appliance, plumbing fixture, and other miscellaneous product manufacturers. In general, this group comprises about 92-95 percent of the industry production and about 80 percent of the plants. The Porcelain Enamel Institute estimates that the appliance market accounts for between 70-80 percent of all porcelain enamel use, sanitary ware manufacturers comprise about 10 percent, and the remaining 10-20 percent is distributed among other manufacturers. Generally, the enameling facilities are situated in the same building as, or in close proximity to, the assembly operations. Virtually none of the captive operation porcelain enameling facilities do jobs for outside customers.

3.2.3 Financial Profile

The indicators of the financial status of the plants and firms covered in this study include:

- Various financial ratios prepared from data contained in the U.S. Department of Commerce 1977 Census of Manufactures for sanitary ware (3431), cookware, architectural panels, and job shops (3469), ranges (3631), home laundry equipment (3633), hot water heaters, and dishwashers (3639)

- Financial data from corporate reports of firms producing porcelain enameled products (1978-1981).

Selected operating ratios from the 1977 Census of Manufactures are presented in Table 3-4. Each ratio is described below:

- Total assets to total employment represents the ratio of capital to labor and measures the average capital intensity of the plants. SIC 3469, the cookware/architectural panels/job shop group, has the lowest ratio ($13,035 per employee), while the home laundry group (SIC 3633) has the highest ratio ($23,740 per employee).

- Total assets to value of shipments provides a measure of the level of investment required to generate each dollar of revenue. A fairly large spread is shown for this ratio. The lowest is 19.6 percent for SIC 3639 (hot water heaters and dishwashers), compared to 31.4 percent for SIC 3431 (the sanitary ware group).

- Cost of materials and labor to value of shipments measures the relative cost structure of the plants, and varies only slightly from a

TABLE 3-4. SELECTED AVERAGE OPERATING RATIOS BY PRODUCT GROUP

Product Groups by SIC Codes	1976 Total Assets to Total Employment[a]	1976 Total Assets to Value of Shipments[a] (%)	1977 Cost of Materials and Labor to Value of Shipments (%)	1977 New Capital Expenditures to Value of Shipments (%)	1977 Value Added per Employee
SIC 3431 Sanitary Ware	$17,589	31.4	69.7	2.3	$30,531
SIC 3469 Cookware Architectural Panels Job Shops	13,035	30.7	74.8	3.3	22,281
SIC 3631 Ranges	14,701	23.3	72.2	2.1	30,846
SIC 3633 Home Laundry	23,740	26.9	67.8	1.5	43,631
SIC 3639 Hot Water Heaters Dishwashers	13,510	19.6	72.9	2.1	33,532

[a] Assets value data are not reported for 1977.

Source: U.S. Department of Commerce, 1977 Census of Manufactures.

high of 74.8 percent for the cookware/architectural panels/job shop group to a low of 67.8 percent for the laundry product group.

- New capital expenditures to the value of shipments provides an indication of the plants ability to attract capital to their operations. The industry groups vary on this measure from a low of 1.5 percent for home laundry to a high of 3.3 percent for the cookware/architectural panels/job shop group.

- Value added per employee measures the economic contribution and productivity of the industry's labor force. SIC 3469 was the convert ratio ($22,281 per employee), while SIC 3633 has the highest ratio ($43,631 per employee).

To assess the financial status of the major firms engaged in porcelain enameling, data were also collected for 18 companies which produce porcelain enameled products and have publicly available financial data. Table 3-5 lists the return on equity, debt-equity, and profit margin ratios for these 18 firms. This table also shows that these 18 firms control a major market share in each product group.

3.2.4 Industry Competition

Competition among firms which manufacture products with porcelain enamel finishes appears to be rather intense, even though the four firm concentration ratios increased between 1972 and 1977 for all home appliance product groups, as shown in Table 3-6. Manufacturers appear to be quite competitive in attempts to maintain and improve their brand names' market share as well as maintaining or improving their private-label production. Competition for private-label business (which for some manufacturers accounts for the greatest proportion of production) demands a continuous emphasis on high quality at a reasonable price. Although many private-label contracts have been controlled by the same firms for many years (e.g., Roper ranges, and Whirlpool refrigerators, freezers, washer and dryers for Sears), the firms are constantly having to maintain high standards in order to keep that business.

Market Share Competition

Market shares for the major porcelain enameled products are listed in Table 3-7. For the major appliance products, General Electric, White, and

TABLE 3-5. CORPORATE FINANCIAL DATA, 1980

Company	Products Manufactured[a]												Before-Tax Profit Margin (%)	Debt To Equity[b]	Before-Tax Return on Equity (%)
	ER	GR	REF	FRE	WASH	EDRY	GDRY	DISH	HWH	SSW	CI	COOK			
Alcoa/Wear Ever												X	14.0	0.77	24.6
American Standard										X	X		9.8	1.48*	41.3
City Investing/Rheem									X				2.9	6.69*	15.6**
Crane										X			5.4	1.54*	21.0**
General Electric	X		X	X	X	X	X	X					9.9	1.26*	30.1
General Housewares												X	8.1	1.65*	45.0
Magic Chef	X	X	X	X	X	X	X						1.0	2.12*	5.8**
Maytag					X	X	X	X					18.6	0	31.6
Mirro Aluminum												X	4.0	0.82	12.2**
Mor-Flo Industries									X				2.0	0.77	16.3**
Revere Copper & Brass												X	4.9	1.39*	20.4**
H.H. Robertson													4.2	2.28*	17.6**
Roper	X	X											2.5	1.12*	13.0**
A.O. Smith									X				(1.9)	1.02	(6.3)**
Sunbeam												X	6.0	1.25*	21.5**
Tappan	X	X						X					1.2	0.92	4.9**
Whirlpool	X		X	X	X	X	X	X					8.3	0.48	25.8
White Consolidated	X		X	X	X	X	X	X					5.1	1.66*	24.0
Market Share Represented (%)	81	55	89	64	94	95	89	40	67	40	NA	NA			
All Manufacturing Average													7.7	1.02	21.9

[a] ER = Electric Ranges; GR = Gas Ranges; REF = Refrigerators; FRE = Freezers
EDRY = Electric Dryers; GDRY = Gas Dryers; DISH = Dishwashers; HWH = Hot Water Heaters
SSW = Steel Sanitary Ware; CI = Cast Iron Sanitary Ware; COOK = Cookware; WASH = Washers

[b] Current liabilities and long term debt divided by stockholders' equity

*Debt to equity ratio greater than All Manufacturing Average
**Return on equity lower than All Manufacturing Average

Source: Moody's Industrial Manual, 1981.
Federal Trade Commission, Quarterly Financial Report for Manufacturing, Mining, and Trade Corporations, First Quarter 1981.

TABLE 3-6. CONCENTRATION RATIOS FOR SIC CODES WHICH CONTAIN MAJOR PORCELAIN ENAMELED PRODUCTS (in percent)

			4 Largest Companies	8 Largest Companies
3631-	Household cooking equipment	1977	51	71
		1972	46	65
3632-	Household refrigerators and freezers	1977	82	98
		1972	75	96
3633-	Household laundry equipment	1977	89	98
		1972	76	95
3639-	Household appliances, n.e.c.	1977	52	83
		1972	45	63
36391-	Household water heaters, electric	1977	78	98
		1972	62	88
36392-	Household water heaters, except electric	1977	81	99
		1972	67	90
36394-	Dishwashing machines and food waste disposers	1977	73	90
		1972	71	91
34310-	Metal plumbing fixtures	1977	50	64
		1972	45	62

Source: U.S. Department of Commerce, 1977 Census of Manufactures.

TABLE 3-7. MARKET SHARES OF MAJOR APPLIANCE MANUFACTURERS, 1980

Product/Company	Market Share (percent)
Ranges (Electric)	
General Electric/Hotpoint	35
White	18
Whirlpool	9
Roper	8
Tappan	6
Magic Chef	5
Jenn Air	5
Ranges (Gas)	
Magic Chef	20
Tappan	20
Roper	15
Caloric	12
Hardwick	10
Refrigerators	
Whirlpool	31
General Electric/Hotpoint	26
White	21
Admiral Div., Magic Chef	11
Amana	5
Freezers	
Whirlpool	30
White	25
Revco	15
Admiral Div., Magic Chef	9
Washers	
Whirlpool	40
General Electric/Hotpoint	20
Maytag	15
White	14
Norge Div., Magic Chef	5
Dryers (Electric)	
Whirlpool	40
General Electric/Hotpoint	20
Maytag	15
White	15
Norge Div., Magic Chef	5
Dishwashers	
Design & Manufacturing	45
General Electric/Hotpoint	25
Hobart (Kitchen Aid)	15
Maytag	6
Water Heaters	
Rheem/Ruud	32
Mor Flo	20
A.O. Smith	15
W.L. Jackson	8
Bradford White	8
State Industries	8
Steel Sanitary Ware[a/]	
Briggs	30
Norris	21
American Standard	10
Alliance Ware (Crane)	9
Verson	6
Active Products	5
Peerless Pottery	5
Lawndale	4
Kilgore Ceramics	4
Cast Iron Sanitary Ware	
Kohler	NA
American-Standard	NA
Eyer	NA
Dryers (Gas)	
Whirlpool	40
General Electric/Hotpoint	15
Maytag	15
White	14
Norge Div., Magic Chef	5

[a/] Estimated by Paul S. Gruber, Porcelain Enamel Consultant

NA: Not available

Source: Appliance, September 1981

Whirlpool maintain sizeable market shares for virtually all products. These companies, which produce a "full-line" of major appliance products, can offer retailers and construction development companies the opportunity to buy all appliances from a single company. For example, in 1979, Montgomery Ward, a major retailer, expressed an interest in switching the purchase of its private labeled appliances to a single full-line appliance maker.* The prospect of increasing market shares for "full-line" firms has precipitated another company, Magic Chef, through its purchases in 1979 of Admiral (refrigerators/freezers) and Fedders (washers/dryers) to move into the "full-line" market. Magic Chef's acquisition of these two product lines, which results in higher concentration ratios in the appliance industry, could actually stimulate competition within the industry, since there will be a new "full-line" competitor in the new home builders market.

The leading market shares for each major appliance product are now controlled by a "full-line" firm with one exception--Design and Manufacturing (D&M), a private-label dishwasher manufacturing firm, maintains a 45 percent market share. D&M's market strength is bolstered by its long standing relationship with Sears Roebuck & Company.

In other product groups, competition appears to be even more intense as manufacturers of sanitary ware and other porcelain enamel products are not only competing among themselves for business, but are also competing with substitute products (i.e., fiberglass tubs, stainless steel sinks, cultured marble sinks, stainless steel cookware, painted panels, plastic signs, etc.). These porcelain enamel products have to remain price competitive with alternative products or risk further erosion of their share of these markets. The substitution pattern of porcelain enamel is discussed in greater detail in Sections 3.3 and 3.4.

Industry Capacity and Competition

Although the production capacity for porcelain enameling has fallen approximately 40 percent during the 1960s and early 1970s, industry sources

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*American Metal Market, May 7, 1979.

still considerable excess porcelain enameling capacity available within the industry.* In order for a firm to maximize plant operating efficiency, it is necessary to maintain high operating levels. With the excess capacity present, it appears likely that there would be strong competitive pressures to set pricing strategies in a way that will keep operating levels high. These pressures may force firms to absorb large portions of increased costs in order to maintain stable prices and market shares.

In addition to price competition there is significant consumer brand name loyalty within the appliance and, to a lesser extent, the sanitary ware groups. In order to maintain a product's reputation among consumers, it is necessary for a company to constantly strive for product quality and durability. Inferior product performance can easily damage a firm's well-established reputation.

Import Competition

Except for cookware, where there is a considerable import problem, there is virtually no competition from foreign producers. The lack of foreign competition stems from the technological advantages of United States manufacturers of major home appliances. Additionally, the generally bulky nature of most products that have porcelain enameled finishes (i.e., home appliances and sanitary ware) results in prohibitively high transportation costs and, thus, minimal import competition or export trade for these products. The imports of porcelain enameled cookware have, however, been steadily increasing. Imports, principally from developing countries, now exceed United States production for porcelain enameled cookware.**

3.3 PRODUCTS AND PRODUCTION TRENDS

Since, as stated in Section 3.1, porcelain enameling is a process which is used as a finish in various products, the assessment of economic impacts resulting from the effluent regulations must involve an examination of the end products which contain porcelain enameling and a review of the competitive conditions present in the markets in which these products are used. This section will examine the prices, growth rates, and trends in production capacity.

*Paul S. Gruber, JRB Porcelain Enamel Consultant.
**Paul Edson--Metal Cookware Manufacturers Association.

3.3.1 Trends in Porcelain Enamel Product Shipments

In addition to trends in porcelain enamel usage, the growth of end product shipments plays a major role in the overall usage of porcelain enamel and in the assessment of the economic condition of the porcelain enamelers.

Figure 3-2 presents the 1971-1981 consumption patterns of major porcelain enameled products. This figure shows that the demand for porcelain enameled products fluctuated widely during that period and except for freezers, seemed to correlate with new home construction.

3.3.2 End Product Prices

Using estimates of manufacturers' wholesale prices and average square footage of enameling per unit, the value of shipments for each product group is estimated and presented in Table 3-8. Manufacturers' prices are calculated from 1977 Census of Manufactures data, except for barbecues, where the price is based on the retail list price (assuming a 100 percent markup). The average square footage per unit figures are based on estimates prepared by Paul S. Gruber, JRB consultant, and Arnold Consdorf, editor of Appliance Manufacturer. Value of shipments (plant revenues) were then estimated by the following means:

$$\frac{\text{Total porcelain enamel square footage}}{\text{Square footage per unit}} = \text{Number of Units Produced}$$

Number of Units Produced x Manufacturers Unit Price = Plant Revenue

These calculated values of shipments range from $67.8 million for cast iron tubs to $1.1 billion for ranges. Table 3-8 also shows the value of shipments recorded for each product group by the Commerce Department. In each case, the JRB estimated value of shipments is less than the corresponding Commerce Deparment figures. This is as expected, since the EPA data sample missed some plants in each product group.

As illustrated in Table 3-9, the porcelain enameling costs as a percentage of manufacturers' product price are highest for bathtubs, cookware, and architectural panels. Of the home appliances, washers and ranges had the

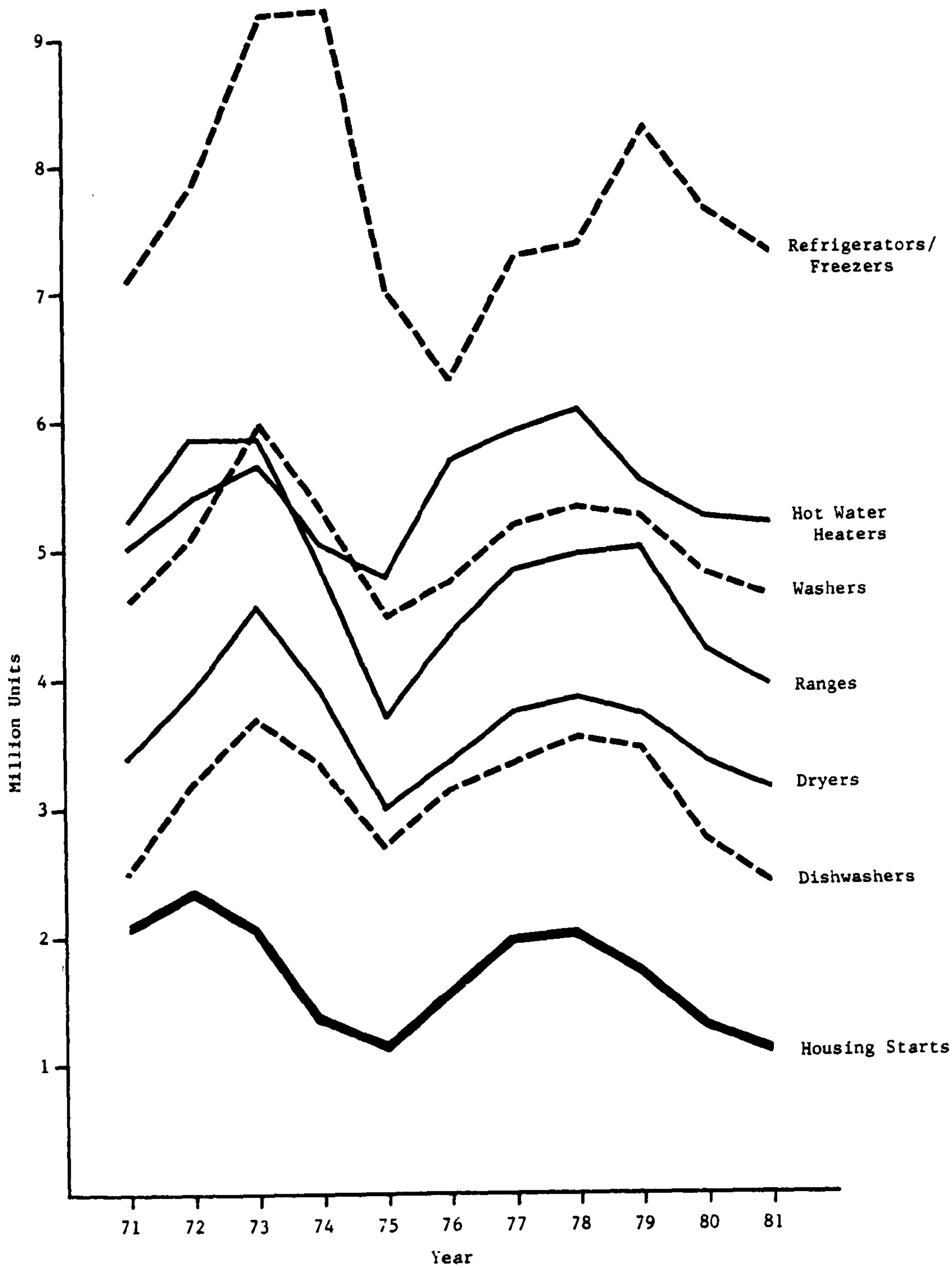

FIGURE 3-2. UNIT SHIPMENTS OF REFRIGERATORS/FREEZERS, HOT WATER HEATERS, WASHERS, RANGES, DRYERS, DISHWASHERS, AND HOUSING STARTS

Source: American Home Appliance Manufacturers, and National Association of Home Builders

TABLE 3-8. ESTIMATED VALUE OF SHIPMENTS OF MAJOR PORCELAIN ENAMELED PRODUCTS, 1977

Product	1977 Census Value of Shipments Thousand ($)	Percentage of Total Plants in EPA Data Base to Total Known Plants	Reported Porcelain Enamel Production and JRB Estimates of Value of Shipments			
			Sq. Ft. (000)	Sq. Ft./ Unit	Units (000)	Thousand ($)
Ranges	1,581,600[a/]	69%	215,933	39	5,526	1,132,830
Washers/Dryers (based on 59% washers, 41% dryers)	1,460,300[b/]	96%	181,720	27.7	4,520 3,140	1,361,200
Hot Water Heaters	504,100[c/]	47%	75,211	23	3,270	245,250
Dishwashers	538,700[d/]	71%	48,060	21.5	2,235	379,950
Cast Iron Tubs			18,659	33	565	67,800
Steel Tubs and Sinks	243,017[e/]	61%	58,255	32	1,820	85,540
Architectural Panels, Signs, & Reflectors	NA	NA	35,552	NA	-	106,656[f/]
Cookware	NA	NA	50,982	1.7	29,989	149,945

a/ Includes electric and gas household ranges and ovens and surface cooking unit equipment, and parts (except small appliances; gas barbecuers grils and braziers for outdoor cooking; domestic cooking appliances (except electric).

b/ Includes househole washing machines, dryers, and washer-dryer combinations.

c/ Includes electric water heaters and non-electric water heaters.

d/ Includes portable and built-in dishwashing machines.

e/ Includes porcelain enameled sinks, lavoratories, steel bathtubs, and cast iron bathtubs. (159,300 represents bathtub equivalents by assuming that three sinks or lavatories equal one bathtub.)

f/ Includes aluminum and steel. Assume average price of $3 per sq ft.

Source: Environmental Protection Agency and U.S. Department of Commerce 1977 Census of Manufactures.

TABLE 3-9. PRODUCT PRICES AND ENAMELING COSTS FOR MAJOR PORCELAIN ENAMELED PRODUCTS
(1977 Dollars)

Product	Representative Manufacturers Product Price[a/]	Estimated Enamel Cost/Unit[a/]	Porcelain Enamel Cost As A Percentage of Price
Ranges	$205.00	$16.73	8.2
Washers	190.00	12.62	6.6
Dryers	160.00	8.20	5.1
Refrigerators	290.00	2.39	.8
Hot Water Heaters	75.00	2.27	3.0
Steel Bathtubs, Sinks & Lavoratories	47.00	18.50	39.4
Dishwashers	170.00	6.42	3.8
Cast Iron Bathtubs	120.00	17.30	14.4
Aluminum Cookware	5.00	0.89	17.8
Aluminum Architectural Panels Signs and Reflectors	3.50	0.93	26.6
Steel Architectural Panels/Chalkboards	2.50	0.17	6.8

[a/] $/unit, except for architectural panels which is $/sq. ft.

Source: JRB Associates estimates.

highest percentage, while refrigerators, hot water heaters, and dishwashers had the lowest.

3.3.3 Trends in Production Capacity

The largest market for porcelain enamel materials is major home appliances, which accounts for over 70 percent of square footage enameled (see Table 3-10). Sanitary ware and cookware were the second and third largest porcelain enamel markets, accounting for 9.9 and 6.5 percent, respectively. During the 1960s and 1970s the square footage of enameling per product unit has declined for most products, but the growth in unit shipments has partially offset the loss in porcelain enameling production. During this period, it is estimated that porcelain enamel production capacity decreased 40 percent.* The trends in porcelain enameling production capacity for each major product group over the 1960s and 1970s is summarized below:

Appliances

- Refrigerators--once the largest user of porcelain enamel--14 net plant closures and a net loss in porcelain enamel production capacity of 90 percent
- Ranges--presently porcelain enamel's largest user--20 net plant closures and a net loss in porcelain enamel production capacity of 50 percent
- Washers and dryers--4 net plant closures and a 10 percent loss in porcelain enamel production capacity
- Dishwashers--a growth market over this time period--one new plant added and a 50 percent increase in production capacity
- Hot water heaters--13 net plant closures but a 25 percent increase in production capacity.

Sanitary Ware

- Cast iron--once the leader in sanitary ware; now shipments of cast iron bathtubs are only about half as large as the shipments of pressed steel tubs--three plant closures and a 50 percent loss in production capacity

*Paul S. Gruber, JRB Porcelain Enamel Consultant

TABLE 3-10. SQUARE FEET PORCELAIN ENAMELED BY MAJOR MARKET, 1976-1977[a/]

	Million Square Feet[b/]	Percent
Home Appliance	550.1	71.1
Sanitary Ware (Steel and Iron)	76.9	9.9
Architectural Panels, Signs, and Reflectors	35.6	4.6
Cookware	51.0	6.5
Other (Includes Job shops and other misc. products)	60.6	7.8
Total	774.6	100.0

[a/] Based upon 106 plants with production data.

[b/] Square footage of exposed surface area (one side of metal).

Source: EPA industry survey (conducted under authority of Section 308, Clean Water Act).

- Steel--five net plant closures but no net change in production capacity.

Cookware

- These products have suffered large losses to alternative finishes and imports from developing countries. There has been a net increase of four plants; however, steel cookware has suffered a 50 percent loss in capacity. For aluminum, it is uncertain whether the change in capacity has been due to the shift of domestic production to U.S.-owned plants in developing countries. Foreign import penetration is most severe in the porcelain-on-steel cookware market where only one domestic producer still remains in business, and in January 1980 a duty relief was granted to improve the competitive position of this producer.

Architectural Panels

- A net loss of 9 plants
- A 50 percent loss in production capacity for steel panels
- A 25 percent loss in production capacity for aluminum, (which has always been a smaller proportion of the architectural panel business).

Job Shops

- A net loss of seven plants, and a loss in production capacity of 40 percent.

In summary, the porcelain enamel industry experienced a net loss of approximately 65 facilities during the 1960's and 1970's. From that point to mid-1982, the declining trend in the number of porcelain enameling facilities appears to have subsided. Indications are that the high degree of substitution leveled out, and the number of facilities has stabilized (see Chapter 4).

3.4 DEMAND ELASTICITY

The demand for porcelain enameled products is dependent on two factors:

- The market strength of the various end products which contain porcelain enamel (i.e., ranges, bathtubs, dishwashers, etc.)
- The availability of substitute materials for porcelain enameled finishes (i.e., plastic in bathtubs, painted steel on appliances, etc.).

In other words, substitutes for porcelain enameled products may be in the form of competing products (i.e., use of a coin laundry vs. a washer and dryer, hand washing vs. a dishwasher, brick and block vs. architectural panels, etc.) or products with alternative surfaces (i.e., a porcelain enameled refrigerator vs. a painted steel and plastic lined refrigerator with no porcelain enamel). Generally, the competition from alternative finishes appears to affect the demand for porcelain enameled products more than from end product competition. Table 3-11 assimilates these factors and shows the elasticity coefficient which has been estimated for each major porcelain enameled product.

The price elasticity measures the degree of responsiveness of quantity demanded to price changes. The elasticity coefficients estimated in this section are used to determine the change in quantity demanded for each product group. An elasticity coefficient between -1.0 and 0 refers to a generally inelastic (less responsive) market reaction to price increases, while a coefficient of -1 or less will portray an elastic (more responsive) market reaction. A price increase for a product with an inelastic coefficient will yield a less than proportional reduction in quantity demanded while a similar price increase for a product with an elastic coefficient will result in a more than proportional reduction in quantity demanded. For example, if a product with a price elasticity coefficient of -0.6 experiences a price increase of 2 percent, the quantity demanded will decrease by 1.2 percent (i.e., 0.6 times 2) which is less than the price increase.

A discussion of the elasticity assessment for each major product follows.

Ranges

The market strength of ranges is strong because there are few other methods for home cooking. Microwave ovens, open fireplaces, wood stoves, and barbecue grills are only partial substitutes. In addition, porcelain enamel usage on ranges appears to be well established. Virtually all ranges contain porcelain enameled oven interiors and over 90 percent have porcelain enameled tops. Approximately 10 percent of oven tops are made of glass or stainless steel. However, increased use of these alternatives appears limited since glass range tops (which at one time were a popular new product) suffer from

TABLE 3-11. ELASTICITY ESTIMATES FOR PORCELAIN ENAMELED PRODUCTS

Product	Substitutability of the End Product	Substitutability of the Porcelain Enameled Finish	Estimated Elasticity of the Porcelain Enameled Products
Ranges	Low	Low	-.3
Home Laundry	Low-Moderate	Moderate-High	-.7
Dishwashers	Moderate	Moderate-High	-.8
Refrigerators	Low	High	-.9
Hot Water Heaters	Low	Low	-.3
Sanitary Ware	Low	High	-.9
Cookware	Low	High	-.9
Architectural Panels, Signs and Reflectors	High	High	-1.2
Barbecues	Moderate	Moderate	-.7
Job Shop Services	Moderate	Moderate-High	-.8

Source: JRB Associates estimates.

energy efficiency problems and stainless steel is currently a more expensive alternative than porcelain enamel.* Therefore, porcelain enamel substitutability appears to be low. With both low end product and porcelain enamel substitutability, a low elasticity coefficient of -.3 is assigned to porcelain enameled ranges.

Home Laundry

As compared with ranges, home laundry products (washers and dryers) have less market strength. Many persons use commercial, coin laundries, and/or outdoor clotheslines instead of buying their own machines. Also, in some apartment buildings, one laundry room is shared by several apartments while a range and refrigerator are provided for each unit.

Virtually all washer tops are currently being porcelain enameled with a small proportion of units containing plastic or painted tops and, while stainless steel and plastic can be substituted in washer drums, porcelain enamel is currently being used for 80-90 percent of washer drums.** Dryer tops and drums are more susceptible to substitution of porcelain enameling because of the lack of the requirement for acid and alkali protection necessary for washers (no detergent or bleach spills are likely on dryers), and the lack of a moisture problem for the drums. Therefore, since potentially viable substitutes exist for many of these porcelain enamel applications, a moderately high elasticity coefficient of -.7 is assigned to the porcelain enamel usage in this product group.

Dishwashers

The percent of the dishwasher interiors that are porcelain enameled has decreased from close to 100 percent to about 80 percent. This slippage has been due to the use of vinyl chloride interiors in some units. Currently, one major manufacturer produces a line of dishwashers with no porcelain enamel. In addition, it appears that the market strength of dishwashers is among the weakest of all major appliance products. While shipments of dishwashers have

*"How To Identify Appliances Finishes." American Iron and Steel Institute.
**Arnold Consdorf, Editor, Appliance Manufacturing.

grown the fastest of all appliance products over the last 10 years, dishwashers are still considered as somewhat of a luxury by many American families and more families do without dishwashers than any other major appliance product (besides freezers). With this moderately high degree of end-product substitutability (dishwashers vs. hand washing) and a moderately high availability of porcelain enamel alternatives, porcelain enameled dishwashers are assigned an elasticity coefficient of -.8.

Refrigerators/Freezers

The substitutability of porcelain enamel on refrigerators is among the highest of all porcelain enameled products. In fact, only one manufacturer is currently using any porcelain enamel on refrigerators; plastic is used throughout the interior and either painted or coil coated steel is used on the exteriors.

However, the end-product market strength of refrigerators is strong since there are virtually no substitutes for storing refrigerated foods. In spite of this high end-product market strength, the high availability of alternative finishes leads to the assignment of an elasticity coefficient of -.9 for porcelain enameled refrigerators.

Hot Water Heaters

A low elasticity coefficient of -.3 is assigned to porcelain enameled hot water heaters, since there is a combination of high end-product market strength and low substitutability for porcelain enamel. There is virtually no practical substitute for hot water heaters and with over 90 percent of the heater liners porcelain enameled (glass lined), alternative finishes, i.e., stainless steel, copper, and concrete covered steel, do not appear to be cost effective substitutes.

Sanitary Ware

Sanitary ware is similar to refrigerators in that there are no practical substitutes for sinks and bathtubs, but the market share of porcelain enameled sanitary ware is being eroded by plastic and stainless steel substitutes.

In the past 10-15 years, substitutes for porcelain enameled sanitary ware have become more prevalent. For example, fiberglass one-piece bathtubs and shower stalls have made significant inroads into the market. In 1977, these "one-piece" tubs had over 26 percent of the market.

As indicated in Table 3-12, the market share of these plastic tubs has grown from 31 percent in 1976 to 49 percent in 1981. Similarly, stainless steel has made a significant impact on kitchen sinks. In 1971, it had 42 percent of the market share and by 1981 it accounted for 80 percent of total shipments. However, Table 3-11 also shows that the market penetration of plastic and stainless steel seems to level off since 1978.

This combination of low-end product substitutability and high porcelain enamel substitutability results in the assignment of an elasticity coefficient of -.9.

Cookware

Cookware also appears to fall into the same situation as refrigerators and sanitary ware, in that few substitutes exist for cookware, but many substitutes exist for porcelain enamel cookware finishes. Also, a large quantity of imported porcelain enamel cookware offers a significant amount of competition. Therefore, a relatively high elasticity coefficient of -.9 is assigned to United States-made porcelain enameled cookware.

Architectural Panels, Signs, and Reflectors

In this broad category, both substitute products and alternative finishes are widely available and highly utilized. In fact, porcelain enameled panels have evolved in the last two decades into a limited, more specialized product. For example, brick, block, and aluminum and vinyl siding are most often used in place of architectural panels, and lighted plastic signs are more frequently used than painted signs. Therefore, because of the high degree of substitutability and the weak demand, the elasticity is high and a coefficient of -1.2 is assigned to this porcelain enameled product group.

TABLE 3-12. PLASTIC AND STAINLESS STEEL SANITARY WARE MARKET SHARES

	MARKET SHARES OF	
	Plastic Bathtubs/ Shower Stalls (%)	Stainless Steel Kitchen Sinks (%)
1971	a/	41.7
1976	31.2	67.5
1977	30.2	66.7
1978	45.9	76.1
1979	46.7	75.2
1980	45.3	79.9
1981[p/]	48.6	82.6

[a/]Not reported

[b/]Preliminary

Source: Appliance, September 1981.

Barbecues

First, even though a large number of American families own a barbecue grill of some kind, they are generally considered to be non-necessity items. Therefore, the market strength of these products is considered to be only moderate. In addition, only a small percentage of barbecue grills are currently porcelain enameled, indicating a high degree of substitutability between porcelain enamel and other finishing materials, such as cast iron and paint. However, the porcelain enameled barbecues are considered prestige products and currently receive a premium price. Therefore, the high elasticity coefficient which might have been assigned based solely upon substitutability is revised downward to a moderate -.7.

Job Shop Services

It is difficult to develop a single, average elasticity coefficient for job shop services, since job shops enamel so many different products. However, some insight can be gained by examining the following three main reasons that lead various manufacturers to contract for enameling services:

- The volume of enameling is too small to make it economically feasible for the end-product manufacturer to create an in-house enameling capability
- In-house enameling capability is insufficient to meet peak demand fluctuations
- The products' future is too uncertain to justify the investment required for the product manufacturer to establish an in-house enameling capability.

Porcelain enameling in these cases appears to serve necessary functional purposes, since the product manufacterers would probably not bother with contracting for the enameling services unless it was necessary. This factor tends to indicate a high level of market strength for job shops. On the other hand, the dependability of these markets appears to be quite weak. For example, the growth in product demand may reach a point whereby the porcelain enameling could be more economically performed by the end-use product manufacturer creating his own in-house enameling capability, and the risk of the product being displaced or phased out is very significant with small volume products. These factors therefore tend to indicate a basic weakness in the demand for job shop services. After considering these two counterbalancing factors, a moderate-high elasticity coefficient of -.8 was assigned to job shop services.

4. BASE CASE ANALYSIS

4.1 OVERVIEW

This section provides projections of conditions in the porcelain enameling industry for the mid-1980s in the absence of the effluent regulations. These projections are used in Chapter 6, together with other information such as estimated compliance costs, to assess the incremental economic effects of the effluent control requirements on future industry conditions.

The baseline projections provide a general point of reference for the analysis and are not intended to be a comprehensive, authoritative forecast of future industry conditions. Although minor changes to the baseline could 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 primary variables of interest have been divided into two broad categories for consideration in this study--demand related factors and supply related factors:

- Demand Factors
  - Quantity demanded
  - Types of products demanded
  - Price elasticities of demand
- Supply Factors
  - Cost of goods sold
  - Profitability
  - Industry structure (number and size of plants and firms, competitiveness, etc.).

The basic approach followed in developing the projections begins with a forecast of demand related factors. Demand related factors, in this report are determined through projections of activity in the major porcelain enamel consuming markets in combination with an assessment of technological trends. It is assumed that output will be sufficient to at least meet demand. Then, industry supply factors are assessed to determine if there would be any significant changes in the relative costs or profitability of porcelain enameling over the next decade, which would be great enough to affect substitution of other materials for porcelain enameling.

4.2 DEMAND RELATED FACTORS

The primary reason for beginning the baseline projections with the demand analysis is that it is hypothesized that porcelain enameling supply factors will adjust to demand conditions. This is because: (1) the porcelain enameling industry is a very small proportion of total economic activity in the U.S. and is, therefore, more likely to react to general trends, rather than influence them; and (2) the demand for porcelain enamel is a derived demand, depending on the sales and use of other products such as appliances, sanitary ware, and cookware and is, therefore, complementary to the demand of these other products. The demand analysis contains two basic components:

- A projection of activity levels in major existing porcelain enamel using industries, and
- An assessment of technological trends that may affect the use of porcelain enamel. This includes:
  - the extent to which new porcelain enamel-containing products will be developed and grow
  - the extent to which porcelain enamel use in current products will change.

These points are discussed below.

4.2.1 New Products

There are two types of new products that might affect growth for porcelain enameled products: products that are already developed and available for commercial application, and those that are not yet conceived or are in the experimental or developmental stage (i.e. technological breakthroughs). Technological breakthroughs are not likely to affect this regulatory analysis because it generally takes at least several years from the time a basic technology is perfected till it becomes of commercial significance and because this study is concerned with an intermediate term analysis (1984-1987). Therefore, the research focused on currently known commercial applications.

For the near future, two new developing markets for porcelain enamel were identified - agricultural applications and solar heating panels. Both markets are currently small in comparison to other porcelain enamel markets (e.g. appliance) and it does not appear likely that these areas will become high volume markets during the 1980s.

4.2.2 Changing Use of Porcelain Enamel in Existing Products

During the 1960s and 1970s, porcelain enamel use in many markets declined. The primary reason for the decline is the increase in cost of producing the final product with porcelain enameling relative to that of producing the product with other materials. The major product groups and the nature of the substitution of other materials for porcelain enamel is shown in Table 4-1.

The future prospects for porcelain enameling depend on whether the substitutions shown in Table 4-1 represent substantially all of the technically possible and economically viable substitutes. In some cases, i.e., oven interiors and hot water heater liners, no viable substitutes are currently being used. In other cases, porcelain enamel is being used because it offers certain quality or cost advantages over available alternative materials. For example, Sears (the largest U.S. appliance retailer) requires porcelain enameling on many surface areas where substitute materials can be used. The Sears catalogue and appliance advertisements emphasize the quality of the porcelain enameling on their appliances. Nevertheless, it appears to be the practice of appliance manufacturers today to use porcelain enameling only on the surface areas where it has a clear functional or cost advantage. In addition, new developments in plastics, fiberglass, paints, and coil coating are all continually challenging porcelain enamel usage. Therefore, the key question regarding the future of porcelain enamel use is whether all practical substitutions have already been made.

TABLE 4-1. SUBSTITUTION AWAY FROM PORCELAIN ENAMEL USAGE SINCE 1960

Product Group	Surface Area Where Porcelain Enamel use has been Discontinued or Heavily Substituted	Substituted Product or Finish Being Used
Sanitary Ware	Bathtubs	Fiberglass, cultured marble
	Sinks	Stainless steel, cultured marble
Refrigerators	Exterior surface	Painted steel, coil coated
	Interior liners	Plastic, painted steel
	Door interiors	Plastic, painted steel
	Crisper trays	Plastic
Washers	Exterior front and side panels	Painted steel
Dryers	Exterior fronts, tops and sides	Painted steel
Ranges	Exterior side panels	Painted steel
Architectural Panels	Architectural panels	Painted, coil coated and vinyl siding
	Signs	Painted, plastic signs
Miscellaneous	Meter dials	Painted dials
	Table tops	Painted, coil coated and plastic tops.

Source: JRB Associates estimates

To answer this question, the nature of the substitutions for each major porcelain enamel market was examined in terms of the availability, acceptance, and cost of substitute materials.

Table 4-2 contains a summary of porcelain enamel usage for all major porcelain enameled products. This table indicates that porcelain enamel usage in architectural panels and chalkboards is likely to decrease significantly over the next 5 years. Usage on ranges, kitchen sinks and in hot water heaters is not expected to change significantly, while trends for washers/dryers, bathtubs and dishwashers are uncertain and are likely to depend on cost and marketing factors.

Ranges

Ranges currently account for more porcelain enamel usage than any other individual product. For oven interiors, there are no alternative materials being used, and over 90 percent of all range tops use porcelain enamel. However, with the increased quantity of insulation currently being used in ranges, fronts and side panels can now be painted steel. Much of this substitution has already been made and further decreases in porcelain enamel usage on ranges appear unlikely.

Washers/Dryers

Potential substitutes exist for all current uses of porcelain enameling on washers and dryers. Decisions on the utilization of substitute materials involve product quality and consumer preference as well as cost considerations. Although stainless steel, galvanized steel, plastic, and painted steel could be substituted, porcelain enameled steel currently appears to have an advantage over these materials. Exposure to water, detergents, bleaches, and various cleaners requires corrosive resistant properties for washer and dryer drums and washer tops. This need is currently being served by porcelain enameled steel. Although product designers have considered using plastic, stainless steel, or galvanized steel drums in washers and galvanized or stainless steel drums in dryers, no definite trend has been observed.

TABLE 4-2. PROSPECTS FOR PORCELAIN ENAMEL USAGE

Porcelain Enameled Products	Growth Prospects: Product Shipments	Possible Substitutes for Porcelain Enamel		Likelihood of Additional Substitutes
Ranges	Stable	Tops:	Stainless Steel, glass	Unlikely
		Interiors:	None	Unlikely
		Exteriors:	Paint, glass (doors), stainless	Unlikely
Washers/Dryers	Stable	Washer Drums:	Stainless Steel, Plastic	Possible
		Washer Tops:	Paint, Plastic	Possible
		Dryer Drums:	Stainless Steel, galvanized steel, aluminized steel, painted steel	Possible
Dishwashers	Good	Interiors:	Plastic, vinyl coated steel	Possible
		Fronts:	Paint	Possible
Hot Water Heaters	Good	Liners:	Copper, Concrete over steel	Unlikely
Sanitary Ware	Stable	Tubs:	Fiberglass, Cultured Marble (plastic)	Possible
		Sinks:	Stainless Steel, Cultured Marble (plastic)	Unlikely
Architectural Panels	Declining	Painted Steel and Aluminum, plastics, glass, concrete		Likely
Chalkboards	Stable	Particle Board		Likely
Cookware	Good	Stainless Steel, Chrome-plated steel, china		Possible

Source: JRB Associates estimates.

Dishwashers

The interior of the door and the tub of dishwashers is generally porcelain enameled. Potential substitutes exist for each of these uses. Plastic tubs and interior door liners are presently being used by one dishwasher manufacturer. In fact, this manufacturer is currently marketing one of its dishwasher lines which has no porcelain enameling. However, some industry sources report technical problems with plastic substitutes, and it does not appear to be the general trend. Since (as discussed in Section 4.3) no change in relative costs are expected, significant loss of this market is considered unlikely, although possible if market acceptance factors shift away from porcelain enameling.

Hot Water Heaters

Virtually all hot water heaters made in the United States have porcelain enameled tanks. Since the porcelain enameling performed on an interior part does not require a quality appearance finish and since it is a single-coat application, the cost per square foot of porcelain enameling on these liners is the lowest of all major products. The total porcelain enameling cost is reported to average between $2.25 and $2.50 per hot water heater. By comparison, the cost of using copper or concrete over steel liners would be greater. Therefore, cost factors appear to point toward a continued use of porcelain enamel on hot water heaters.

Sanitary Ware

Stainless steel and cultured marble (plastic) sinks have gained market share at the expense of porcelain enameled products. However, most of the sink makers have already abandoned porcelain enameling, indicating that the potential for additional market share deterioration is minimal. For example, in 1972 half of the 5.1 million kitchen sinks shipped were porcelain enameled steel or cast iron. By 1981, this figure had dropped to 15 percent of the kitchen sinks shipped.*

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*Appliance, September 1981.

Cast iron and steel bathtubs accounted for 76 percent of the bathtubs shipped in 1976. By 1978 this figure had dropped to 60 percent. During the next three years it did not fluctuate significantly around the 40 percent figure*.

For these reasons, the porcelain enamel share of the sanitary ware market is not expected to change significantly in the 1980s.

Architectural Panels/Signs/Reflectors

Porcelain enameled architectural panels have been steadily declining in use. Coil coated (painted) aluminum and steel, as well as plastics, glass, and prefabricated concrete panels offer substantial competition to porcelain enameling in this market. All evidence seems to indicate that current trends will not change and the use of porcelain enamel panels will continue to decrease. Porcelain enameled signs and reflectors have also experienced significant decreases in market shares. Painted metals and plastics have been the principal beneficiaries of the decline of porcelain enameled signs and reflectors. Primarily because of the substantial cost economies of the substitute surfaces, little prospect exists for a reversal in the declining trend for these porcelain enameled products.

Cookware and Small Appliances

This product group can be divided into two sections -- steel and aluminum cookware and small appliances. The demand for steel cookware has substantially diminished over the last 30 years, and porcelain enameled steel cookware has become a rather specialized commodity. On the other hand, porcelain enameled aluminum cookware and small appliances have experienced a growth in demand over this same time period. Even though the production volumes of both of these sectors combined is very small compared to the volumes contained in the appliance and sanitary ware markets, the combined trend of these two sectors probably reflects a slight positive movement. However, available

*Appliance, September 1981.

substitutes exist for porcelain enameled cookware and small appliances, and relatively small shifts in cost factors or consumer preferences could lead to a substantial reduction of porcelain enamel usage over the next 5 years. In addition, imported cookware is a possible substitute for domestic porcelain enameled cookware.

4.2.3 Demand for Porcelain Containing Products

As described in Chapter 3, annual shipments of appliances and other porcelain enamel containing products has fluctuated widely over the 1971 to 1981 period. Wide fluctuations of shipments of durable goods is not uncommon in our economy primarily because in times of financial stress consumers can postpone the purchase of most of these products and because of large inventory adjustments at all stages of manufacturing and distribution. The forecasts used in this study are derived from that published in the January, 1982 edition of Appliance magazine and in Predicasts Composite Forecasts of June, 1982. These forecasts are primarily the result of surveys of industry personnel and are contingent on an economic recovery starting in 1983. These projections are shown in Table 4-3.

As the table shows, shipments of porcelain enamel containing products is expected to increase with economic recovery in the next several years. Over the 1982 to 1987 period, growth of household appliances that contain porcelain enamel is expected to range from 3 to 7 percent annually. This compares to 4.2 percent from total durable manufactures. However, the industry is expected to be quite sensitive to cyclical economic movements.

4.2.4 Net Demand For Porcelain Enameling

The estimated net demand increase for porcelain enameling for the 1983 to 1987 period is derived as the total porcelain enamel in new uses plus increased porcelain enamel used in the production of existing products (due to growth in demand of existing products) less expected market deterioration due to substitution of other materials for porcelain in existing products. As described above, there are few new uses identified; thus, no growth is expected from new uses.

TABLE 4-3. ANNUAL SHIPMENTS (1968-1981) AND PROJECTED ANNUAL SHIPMENTS (1982-1987) FOR HOUSEHOLD APPLIANCES AND SANITARY WARE ($ THOUSAND)

Product	Average Shipments 1968-1978[a]	Actual			Projected Shipments					
		1979	1980	1981[d]	1982	1983	1984	1985	1986	1987
Ranges	4,906.8	5,018	4,224	3,958	4,267	4,517	4,653	4,731	4,894	5,066
Washers	4,714.9	5,264	4,816	4,649	5,062	5,323	5,384	5,492	5,696	5,916
Dryers	3,349.6	3,769	3,384	3,183	3,485	3,751	3,761	3,914	4,115	4,764
Dishwashers	2,877.1	3,488	2,738	2,484	2,744	3,021	3,100	3,184	3,294	3,554
Water Heaters	5,164.7	5,549	5,269	5,236	5,666	6,132	6,553	6,993	7,506	7,987
Kitchen Sinks	4,222.3[b]	4,500	3,787	4,145	3,916	4,190	4,483	4,797	4,941	5,089
Bathtubs	2,635.9[b]	3,191	2,278	2,353	2,223	2,378	2,545	2,723	2,804	2,889
Refrigerators/ Freezers	7,357.1	8,339	7,658	7,330	7,346	7,792	7,921	8,029	8,361	8,701
Total Household Appliances (index)[c]	138	150.2	136.1	138	122	142.7	169	196	204	212

a/ American Home Appliance Manufacturers; American Gas Association; and Appliance Shipments, U.S. Department of Commerce

b/ Data average for 1968-1977

c/ Federal Reserve Board index of industrial production, 1967=100

d/ Preliminary data

Source: "30th Annual Forecasts," Appliance, January, 1982, and PREDICASTS Composite Forecasts, June, 1982 and extrapolations by JRB Associates.

Section 4.2.3 concluded that shipments of porcelain containing products will probably grow moderately during the 1980s. Information in Section 4.2.2 indicates that porcelain use per unit of some existing products has declined during the 1960s and 1970s and that this decline has slowed substantially. The net effect of these trends cannot be precisely quantified. The net effects of these two conflicting trends appears to be that demand for porcelain enamel will be stable during the 1980s. That is, production levels during the mid-1980s will be similar to those in existence at the time of the EPA industry survey (1977). It is appropriate to assume, therefore, that production data gathered in that survey is valid for this analysis.

4.3 SUPPLY FACTORS

The primary supply factors of interest are prices of porcelain enameling and the number of production facilities.

4.3.1 Price of Porcelain Enameling

Large changes in the price of porcelain enameling could significantly affect demand over the long run. Therefore, it is of interest to assess the likelihood of baseline changes in the cost of porcelain enameling. This is done by qualitatively assessing the likelihoood of changes in the relative prices of the three major inputs to the porcelain enameling process--frit, energy, and labor.

No reason was found to expect the price of frit to increase faster than prices of other goods and services in the economy over the next 10 years. That is, its relative price will remain constant. The future price of energy, as we have seen in recent years, is highly uncertain and the projections of various forecasters differ widely. Moreover, future energy cost increases may be offset, somewhat, by technological development in the industry. In recent years there has been progress in improving enamel furnace efficiency by converting the furnace design from refractory and insulation materials to ceramic fibers. This change permits a significant reduction in idling periods of the furnace and, therefore, fuel savings (gas and electric).

Other technological developments that could affect the future cost of porcelain enameling include lower enamel firing temperatures, less expensive metal preparation systems, and the use of direct-on-steel coatings (one coat). These factors were not quantified in this study.

Most of the labor force used in porcelain enameling operations are not highly trained, and do not exhibit characteristics that make them unique in comparison to workers in other metal fabricating and finishing operations. Therefore, labor costs are expected to remain constant in comparison to general wage rates in the economy.

Because the prices of the three primary factor inputs of production for porcelain enameling are expected to remain constant relative to the prices of other products, there is no reason to expect porcelain enamel prices to change relative to general price levels.

4.3.2 Number of Production Facilities

During the 1960s and 1970s there were 25 new plants built while about 90 plants have closed for a net reduction of 65 plants.* Further decline in the number of plants is not expected in the baseline since, as described in Section 4.2, the demand for porcelain enameling is expected to be stable through the 1980s. It is believed that most of the technological change that caused substitution of other materials for porcelain enameling appears to have occurred. Although substitution of other products for porcelain enameling is expected to continue, the rate of substitution is expected to be much lower than that of the 1960s and 1970s. The above forecasts of major porcelain enamel-using industries' activity for the 1983-1987 period also indicate no decline in production. For these reasons, a stable level of demand through the 1980s is projected and the number of facilities that exist in 1982 is expected to remain the same over the 1983 to 1987 period.

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*Paul S. Gruber, JRB Porcelain Enamel Consultant.

4.4 SUMMARY OF BASELINE CONDITIONS

The above discussion of baseline conditions for the 1983-1987 period is summarized as follows:

- Quantity demanded will be stable
- The types of products demanded will not change significantly
- The cost of porcelain enameling metals relative to costs of other metal finishing methods will not change
- The number of porcelain enamel production facilities will not change significantly. Therefore, for the impact analysis in Chapter 6, a zero baseline closure estimate is used.
- Because the above forecasts are fairly constant, there is no reason to expect profitability of porcelain enameling operations to change over the 1983-87 period.

These conclusions form the basic background for the conclusions regarding economic impacts that are presented in Chapter 6.

5. PORCELAIN ENAMELING EFFLUENT GUIDELINE CONTROL OPTIONS AND COSTS

5.1 OVERVIEW

The alternative water treatment control systems, costs, and effluent limitations for the Porcelain Enameling Point Source Category are enumerated in the Development Document. The Development Document also identifies various characteristics of the industry, including manufacturing processes; products manufactured; volume of output; raw waste characteristics; supply, volume, and discharge destination of water used in the production processes; sources of waste and wastewaters; and the constituents of wastewaters. Using this data, 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. This involved an evaluation of both in-plant and end-of-pipe technologies which could be designed for each subcategory. This information was then evaluated for existing surface water industrial dischargers to determine the effluent limitations required for the Best Practicable Control Technology currently available (BPT), and the Best Available Technology economically achievable (BAT). Existing and new dischargers to Publicly Owned Treatment Works (POTWs) are required to comply with Pretreatment Standards for Existing Sources (PSES) and Pretreatment Standards for New Sources (PSNS), and new direct dischargers are required to comply with New Source Performance Standards (NSPS), which require Best Available Demonstrated Control Technology (BDT). The identified technologies were analyzed to calculate cost and performance. Cost data were expressed in terms of investment, operating and maintenance costs plus depreciation, and interest expense.

5.2 CONTROL AND TREATMENT TECHNOLOGY

Based on the analysis of the potential pollutant parameters and treatment in place in the porcelain enameling industry, EPA identified five treatment technologies that are most applicable for the existing sources in the industry:

- Treatment Level 1: Settling sump plus chemical addition
- Treatment Level 2: Physical and chemical treatment (Lime and settle)
- Treatment Level 3: In-process flow reduction plus physical and chemical treatment (Lime and settle plus flow reduction)
- Treatment Level 4: Physical and chemical treatment plus filtration (Lime and settle plus filtration)
- Treatment Level 5: In-process flow reduction, physical and chemical treatment plus filtration (Lime and settle, filtration, and flow reduction).

For new sources, two alternative treatment technologies were examined:

- Treatment Level 1: Lime and settle plus flow reduction
- Treatment Level 2: Lime and settle, flow reduction, plus filtration and 3-stage countercurrent cascade rinse to further reduce wastewater flow.

The above treatment technologies are described in detail in the Development Document.

5.3 TREATMENT COSTS

5.3.1 Assumptions Made in Estimating Compliance Costs

A number of critical assumptions were used to estimate compliance costs:

- Capital costs are amortized at 10 years and 16 percent interest
- Depreciation was straight line at 10 percent per year for 10 years
- All costs are expressed in January 1978 dollars
- Where either a batch or continuous treatment system was possible, the system with the lowest life-cycle costs (over

a 10-year period) was selected for presentation in the system cost tables. The mode of treatment is noted in the tables for each case

- Nonsupervisory labor costs assumed an average wage rate reported by the Bureau of Labor Statistics of the U.S. Department of Labor for January 1978 (as reported in BLS periodical, Employment and Earnings)

- An average rate of 3.3 cents per kilowatt hour was used for all electric energy costs.

In addition to these basic assumptions, EPA also had to make some assumptions in relation to the size of the treatment facility needed for each plant and the cost of plant modifications and treatment system installation costs. The assumptions are outlined in the Development Document.

5.3.2 Compliance Cost of Existing Sources

Table 5-1 presents total compliance capital investment and total annual compliance cost estimates for each economic subcategory*. These costs were tabulated from the plant-specific cost estimates for the 106 sample plants and for the total 116 plants in the industry. Total capital investment requirements for the 116 plants range from $5.2 million for Treatment Level 1 to $30.8 million for Treatment Level 5, while total annual compliance costs range from $1.3 million to $13.8 million.

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*Treatment Level 1 compliance costs were estimated on a plant-specific basis for 51 plants with flow rates less than 50,000 l/day only. Compliance costs for the remaining plants with flow rates over 50,000 l/day were then calculated based on compliance capital investment estimate ($14,267) and flow rate (6,156 gal/day) of a selected plant and using the following formulas:

$$CCI_i = (14{,}267 - 500) \times \left(\frac{\text{Flow } i}{6{,}156}\right)^{0.7} + 500$$ (assumed $500 fixed cost for neutralization)

$$ACC_i = CCI_i \div 4.66$$

where: CCI_i = Compliance capital investment of plant i
Flow i = Flow rate of plant i (in gal/day)
ACC_i = Annual compliance costs of plant i

Product Groups	No. of Plants	Annual Production (10^3 x sq.ft.)	Total Compliance Capital Investment ($ Thousand)					Total Annual Cost of Compliance ($ Thousand)				
			Level 1	Level 2	Level 3	Level 4	Level 5	Level 1	Level 2	Level 3	Level 4	Level 5
Ranges	25	215,533	1,435.2	4,991.9	5,340.4	6,690.0	7,036.0	371.4	3,031.7	3,108.3	3,504.8	3,580.9
Home Laundry	9	181,720	1,004.0	1,771.2	1,900.6	3,293.3	3,421.4	259.8	2,141.1	2,170.1	2,560.9	2,589.7
Dishwashers	4	48,060	341.8	1,429.3	1,507.4	1,909.9	1,987.8	88.5	692.3	709.3	824.0	841.0
Hot Water Heaters	9	75,211	179.2	1,309.6	1,385.7	1,418.4	1,494.3	46.4	536.3	553.1	565.7	589.9
Refrigerators	2	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)
Steel Sanitary Ware	9	58,255	416.8	2,296.9	2,384.5	2,807.8	2,895.3	107.9	960.9	980.4	1,100.7	1,120.2
Cast Iron Sanitary Ware	2	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)
Cookware	11	50,982	434.3	2,526.0	2,681.5	3,136.0	3,291.1	112.4	846.0	880.1	1,011.7	1,045.7
Architectural Panels	11	35,552	221.9	1,464.9	1,532.8	1,590.6	1,658.4	57.6	597.1	612.2	629.5	644.5
Job Shops	23	52,310	613.4	4,452.4	4,674.8	5,018.8	5,240.9	158.7	1,649.5	1,698.4	1,802.2	1,850.9
Barbecues	1	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)
Total for Sample Plants	106	774,628	4,931.7	21,450.3	22,673.9	27,498.1	28,716.0	1,276.5	11,097.7	11,367.6	12,760.5	13,036.4
Indirect Dischargers	82	556,389	3,780.9	17,326.3	18,300.8	21,866.8	22,837.3	978.7	8,671.6	8,886.0	9,911.7	10,132.5
Direct Dischargers	24	218,240	1,150.8	4,124.0	4,373.0	5,631.2	5,878.7	297.8	2,426.1	2,481.4	2,848.9	2,903.9
Total for Industry	116	851,700	5,170.4	23,242.8	24,544.8	29,487.3	30,783.6	1,338.3	11,803.5	12,090.6	13,520.3	13,813.5
Indirect Dischargers	88	597,100	3,912.8	18,529.3	19,565.8	23,143.9	24,176.2	1,012.8	9,105.1	9,333.2	10,364.4	10,599.0
Direct Dischargers	28	254,000	1,257.6	4,713.4	4,979.0	6,343.4	6,607.3	325.5	2,698.4	2,757.4	3,155.9	3,214.6

(a)Withheld to avoid disclosure of confidential data.

NA: Not available.

Source: EPA.

In terms of total annual compliance costs per industry segment, the ranges and home laundry segments bear the heaviest aggregate burden (see Table 5-1). However, Table 5-2 indicates that the job shops and architectural panels industry segment have the highest average annual compliance costs per square foot of enameled surface.

5.3.3 Compliance Costs of New Sources

As indicated in Section 5.2, two treatment alternatives are considered by EPA for new sources. Table 5-3 summarizes the compliance cost estimates of these alternatives by each technical subcategory. The costs apply to both major modifications of existing facilities and to greenfield (new) sites.

TABLE 5-2. AVERAGE ANNUAL COMPLIANCE COST PER SQUARE FOOT OF PORCELAIN ENAMELED PRODUCT (CENTS PER SQUARE FOOT)

Product Groups	Treatment Level 1	Treatment Level 2	Treatment Level 3	Treatment Level 4	Treatment Level 5
Ranges	0.17	1.41	1.44	1.63	1.66
Home Laundry	0.14	1.18	1.19	1.41	1.43
Dishwashers	0.18	1.44	1.48	1.72	1.75
Hot Water Heaters	0.06	0.71	0.74	0.75	0.78
Refrigerators	(a)	(a)	(a)	(a)	(a)
Steel Sanitary Ware	0.19	1.65	1.68	1.89	1.92
Cast Iron Sanitary Ware	(a)	(a)	(a)	(a)	(a)
Cookware	0.22	1.66	1.73	1.98	2.05
Architectural Panels	0.16	1.68	1.72	1.77	1.81
Job Shops	0.30	3.15	3.25	3.45	3.54
Barbecues	(a)	(a)	(a)	(a)	(a)
Total for 106 Sample Plants	0.16	1.43	1.47	1.65	1.68
Indirect Dischargers	0.18	1.56	1.60	1.78	1.82
Direct Dischargers	0.14	1.11	1.14	1.31	1.33

(a) Withheld to avoid disclosure of confidential data

Source: JRB Associates estimates

TABLE 5-3. NEW SOURCE COMPLIANCE COSTS

	Technical Subcategory			
	Steel	Aluminum	Cast Iron	Copper
Average Annual Production per Plant* (thousand sq ft)	6,610	1,380	4,280	280
Treatment Level 1 Compliance Costs per Plant ($ thousand)				
Capital Investment	247.8	183.0	72.0	72.0
Annual Costs	80.6	61.6	22.1	22.1
Treatment Level 2 Compliance Costs per Plant ($ thousand)				
Capital Investment	259.8	195.0	82.0	84.0
Annual Costs	83.6	63.5	24.0	24.1

*One side of metal

Source: EPA

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Dishwashers	0.18	1.44	1.48	1.72	1.75
Hot Water Heaters	0.06	0.71	0.74	0.75	0.78
Refrigerators	(a)	(a)	(a)	(a)	(a)
Steel Sanitary Ware	0.19	1.65	1.68	1.89	1.92
Cast Iron Sanitary Ware	(a)	(a)	(a)	(a)	(a)
Cookware	0.22	1.66	1.73	1.98	2.05
Architectural Panels	0.16	1.68	1.72	1.77	1.81
Job Shops	0.30	3.15	3.25	3.45	3.54
Barbecues	(a)	(a)	(a)	(a)	(a)
Total for 106 Sample Plants	0.16	1.43	1.47	1.65	1.68
Indirect Dischargers	0.18	1.56	1.60	1.78	1.82
Direct Dischargers	0.14	1.11	1.14	1.31	1.33

(a) Withheld to avoid disclosure of confidential data

Source: JRB Associates estimates

TABLE 5-3. NEW SOURCE COMPLIANCE COSTS

	Technical Subcategory			
	Steel	Aluminum	Cast Iron	Copper
Average Annual Production per Plant* (thousand sq ft)	6,610	1,380	4,280	280
Treatment Level 1 Compliance Costs per Plant ($ thousand)				
Capital Investment	247.8	183.0	72.0	72.0
Annual Costs	80.6	61.6	22.1	22.1
Treatment Level 2 Compliance Costs per Plant ($ thousand)				
Capital Investment	259.8	195.0	82.0	84.0
Annual Costs	83.6	63.5	24.0	24.1

*One side of metal

Source: EPA

6. ECONOMIC IMPACT ANALYSIS

This section provides an estimate of the economic impacts which are associated with the costs of the effluent treatment technologies described in Chapter 5. The analysis is based upon an examination of the estimated compliance costs and other economic, technical, and financial characteristics of the 106 porcelain enameling plants for which production and price data are available and uses the analytical methodology described in Chapter 2. The primary economic impacts include changes in industry profitability, ability to raise capital, plant closures, industry concentration, and changes in employment.

The 106-plant sample represents over 90 percent of the plants in the industry and contains a wide range of both large and small plants. Production level data for the analysis were obtained from the EPA industry survey. Most of the reported production levels are for 1976-77. The economic impact analysis in Chapter 6 uses this 1976-77 data. The projected production levels for 1982-83 are similar to the actual levels used in the analysis. Therefore, it is appropriate to assume that the 1977 production levels are realistic for the analysis.

6.1 PRICE AND QUANTITY CHANGES

As discussed in Chapter 2, it is expected that, except for the architectural panel product group, each product group will adopt a price increase that will maintain the industry's initial return on sales. Due to weak market conditions and declining demand for porcelain enameled architectural panels (as discussed in Section 3.4 and 4.2), it is assumed that architectural panel producers will not be able to raise their prices and, therefore, will have to absorb the compliance costs.

Table 6-1 shows the estimated industry-wide price increases and the resulting quantity changes at each compliance level. The price increases are generally small for any treatment option, exceeding one percent for the steel sanitary ware and job shops groups only for treatment levels 2 through 5. Similarly, the quantity changes are also very small. The quantity changes

TABLE 6-1. ANTICIPATED INDUSTRY PRICE AND PRODUCTION CHANGES
(in percent)

	Level 1		Level 2		Level 3		Level 4		Level 5	
	dP/P	dQ/Q	dP/P	dQ/Q	dP/P	dQ/Q	dP/P	dQ/Q	dP/P	dQ/Q
Ranges	.03	-.01	.28	-.08	.29	-.09	.33	-.10	.34	-.10
Home Laundry	.02	-.01	.16	-.11	.17	-.12	.19	-.13	.20	-.14
Dishwasher	.02	-.02	.19	-.17	.20	-.18	.23	-.21	.24	-.22
Hot Water Heaters	.02	-.01	.23	-.07	.24	-.07	.25	-.08	.26	-.08
Refrigerators	b/	b/	b/	b/	b/	b/	b/	b/	b/	b/
Steel Sanitary Ware	.13	-.12	1.19	-1.07	1.22	-1.10	1.37	-1.23	1.39	-1.25
Cast Iron Sanitary Ware	b/	b/	b/	b/	b/	b/	b/	b/	b/	b/
Cookware	.08	-.07	.60	-.54	.62	-.56	.72	-.65	.74	-.67
Architectural Panels[a]	0	0	0	0	0	0	0	0	0	0
Job Shops	.27	-.24	2.85	-2.57	2.93	-2.64	3.11	-2.80	3.19	-2.87
Barbecues	b/	b/	b/	b/	b/	b/	b/	b/	b/	b/

a/ It is assumed that architectural panel producers will not attempt to raise prices.

b/ Withheld to avoid disclosure of confidential data.

Source: JRB Associates estimates.

result from applications of the elasticity estimates to the price changes. For example, the price of job shop products will increase 3.19 percent at level 5 and quantity demanded will fall 2.87 percent.

After the industry-wide price and quantity adjustments are determined, attention is focused on the analysis of individual plant impacts. Individual "plants" include establishments that are primarily engaged in porcelain enameling as well as production "lines" that are parts of larger establishments whose primary activity might not be porcelain enameling. However, in reporting the potential closures, later in this chapter, plants and lines are identified separately.

6.2 PROFIT IMPACT ANALYSIS

As described in Chapter 2, the assessment of the impact of compliance on plant profitability is based on the plants' after compliance return on investment (ROI) ratios, investment being defined as total plant assets (i.e. current assets plus net property, plant and equipment). Because plant-specific baseline financial characteristics (e.g., plant profit margin, assets value, variable and fixed costs of production) are not available, average industry financial and operating ratios for each porcelain enameling product group were applied to each plant. The resulting estimated baseline characteristics are summarized in Table 6-2. Appendix B describes the methodology for estimating the two key financial variables: plant average baseline profit margin and assets value.

As explained in Section 2.6, plants with post-compliance ROI less than 7 percent were considered to be "potential" plant closures. The 7 percent ROI threshold level was based on the condition that plants cannot continue to operate as a viable concern if they are unable to generate for the owners/stockholders an after taxes return on their investments (i.e. return on equity) equal to the opportunity cost of other investment alternatives. In this case the opportunity cost of their investments is defined as the 12 percent yield on U.S. Treasury bonds expected to be in effect when the regulation is implemented. Given certain assumptions regarding the capital structure

TABLE 6-2. PROFIT IMPACT ANALYSIS INPUTS

Product Groups	P_1 ($/sq.ft.)	Baseline Profit Margin (%) Before Tax	After Tax[a/]	Assets to Revenue	Variable Cost to Price	Price Elasticity
Ranges	5.26	6.0	3.6	.50	.70	-.3
Home Laundry	7.69	6.0	3.6	.50	.70	-.7
Dishwashers	7.91	6.0	3.6	.50	.70	-.9
Hot Water Heaters	3.26	6.0	3.6	.50	.70	-.3
Refrigerators	13.81	6.0	3.6	.50	.70	-.9
Steel Sanitary Ware	1.47	6.0	3.6	.60	.70	-.9
Cast Iron Sanitary Ware	3.75	6.0	3.6	.60	.70	-.9
Cookware	2.94	6.0	3.6	.50	.70	-.9
Architectural Panels						
Aluminum	3.50	5.0	3.3	.50	.70	-1.2
Steel/Strip Steel	2.50	5.0	3.3	.50	.70	-1.2
Job Shops	1.0	7.0	4.6	.55	.70	-.9
Barbecues	1.82	6.0	3.6	.50	.70	-.7

[a/] Assume average corporate tax rate of 40 percent, except for architectural panels and job shops which is assumed to be 35 percent.

Source: JRB Associates estimates.

(i.e., debt to equity ratio), tax rates, and salvage value of equipment that are described in Section 2.6, the 12 percent return on equity is approximated by the 7 percent ROI.

Table 6-3 presents the results of the profitability analysis of the 106 porcelain enameling sample plants. The table shows that at treatment level 1, only one job shop and one cookware plant have after-compliance ROI below the 7 percent threshold level. Treatment levels 2 to 5 present more significant profit impacts affecting 19 plants in the ranges, hot water heaters, steel sanitary ware, job shops, architectural panels, and cookware product groups.

6.3 CAPITAL REQUIREMENTS ANALYSIS

As presented in Chapter 2, the ratio of "compliance capital investment to revenues" (CCI/R) was used to evaluate a firm's ability to raise the capital necessary to install the pollution control systems. Although the CCI/R ratio does not precisely indicate whether or not firms can afford to make the required investments, it provides a good indication of the relative magnitude of the compliance capital investment requirements. The ratio CCI/R was calculated for each of the 106 sample plants and compared to the plants' respective capital availability threshold values which are defined as the plants' net after-tax profit margins (shown in Table 6-2). Exceeding the threshold is an indicator of potential closure.

Table 6-4 presents the results of the capital requirements analysis and suggests that at treatment level 1, two plants exceed the threshold values for capital expenditures and at treatment levels 2 to 5, 31 to 37 plants exceed the threshold. Sixteen of the 37 plants belong to larger establishments or firms and the required pollution control capital investments represent a relatively small proportion of total revenues for these entities. For this reason, it is expected that these 16 operations would have capital available to them. The remaining 21 plants (10 job shops, 4 architectural panel, 4 cookware, 1 range, 1 hot water heater and 1 steel sanitary ware) would have difficulty raising the investment capital.

TABLE 6-3. SUMMARY OF PROFIT IMPACT ANALYSIS

Product Groups	Number of Plants in Sample	Number of Plants with After-Compliance Return on Investment less than Threshold				
		Level 1	Level 2	Level 3	Level 4	Level 5
Ranges	25	0	1	1	1	1
Home Laundry	9	0	0	0	0	0
Dishwashers	4	0	0	0	0	0
Hot Water Heaters	9	0	1	1	1	1
Refrigerators	2	0	0	0	0	0
Steel Sanitary Ware	9	0	1	1	1	1
Cast Iron Sanitary Ware	2	0	0	0	0	0
Cookware	11	1	4	4	4	4
Architectural Panels	11	0	4	4	4	4
Job Shops	23	1	8	8	8	8
Barbecues	1	0	0	0	0	0
TOTAL	106	2	19	19	19	19

Source: JRB Associates estimates.

TABLE 6-4. SUMMARY OF CAPITAL REQUIREMENTS ANALYSIS

Product Groups	Number of Plants in Sample	Number of Plants with CCI/Revenue Greater than Threshold Value [a/]				
		Level 1	Level 2	Level 3	Level 4	Level 5
Ranges	25	0	1	1	1	2
Home Laundry	9	0	0	0	0	0
Dishwashers	4	0	0	0	0	1
Hot Water Heaters	9	0	2	2	2	2
Refrigerators	2	0	0	0	0	0
Steel Sanitary Ware	9	0	4	5	6	6
Cast Iron Sanitary Ware	2	0	0	0	0	0
Cookware	11	1	4	4	4	4
Architectural Panels	11	0	5	5	5	5
Job Shops	23	1	15	16	17	17
Barbecues	1	0	0	0	0	0
TOTAL	106	2	31	33	35	37

[a/] Threshold values are baseline after tax profit margins as reported in Table 6-2.

Source: JRB Associates estimates.

6.4 PLANT CLOSURE POTENTIAL

Although major investment decisions, such as plant closure decisions, are largely made on the basis of financial performance, they are ultimately judgmental. That is, in addition to financial variables, decisions makers must consider a number of other factors, such as market growth potential, the existence of specialty markets, intra-industry competition, the potential for technological obsolescence, and substitution potential for their products. As discussed in Chapter 2, the plant closure estimates presented here are based primarily on the financial variables.

Table 6-5 summarizes the estimated number of plant and line closure by product group and by treatment level. Twenty-one facilities (10 job shops, 4 architectural panels, 4 cookware, 1 range, 1 hot water heater, and 1 steel sanitary ware) are estimated to close at treatment levels 2 to 5. Nineteen of these closures were below the ROI threshold and above the capital requirements threshold. Two facilities (both job shops) were estimated to close solely on the basis of capital availability. As shown in Table 6-5, the rate of plant closure is higher among the indirect dischargers.

At treatment level 1, only one job shop is projected to close. Also at treatment level 1, one cookware operation is slightly below the ROI threshold and above the capital requirements threshold; however, this porcelain enameling operation is part of a much larger plant that manufacturers other types of cookware. Since the porcelain enameled cookware operation remains profitable and the required compliance capital investment represents a small percentage of the plant's total revenues, it is concluded that the company will probably maintain this operation to offer a more complete product line.

The above plant closure analysis focused on 106 sample plants. Ten plants were excluded from the analysis due to lack of data on plant production volume and revenue. Among these ten plants are 6 specialty, 2 range, 1 hot water heater and 1 cast iron sanitary ware plants.

TABLE 6-5. SUMMARY OF ESTIMATED FACILITY CLOSURES AMONG EXISTING SOURCES AT TREATMENT LEVELS 2 TO 5

Product Groups	Number of Plants in Sample	Number of Estimated Closures			Market Share of Closures	Changes in Quantity Demanded
		Total	Plant	Line		
TOTAL 106 SAMPLE PLANTS						
Ranges	25	1	0	1	0.1	0.08-0.10
Hot Water Heaters	9	1	0	1	0.2	0.07-0.08
Steel Sanitary Ware	9	1	1	0	3.7	1.07-1.25
Cookware	11	4	0	4	5.0	0.54-0.67
Architectural Panels	11	4	3	1	6.4	0
Job Shops	23	10	5	5	19.9	2.57-2.87
Total	106	21	9	12	2.4	
82 INDIRECT DISCHARGERS						
Ranges	18	1	0	1	0.1	
Hot Water Heaters	8	1	0	1	1.2	
Steel Sanitary Ware	8	1	1	0	3.7	
Cookware	9	3	0	3	2.7	
Architectural Panels	7	3	2	1	5.4	
Job Shops	17	9	5	4	19.2	
Subtotal	82	18	8	10	2.2	
24 DIRECT DISCHARGERS						
Cookware	2	1	0	1	2.3	
Architectural Panels	4	1	1	0	1.0	
Job Shops	6	1	0	1	0.8	
Subtotal	24	3	1	2	0.2	

Source: *JRB Associates estimates.*

Because the demand for porcelain enameled specialty items is estimated to be price inelastic and products are differentiated, producers will probably be able to pass through most of the cost increase to their customers. Consequently, it is estimated that the impacts of the regulations on plant profits will be insignificant and that there will be no closure among the specialty porcelain enameling plants. Finally, after extrapolating the closure analysis from the 106 sample plants, to the remaining plants in the industry, no additional closures are expected.

6.5 OTHER IMPACTS

6.5.1 Industry Structure and Competition

The impact of the regulations on industry structure and competition is assessed via a review of estimated post-compliance concentration ratios and the differential in compliance costs among small versus large plants. The plant closures represent a decline in industry capacity and hence, an increase in industry concentration. As Table 6-5 shows, the amount of production capacity lost by plant closures is greater than the quantity demanded reductions due to regulation-induced industry-wide price changes.

The increase in concentration is most noticeable in the job shop, architectural panels and cookware subcategories. For example, 10 job shops representing 25 percent of the job shop industry are estimated to close. Given a 3 percent drop in quantity demanded there could be a potential net increase in demand from the remaining 22 plants equal to 22 percent of pre-compliance industry output.* This is equivalent to a 29 percent increase in output for the remaining job shops. Increased concentration is often associated with increased occurence of non-competitive pricing. However, the competition from competing materials (e.g. coil coating, paint, etc.) described in Chapters 3 and 4 is expected to mitigate such occurrences.

*There is insufficient information to determine the proportion of the 22 percent lost output that will be produced by the remaining plants and that which will be permanently lost to the porcelain industry.

6.5.2 Substitution Effects

It is clear that effluent guidelines will add to the cost of using porcelain enamel finishes on all products. These added costs may cause and/or accelerate substitution of other materials for porcelain enamel, as previously discussed in Chapter 4. Substitution can occur in a variety of forms in the various subcategories. Manufacturers may use thinner coatings, substitute other materials for some components and continue using porcelain enamel on others, redesign their products to eliminate all porcelain enamel, or consumers may switch to other products. The degree of these substitution effects are approximated by the estimated reduction in quantity demanded shown in Table 6-1. The highest quantity reduction is estimated for the job shop and sanitary ware subcategories (2.9 and 1.3 percent, respectively at treatment level 5). Quantity reductions for other subcategories are less than one percent. A proportionate reduction in the demand for frit is expected.

6.5.3 Community and Employment Impacts

The findings on plant closure potential derived in Section 6.5 and the conclusions concerning the possible impacts of compliance on substitution away from porcelain enamel formed the basis for the assessment of employment impacts.

Using the plant and porcelain enameling process employment data collected by EPA in an industry survey, Table 6-6 demonstrates the effects of this regulation on employment. At treatment levels 2 to 5, a total loss of 488 jobs is associated with potential facility closures. Meanwhile, at treatment level 1 only one line closure affecting 2 employees is projected.

The 21 facilities projected to close are all located in different localities/municipalities. The largest employment impact to a single locality is 55 employees. This particular porcelain enameling facility is located in a large industrial city; thus, the impact on local employment situations will probably be insignificant.

TABLE 6-6. SUMMARY OF EMPLOYMENT EFFECTS

	Number of Employees Affected by		
	Plant Closures	Line Closures	Total
Total 106 Sample Plants			
Treatment Level 1	0	2	2
Treatment Levels 2-5	303	185	488
82 Indirect Dischargers			
Treatment Level 1	0	2	2
Treatment Levels 2-5	295	134	429
24 Direct Dischargers			
Treatment Level 1	0	0	0
Treatment Levels 2-5	8	51	59

Source: JRB Associates estimates based on EPA Industry Survey (308 survey).

6.5.4 Foreign Trade Impacts

Except for the cookware group, where a significant level of import competition already exists, effluent regulations will have no foreign trade impacts. Import and export of other porcelain enameled products are negligible. The porcelain enamel cookware manufacturers, which already have lost half of the domestic market to imports, could be further affected by compliance requirements. However, Table 6-1 indicates that price increase due to the regulation is only 0.7 percent at treatment level 5. A price increase of this magnitude would not alter the trading pattern substantially.

6.6 NEW SOURCE IMPACTS

As reported in Section 5.2, two treatment alternatives are considered for porcelain enameling new sources. Total system compliance costs of these two alternatives for typical new sources are summarized in Table 5-3.

For the purpose of evaluating the new source impacts, compliance costs of new source standards are defined as incremental costs over the costs of selected standards for existing sources. The selected treatment technology for existing sources corresponds to new source alternative 1. Consequently, compliance costs for this new source option are zero and there will be no associated economic impact.

The impact analysis of new source alternative 2 is summarized in Table 6-7. Assuming the minimum price of $1 per square foot for porcelain enameled products (i.e., job shop price), the annual compliance costs of new source treatment alternative 2 range from 0.03 to 0.7 percent of plant revenues for the steel and copper subcategories, respectively. Incremental costs of such magnitude will not deter new entry because they are small in relation to expected profit margins.

Based on the low level of impact indicated from these results, new source standards are not expected to result in barriers to entry.

Table 6-7. IMPACT ANALYSIS OF NEW SOURCE ALTERNATIVE 2

	Technical Subcategory			
	Steel	Aluminum	Cast Iron	Copper
Annual Production of Typical New Facility (thousand sq.ft.)	6,610	1,380	4,280	280
Plant Revenue ($ thousand)[a/]	6,610	1,380	4,280	280
Compliance Costs ($ thousand)				
Investment	12.0	12.0	10.0	12.0
Annual	2.0	2.0	1.9	2.0
Ratio of Compliance Costs to Plant Revenue (percent)				
Investment	0.18	0.87	0.23	4.29
Annual	0.03	0.14	0.04	0.71

[a/] Assume $ 1 per sq.ft.

Source: EPA and JRB Associates estimates.

7. 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 affected. If so, regulatory alternatives that eliminate or mitigate the impacts must be considered. This chapter addresses these objectives by identifying and evaluating the economic impacts on small porcelain enamelers. 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 porcelain enameling plants, plant revenues, wastewater volumes, compliance costs and potential closures from the regulation.

Three approaches were selected to define small porcelain enameling plants for purposes of the small business analysis. These approaches are based on the following factors:

- The Small Business Administration (SBA) definition of small business based on firm total employment
- Plant value of shipments for porcelain enameled products
- Plant wastewater flow rates.

The SBA definition of small business had a disadvantage for purposes of developing water pollution control regulations. It is based on firm size rather than plant size. Because firm size often does not correspond to plant size in this industry, the use of SBA definition would fail to recognize economies of scale in the pollution control technologies. For this reason, an alternative definition based on plant revenues was evaluated to account for unit compliance cost differentials due to plant size. Similarly, another alternative size definition based on plant wastewater flow rates was also examined since flow rates often vary with plant size and is a major factor in the development of effluent guidelines.

7.1 SMALL BUSINESS ANALYSIS BASED ON SMALL BUSINESS ADMINISTRATION EMPLOYMENT LEVELS

Using SBA loan eligibility size standards for SIC's 3431, 3469, 3631, 3632, 3633, and 3639, the porcelain enameling small business can be defined as follows:

- SIC 3431, Enameled Iron and Metal Sanitary Ware: Firms of fewer than 750 employees. This definition applies to the steel, cast iron sanitary ware, and specialties product groups
- SIC 3469, Metal Stampings: Firms of fewer than 250 employees. This definition applies to the cookware, architectural panels and job shop groups
- SIC 3631, Household Cooking Equipment: Firms of fewer than 750 employees. This definition applies to the range and barbecue groups
- SIC 3632, Household Refrigerators and Home and Farm Freezers: Firms of fewer than 1,000 employees
- SIC 3633, Household Laundry Equipment: Firms of fewer than 1,000 employees
- SIC 3639, Household Appliances, Not Elsewhere Classified: Firms of fewer than 500 employees. This definition applies to the hot water heater and dishwasher groups.

Table 7-1 summarizes the distribution of "small" plants for the 106-plant sample. The table shows that 42 plants are owned by "small" firms, of which 17 are projected to close at treatment levels 2 to 5. These 42 "small" plants discharge a total of about 729,400 gpd (about 16 percent of all wastewater discharged), and their annual compliance costs vary from $281,400 at treatment level 1 to approximately $3.2 million at treatment level 5.

7.2 SMALL BUSINESS ANALYSIS BASED ON PLANT VALUE OF SHIPMENTS

Table 7-2 presents the distribution by value of shipments of the number of porcelain enameling plants, plant production, revenues, flow rates, compliance costs and potential closures from regulations. The five size categories are:

- Less than $1 million in value of shipments of porcelain enameled products.

TABLE 7-1. DISTRIBUTION OF SMALL PORCELAIN ENAMELING PLANTS BASED ON SMALL BUSINESS ADMINISTRATION EMPLOYMENT LEVELS

Product Groups	Number of Plants	Flow Rate (000 GPD)	Annual Production (million x sq.ft.)	Annual Revenue ($ millions)	Treatment Level 1			Treatment Level 2			Treatment Level 3			Treatment Level 4			Treatment Level 5		
					Investment ($000)	Annual ($000)	Closures	Investment ($000)	Annual ($000)	Closures	Investment ($000)	Annual ($000)	Closure	Investment ($000)	Annual ($000)	Closure	Investment ($000)	Annual ($000)	Closure
TOTAL SMALL BUSINESS																			
Range	4 (3.8)	62.8 (1.4)	8.2 (1.1)	42.9 (1.1)	92.1 (1.9)	23.8 (1.9)	0	610.0 (2.8)	245.9 (2.2)	1	659.1 (2.9)	256.7 (2.3)	1	662.9 (2.4)	239.5 (2.0)	1	711.8 (2.5)	270.2 (2.1)	1
Home Laundry	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Dishwasher	6	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Hot Water Heaters	1 (0.9)	3.1 (0.07)	a/	a/	12.0 (0.2)	3.1 (0.2)	0	53.2 (0.2)	25.2 (0.2)	0	63.1 (0.3)	27.4 (0.2)	0	64.4 (0.2)	27.9 (0.2)	0	74.2 (0.3)	30.0 (0.2)	0
Refrigerators	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Steel Sanitary Ware	6 (5.7)	218.3 (4.9)	37.6 (4.9)	55.3 (1.4)	237.3 (4.8)	61.4 (4.8)	0	1320.1 (6.2)	543.7 (4.9)	1	1374.2 (6.1)	555.8 (4.9)	1	1539.3 (5.6)	602.0 (4.7)	1	1593.3 (5.5)	614.8 (4.7)	1
Cast Iron Sanitary Ware	1 (0.9)	1.7 (0.04)	a/	a/	11.0 (0.2)	2.8 (0.2)	0	127.5 (0.6)	52.4 (0.5)	0	127.5 (0.6)	52.4 (0.5)	0	134.0 (4.9)	54.6 (0.4)	0	134.0 (0.5)	54.6 (0.4)	0
Cookware	1 (0.9)	25.8 (0.6)	a/	a/	38.0 (0.8)	9.8 (0.8)	0	235.9 (1.1)	95.8 (0.9)	1	248.1 (1.1)	98.5 (0.9)	1	251.7 (0.9)	100.0 (0.8)	1	263.8 (0.9)	102.7 (0.8)	1
Architectural Panels	8 (7.5)	46.1 (1.0)	14.2 (1.8)	36.1 (0.9)	135.4 (2.7)	35.3 (2.8)	0	989.8 (4.6)	356.3 (3.2)	4	1033.8 (4.6)	366.0 (3.2)	4	1070.8 (3.9)	376.9 (3.0)	4	1114.8 (3.9)	386.6 (3.0)	4
Job Shops	20 (18.9)	353.8 (7.9)	46.1 (6.0)	56.0 (1.4)	532.0 (10.8)	137.6 (10.8)	1	3807.2 (17.7)	1427.2 (12.9)	9	3991.8 (17.6)	1467.8 (12.9)	9	4323.2 (15.7)	1567.3 (12.3)	9	4507.5 (15.7)	1607.8 (12.3)	9
Barbecues	1 (0.9)	17.8 (0.4)	a/ (1.1)	a/ (0.4)	29.4 (0.6)	7.6 (0.6)	0	210.1 (1.0)	89.8 (0.8)	0	221.1 (0.9)	92.3 (0.8)	0	223.5 (0.8)	93.6 (0.7)	0	234.5 (0.8)	96.0 (0.7)	0
SUBTOTAL	42 (39.6)	729.4 (16.3)	125.6 (16.2)	244.9 (6.1)	1087.2 (22.0)	281.4 (22.0)	1	7353.8 (34.3)	2836.3 (25.6)	16	7718.7 (34.0)	2916.9 (25.7)	16	8269.8 (30.1)	3082.6 (24.2)	16	8633.9 (30.1)	3162.7 (24.3)	16
TOTAL SMALL DIRECT DISCH.	9 (8.5)	166.8 (3.7)	23.5 (3.0)	39.1 (1.0)	246.8 (5.0)	63.9 (5.0)	0	1733.8 (8.1)	660.5 (6.0)	3	1812.9 (8.0)	677.9 (6.0)	3	2023.6 (7.4)	740.3 (5.8)	3	2102.5 (7.3)	757.6 (5.8)	3
TOTAL SMALL INDIRECT DIS.	33 (31.1)	562.6 (12.6)	101.7 (13.2)	205.6 (5.1)	840.4 (17.0)	217.7 (17.0)	1	5620.0 (26.2)	2175.8 (19.6)	13	5905.8 (26.0)	2238.9 (19.7)	13	6246.2 (22.7)	2342.2 (18.4)	13	6531.4 (22.8)	2405.2 (18.5)	13
TOTAL FOR SAMPLE PLANTS	106	4473.3	774.6	4063.9	4931.7	1276.5	1	21450.3	11097.7	21	22673.9	11367.4	21	27498.1	12760.5	21	28716.0	13036.4	21

( ) Values in parentheses represent percentage of all plants

a/ Withheld to avoid disclosure of confidential data.

Source: JRB Associates estimates.

TABLE 7-2. PLANT DISTRIBUTION BY VALUE OF SHIPMENTS

Product Groups	Number of Plants	Flow Rate (000 GPD)	Annual Production (million x sq.ft.)	Annual Revenue ($ millions)	Treatment Level 1 Investment ($000)	Treatment Level 1 Annual ($000)	Treatment Level 1 Closures
TOTAL 106 SAMPLE PLANTS							
Plants with Revenues:							
Less than $1 million	14 (13.2)	98.1 (2.2)	5.5 (0.7)	7.1 (1.0)	187.2 (3.8)	48.5 (3.8)	1
$1-5 million	24 (22.6)	386.0 (8.9)	35.6 (4.6)	76.2 (1.9)	623.6 (12.6)	161.6 (12.7)	0
$5-10 million	18 (3.8)	426.0 (1.7)	69.0 (2.3)	121.2 (0.7)	603.3 (2.4)	156.1 (2.4)	0
$10-25 million	11 (10.4)	349.3 (7.8)	57.4 (7.4)	109.1 (4.7)	467.0 (9.5)	120.8 (9.5)	0
Over $25 million	39 (36.8)	3,205.1 (71.6)	607.2 (78.4)	3,650.3 (90.2)	3,050.5 (61.9)	789.5 (61.8)	0
24 DIRECT DISCHARGERS							
Plants with Revenues:							
Less than $1 million	2 (1.9)	3.6 (0.1)	0.5 (0.07)	0.7 (0.02)	13.1 (0.3)	3.4 (0.3)	0
$1-5 million	5 (4.7)	152.2 (3.4)	10.0 (1.3)	13.2 (0.3)	201.3 (4.1)	52.1 (4.1)	0
$5 10 million	4 (3.8)	77.5 (1.7)	17.0 (2.3)	30.0 (0.7)	119.0 (2.4)	30.8 (2.4)	0
$10-25 million	4 (3.8)	130.5 (2.9)	18.5 (2.4)	71.5 (1.8)	170.9 (3.5)	44.2 (3.5)	0
Over $25 million	9 (8.5)	631.4 (14.1)	171.3 (22.1)	1,163.1 (28.0)	646.4 (13.1)	167.3 (13.1)	0
82 INDIRECT DISCHARGERS							
Plants with Revenues:							
Less than $1 million	12 (11.3)	95.5 (2.1)	5.0 (0.6)	6.4 (0.2)	174.1 (3.5)	45.1 (3.5)	1
$1-5 million	19 (17.9)	244.6 (5.5)	25.6 (3.3)	63.0 (1.6)	422.3 (8.6)	109.5 (8.6)	0
$5-10 million	14 (13.2)	346.5 (7.7)	51.1 (6.6)	93.2 (2.3)	484.3 (9.8)	125.3 (9.8)	0
$10-25 million	7 (6.6)	218.8 (5.0)	38.8 (5.0)	117.6 (2.9)	296.1 (6.0)	76.6 (6.0)	0
Over $25 million	30 (28.3)	2,573.7 (57.5)	435.9 (56.4)	2,487.3 (61.5)	2,404.1 (48.7)	622.2 (48.7)	0
TOTAL	106	4,473.3	774.6	4,043.9	4,931.6	1,276.5	1

Product Groups	Treatment Level 2 Investment ($000)	Treatment Level 2 Annual ($000)	Treatment Level 2 Closures	Treatment Level 3 Investment ($000)	Treatment Level 3 Annual ($000)	Treatment Level 3 Closures	Treatment Level 4 Investment ($000)	Treatment Level 4 Annual ($000)	Treatment Level 4 Closures	Treatment Level 5 Investment ($000)	Treatment Level 5 Annual ($000)	Treatment Level 5 Closures
TOTAL 106 SAMPLE PLANTS												
Plants with Revenues:												
Less than $1 million	1,627.4 (7.6)	530.5 (4.9)	11	1,606.2 (7.4)	551.6 (4.9)	11	1,727.6 (6.3)	564.8 (4.4)	11	1,727.3 (6.0)	577.8 (4.4)	11
$1-5 million	4,292.9 (20.0)	1,550.0 (14.0)	10	4,550.6 (20.1)	1,614.5 (14.2)	10	4,860.4 (17.7)	1,708.8 (13.4)	10	5,117.5 (17.9)	1,765.3 (13.5)	10
$5-10 million	4,007.2 (4.2)	1,557.3 (2.8)	0	4,212.8 (18.6)	1,602.6 (14.1)	0	4,596.4 (16.7)	1,716.1 (13.5)	0	4,801.6 (16.8)	1,761.1 (13.6)	0
$10-25 million	1,957.9 (9.1)	900.2 (8.1)	0	2,100.6 (9.3)	931.7 (8.2)	0	2,552.5 (9.3)	1,062.9 (8.3)	0	2,694.3 (9.4)	1,096.0 (8.4)	0
Over $25 million	9,564.9 (44.6)	6,543.6 (59.0)	0	10,123.7 (44.6)	6,667.2 (58.7)	0	13,761.1 (50.)	7,708.0 (60.4)	0	14,316.2 (49.9)	7,838.2 (60.1)	0
24 DIRECT DISCHARGERS												
Plants with Revenues:												
Less than $1 million	116.7 (0.5)	30.9 (0.1)	1	116.7 (0.5)	30.9 (0.3)	1	116.7 (0.4)	39.3 (0.3)	1	57.6 (0.2)	39.3 (0.3)	1
$1-5 million	1,112.5 (5.2)	459.9 (4.1)	2	1,166.1 (5.1)	471.6 (4.2)	2	1,282.9 (4.7)	506.2 (4.0)	2	1,336.4 (4.7)	518.0 (4.0)	2
$5 10 million	899.3 (4.2)	315.1 (2.8)	0	965.5 (2.9)	325.2 (2.9)	0	1,174.3 (4.3)	390.6 (3.1)	0	1,220.4 (4.3)	400.0 (3.1)	0
$10-25 million	630.9 (2.9)	320.1 (2.9)	0	685.0 (3.0)	332.0 (2.9)	0	787.3 (2.9)	362.6 (2.8)	0	841.1 (2.9)	374.4 (2.9)	0
Over $25 million	1,364.6 (6.4)	1,292.1 (11.6)	0	1,459.0 (6.4)	1,313.6 (11.6)	0	2,270.0 (8.3)	1,550.1 (12.1)	0	2,366.1 (8.2)	1,571.4 (12.1)	0
82 INDIRECT DISCHARGERS												
Plants with Revenues:												
Less than $1 million	1,510.7 (7.0)	499.6 (4.5)	10	1,569.5 (6.9)	512.7 (4.5)	10	1,610.9 (5.9)	525.5 (4.1)	10	1,669.7 (5.9)	538.5 (4.1)	10
$1-5 million	3,180.4 (14.8)	1,090.1 (9.9)	8	3,304.5 (14.9)	1,142.9 (10.1)	8	3,577.5 (13.0)	1,202.6 (9.4)	8	3,781.1 (13.2)	1,247.3 (9.6)	8
$5-10 million	3,107.9 (14.5)	1,242.2 (11.2)	0	3,267.3 (14.4)	1,277.2 (11.2)	0	3,422.1 (12.5)	1,325.5 (10.4)	0	3,581.2 (12.5)	1,360.3 (10.4)	0
$10-25 million	1,327.0 (6.2)	580.1 (5.2)	0	1,415.6 (6.2)	599.7 (5.3)	0	1,765.2 (6.4)	700.3 (5.5)	0	1,853.2 (6.5)	719.6 (5.5)	0
Over $25 million	8,200.3 (38.2)	5,251.5 (47.3)	0	8,663.9 (38.2)	5,353.6 (47.1)	0	11,491.1 (41.8)	6,157.9 (48.3)	0	11,952.1 (41.7)	6,266.8 (48.1)	0
TOTAL	21,450.3	11,097.6	21	22,673.9	11,367.4	21	27,498.0	12,760.6	21	28,656.9	13,036.4	21

( ) Values in parentheses represent percentage of all plants

Source: JRB Associates estimates.

- $1 million to $5 million
- $5 million to $10 million
- $10 million to $25 million
- Over $25 million.

Table 7-2 shows that 38 of the 106 sample plants have less than $5 million in value of shipments of porcelain enameled products, and account for 11 percent of the total wastewater discharged and 5.3 percent of total porcelain enameling square footage. The annual compliance costs for these 38 "small" plants range between $210,000 (16.5 percent of the total for the 106 sample plants) at treatment level 1 to $2.3 million (18 percent of the total for the 106 sample plants) at treatment level 5. These observations are consistent with earlier observations that average compliance costs are greater per unit of production for small plants than for larger plants. All of the projected plant closures are among these "small" plants.

7.3 SMALL BUSINESS ANALYSIS BASED ON PLANT FLOW RATES

For purposes of developing water pollution regulations, plant wastewater flow rate is a reasonable definition of plant size, as flow rates often vary with production volume. Additionally, plant flow rate often correlates with pollutant volume, although there are some exceptions in this industry. Flow rate, therefore, serves as a reasonable measure of plant size both on economic and technological grounds.

Table 7-3 presents the distribution of the 106 porcelain enameling sample plants by plant flow rates for the number of plants, plant production, revenues, compliance costs and potential closures. The plant size categories are as follows:

- Plants with less than 30,000 liters per day (l/day)
- Plants with 30,000 to 60,000 l/day
- Plants with 60,000 to 100,000 l/day
- Plants with over 100,000 l/day.

TABLE 7-3. PLANT DISTRIBUTION BY FLOW RATES

Total 106 Sample Plants	Number of Plants	Flow Rate (000 GPD)	Annual Production (10 x sq.ft)	Annual Revenue ($ millions)	Treatment Level 1 Investment ($ 000)	Treatment Level 1 Annual ($ 000)	Treatment Level 1 Closures	Treatment Level 2 Investment ($ 000)	Treatment Level 2 Annual ($ 000)	Treatment Level 2 Closures	Treatment Level 3 Investment ($ 000)	Treatment Level 3 Annual ($ 000)	Treatment Level 3 Closures	Treatment Level 4 Investment ($ 000)	Treatment Level 4 Annual ($ 000)	Treatment Level 4 Closures	Treatment Level 5 Investment ($ 000)	Treatment Level 5 Annual ($ 000)	Treatment Level 5 Closures
Total 106 Sample Plants w/Flow Rate:																			
less than 30,000 l/day	29 (27.4)	91.2 (2.0)	84.9 (11.0)	276.6 (6.9)	330.0	87.7 (6.9)	1	3,279.0 (15.3)	1,149.7 (10.4)	10	3,422.2 (15.1)	1,181.4 (10.4)	10	3,505.6 (12.8)	1210.0 (9.5)	10	3,640.6 (12.7)	1,249.0 (9.6)	10
30,000-60,000 l/day	17 (16.0)	217.6 (4.9)	48.3 (6.2)	156.4 (3.8)	373.2 (7.6)	96.8 (7.6)	0	2,811.2 (13.1)	1,082.5 (9.8)	6	2,996.9 (13.2)	1,123.5 (9.9)	6	3,062.5 (11.1)	1,146.5 (9.0)	6	3,2767.4 (11.3)	1,187.3 (9.1)	6
60,000-100,000 l/day	12 (11.3)	266.1 (6.0)	61.4 (7.9)	181.6 (4.5)	410.4 (8.3)	106.2 (8.3)	0	2,400.8 (11.2)	951.5 (8.6)	1	2,547.6 (11.2)	983.8 (8.7)	1	2,881.8 (10.5)	1,082.0 (8.5)	1	3,027.8 (10.5)	1,114.0 (8.6)	1
over 100,000 l/day	48 (45.3)	3,898.1 87.2)	580.0 (74.9)	3,433.3 (84.9)	3,809.2 (77.2)	985.8 (77.2)	0	12,959.3 (60.4)	7,916.0 (71.3)	4	13,707.3 (60.5)	8,078.7 (71.1)	4	18,048.2 (65.6)	9,322.1 (73.1)	4	18,792.1 (65.4)	9,486.0 (72.8)	4
82 Indirect Discharge Plants w/Flow Rate:																			
less than 30,000 l/day	24 (22.6)	76.1 (1.7)	68.2 (8.8)	225.0 (5.6)	284.4 (5.8)	73.6 (5.8)	1	2,837.6 (13.2)	969.6 (8.7)	8	2,961.4 (13.1)	997.1 (8.8)	8	3,036.4 (11.0)	1,021.9 (8.0)	8	3,160.0 (11.0)	1,056.6 (8.1)	8
30,000-60,000 l/day	14 (13.2)	18.30 (4.1)	40.1 (5.2)	138.3 (3.4)	311.4 (6.3)	80.8 (6.3)	0	2,363.3 (11.0)	904.6 (8.2)	5	2,526.9 (11.1)	940.6 (8.3)	6	2,573.6 (9.4)	958.2 (7.5)	6	2,736.6 (9.5)	994.0 (7.6)	6
60,000 100,000 l/day	8 (7.6)	171.0 (3.8)	41.3 (5.3)	123.6 (3.1)	266.7 (5.4)	69.0 (5.4)	0	1,690.5 (7.9)	655.1 (5.9)	1	1,794.9 (7.9)	677.9 (6.0)	1	1,911.8 (7.0)	714.3 (5.6)	1	2,015.5 (7.0)	737.8 (5.7)	1
over 100,000 l/day	36 (34.0)	3,049.7 (68.2)	406.7 (52.5)	2,280.6 (56.4)	2,918.4 (59.2)	755.3 (59.2)	0	10,434.7 (48.7)	6,142.2 (55.4)	3	11,017.9 (48.6)	6,270.5 (55.2)	3	14,345.1 (52.2)	7,217.2 56.6)	3	14,925.5 (52.0)	7,344.9 56.3)	3
24 Direct Dischargers Plants w/Flow Rate:																			
less than 30,000 l/day	5 (4.7)	15.1 (0.3)	16.7 (2.2)	40.6 (1.2)	34.4 (1.1)	14.1 (1.1)	0	441.4 (2.1)	180.0 (1.6)	2	460.0 (2.0)	184.3 (1.6)	2	469.3 (1.7)	188.1 (1.5)	2	488.6 (1.7)	192.3 (1.5)	2
30,000-60,000 l/day	3 (2.8)	35.5 (0.8)	8.2 (1.1)	16.1 (0.4)	61.9 (1.3)	16.0 (1.3)	0	467.7 (2.1)	177.9 (1.6)	0	470.0 (2.1)	182.9 (1.6)	0	480.0 (1.8)	188.2 (1.5)	0	511.1 (1.8)	193.3 (1.5)	0
60,000-100,000 l/day	4 (3.8)	95.1 (2.1)	20.1 (2.6)	58.0 (1.4)	143.7 (2.9)	37.2 (2.9)	0	710.3 (3.3)	296.4 (2.7)	0	752.9 (3.3)	305.9 (2.7)	0	970.0 (3.5)	367.6 (2.9)	0	1,012.3 (3.5)	377.1 (2.9)	0
over 100,000 l/day	12 (11.3)	848.4 (19.0)	173.2 (22.4)	1,152.6 (28.5)	890.8 (18.1)	230.5 (18.1)	0	2,524.6 (11.8)	1,771.77 (16.0)	1	2,609.3 (11.9)	1,808.2 (15.9)	1	3,703.2 (13.5)	2,104.9 (16.5)	1	3,666.6 (13.5)	2,141.2 (16.4)	1
TOTAL	106	4,473.0	774.6	4,043.9	4,931.7	1,276.5	1	21,450.3	11,097.7	21	22,673.9	11,367.4	21	27,409.1	12,760.5	21	28,716.0	13,036.4	21

( ) Values in parentheses represent percentage of all plants

Source: JRB Associates estimates.

Table 7-3 indicates that over 40 percent (46 plants) of 106 sample plants discharge less than 60,000 l/day. These "small" plants account for approximately 7 percent of total wastewater discharged and about 17 percent of total porcelain enameled square footage. Annual compliance costs for these 42 plants vary between $184,500 (14.5 percent of total industry annual compliance costs) at treatment level 1 and $2.4 million (18.7 percent of total industry costs) for treatment level 5. Sixteen of the "small" plants are projected to close at treatment levels 2 to 5.

Small plants may also be defined in terms of flow rate <u>and</u> a measure of production volume such as metal preparation surface area. Table 7-4 presents a summary of the key parameters based on "small" plants defined as plants with less than 60,000 l/day flow rate <u>and</u> with less than 1,600 m^2 metal preparation per day. This table shows that the such defined 38 "small" indirect discharge plants account for 5.8 percent of total industry wastewater discharged and 14.8 percent of the annual compliance costs at treatment level 5. Fourteen of the projected plant and line closures at treatment levels 2 to 5 are among these "small" indirect discharge plants.

Table 7-5 summarizes the projected potential closures by plant size and discharge status. Comparing the results for indirect and direct dischargers indicates that the potential plant and line closures are concentrated among the "small" indirect dischargers (as defined by both flow rate and production volume).

7.4 SUMMARY OF SMALL BUSINESS ANALYSIS

The following general conclusions are drawn from the above discussion:

- Some categories contain primarily small plants (e.g., job shops and cookware) while others contain primarily large plants (e.g., dishwashers)

TABLE 7-4. SMALL BUSINESS ANALYSIS BASED ON EPA DEFINITION OF SMALL PLANTS[a/]

	All 116 Plants	"Small" Plants[a/] Indirect	Direct
Number of Plants	116	38 (32.8)	6 (5.2)
Flow Rate - 000 gpd	4,628.1	268.5 (5.8)	38.3 (0.8)
Production[b/] - million sq.ft.	774.6[b/]	38.3 (4.9)	9.1 (1.1)
Value of Shipments[b/] - $ million	4,043.9[b/]	122.2 (3.0)	18.1 (0.4)
Investment Costs - $000			
Treatment Level 1	5,170.4	607.6 (11.8)	88.9 (1.7)
Treatment Level 2	23,242.8	5,355.2 (23.0)	611.1 (2.6)
Treatment Level 3	24,544.8	5,641.5 (23.0)	633.4 (2.6)
Treatment Level 4	29,487.3	5,752.6 (19.5)	658.1 (2.2)
Treatment Level 5	30,783.6	6,057.9 (19.7)	680.4 (2.2)
Annual Costs - $000			
Treatment Level 1	1,338.3	157.5 (11.8)	23.0 (1.7)
Treatment Level 2	11,803.5	1,869.9 (15.8)	235.7 (2.0)
Treatment Level 3	12,090.6	1,937.5 (16.0)	240.8 (2.0)
Treatment Level 4	13,520.3	1,976.2 (14.6)	248.0 (1.8)
Treatment Level 5	13,813.5	2,043.6 (14.8)	253.0 (1.8)
Closures (Plants and Line)			
Treatment Level 1	1		0
Treatment Levels 2-5	22	14	2
Employees Affected by Closures			
Treatment Level 1	2	2	0
Treatment Levels 2-5	488	339	38

( ) Values in parentheses represent percentage of all plants

[a/] "Small" plants defined as plants with less than 60,000 l/day flow rate <u>and</u> less than 1,600 m^2/day metal preparation.

[b/] Production and value of shipments reflect 106 plants only.

TABLE 7-5. SUMMARY OF PLANT AND LINE CLOSURES FOR SMALL PLANTS[a/]

	Indirect Dischargers			Direct Dischargers		
	All Plants	Large Plants	Small Plants	All Plants	Large Plants	Small Plants
Number of Plants	88	50	38	28	22	6
Number of Closures						
Plant Closures	8	2	6	1	0	1
Line Closures	10	2	8	2	1	1
All Closures	18	4	14	3	1	2
Closure Rate (percent of all plants)						
Plant Closures	9	2	7	4	0	4
Line Closures	11	2	9	7[b/]	4	4
All Closures	20[b/]	5[b/]	16	11	4	7[b/]
Employees affected from						
Plant Closures	295	53	242	8	0	8
Line Closures	134	37	97	51	21	30
All Closures	429	90	339	59	21	38

[a/] "Small" plants defined as plants with less than 60,000 l/day flow rate <u>and</u> less than 1,600 m^2/day metal preparations.

[b/] Do not add up due to rounding errors.

Source: JRB Associates estimates.

- Most of the projected closures are small plants (under one criteria--value of shipments--all closures are "small" plants)
- The compliance cost per unit of output is generally higher for smaller than for larger plants
- The number of plants involved varies with the definition of "small."

8. LIMITATIONS TO THE ACCURACY 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.

8.1 DATA LIMITATIONS

The major assumptions and estimates made in the economic impact analysis are related to the data used for the analyses. Of primary importance are assumptions and estimates relating to the compliance cost estimates, plant-level production and financial variables estimates, and the production levels used in the analysis.

A critical data input to this study is the compliance cost estimates. The assumptions relating to the estimation of compliance costs are outlined in the technical Development Document and summarized in Chapter 5 of this report. However, throughout this study, an effort was made to evaluate and update the cost estimates whenever possible. For example, original EPA estimates used a 10 percent interest rate and, indeed, at the early stages of the study that figure seemed plausible. However, recent high interest rate levels and limitations on the availability of industrial revenue bond funding suggest that a higher interest rate should be used. For these reasons EPA compliance cost estimates were revised for purposes of this analysis to assume a 16 percent rate of interest.*

Since no industry survey was conducted to collect plant-specific financial data, much of the data used in this report had to be estimated and/or extrapolated from public sources. The limitations of major assumptions made in the estimating and extrapolating of these data are outlined below:

- The production rates reported to EPA measured production in terms of square feet enameled. These figures had to be adjusted to reflect the square footage of metal coated on one side so that the square footage figures of porcelain enameling production could be converted to product units.

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*Assume cost of borrowing money is 2 to 3 percent above prime rate projected by Data Resources, Inc. to be about 13 percent in 1983-1984.

- Estimates of average square feet of porcelain enameling per unit and average manufacturer's price per unit were used to derive projected plant revenue estimates from the adjusted porcelain enamel production volumes.
- Average product group financial and operating characteristics such as profit margin, asset turnover (i.e., sales to assets ratio) and capital structure were used in the economic impact analysis. These financial characteristics were estimated based on published financial data of selected porcelain enameling companies and on survey data from 11 companies provided by the Porcelain Enameling Institute.

The third major data limitation in the analysis lies in the fact that only a single year's production data (1976) were collected. Multiple years production data would have enabled a more in-depth analysis, encompassing the cyclical nature of the industry. As shown in Figure 3-2, the 1976-1977 time period used for the production data 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. Section 8.3.2 in this Chapter presents the results of a sensitivity analysis on production levels. This sensitivity analysis responds to the limitation inherent in assuming current production levels will recover to the level at the time data was collected.

8.2 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 analyses.

8.2.1 Price Increase Assumptions

Because most product groups in the porcelain enameling industry exhibit characteristics of both competitive and non-competitive market behavior, it is assumed that the industry would adopt the pricing strategy described in Section 2.2 and would establish an industry-wide price increase which would maintain the industry's initial return on sales for each product group. Due to weak market conditions, it is assumed that architectural panel producers will not be able to raise their prices.

8.2.2 Profit Impact Assumptions

In studies where detailed, plant-specific data are available, potential plant closures can be identified by using discounted cash flow analyses. Using this approach, a judgment can be made about the ability of a plant to continue in business after compliance with effluent regulations, by comparing the discounted value of the plant's cash flow with the plant's estimated salvage value. The application of this approach requires plant-specific data on cash flows and salvage values, and since data at this level of specificity were not available for this study, this approach was not deemed to be practical. As an alternative method, profitability impacts were measured through the use of return on investment (assets) analysis. Although this financial ratio analysis is based upon accounting data and does not account for the time value of money, it is widely used in comparative financial analyses and is simple to apply.

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. As shown in Figure 3-2, the 1976-1977 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.

8.2.3 Capital Availability Assumptions

Because data on the current debt-equity position of many of the firms were not available, an analysis of impacts of compliance costs on debt service coverage could not be performed. Therefore, the capital investment requirements analysis was assessed through an evaluation of compliance investments in comparison to cash flow. 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.

8.3 SENSITIVITY ANALYSES

Two of the study's parameters, compliance costs and capital availability threshold, were varied to assess the sensitivity of the study's results to each of the parameters. The study's conclusions, as presented in Chapter 6, are based on the best estimates for each of these two parameters. The paragraphs below address the question of a change in these assumptions.

8.3.1 Compliance Cost Sensitivity Analysis

The major determinant of the economic impacts of the regulations is the cost of compliance. Comments received from industry sources express serious concern over the accuracy of the cost estimates. In response to this concern, the compliance cost estimates were revised to consider many of the industry comments. However, a comparison of the revised EPA estimates (which are used in the above analyses) with industry plant-specific estimates shows a discrepancy of 20 to 30 percent still exists. For this reason, a 30 percent sensitivity analysis on the compliance costs was performed. The sensitivity analysis also accounts for site specific costs that cannot be explicitly identified in compliance cost estimates. Tables 8-1 and 8-2 present the results of this sensitivity analysis on profit and capital requirements. These tables show that at Treatment Level 5, six additional plants have significant profit impacts and five other have high capital requirements. However, only one additional steel sanitary ware plant is projected to close at Treatment Levels 2 through 5 and one additional job shop at Treatment Level 5. Both closures are line closures. The other plants with high profit impacts have after-compliance ROIs only slightly below threshold level and are expected to continue their operations. Meanwhile, the five plants with high capital requirements are owned by larger firms and would be able to obtain the required capital from their parent firms.

8.3.2 Plant Revenues Sensitivity Analysis

A sensitivity analysis based on 20 percent reduction in plants' baseline revenues (which represents approximately the decline in porcelain enameled product shipments between 1976 and 1981) was performed to estimate the incremental capital requirements impacts. This sensitivity analysis assumes

TABLE 8-1. SUMMARY OF 30 PERCENT COST SENSITIVITY ANALYSIS - PROFIT IMPACT

Product Groups	Number of Plants in Sample	Number of Plants with After-Compliance Return on Investment less than Threshold				
		Level 1	Level 2	Level 3	Level 4	Level 5
Ranges	25	0	1	1	1	1
Home Laundry	9	0	0	0	0	0
Dishwashers	4	0	0	0	0	0
Hot Water Heaters	9	0	2 (+1)	2 (+1)	2 (+1)	2 (+1)
Refrigerators	2	0	0	0	0	0
Steel Sanitary Ware	9	0	3 (+2)	3 (+2)	4 (+3)	4 (+3)
Cast Iron Sanitary Ware	2	0	0	0	0	0
Cookware	11	1	4	4	4	4
Architectural Panels	11	0	4	5 (+1)	5 (+1)	5 (+1)
Job Shops	23	1	10 (+1)	10 (+1)	10 (+1)	10 (+1)
Barbecues	1	0	0	0	0	0
TOTAL	106	2	24 (+4)	25 (+5)	26 (+6)	26 (+6)

Source: JRB Associates estimates.

TABLE 8-2. SUMMARY OF 30 PERCENT COST SENSITIVITY ANALYSIS - CAPITAL REQUIREMENTS

Product Groups	Number of Plants in Sample	Number of Plants with CCI/Revenue Greater than Threshold				
		Level 1	Level 2	Level 3	Level 4	Level 5
Ranges	25	0	2 (+1)	2 (+1)	2 (+1)	2
Home Laundry	9	0	0	0	0	0
Dishwashers	4	0	1 (+1)	1 (+1)	1 (+1)	1
Hot Water Heaters	9	0	3 (+1)	3 (+1)	3 (+1)	3 (+1)
Refrigerators	2	0	0	0	0	0
Steel Sanitary Ware	9	0	6 (+2)	6 (+1)	7 (+1)	7 (+1)
Cast Iron Sanitary Ware	2	0	0	0	0	0
Cookware	11	2 (+1)	5 (+1)	5 (+1)	5 (+1)	5 (+1)
Architectural Panels	11	0	6 (+1)	6 (+1)	6 (+1)	6 (+1)
Job Shops	23	4 (+3)	18 (+3)	18 (+2)	18 (+1)	18 (+1)
Barbecues	1	0	0	0	0	0
TOTAL	106	6 (+4)	41 (+10)	41 (+8)	42 (+7)	42 (+5)

Source: JRB Associates estimates.

the event that the porcelain enamel industry sales would not recover from the current recession and would remain at the current level even as the economy improves.

In terms of capital requirements, a 20 percent decline in revenues affects an additional five to eight plants at Treatment Levels 2 to 5. The additional plants are noted by product group in Table 8-3. In terms of projected closures, however, there are only two cases where additional line closures might be indicated. Even with the assumed reduced level of revenues, both plants remain profitable after compliance. In terms of ability to raise capital, both plants exceeded the threshold criteria by a small amount. The conclusion of this analyses is a maximum of two additional product line closures. Neither plant has porcelain enameling as its only production activity.

8.4 SUMMARY OF LIMITATIONS

Although the above factors limit the quantitative accuracy of the impact assessments, sensitivity analysis indicates the results to be relatively consistent over a range of assumptions regarding complaince costs and industry demand conditions. Therefore, it is believed that the results of this study represent a valid industry-wide assessment of the economic impacts associated with effluent guideline control costs.

TABLE 8-3. SUMMARY OF 20 PERCENT REVENUE REDUCTION SENSITIVITY ANALYSIS

Product Groups	Number of Plants in Sample	Number of Plants with CCI/Revenue Greater than Threshold				
		Level 1	Level 2	Level 3	Level 4	Level 5
Ranges	25	0	2 (+1)	2 (+1)	2 (+1)	2
Home Laundry	9	0	0	0	0	0
Dishwashers	4	0	1 (+1)	1 (+1)	1 (+1)	1
Hot Water Heaters	9	0	3 (+1)	3 (+1)	3 (+1)	3 (+1)
Refrigerators	2	0	0	0	0	0
Steel Sanitary Ware	9	0	6 (+2)	6 (+1)	7 (+1)	7 (+1)
Cast Iron Sanitary Ware	2	0	0	0	0	0
Cookware	11	2 (+1)	5 (+1)	5 (+1)	5 (+1)	5 (+1)
Architectural Panels	11	0	6 (+1)	6 (+1)	6 (+1)	6 (+1)
Job Shops	23	3 (+2)	18 (+3)	18 (+2)	18 (+1)	18 (+1)
Barbecues	1	0	0	0	0	0
TOTAL	106	5 (+3)	41 (+10)	41 (+8)	42 (+7)	42 (+5)

Source: JRB Associates estimates.

APPENDIX A

CALCULATION OF PROFIT IMPACT THRESHOLD VALUE

APPENDIX A

CALCULATION OF PROFIT IMPACT THRESHOLD VALUE

To assess the impact of compliance on plant profitability, the plants' post-compliance return on assets (ROI) ratios were calculated and compared to a threshold value. The threshold value was set at a level that would generate to the stockholders/owners a return on the liquidation value of their investment (after taxes return on their equity) equal to the opportunity cost of other investment alternatives, which in this case is defined as the U.S. Treasury bond yield. The first step in relating the ROI threshold value and the opportunity return is the following equation:

$$\begin{aligned} \text{BTROI} &= \frac{\text{NPBT}}{\text{ASSETS}} = \frac{\text{NPBT}}{\text{EQUITY}} \times \frac{\text{EQUITY}}{\text{ASSETS}} \\ &= \text{BTROE} \times \frac{\text{EQUITY}}{\text{ASSETS}} \\ &= \text{ATROE} \times \frac{1}{(1 - t)} \times \frac{\text{EQUITY}}{\text{ASSETS}} \qquad (1) \end{aligned}$$

where

BTROI = Target before taxes return on assets

NPBT = Net profit before taxes

ASSETS = Asset book value

EQUITY = Equity book value

BTROE = Target before taxes return on equity

ATROE = Target after taxes return on equity

t = Average corporate tax rate.

Using the above equation, a projected U.S. Treasury bond yield (or target after taxes ROE) of 12 percent, corporate tax rate of 40 percent, and equity to assets ratio of 50 percent, the before taxes ROI threshold value would be 10 percent.

However, the liquidation value of a plant is generally a fraction of its book value. Assuming that the liquidation value is 85 percent of the book value, the liquidation value of stockholders' equity is only 85 - 50 = 35 or 35/50 = 70 percent of its value if liquidation value equaled book value:

	Percent
Asset book value	100
Asset liquidation value	85
Book value of equity	50
Debt	50
Liquidation value of equity (Assets liquidation value - debt)	35

As a result, a 12 percent return on equity book value (ATROE) would yield an effective ATROE on liquidation value of 17 percent (12 ÷ .70). That is,

$$\text{ATROE (effective)} = \text{ATROE}/(.70).$$

By similar reasoning, to get an effective ROE of 12 percent liquidation value requires an 8.4 percent ATROE (12 x .70). Based on equation (1), the corresponding before taxes ROI will be 7 percent (.084 ÷ (1 - .4) x 50/100 = .07).

Table A-1 presents estimates of profit impact threshold values based on various assumptions on assets liquidation value and equity to assets ratio.

TABLE A-1. ESTIMATED ROI THRESHOLD VALUES THAT GENERATE 12 PERCENT ROE ASSUMING VARIOUS ASSETS LIQUIDATION VALUES AND EQUITY TO ASSETS RATIOS

CORPORATE TAX RATE: 40%

	Assets Liquidation Value (Percent of Book Value)						
Equity/Assets Ratio	60%	70%	75%	80%	85%	90%	100%
0.30	*	*	1.0	2.0	3.0	4.0	6.0
0.35	*	1.0	2.0	3.0	4.0	5.0	7.0
0.40	*	2.0	3.0	4.0	5.0	6.0	8.0
0.45	1.0	3.0	4.0	5.0	6.0	7.0	9.0
0.50	2.0	4.0	5.0	6.0	7.0	8.0	10.0
0.55	3.0	5.0	6.0	7.0	8.0	9.0	11.0
0.60	4.0	6.0	7.0	8.0	9.0	10.0	12.0
0.65	5.0	7.0	8.0	9.0	10.0	11.0	13.0
0.70	6.0	8.0	9.0	10.0	11.0	12.0	14.0

CORPORATE TAX RATE: 35%

	Assets Liquidation Value (Percent of Book Value)						
Equity/Assets Ratio	60%	70%	75%	80%	85%	90%	100%
0.60	4.3	6.0	6.8	7.7	8.5	9.4	11.1
0.65	4.6	6.5	7.4	8.3	9.2	10.2	12.0
0.70	5.0	7.0	8.0	8.9	9.9	10.9	12.9

APPENDIX B

ESTIMATION OF KEY FINANCIAL PARAMETERS

APPENDIX B

ESTIMATION OF KEY FINANCIAL PARAMETERS

This appendix describes the assumptions and methodology for estimating two key financial ratios used in the economic impact analysis: plant baseline assets to sales and return on sales (profit margin) ratios. Data used to estimate these two ratios are obtained from:

- A financial survey of eleven small porcelain emaneling companies conducted by the Porcelain Enamel Institute (PEI) in 1981
- Robert Morris Associates' (RMA) Statement Studies, 1981 edition
- Published corporate annual reports.

Tables B-1 to B-3 summarize the critical data items. The following paragraphs explain how the data are used in the analysis.

Table B-1 lists the 1976-1980 profit margins and assets to sales ratios as reported in the RMA's Statement Studies for the Metal Stampings industry (SICs 3465, 3466, 3469); Enameled Iron, Metal Sanitary Ware and Plumbing Supplies industry (SICs 3431, 3432); and Household Appliances industry (SICs 3631, 3632, 3633, 3634, 3635, 3636). It is assumed that:

- The 1976-1980 averages for Metal Stampings would represent the porcelain enameled cookware industry return on sales (profit margin) and assets to sales ratio. Architectural panels plants are also classified under this industry group; however, due to weak market conditions, the profit margin of architectural panels is assumed to be lower than that for cookware and is set to be 5 percent.

- The 1976-1980 average profit margin and assets to sales ratio for the Enamel Iron, Metal Sanitary Ware, and Plumbing Supplies industries would apply to the steel and cast iron sanitary ware plants.

For the home appliances industry (i.e., ranges, home laundry, dishwashers, hot water heaters, refrigerators, barbecues), average data for six companies with published financial data (three are primarily appliance manufacturers, and three are more diversified companies with financial data on their appliances line of product) were selected to represent the financial characteristics of the home appliances plants. These financial ratios are presented in Table B-2 and are consistent with the RMA's averages shown in Table B-1 for the Household Appliances industry group.

Table B-3 describes the financial profile of small porcelain enameling operations based on survey data collected by the PEI. Since porcelain enamel job shops are generally small operations, the financial ratios presented in Table B-3 are assumed to apply to the job shops.

TABLE B-1. SALIENT FINANCIAL RATIOS FOR SELECTED INDUSTRY GROUPS BASED ON ROBERT MORRIS ASSOCIATES DATA

	1976	1977	1978	1979	1980	1976-1980 Average
Metal Stampings (SICs 3465, 66, 69)						
Before Taxes Profit Margin (%)	6.50	6.70	6.40	6.60	4.30	6.10
Total Assets to Sales	0.47	0.49	0.46	0.49	0.54	0.49
Enameled Iron, Metal Sanitary Ware, and Plumbing Supplies (SICs 3431, 32)						
Before Taxes Profit Margin (%)	6.30	7.40	6.80	5.10	4.40	6.00
Total Assets to Sales	0.59	0.58	0.60	0.57	0.61	0.59
Household Appliances (SICs 3631, 32, 33, 34, 35, 36)						
Before Taxes Profit Margin (%)	5.50	8.40	5.20	6.70	8.10	6.80
Total Assets to Sales	0.53	0.57	0.56	0.51	0.64	0.56

SOURCE: Robert Morris Associates, Statement Studies, 1981 Edition.

TABLE B-2. FINANCIAL RATIOS FOR SELECTED HOME APPLIANCE MANUFACTURERS

	Before Taxes Profit Margin[a] (%)	Total Assets to Sales[a]
Hobart Corp.	9.2	0.67
Magic Chef, Inc.[b]	7.3	0.50
Roper Corp.[b]	2.8	0.36
Tappan Co.	3.7	0.50
Whirlpool Corp.[b]	9.0	0.45
White Consolidated Industries, Inc.[b]	3.2	0.53
Average	5.9	0.50

[a] 1978-1980 averages, except for Roper (1979-1981), Whirlpool and Hobart (1977-1979).

[b] Home appliances product line only.

SOURCE: Corporate Annual Reports.

TABLE B-3. FINANCIAL CHARACTERISTICS OF SMALL PORCELAIN ENAMELING FIRMS

Operating Profit (percent of sales)	
Before Taxes Gross Profit Margin	17.9[a/]
Interest Expenses	3.4[b/]
Other Overhead Expenses	7.5[c/]
Before Taxes Profit Margin	7.0
Total Assets to Sales	0.54[a/]

[a/] 1978-1980 averages as reported in PEI's financial survey.

[b/] Assume 18.15% interest rate on average current and long-term liabilities at beginning and end of year as reported in PEI's financial survey (1980).

[c/] 1976-1980 average depreciation, lease, and rental expenses, and officers' compensation for Metal Stampings industry (SICs 3465, 3466, 3469) as reported in Robert Morris Associates' Statement Studies, 1981 Edition.

SOURCES: Porcelain Enamel Institute, 1981 Financial Survey.
Robert Morris Associates, Statement Studies, 1981 Edition.

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