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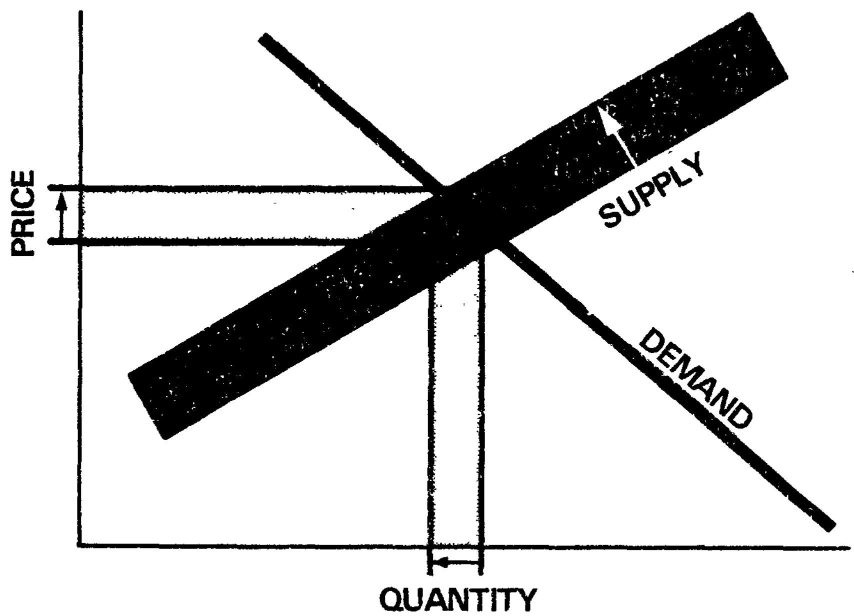
Economic Analysis of Proposed Effluent Standards and Limitations for the Metal Finishing Industry



ECONOMIC ANALYSIS OF PROPOSED
EFFLUENT STANDARDS AND LIMITATIONS
FOR THE METAL FINISHING INDUSTRY

Prepared for:

Office of Water Regulations and Standards
U.S. Environmental Protection Agency
Washington, D.C. 20460

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PREFACE

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

The study supplements the technical study ("EPA Development Document") supporting the proposal of regulations under the Act. The Development Document surveys existing and potential waste treatment control methods and technology within particular industrial source categories and supports proposed limitations based upon an analysis of the feasibility of these limitations in accordance with the requirements of the Act. Presented in the Development Document are the investment and operating costs associated with various alternative control and treatment technologies. The attached document supplements this analysis by estimating the broader economic effects which might result from the required application of various control methods and technologies. This study investigates the effect of alternative approaches in terms of price increases, effects upon employment and the continued viability of affected plants, effects on production, and other competitive effects.

The study has been prepared with the supervision and review of the Office of Analysis and Evaluation of the EPA. This report was submitted in fulfillment of Contract No. 68-01-6214 by Booz, Allen & Hamilton. This report reflects work completed as of August 1982.

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

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I. EXECUTIVE SUMMARY

1. INTRODUCTION

This report presents the economic impacts of BPT/BAT and PSES/PSNS Water Pollution limitations and standards on the Metal Finishing Industry. This study was prepared under the supervision of the Office of Analysis and Evaluation, U.S. Environmental Protection Agency. As required by the Clean Water Act, this study presents for consideration the economic impacts of regulations proposed which would control the industry's discharge of its effluents. Specifically this report includes:

- The economic characteristics and size of the Metal Finishing Industry
- Derivation of compliance costs
- Economic impact methodology
- Economic impacts on the Metal Finishing Industry due to the additional costs of meeting the regulations
- Analysis of new sources
- Regulatory Flexibility Analysis
- Estimates of social costs.

This Executive Summary presents a brief discussion of the following:

- Industry structure and characteristics
- Derivation of compliance costs
- Economic impact methodology
- Economic impacts
- Limits of the analysis.

The study is based on data from various sources, including a 1976-77 Survey of the Metal Finishing Industry, Dun and Bradstreet's Market Identifiers File, the Permit Compliance System (PCS) File and the 1977 Census of Manufacturers.

2. INDUSTRY STRUCTURE AND CHARACTERISTICS

The Metal Finishing Industry is divided into two segments: job shops and captives. The job shops are mostly small, privately-owned operations classified as SIC's 3471 and 3479 by the Standard Industrial Classification Manual. 300 of the estimated 5500 job shops are forecasted to be affected by the BATEA regulations. The remainder of the job shops are either indirect dischargers, and subject to earlier pretreatment regulations, or they do not perform regulated operations. The 300 job shop plants accounted for $300 million in sales in 1980 and employed 7200 people. The job shop segment is competitive, with a 4-firm concentration ratio of 7.2 percent in SIC 3471 and 15.1 percent in SIC 3479.

The captive segment of the Metal Finishing Industry is comprised of plants or production centers found within manufacturing firms who provide metal finishing services to the parent company. There are an estimated 10,000 captive plants that will be covered by these effluent guidelines, 7500 indirect dischargers and 2500 direct dischargers. Captive metal finishing operations occur in an estimated 150 four digit SIC's and vary in size from $.5 million to over $100 million in sales. Further, captive plants vary with respect to the relative importance of their metal finishing operations and the degree with which they provide finishing services to outside customers. Plants range from those which metal finish all of their own goods to those which occasionally finish in-house goods, and take in finishing work from other producers. The total value of shipments of the captives is estimated at $140 billion, shipments of just the metal finished goods is on the order of $76 billion, and total employment in captive plants is 6.5 million. Metal finishing process employment is estimated at 0.6 million. [Exhibit I-1 on the following page contains summary data on the industry.]

3. REGULATORY OPTIONS

The Agency evaluated two regulatory options for existing industrial sources. A third option was also evaluated for new sources. Each option sets a compliance standard and, where applicable, assigns the following pollution abatement equipment:

- Option I equipment includes:
  - Chemical oxidation unit
  - Reduction converter
  - Clarifying units
  - Sludge drying beds.

EXHIBIT I-1

Characteristics of the Regulated Metal Finishing Universe

	Job Shops			Captives		
	I. Disch.	D. Disch.	Total	I. Disch.	D. Disch.	Total
Number of Plants	2,700*	300	3,000	7,500	2,500	13,000
Value of Ship ments (Billions 1980 $)	-	0.33	0.33	106.0	34.8	141.1
Total Employment (000)	-	7.2	7.2	4,900	1,640	6,547
Employment in Metalfinishing Process (000)	-	7.2	7.2	450	150	607

* Will not be affected by this regulation.

- Option II equipment includes all of the equipment necessary to meet Option I with the addition of a Multimedia Filtration Unit.

- Option III equipment includes all of the equipment necessary to meet Option I plus in-plant controls on cadmium.

4. DERIVATION OF COMPLIANCE COSTS

The Agency generated costs for both the direct and indirect dischargers. Different methods for applying the costs were developed for job shops and captives. Each is discussed below.

(1) JOB SHOP PLANT COSTING

Plant process information from the 1976-77 Survey of Metal Finishers on 28 direct discharging job shops was submitted to the technical contractor. In this fashion each plant could be run through the technical contractor's cost generating program for each Regulatory Option. Information existed on such parameters as:

- plant flow
- flow constituents
- plant layout
- materials finished
- hours of operations
- finishing processes
- amperage, thickness of plate
- pollution control equipment in place
- tooling, piping
- construction, laboratory costs.

(2) CAPTIVE PLANT COSTING

Information on captive plants' processes was not available from the 1976-77 Survey of Metal Finishers. As a result the determination of the expected water pollution control expenditures was performed by taking the following steps:

- The technical contractor accumulated manufacturing process data on a sample of 100 direct discharging captives and 100 indirect discharging captives.

- Each plant in the sample was costed by the technical contractor using its costing program.

- The cost data was then grouped and classified according to water use and discharge category.

- In the calculation of the baseline and Option II costs, the 1087 captive plants from the 1976-77 Survey of Metal Finishers, for which water use figures were available, were grouped by metal finishing water usage and then individually matched with the technical contractor's cost estimates.

- For the computation of the cost of the metal finishing flow only, the technical contractor costed the metal finishing flow and the electroplating flow of the integrated indirect discharging captive plants.* The electroplating flow costs were subtracted from the total metal finishing flow costs to obtain the cost of treating the metal finishing flow only. These plants were then matched with plants in the 1976-77 Survey data base according to water flow characteristics.

- In this fashion all model plants could be costed and results extrapolated to the 7500 indirect discharging plants and 2500 direct discharging plants.

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* Amongst the indirect dischargers, EPA drew a distinction between "integrated" and "non-integrated" plants. Integrated plants are those whose metal finishing processes include both electroplating and non-electroplating processes. Non-integrated plants have only electroplating processes. The 1979 Electroplating Pretreatment Standards regulate all electroplating processes in metal finishing plants. These proposed metal finishing guidelines, which regulate electroplating processes at more stringent levels than the 1979 Guidelines, will have an incremental cost impact only on integrated plants. The pollution control technology basis for the 1979 Standard is the same as that prescribed for this proposed regulation. It is therefore sufficient for compliance with the proposed metal finishing regulation without any additional investment.

(3) NEW SOURCE PERFORMANCE STANDARDS/PRETREATMENT STANDARDS FOR NEW SOURCES

New Source Performance Standards/Pretreatment Standards for New Sources were estimated for new source metal finishers that will need in-plant cadmium controls. The cadmium controls will result in an additional annual compliance cost of between $17,800 and $24,000 (in 1980 dollars) per plant. These costs are not expected to have adverse competitive impacts. A more detailed analysis is presented in chapter IX.

5. ECONOMIC IMPACT METHODOLOGY

As in costing, two different analyses were developed for each industry segment. Each method is presented below.

(1) JOB SHOPS

The economic impact analysis for the job shops consisted of a financial assessment of the 28 model plants and their capacity to handle the incremental cost of the capital investment.

Estimated BATEA costs and a linked price increase that passes through these costs to customers are used to calculate new financial statements for each model plant. These statements forecast what the firm's financial performance would be in the first year after a BATEA investment. A closure is a plant that would close either because of inadequate cash flow to support a bank loan to purchase the BATEA equipment or from inadequate profits to the owners. Plants with a coverage ratio (which basically is projected cash flow divided by scheduled loan repayments) of less than 1.5 are deemed closures in this analysis.

(2) CAPTIVE ANALYSIS

The analysis of the economic effects on captives of the investment in pollution control equipment is based upon considerations of both changes in plant costs and industry-wide changes in price. Throughout the analysis two key assumptions are made:

- A captive operation owned wholly or in part by a parent operation experiences no significant capital availability problems.

- The demand curve facing the industry is inelastic. This means that all cost increases will be passed on to consumers in the form of price increases.

Firms which will experience much higher relative cost increases than the industry average or price leaders in the industry will not be able to raise prices sufficiently to fully recover their added cost. The closure routine identifies those captive firms which are candidates to close or divest their metal finishing operations because they are unable to change prices sufficiently to fully recover the costs of pollution control. The flow chart on the next page illustrates the plants' closure logic.

6. ECONOMIC IMPACTS

The estimated economic impacts of the regulations are significantly different for Option I compliance levels and Option II compliance levels. Compliance with Option I standards will have very small effects on the metal finishing universe, while compliance with Option II will have a measurable impact. In both cases, the costs of complying with the 1979 Electroplating Pretreatment Standards were factored into the baseline conditions.

Exhibit I-3 shows that the total compliance burden of Option I is $271.0 million*. Only indirect discharging captives will have to make investment to comply with this regulation. Surveys** conducted by the Agency show that

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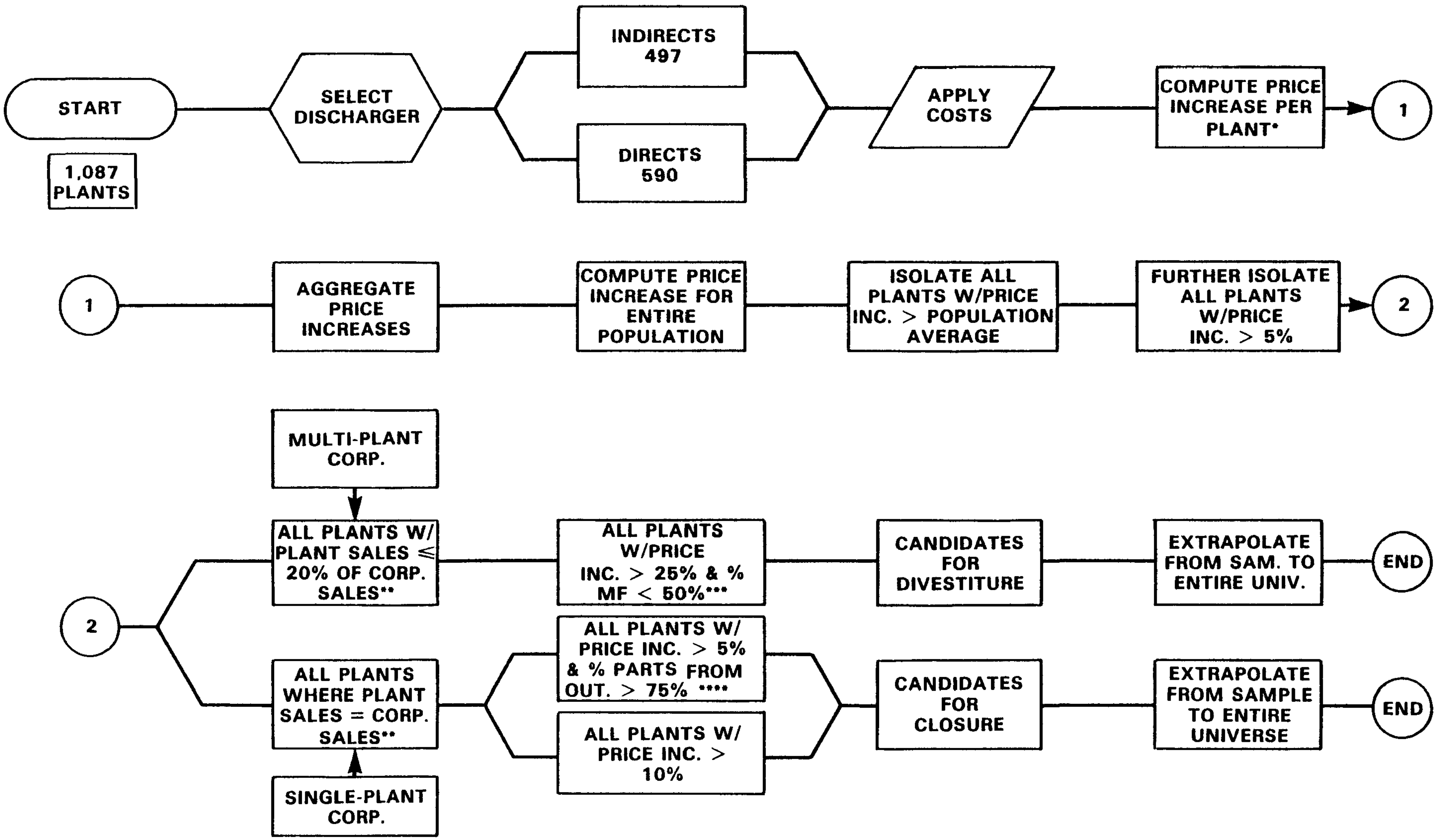
* This figure includes $26 million of investment in compliance with RCRA standards. These RCRA costs are incremental to a plants' total RCRA compliance requirements; i.e., they are attributable directly to compliance with the metal finishing effluent guidelines. The costs were derived through the technical contractor's solid waste disposal costing model.

** The results of the first survey are outlined in a July 30, 1981 memorandum from Mr. Richard Kinch to Mr. Art Berman. The second survey's sample design and selection procedure is described in an August 20, 1981 memorandum from Mr. Richard Kotz to Mr. David Pepson. The results of the survey are contained in a memorandum from Mr. Henry D. Kahn to Mr. David Pepson. The results of the last survey are described in a memorandum dated December 3, 1981 from Mr. Kinch to Mr. Berman.

EXHIBIT I-2

FLOWCHART OF THE CAPTIVE PLANTS CLOSURE ROUTINE



*Footnotes on following page.

*1. Price increase is computed as

$$\frac{\text{Annual Pollution Control Costs}}{\text{Value of Sales}}.$$

Due to lack of demand elasticity information, this computation does not reflect the projected increase in prices of metal finished goods. It is rather, an estimate of the necessary price increase to recover the costs of pollution control equipment and operations.

**2. Segmentation into multi-plant corporations and single plant corporations is due but not limited to the following reasons:

- Multi-plant corporations have greater access to capital due to their size
- The annual PCC for a plant which is part of a multi-plant firm is very small relative to the firm's value of sales
- Multi-plant firms' structure indicates an economic and/or financial advantage in having a captive metal finishing operation.

***3. All plants with a projected price increase of more than 25 percent where less than 50 percent of the products are metal finished. For these plants it would effectively mean that the cost of the metal finishing process will increase at least 50% in comparison with an industry wide price increase of less than 1%.

****4. This is a measure of the elasticity of demand facing the firm. The greater the percentage of parts from outside customers the more elastic the demand will be.

all direct dischargers and 84 percent of indirect discharging captives are in full compliance with Option I control levels. One reason for the high rate of equipment in place is that indirect dischargers are subject to earlier pretreatment regulations. Also, direct dischargers have to comply with state and regional standards. Exhibit I-4 shows that no plant closures, divestitures or employment losses are expected due to compliance with Option I. The estimated price increase is 0.2 percent.

Exhibits I-3 and I-4 summarize the estimated impacts of compliance with Option II. The total investment costs for the job shop sector is estimated at $13.2 million, while investment for captives will be slightly less than a billion dollars. Total job shop closures are estimated at 42 (14 percent) while captives are expected to shut down 29 (0.2 percent) establishments and divest of 10 more. A total of 2069 jobs would be lost due to Option II compliance requirements, with 1122 (15.6 percent) accounted for by job shops. The price increase in the job shop sector is calculated to be 4 percent, while in the captive sector it will be 0.5 percent.

EXHIBIT I-3

Total Capital Investment
And Annual Costs By Options
(In Million 1980 $)

Option I	Job Shops	Captives D.D.	Captives I.D.	Total
Investment Costs	0	0	271.0	271.0
Annual Cost	0	0	81.0	81.0
Option II				
Investment Cost	13.2	380.0	601.0	994.2
Annual Cost	4.0	114.0	180.0	298.0

EXHIBIT I-4

Estimated Impacts of Regulatory Compliance

Option I

	Job Shops	Captive D.D	Captive I.D	Total
Plant Closures	0	0	0	0
MF Divestiture	0	0	0	0
Employment Loss	0	0	0	0
Price Increase	0	0	0.2%	0.08%

Option II

	Job Shops	Captive D.D	Captive I.D	Total
Plant Closures	42	21	8	71
Plant Closures(%)	14	0.8	0.1	0.7
MF Divestiture	0	10	0	10
Employment Loss	1122	760	185	2067
Employment Loss(%)	15.6	0.04	0.05	0.04
Price Increase	4.0%	0.5%	0.5%	0.5%

II. INTRODUCTION

This chapter provides a brief overview of the content and direction of the report. It serves to highlight the rationale for the rule-making effort as well as the approach chosen for the industry analysis. To guide a review of the work the chapter deals with the following major issues:

- History of the metal finishing regulation
- Unique nature of the industry
- Organization of the economic impact analysis

1. THE REGULATION

The metal finishing industry has been affected by EPA pollution control regulations since 1973. The 1972 Clean Water Act (as amended) states:

- "By July 1, 1977, existing industrial dischargers were required to achieve effluent limitations requiring the application of the best practicable control technology currently available' ("BPT"), Section 301(b)(1)(A); and by July 1, 1983, these dischargers were required to achieve 'effluent limitations requiring the application of the best available technology economically achievable... which will result in reasonable further progress toward the national goal of eliminating the discharge of all pollutants' ("BAT"), Section 301(b)(2)(A).

- New industrial direct dischargers were required to comply with Section 306 new source performance standards ("NSPS"), based on best available demonstrated technology, and new and existing dischargers to publicly owned treatment works ("POTWs") were subject to pretreatment standards under Sections 307(b) and (c) of the Act. While the requirements for direct dischargers were to be incorporated into National Pollutant Discharge Elimination System (NPDES) permits issued under Section 402 of the Act, pretreatment standards were made enforceable directly against dischargers to POTWs (indirect dischargers)."

As with many regulatory initiatives there were court challenges, delays, revisions and negotiations in the course of promulgated regulations in final form. Pretreatment Guidelines for Electroplating were promulgated in September of 1979.

With revisions to the Clean Water Act (1977), Sections 301(b)(2)(a) and 301(b)(2)(C) of the Act now require the achievement by July 1, 1984 of effluent limitations requiring application of BAT for "toxic" pollutants, including the 65 "priority" pollutants and classes of pollutants which Congress declared "toxic" under Section 307(a) of the Act.

This body of work is the culmination of Agency efforts to define the costs and pollution control technologies appropriate for effluent limitations for existing sources after July 1, 1977, ("Best Practicable Control Currently Available") and after July 1, 1984 ("Best Available Technology Economically Achievable"). Levels of technology appropriate for pretreatment of wastewater discharges to POTW's from both new and existing sources were also identified.

2. THE INDUSTRY

For purposes of this regulation, the metal finishing industry consists of any manufacturing establishment performing one or more of the 44 unit operations -- one of which must be an Electroplating operation -- shown in Exhibit II-1 on the following page.

Two commercial sectors are most likely to perform these operations. One is the small, job shop covered under SIC (Standard Industrial Classification) 3471 and 3479. The other sector is any establishment producing a final good in which metal finishing is an intermediary step in the production cycle. Such establishments are called "captives" and are primarily associated with SIC's 34 through 39. The two sectors comprise the metal finishing industry. They are, however, structurally different, and different economic analyses are required for each:

- The job shop sector constitutes a definable industry (SIC's 3471/3479). It produces a final product which is metal finishing services. The captive sector is not an industry; rather it represents plants within which a metal finishing process is performed.

EXHIBIT II-1

Metal Finishing Category Unit Operations

UNIT OPERATIONS	
1.	Electroplating
2.	Electoless Plating
3.	Anodizing
4.	Conversion Coating
5.	Etching (Chemical Milling)
6.	Cleaning
7.	Machining
8.	Grinding
9.	Polishing
10.	Tumbling
11.	Burnishing
12.	Impact Deformation
13.	Pressure Deformation
14.	Shearing
15.	Heat Treating
16.	Thermal Cutting
17.	Welding
18.	Brazing
19.	Soldering
20.	Flame Spraying
21.	Sand Blasting
22.	Other Abrasive Jet Machining
23.	Electric Discharge Machining
24.	Electrochemical Machining
25.	Electron Beam Machining
26.	Laser Beam Machining
27.	Plasma Arc Machining
28.	Ultrasonic Machining
29.	Sintering
30.	Laminating
31.	Hot Dip Coating
32.	Sputtering
33.	Vapor Plating
34.	Thermal Infusion
35.	Salt Bath Descaling
36.	Sovlent Degreasing
37.	Paint Stripping
38.	Painting
39.	Electrostatic Painting
40.	Electroplating
41.	Vacuum Metalizing
42.	Assembly
43.	Calibration
44.	Testing

- A job shop faces a demand curve for its services while the demand curve facing captive metal finishers is for a final product. That is, the demand for metal finishing in captives is a derived demand for production inputs, rather than a primary demand for a specific good or service.

- The prices for job shop services are determined by the market. However, there are no market prices for captive metal finishers. The "prices" of metal finishing services performed by captives are determined by accounting procedures and are used for internal transfers alone.

Given the fundamental differences between the two sectors, two separate designs and methods were developed for the industry impact analysis.

3. ORGANIZATION

This report consists of ten chapters of which the third through the sixth represent the major substantive sections. In the third chapter the characteristics of the metal finishing universe are presented. This basically defines the object of the regulation. Chapter five presents the costs developed by the Agency's technical contractor coupled with the guidance from the Agency on such matters as prior investments in controls, degree of equipment in place and stringency of the regulatory scenarios. Chapters four and six are tightly linked with designing the methods for calculating impacts and displaying the estimates of resulting impacts on the industry. Subsequent chapters reflect all the added considerations of the regulatory review including:

- Social Costs
- Regulatory Flexibility
- New Source Performance Standards/Pretreatment Standards for New Sources

The report closes with a discussion of the possible limitations on the reliability or validity of the analysis.

III. CHARACTERISTICS OF THE METAL FINISHING UNIVERSE

1. INTRODUCTION

This description of the economic and financial characteristics of the metal finishing universe is organized on the basis of the two industry sectors, job shops and captives. Both job shops and captives are engaged in similar production activities, but face different economic variables. The job shop sector constitutes an industry and provides finishing services as a final product to outside customers. Job shops fall into the standard industrial classifications (SIC) of 3471 and 3479. The captive sector does not constitute an industry in the normal sense. Captives perform metal finishing operations as part of the production process and for the most part do not provide finishing services to outside customers as a final good. Further, captive operations occur in an estimated 150 four-digit SIC's, with metal finishing applied to hundreds of products. Products and markets for final goods are used as the basis for dividing the metal finishing universe into sectors since they are the focus of the economic activity affecting the universe. It is these economic considerations which will determine how the industry responds to increased effluent control costs. This chapter characterizes the two sectors of the metal finishing universe in terms of economic significance, size, financial strength and competitive structure.

2. JOB SHOP SECTOR

A metal finishing job shop is defined as a firm whose primary operations are classified as SIC's 3471 or 3479. There are an estimated 3000 firms performing regulated operations in these SIC's but 2700 are indirect dischargers and fall under an earlier pretreatment regulation. In general, job shops are small, owner-operated, single-plant firms that provide metal finishing services to outside customers. The job shop industry sector appears to be competitive with a four firm concentration ratio of 7.2 percent in SIC 3471 and 15.1 percent in

SIC 3479. The 1976-77 survey of the industry* indicated that the demand curve facing the industry is inelastic. The 424 owners surveyed reported that an average price increase of 10 percent did not have a measurable affect on quantity sold.

The average direct discharging job shop in 1980 had:

- Sales of $1,110,000
- Employment of 24, with 16 of these in production
- Water use of 1,630 gallons per hour.

The total job shop direct discharging population accounted for $330 million in sales, 7200 employees, and 468,000 gallons per hour. Exhibit III-1 below shows a classification of a representative sample of 28 direct discharging job shops by employment and sales.

EXHIBIT III-1

DIRECT DISCHARGERS CLASSIFICATION

	Sales (Thousands of 1980 Dollars)				
Employment	Under $250	$250 to 499	$500 to 999	$1,000 and up	Totals
1 to 4	1	2	0	0	3
5 to 9	1	3	1	0	5
10 to 19	0	3	0	2	5
20 to 49	0	0	3	7	10
50 to 99	0	0	0	4	4
100 to 249	0	0	0	1	1
Totals	2	8	4	14	28

From a financial standpoint job shops appear to be moderately profitable. Of the sample of 28 firms, 21 showed an average profit before taxes of $65,000 while 7 showed losses averaging $209,000 in 1980 dollars. (The

*U.S. Environmental Protection Agency, economic analysis of pretreatment standards for existing sources of the electroplating point source category. Information on the characteristics of the metal finishing universe was derived from the 1976-77 survey of the industry.

net average is a loss of $5,000.) A more important measure for small businesses, though, is provided by the return to a working owner. The average return to an owner is $19,000. Of the 28 firms, 24 show returns now to each owner averaging $47,000 while 4 show losses averaging $143,000 in 1980 dollars--although 2 of these 4 lost less than $20,000.

The average balance sheet for a direct discharger is shown in Exhibit II-2 below.

EXHIBIT III-2

Typical Direct Discharger Balance Sheet
(Thousands of 1980 Dollars)

Current Assets	$283	Current Liabilities	$194
Fixed and Other Long-Term Assets	320	Long-Term Debt	137
		Owners Equity (Net Worth)	272
Total Assets	$603	Total Liabilities	$603

3. CAPTIVE SECTOR

Captive metal finishing operations occur in approximately 150 four digit SIC's.* The Environmental Protection Agency estimates that 10,000** captive plants perform regulated processes. There are virtually hundreds of different products that are wholly or partially metal finished. Each one of these products has a unique price, demand, and demand elasticity. In the 1976-77 survey of captives it was found that 24 percent of the plants judge their in-house metal finishing contributes at least 10 percent of the final cost of the finished good. For 40 percent of the sample, metal finishing's contribution to the value of the finished good was less than 3 percent. In general, captives use metal finishing as part of the production process for the purpose of protecting the final product and/or enhancing it's aesthetic value.

Metal finishing application may occur in the same plant where the final good is produced, or the firm may use a specialized plant to provide finishing services to all its other plants. Captive plants that engage in metal

*Source - Products Finishing magazine.
**More detailed explanation follows in chapter IV.

finishing operations are rather large. One-sixth of all establishments (16.7 percent) have at least 1000 total employees, with 57 percent having between 100 and 999 men. An average of 60 people are employed in metal finishing activities, while only an average of 20 people are employed in actual finishing operations. The average sales of a captive plant is $14 million a year, while the average sales of the whole firm is more than $50 million a year. Exhibit II-3 below summarizes the major characteristics of the captive universe.

EXHIBIT III-3

Characteristics of the Captive Universe

	I. Disch.	D. Disch.	Total
Number of Plants	7,500	2,500	10,000
Sales (Billions $)	106.0	34.8	140.8
Total Employment (000)	4,900	1,640	6,540
Employment in Metal Finishing Process (000)	450	150	600
Total Process Water Use (BGD)	3.6	1.5	5.1
Total Metal Finishing Water Use (BGD)	1.5	0.6	2.1

Source: 1976-77 Survey of Metal Finishers.

IV. ECONOMIC IMPACT METHODOLOGY

1. INTRODUCTION

Two distinct impact methodologies were designed. One examines impacts on the job shop sector while the other analyzes the captive sector of the metal finishing universe. The rationale for this segmentation is summarized below:

- The job shop sector constitutes an industry (SIC's 3471/3479). It produces a final product which is metal finishing services. The captive sector is not an industry, but rather a metal-finishing process performed across 150 four-digit SIC's.

- A job shop faces a demand curve for its products while the demand curve facing a captive is for a final product. That is, the demand for metal finishing in captives is derived demand for production inputs.

- The prices for job shop services are determined by the market. However, there are no market prices for captive metal finishers. The prices of metal finishing services employed by captives are determined by accounting procedures and are used for internal transfers alone.

- The 1976-77 Survey of Metal Finishers provides an elaborate financial and economic data base for individual job shops and the entire job shop sector. The availability of data for the investigation of the captive sector was limited and the use of secondary data sources was extensive.

Due to the above reasons, the job shop impact methodology relied on the use of a capital budgeting model while the captive sector methodology is driven by price considerations.

2. JOB SHOP SECTOR METHODOLOGY

The job shop impact methodology centers around a plant closure model developed specifically for job shops in the metal finishing industry. The reason for pursuing a plant specific closure model is four-fold:

- Primary data on a large, representative sample of job shops had been gathered previously* and was judged still valid.
- Critical data on a plant's fiscal condition and financial performance had been obtained for a sizable number of respondents.
- Plants are known to be small and undercapitalized, making cash flow and liquidity key factors in their continued survival.
- Job shops can be defined as a discrete market and economic segment. Given that price rises can be computed directly and demand elasticity estimated reliably, a sound basis exists for forecasting the plants' direct response to incremental capital burdens.

Since the job shop sector is characterized by a large number of small, heterogeneous producers, the relevance of the impact methodology rests on meeting the following criteria:

- Primary surveys of plants and companies that establish the affected population and characterize accurately the industry's economic, fiscal and wastewater control position.
- Technical costing geared toward the unique conditions and needs of individual plants using cost and sizing rules that mirror the "real world".
- Estimation of candidates for closure based on an analysis of the price/cost impacts of the pollution control investment decision from the standpoint of owners, managers, competitors, customers, and lenders.

*Information gathered from the 1976-77 Survey of Metal Finishers.

- Extrapolation of sample plant impacts to the industry as a whole based on a defensible decision rule that reflects accurately the dynamics of the marketplace; e.g., baseline closures, attrition rates, induced closures and new entrants.

The closure model developed for the job shop metal finishers is a financially driven set of operational analyses designed to identify economically disadvantaged firms by virtue of:

- Limited capital access or
- Insufficient profits.

Determinations of which firms would close are based on projections of what the firm's financial standing would be one year after the pollution control investment was made. The basic premise is that those future conditions would be evaluated by:

- A banker to determine if he would lend the firm sufficient funds for the investment, or by

- The owner(s) to determine if sufficient profits are projected to make it worthwhile for him (them) to remain in business, or whether the state of the business warrants an investment of further funds--called an equity infusion--into the firm in order to secure a bank loan.

These closure determinations are predicted by the closure model based on pro forma balance and income statement forecasts and quantitative decision rules. The methodology is developed in six steps:

- Determination of allowable price increase, interest rates and lengths of loans

- Forecast of financial statements

- Coverage ratio test

- Equity infusion test

- Profitability test

- Classification of firms.

(1) Determination of Variable Values

Exhibit IV-1, on the following page, displays the data and variables used by the model and the abbreviations used in the equations. The model accepts as inputs from the user the five variables shown. The first four--the interest rate and length of loans--are input as numbers; the fifth variable--allowable price increase (PIC)--is a set of options including:

- Forecast price increase of respondent
- Average forecast price increase of respondents
- Cost pass through (CPT)
- Weighted cost pass through (CPTW).

Cost pass through is calculated as follows:

$$CPT = PCC\ (0.2 + I_p - .02) + PCO$$

Where the 0.2 reflects a 5 year depreciation schedule and the .02 a 5 year flow through (accounting term; the alternate method is capitalization) of investment tax credit.

Weighted cost pass through is the average of cost pass through of the respondents weighted by sales values as follows:

$$\frac{\sum_{i=1}^{28} CPT(i) \times SA(i)}{\sum_{i=1}^{28} SA(i)}$$

The cost pass through case is used to estimate price level changes. This assumes that each firm has sufficient market protection for that firm to pass its unique pollution control cost increase on to its customers; the aggregate industry-wide price increase, therefore, would be that of average cost producers.

(2) Forecast of Financial Statements

Two sets of equations are used to produce financial statements:

EXHIBIT IV-1

COMPUTERIZED FINANCIAL MODEL DATA AND VARIABLES

1. RESPONDENT PROVIDED DATA

Balance Sheet Data	Income Statement Data	Other Information
Current Assets (CA)	Depreciation (DEP)	Ownership
Fixed and Other assets (FA)	Sales (SA)	Forecast Maximum Allowable Price Increase (FPI)
	Owners Compensation (OC)	
Current Liabilities (CL)	Profit (Loss) Before Taxes (PBT)	Number of Owners Who Work Full Time
Long Term Debt (LTD)	Profit (Loss) After Taxes (PAT)	

2. ADDITIONAL INPUT/VARIABLE DATA

Inputs	Variables
Pollution Control Capital Cost (PCC)	Interest on Outstanding Debt (I)
Pollution Control Operating Costs (PCO)	Interest on Pollution Control Loan (IP)
	Remaining Length of Outstanding Debt (Y)
	Length of Pollution Control Loan (YP)
	Allowable Price Increase (PIC)

3. OUTPUTS

Coverage Ratio (cash flow divided by fixed obligations
Profit after tax as percentage of:

- Sales
- Total assets
- Net worth

Profit after tax plus owners compensation as:

- A percentage of net worth
- Dollar per owner who works full time

Financial ratios such as:

- Debt percent
- Current ratio

Equity infusion required per working owner

Closure Classification

- Current statements are prepared using the respondent's balance sheet--taken directly from the questionnaire--and supplemented by the calculations shown on Exhibit IV-2.

- Projected statements are prepared using the current balance sheet information and the input variables in the formulas shown in Exhibit IV-3.

(3) Coverage Ratio Test

The coverage ratio test is straightforward. If PCR is greater than or equal to 1.5, a firm is considered to be able to obtain a loan. This level is typical for small businesses with the owner's guarantee, but still represents a moderate level of risk to the banker. The 1.5 provides for some coverage of seasonal trends and temporary business down terms. If PCR is less than 1.5, then an equity infusion test is made.

(4) Equity Infusion Test

The amount of equity that the owner(s) would have to invest to qualify for a smaller loan, thus raising PCR to 1.5, is defined as the equity infusion (EI). An owner would invest EI and borrow PCC-EI. The test is that the owners would make the investment if they could maintain an income of 23,610* during the year of the investment and the loss in income for that one year would be less than one third the total, i.e., an equity infusion would be made:

$$\frac{(PPAT + OC - EI)}{WO} \geq \$23,610, \text{ and } \frac{EI}{PAT + OC} < 1/3$$

In cases where equity infusion was not possible, the above test was made using PCC instead of EI. Again, if the value were greater than $23,610, it was assumed that the investment would be made by the owners.

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* $15,000 was used as the cut-off in 1976. $23,610 adjusts $15,000 to 1980 dollars.

EXHIBIT IV-2

CURRENT FINANCIAL STATEMENTS

Using the respondent's questionnaire data and:

T = TAX RATE = 22% of first $75,000 of PBT
43% of PBT over $75,000

CF = CASH FLOW

CR = COVERAGE RATIO

The following current financial measures are calculated:

PAT = PBT (1 - T)

CF = PAT + DEP

CR = CF/(LTD/Y)

EXHIBIT IV-3

PROJECTED FINANCIAL STATEMENTS

Using current financial measures and input variables, projected income measures and a projected balance sheet are prepared; projected measures begin with a "P," e.g., Projected Depreciation is labeled PDEP.

1. PROJECTED INCOME MEASURES

PDEP = DEP + PCC/YP

PSA = SA(1 + PIC)

PPBT = PBT + SA(PIC) - PCC/YP - PCC x IP - PCO

PPAT = PPBT(1 - T) + PCC(.02)

PCF = PPAT + PDEP

PCR = PCF/(LTD/Y + PCC/YP)

2. PROJECTED BALANCE SHEET

PCA = CA

PFA = FA + PCC - PDEP

PCL = CL + BALANCE

PLTD = LTD + PCC - (LTD/Y + PCC/YP)

PNW = NW + PPAT

Where BALANCE = (LTD/Y + PCC/YP) - PDEP - PPAT, unless this causes PCL to be less than 0, in which case:

$$PCA_{(new)} = PCA_{(old)} - PCL_{(old)}$$

PCL = 0

(5) Profitability Test

No profitability test was incorporated into the model, but the following rule was used when examining matrices depicting either (PPAT + OC) or (PAT + OC) versus PCC, and (PPAT + OC) versus CR. A baseline closure is a firm that would close regardless of the pollution control investment because of poor pre-investment profitability, defined to be PAT + OC of less than $10,000 per working owner.

(6) Classification of Firms

As a result of the foregoing tests--all of which are incorporated into the model except for the profitability test--the firms are classified into categories.

- Non-closure, no equity infusion needed
- Non-closure due to equity infusion
- Candidate for closure due to lack of profitability
- Candidate for closure due to lack of capital access
- Vulnerable firm on pre-investment basis, i.e., baseline closure.

The relationship between the model plants and the universe of direct discharging job shops was established using variables and values provided from several sources. This analysis revealed that model plants show sufficient similarity to the universe to allow closures for the model plants to represent impacts in the universe on a directly proportional basis.

Development of the extrapolation rules entailed several sequential steps summarized as follows:

- The number of baseline closures (i.e., plants likely to close prior to BATEA investment) were estimated.
- The model plant data base was corrected for the baseline closures.

- Extrapolations from the model plant impacts to the corrected universe were conducted on a straight line basis.

The impact closure rate estimated by the closure routine was applied across the balance of job shops remaining after purging the universe of baseline closures. The rationale for this approach is that there is not sufficient sample data to support the development of a probability distribution from which unique closure probability estimates could be developed for selected plant characteristics, such as size, sales, water use, etc. Employing this technique does not alter the aggregate result, but may over-or underestimate the number of closures and primary economic impacts associated with a specific category of job shops.

3. CAPTIVE SECTOR METHODOLOGY

Economic analysis of the captive metal finishing universe is extremely complex. Captive metal finishing operations occur across 150 industries (four-digit SIC level). Each industry markets products which are different than products manufactured by other industries. Consequently, any one industry faces a unique demand curve for its products and a particular pricing structure. Moreover, the economic structure of different industries varies, especially degrees of competition and concentration ratios. In addition, individual firms within each industry face different demand elasticities than other firms in the same industry. There are well established empirical techniques for the investigation of markets and for estimating demand and demand elasticities, but there are several difficulties involved when the objective function is the market conditions for metal finished products:

- Output for metal finishing cannot be measured readily as it is not a final product; rather, it is an input into the production function with varying degrees of use in many final products.

- The prices of metal finished products vary with their final use. The price charged by any one firm will depend on:

  - The extent of price or non-price competition in the industry

- Types of manufacturing processes used

- The availability of substitutes

- The geographic distribution of the firm's customers and suppliers.

. In captive firms there is no market price for metal finishing since all output is for intermediate consumption.

. The elasticity of demand facing each firm will be different from the industry as a whole.

The analysis of the metal finishing industry is further complicated because individual firms process more than one product and use several types of metal finishing processes. Many firms can substitute between inputs, products and processes to meet external requirements. Any substitution between products can change total revenues as well as operating and capital costs. Moreover, a firm will not necessarily pass on cost to consumers in the products most affected by the cost increases; rather, it will increase costs according to the elasticities of demand. The more inelastic the demand the higher the probable price increase.

In general, there are three methods available for estimating the impacts of pollution control expenditures. They are the following:

. A plant specific, financially driven closure model that assesses the cash flow and profitability of the plant under two conditions: pre- and post-expenditures for pollution controls. Plants whose cash flows and equity positions cannot support the purchase are judged candidates for closure. This is essentially the method that was used for the analysis of the job shop metal finishers.

. A general industry model that estimates the ability of industries and individual firms to pass on the incremental direct costs associated with pollution control expenditures. These models rely on the knowledge of the following:

  - Concentration in the industry
  - General structure of the industry
  - Industry growth trends

- Prices of final goods
- Prices of inputs
- Production technology
- Substitute products.

In addition to the above, the analysis depends upon formulations of scenarios of demand elasticities and cross elasticities.

- A macro-economic approach which attempts to estimate the impact of the capital expenditures on the economy as a whole and derive values for the following variables:

  - Employment level in the economy
  - Price level [inflationary pressures]
  - Relative prices
  - Interest rates
  - Aggregate level of demand and supply
  - Capital availability.

None of the approaches cited above were used in their pure form in this analysis due to the following reasons:

- Plant specific financial or operating data do not exist for cases at the four-digit SIC level.

- With more than 150 four-digit SIC industries a sector analysis is not cost-effective.

- Adopting a macro approach similarly poses limitations for this analysis. Not only are the available macro models static, they often require input specifications for demand coefficients or price changes, the very factors one wishes to predict. Moreover, macro models are insensitive to small price changes (as is the case here) and thus their application is unwarranted.

The chosen approach is effectively a blending of methods; a modified microeconomic analysis which best satisfies the prevailing data constraints. This analysis relies on a large sample of plants (1087) for which key data requirements are available with the use of simplifying yet realistic assumptions. A comparative pricing model is applied to generate estimations of price changes, plant closure candidates, divestiture candidates, and employment effects.

The analysis of the effects of the pollution control expenditures on an individual plant is based upon considerations of, first, the projected change in the price level of the entire metal finishing universe required to offset the investment for pollution control equipment, and second, the ability of individual firms to change their own prices vis-a-vis universe-wide price changes. Due to the complexity of estimating demand elasticities in the metal finishing universe (described in detail above), it is assumed that markets for metal finished goods are competitive. Firms able to raise prices sufficiently to fully recover the costs of pollution control will experience negligible economic impact. The impacted firms are those unable to raise prices which are vastly different than the industry's average. That is, firms with a ratio of pollution control expenditures to total revenues which significantly exceed the industry average will not be able to raise prices by an amount (percent) equal to their added costs. These plants are singled out as impacted firms.

The plant impact model which is illustrated by the flow chart in Exhibit IV-4 on the following page identifies those captive firms which are candidates to close or divest their metal finishing operations because they are found to require price increases that are untenable in the marketplace. The following steps explain in some detail the logic of the model.

- The model is based on information available from the 1976-77 Survey of Metal Finishers from which key data is present for 1087 plants. It is important to note that the survey results do not classify the individual plants by SIC's.

- The sample of 1087 plants is divided into two groups by mode of discharge:

  - Direct dischargers (270 plants)
  - Indirect dischargers (817 plants).

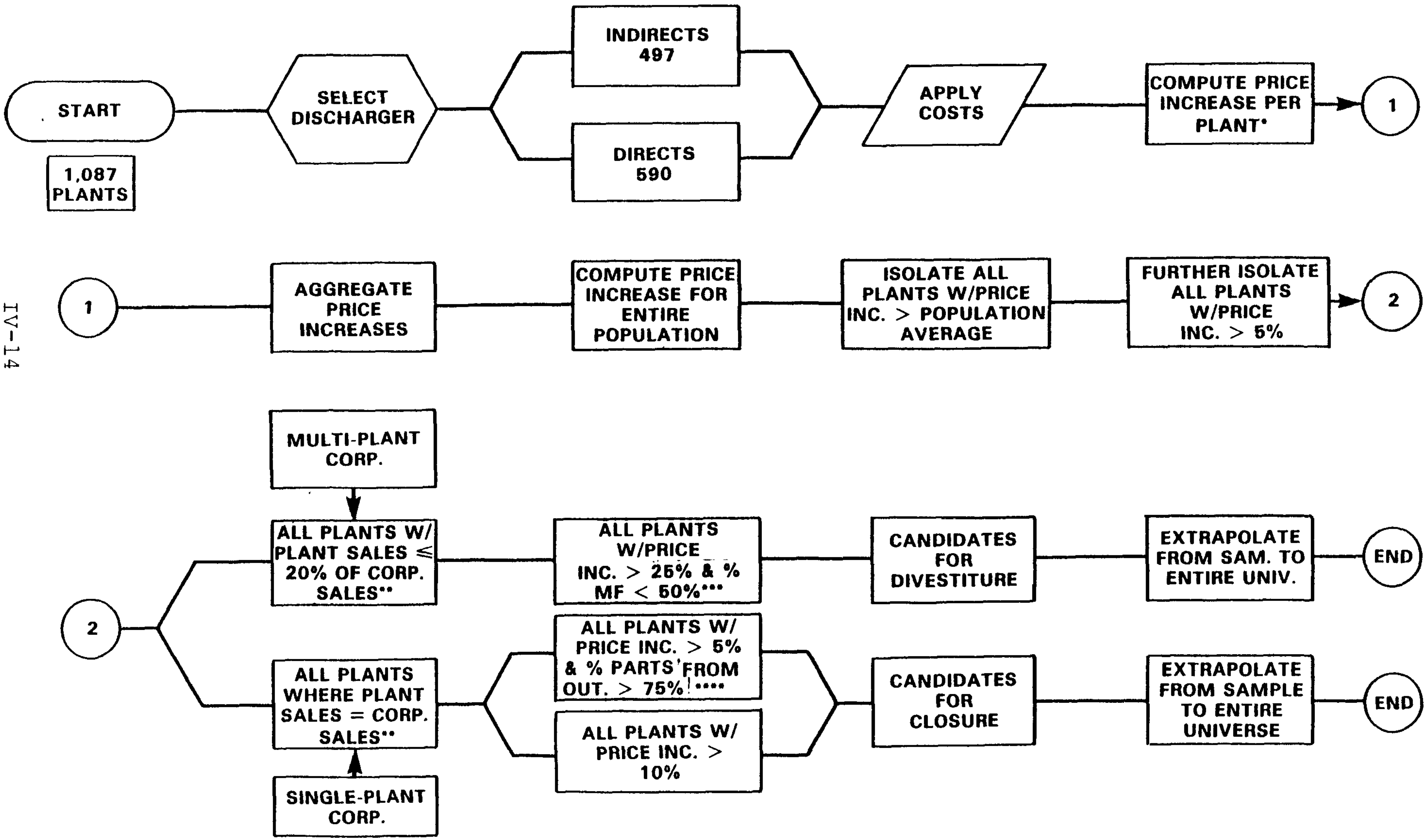
  The distinction is used to reflect the Agency's costing rules which assign different costs to direct and indirect discharging plants.

- Each plant's estimated capital pollution control expenditure obtained from the technical contractor is annualized* and divided by the plant's

* Annualization computations were based on information obtained from the 1976-77 survey of metal finishers. The calculations assumed a five-year depreciation schedule, a ten year asset life period, operating and maintenance costs of 12 percent of total investment costs, and an average cost of capital of 10 percent.

EXHIBIT IV-4

FLOWCHART OF THE CAPTIVE PLANTS CLOSURE ROUTINE



*Footnotes on following page.

*1. Price increase is computed as

$$\frac{\text{Annual Pollution Control Costs}}{\text{Value of Sales.}}$$

Due to lack of demand elasticity information, this computation does not reflect the projected increase in prices of metal finished goods. It is rather, an estimate of the necessary price increase to recover the costs of pollution control equipment and operations.

**2. Segmentation into multi-plant corporations and single plant corporations is due but not limited to the following reasons:

- Multi-plant corporations have greater access to capital due to their size

- The annual pollution control cost for a plant which is part of a multi-plant firm is very small relative to the firm's value of sales

- Multi-plant firms' structure indicates an economic and/or financial advantage in having a captive metal finishing operation.

***3. All plants with a projected price increase of more than 25 percent where less than 50 percent of the products are metal finished. For these plants it would effectively mean that the cost of the metal finishing process will increase at least 50% in comparison with an industry wide price increase of less than 1%.

****4. This is a measure of the elasticity of demand facing the firm. The greater the percentage of parts from outside customers the more elastic the demand will be.

value of sales to obtain the price increase necessary to cover the added costs of pollution control for each individual plant. To clarify, the price increase per plant is computed as,

$$\text{Price Increase} = \frac{\text{Annual Pollution Control Costs}}{\text{Value of Sales}}$$

- The price increase for the total population of plants is then computed using a weighting scheme based on the sales volume of each plant.

- The entire population is divided into those plants with projected price increases lower than the sample average and those higher than the sample average. Those plants with projected necessary price increases of less than the average were considered to experience minor economic impact and flagged out.

- All remaining plants are further distinguished according to those with a projected price increase of greater than either the sample average or five percent, whichever is larger. The five percent figure was chosen because five percent price increase is considered a major change, as it is significant enough to alter demand-supply relationships. It is especially appropriate in lieu of the assumption of no capital availability constraints.

- All the remaining plants are divided into those which are multi-plant corporations and those which are single plant corporations. A multi-plant corporation is one where the production process is performed in more than one plant. In these cases the firm uses one, or any one of its plants for peforming metal finishing services for all its products. A single plant corporation is one that operates only a single plant and metal finishing is a major part of the production process. The segmentation of the plants into multiplant companies and single plant firms was done for the following reasons:

  - Multi-plant firms' structure indicates an economic and/or financial advantage in having a captive metal finishing operation.

  - The annual pollution control cost for a plant which is part of a multi-plant firm is very small relative to the firm's value of sales.

- Multi-plant corporations have a greater access to capital due to their size.

- All single plant firms were singled out as candidates for closure if they met one of two conditions: they faced price increases greater than ten percent; or they faced price increases greater than five percent and the percentage of metal finishing performed for outside customers was greater than 50 percent.

  - Any firm that obtains more than 50 percent of its total revenue by performing metal finishing services for outside customers is a quasi-job shop and faces a relatively elastic demand curve; i.e., the firm's services are relatively price sensitive. The reason that the demand curve is more elastic in these cases is that in a competitive industry outside customers can readily observe prices and by careful shopping, always choose the lowest price.

  - A firm with a ten percent increase will not be able to compete in an industry where the average price increase is less than one percent (0.2 percent is the estimated price increase for the chosen option).

- All multi-plant corporations are singled out as candidates to divest their captive operation if the projected price increase in the captive plant is 25 percent or more and the percentage of products receiving metal finishing is less than 50 percent. As mentioned above, multi-plant corporations are not as vulnerable to the rising costs of production and thus would only divest their metal finishing operation under extreme conditions. A captive plant that metal finishes less than 50 percent of its products and has an overall price increase of more than 25 percent due to metal finishing pollution control costs will effectively experience at least a 50 percent increase in the cost of the metal finishing process. Thus, it will have a great incentive to contract out its metal finishing operations or do away with the process altogether in favor of a less costly alternative.

In addition, an analysis of secondary impacts on final consumption goods is carried out with the use of an input-output analysis. (I/O model is discussed in detail in the appendix.)

V. REGULATORY OPTIONS AND DERIVATION OF COMPLIANCE COSTS

Effluent treatment options and their associated costs are obviously instrumental in the assessment of the economic impacts of water pollution controls. This chapter addresses the following:

- Regulatory options
- Derivation of compliance costs
- Derivation of the size of the affected universe.

1. REGULATORY OPTIONS

The Environmental Protection Agency evaluated two regulatory options for existing industrial sources. A third option was also evaluated for new sources. Each option sets a compliance standard and assigns specific pollution abatement equipment.

- Option I equipment includes:

  - Chemical Oxidation Unit
  - Chemical Reduction Converter
  - Clarifying Units
  - Sludge Drying Beds.

- Option II equipment includes all the equipment necessary to meet Option I, with the addition of a multimedia-filtration unit.

- Option III equipment includes all the equipment necessary to meet Option I plus in-plant controls on cadmium.

The pollution control equipment requirements are the same for both job shops and captives.

2. DERIVATION OF COMPLIANCE COSTS

The derivation of water pollution control costs differs somewhat between job shops and captives.

(1) Job Shop Plant Costing

Information from the 1976-77 Survey of Metal Finishers on 28 direct discharging job shops was submitted to the technical contractor for costing. In this fashion each plant was run individually through the technical contractor cost generating program. Information exists on such key parameters as:

- Flow constituents
- Plant layout
- Materials finished
- Hours of operations
- Finishing processes
- Amperage, thickness of plate
- Equipment in place
- Tooling, piping
- Construction, laboratory costs.

Thus, each plant used as a model for the economic analysis has a unique set of costs corresponding to the regulatory options defined by the agency.

(2) Captive Plant Costing

Information on processes of captive plants was not available from the 1976-77 Survey of Metal Finishers. As a result the determination of the expected water pollution control expenditures was performed by taking the following steps:

- The technical contractor accumulated manufacturing process data on a sample of 100 direct discharging captives and 100 indirect discharging captives.

- Each plant in the sample was costed by the technical contractor using its costing program.

- The cost data was then grouped and classified according to a plant's water use and discharge category.

- In the calculation of the baseline and Option II costs, the 1087 captive plants from the 1976-77 Survey of Metal Finishers were grouped by metal finishing water usage and then individually matched with the technical contractor's cost estimates.

- For the computation of the cost of the metal finishing flow only, the technical contractor costed the metal finishing flow and the electroplating flow of the integrated indirect discharging captive plants. The electroplating flow costs were subtracted from the total metal finishing flow costs to obtain the cost of treating the metal finishing flow only. These plants were then matched with plants in the 1976-77 Survey data base according to water flow characteristics.

- In this fashion all 1087 plants could be costed and results extrapolated to the 7,500 indirect discharging plants and 2,500 direct discharging plants.

3. ESTIMATION OF THE SIZE OF THE UNIVERSE

The agency relied on the Permit Compliance System (PCS) File for the estimation of the captive metal finishing universe. That file was also used to estimate a total of 300 direct discharging job shops in SIC's 3471 and 3479.

The PCS File showed that there are approximately 2,500 direct discharging captives in SIC's 25-39 that will be covered by the metal finishing effluent guidelines. Most of these plants are in SIC's 34-39. The 1976-77 Survey of Metal Finishers indicated that there were three times as many indirect dischargers as direct dischargers, and thus, it was determined that there are 7,500 indirect discharging captives in the metal finishing universe.

(1) Segment of the Universe Affected By This Regulation

In order to determine the affected universe the Agency recently conducted three surveys to update its information on pollution control equipment in place.* The findings of these surveys are as follows:

- None of the 300 direct discharging job shops will have to invest in order to comply with Option I standards.

- None of the 2,500 direct discharging captives will have to invest in order to meet Option I standards.

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* The results of the first survey are outlined in a July 30, 1981 memorandum from Mr. Richard Kinch to Mr. Art Berman. The second survey's sample design and selection procedure is described in an August 20, 1981 memorandum from Mr. Richard Kotz to Mr. David Pepson. The results of the survey are contained in a memorandum from Mr. Henry D. Kahn to Mr. David Pepson. The results of the last survey are described in a memorandum dated December 3, 1981 from Mr. Kinch to Mr. Berman.

- Of the 7500 indirect discharging captives, the Electroplating Pretreatment regulation covers all process flows at the non-integrated plants (3750 plants). The electroplating standards also regulate the electroplating processes of integrated plants which also number 3750 plants. Of the integrated plants:

    - 17 percent will not need to install treatment because they meet EPA limitations through the use of in-process controls

    - 51 percent have already installed Option 1 level pollution treatment equipment for all relevant processes.

This leaves 1200 integrated plants that EPA estimates will bear additional costs to meet Option I standards.

To summarize, the surveys conducted by the Environmental Protection Agency found that all direct dischargers, job shops and captives have already met Option I compliance standards, and 1200 indirect discharging captives require an addition to their existing equipment to meet Option I levels. Nearly all plants in the metal finishing universe will have to make additional investments to meet Option II compliance standards.

VI. ECONOMIC IMPACTS

The estimated economic impacts of the regulations are significantly different for Option I compliance levels and Option II compliance levels. Compliance with Option I standards will have very small effects on the metal finishing universe, while compliance with Option II will have measurable impacts.

1. BASELINE CONDITIONS

The indirect discharging segment of the metal finishing industry is also covered by the Electroplating Pretreatment regulation promulgated by EPA in 1979. Compliance with the Electroplating standards requires a considerable investment cost. Because the process coverage of the Metal Finishing regulation is more comprehensive, it will require an additional capital investment for approximately 16 percent of all indirect discharging plants. A vast majority of the metal finishing plants will not need an additional investment in treatment technology because they either:

- Have only electroplating process flows (and are therefore completely covered by the Electroplating Pretreatment regulation)

- Have already installed pollution control equipment that treats all their metal finishing processes

- Have in-plant "process" controls that treat process flows sufficiently to meet proposed EPA Limitations.*

For those plants requiring an additional investment in pollution control equipment, electroplating compliance costs are factored into the baseline conditions. The costs attributable strictly to this Metal Finishing regulation are then added on so that incremental economic impacts can be measured. The baseline costs for this segment of the metal finishing population -- derived by employing assumptions identical to those for deriving the metal finishing costs and using 1980 as the baseline year -- are $453 million in capital costs and $136 million

*This calculation is partially based on EPA surveys of the metal finishing industry.

in annual costs. As a result of these compliance expenditures EPA estimates that there will be 24 baseline plant closures and 6 electroplating process line divestitures. The incremental costs and impacts for the Metal Finishing regulation are described below.

2. CAPITAL AVAILABILITY CONSIDERATIONS

The job shop methodology explicitly takes into consideration the ability of plants to finance new investments. In fact, the closure model is based on financial variables, the magnitude of some are determined by the market.

No systematic analysis of the ability of captive plants to finance investment was conducted because the majority of the captive plants that require investment in pollution control equipment are large (more than $50 million in annual sales). Moreover, the magnitude of the average required annual investment is small relative to the size of the plants. In addition, no finance information was available for captive plants.

3. ESTIMATED IMPACTS OF OPTION I

As Exhibit VI-1 on the following page shows the total compliance burden of Option I is $271 million in investment costs and $81 million in annual costs. Annualized costs include an annualized portion of investment costs plus yearly operation and maintenance costs.

These investment and annual costs apply to an estimated 1200 of the 3750 integrated indirect discharging captive shops. They arise from treating the non-electroplating portion of the effluent from integrated plants. The electroplating effluent portion was regulated already by the 1979 Electroplating Pretreatment Standard. Exhibit VI-2 shows that no plant closures, divestiture or employment losses are expected due to compliance with Option I. The estimated price increase is approximately 0.2 percent.

Other sectors covered by the metal finishing regulation -- the balance of the integrated indirect discharging captives, the direct discharging job and captive shops, and the non-integrated indirect discharging captives are not expected to incur additional costs from the regulation. A series of 1981 agency surveys indicated that approximately 2550 of the integrated indirect discharging captives and all direct discharging job and captive shops already have treatment in place sufficient

EXHIBIT VI-1

TOTAL CAPITAL INVESTMENT AND ANNUAL
COSTS BY OPTIONS
(In Millons of 1980 $)

OPTION I	JOB SHOPS	CAPTIVES D.D	CAPTIVES I.D	TOTAL
Investment Costs	0	0	271.0	271.0
Annual Cost	0	0	81.0	81.0
OPTION II				
Investment Costs	13.2	380.0	601.0	994.2
Annual Cost	4.0	114.0	180.0	298.0

to meet option I standards or do not need treatment. The 3750 non-integrated indirect discharging captives are also not expected to incur costs from the metal finishing regulation. These shops are already covered by the Electroplating Treatment Standards. Although the limitations in the metal finishing regulation are more stringent, they can be met with the same technology basis as that employed to meet the electroplating standards, and, thus, are not expected to give rise to additional costs.

4. ESTIMATED IMPACTS OF OPTION II

Exhibits VI-1 and VI-2 summarize the estimated impacts of compliance with Option II. The total investment cost for the job shop sector is estimated at $13.2 million, while investment for captives will be slightly less than a billion dollars. Total job shop closures are estimated at 42 (14 percent of job shop universe) while captives are expected to shut down 29 establishments (less than one percent of captive universe) and divest of 10 more. A total of 2,067 jobs will be lost due to Option II compliance requirements, with 1,122 accounted for by job shops. The price increase in the job shop sector is calculated to be 4 percent, while in the captive sector it will be 0.5 percent.

5. ESTIMATED IMPACTS OF OPTION III

Option III compliance costs were estimated for New Source Performance Standards/Pretreatment Standards for New Sources. These standards will apply only to those metal finishing plants that will need in-plant cadmium controls. The incremental annual cost of the cadmium controls will be between $17,800 and $24,000 (in 1980 dollars) per plant. These costs are not expected to have adverse competitive impacts. Chapter IX contains a more detailed discussion of Option III costs and impacts.

6. ESTIMATED SECONDARY PRICE IMPACTS

The secondary price impacts were derived with the use of an input-output analysis. The analysis estimates the inflationary impact of a change in the price of metal finishing services. The input-output analysis provides a method of examining in a simple but quantifiable way the relationship between prices in a particular economic system. It makes possible an estimate of the consequences of a change in any one price upon the others in the system. (Appendix A provides a detailed exposition of the input-output model). The input-output analysis assumes that all increases in costs, direct or indirect, are passed on: i.e., that each sector raises the price of its primary inputs, plus the rise in the price of the inputs absorbed from other industries. However, it is important to note that the input-output model employed assumes that the whole economy could be adequately represented by static input-output technical coefficients. Therefore, estimation results based on the I/O model should be read with this inherent weakness in mind.

Exhibits VI-3 and VI-4 on the next page show the secondary price impact on the following:

- SIC's 34-39
- Personal consumption expenditures
- Gross private fixed capital formative
- Net exports
- Total federal government purchases.

EXHIBIT VI-2

ESTIMATED IMPACTS OF REGULATORY COMPLIANCE

OPTION I

	JOB SHOPS	CAPTIVE D.D	CAPTIVE I.D.	TOTAL
Plant Closures	0	0	0	0
MF Divestiture	0	0	0	0
Employment Loss	0	0	0	0
Price Increase	0	0	0.2%	0.08%

OPTION II

	JOB SHOPS	CAPTIVE D.D	CAPTIVE I.D.	TOTAL
Plant Closures	42	21	8	21
Plant Closures (%)	14	0.8	0.1	0.7
MF Divestiture	0	10	0	10
Employment Loss	1122	760	185	2067
Employment Loss (%)	15.6	0.04	0.05	0.04
Price Increase	4.0%	0.5%	0.5%	0.5%

EXHIBIT VI-3

ESTIMATED PRICE INCREASES FOR
2-DIGIT SIC'S (IN PERCENT)

SIC	OPTION I	OPTION II
34	0.3	0.9
35	0.3	0.9
36	0.1	0.3
37	0.1	0.2
38	0.1	0.2
39	0.1	0.3

EXHIBIT VI-4

ESTIMATED TOTAL PRICE IMPACT OF EPA BATEA
METAL FINISHING REGULATIONS ON PRINCIPAL
FINAL DEMAND COMPONENTS

FINAL DEMAND SECTORS	PERCENTAGE PRICE INCREASE	
	Option I	Option II
Personal Consumption Expenditures	0.01	0.02
Gross Private Fixed Capital Formation	0.005	0.01
Net Exports	0.01	0.02
Total Federal Government Purchases	0.007	0.01

VII. REGULATORY FLEXIBILITY ANALYSIS

The Regulatory Flexibility Act (Public Law 96-354) is a regulatory reform initiative designed to ensure that, while achieving statutory goals, regulations do not impose unnecessary costs on "small entities." Small entities are defined in Section 2(a)(3) as "small businesses, small organizations, and small governmental jurisdictions with limited resources." The analytical requirements for regulatory flexibility analysis are enumerated in Sections 603 and 604 of this statute. Section 605(b) qualifies these requirements and states that:

> "Sections 603 and 604 of this title shall not apply to any proposed or final rule if the head of the agency certifies that the rule will not, if promulgated, have a significant economic impact on a substantial number of small entities."

Option I, the selected option, will affect only integrated captive shops. These tend to be extremely large operations. The economic impact analysis set forth in this document indicates that for Option I there will be no economic impacts in terms of plant closures for any metal finishing establishments, including those affected that are considered to be small entities. Thus, there will not be "a significant economic impact on a substantial number of small entities." Exhibits VII-1 and VII-2 display the industry-wide costs and impacts attributable to compliance with Option I standards.

Despite the fact that there is, thus, no statutory requirement to perform this analysis, a preliminary investigation into regulatory flexibility issues has been undertaken. These issues include:

- Definition of a small firm
- Establishment of an "optimal" small firm criterion
- Regulatory impacts on small firms.

EXHIBIT VII-1
Total Captive Investment and Annual Costs
(In Million $)

Option I	Job Shops	Captives D.D.	Captives I.D.	Total
Investment Costs	0	0	271.0	271.0
Annual Costs	0	0	81.0	81.0

EXHIBIT VII-2
Estimated Impacts of Regulatory Compliance

OPTION I

	Job Shops	Captive D.D.	Captive I.D.	Total
Plant Closures	0	0	0	0
MF Divestiture	0	0	0	0
Employment Loss	0	0	0	0
Price Increase	0	0	0.2%	0.2%

1. DEFINITION OF A SMALL FIRM

In considering reasonable definitions of small firms in the metal finishing industry, four separate approaches appeared promising. The four methods considered the following criteria:

- Number of employees, using either total employment or metal finishing production employees
- Sales volume or value added by manufacturing
- Pollution generation volume either in terms of metric tons of contaminant or types of contaminants in the wastestream
- Production/process water volume in gallons per day.

Several problems are apparent with each index, although a basis for selecting one, the last criterion, is readily defensible. Briefly, the operant difficulties in relying on these measures include:

- Number of employees in the firm does not show a large positive correlation with sales of the firm. Businesses with relatively few employees can generate sales volumes greater than that of a plant with ten times the employment. The problem here is plant technology and automation levels. In metal finishing a highly automated plant could be a production giant, yet appear, on the basis of employment, to be a small business.
- Dollar volume in sales or value added is equally unsatisfactory due to the fact that by itself it fails to reflect market vulnerability. As SBA has long maintained, a small business is small only in relation to its competitors. Small in this sense means lacking the stature to influence price or production trends in the industry. There is no obvious basis for establishing any sales level as a distinguishing cut-off for a small firm in this industry because of the heterogeneity of the producers.

- For regulatory purposes establishing pollution generating volume is a highly relevant factor for defining plant size. Regardless of employment or sales, plants generating large hazardous waste volumes are of more importance than those generating trivial quantities. The problem here is that waste volume is a function of many plant-specific considerations (processes, chemicals, and operations), and data on a plant's pollution volume are not readily available.

- Plant water volume correlates moderately well with both employment and sales. While not a predictor of economic size, water volume is at least associated with plant economics. Additionally, plant water volume correlates with but does not predict pollution generation volume. It serves, therefore, as a reasonable measure of plant size both on economic and technological grounds.

Extensive sensitivity analysis that was performed in the economic impact analysis for the earlier electroplating pretreatment regulation showed that the most vulnerable plants had a water flow level of less than 10,000 G.P.D.

EPA, therefore, chose plant water volume as the primary criterion to use in confirming its earlier conclusions that there would be no significant economic impact on a substantial number of small entities. It selected the 10,000 G.P.D. flow level used in the earlier Electroplating Pretreatment Regulation as the cut-off level for identifying potential small business economic impacts. Exhibit VII-3 on the following page shows a profile of the metal finishing revenues for a 10,000 G.P.D flow level.

2. REGULATORY IMPACTS ON SMALL FIRMS

As stated earlier, only integrated captive shops will incur incremental investment costs to comply with the metal finishing BAT/PSES effluent guidelines. The EPA data base indicates that plants in this subcategory are much larger than other metal finishing plants. Integrated captives typically have multi-million dollar sales levels and a metal finishing process water flow of several hundred thousand gallons per day. It is likely, therefore, that very few small establishments, as defined in this chapter, will be affected by these effluent guidelines.

EXHIBIT VII-3
Profile of Captive Metal Finishers
by 10,000 G.P.D. Flow Volume

	< 10,000 G.P.D.	> 10,000 G.P.D.
Population Size	3400	6600
Average Plant Employment	420	1,205
Average Plant Sales (Millions)	7.5	48.1*
Average MF Value (Millions)	.53	1.83
Average MF G.P.D.	5,190	355,000

* 53.6% of all the firms in the 1976-77 survey reported sales of greater than $50 million in 1976 dollars.

In any case, this report clearly documents that small firms are expected to experience no economic impacts due to this regulation. In effect, this means that in no instance will a plant's annual pollution control costs exceed five percent of its sales. This conclusion is based on an analysis of the 1,087 plants surveyed. The plant population covers an extensive range of plant sizes, processes, sales, metal finishing water flow, levels of pollution treatment operating, and other pertinent parameters.

VIII. A DISCUSSION OF SOCIAL COSTS

The purpose of this chapter is to explore some practical means by which the social costs of the metal finishing regulation can be analyzed, and highlight some of the difficulties in performing such an analysis on the metal finishing industry. It should be noted, however, that it is not the intent here to formally conduct a study of social costs.

Given the complexity of the metal finishing industry and the lack of good data it would be most appropriate to use a static, partial equilibrium/method to estimate the social costs. Under this approach costs are measured by the total amount individuals would be willing to pay for goods and services that could be rendered if the resources to be employed in compliance with the regulation were instead used in their next highest valued use. This framework relies on an analysis of supply and demand relationships in the directly affected markets. The main difference between this method and the Hicks-Kaldor/ general equilibrium criterion is that the partial equilibrium approach focuses attention solely on the direct effects of the regulation. The general equilibrium approach considers all effects, whether directly or indirectly related to the regulation.

For illustrative purposes, the basic social costs of the metal finishing regulation can be segmented into the following components.

- The most obvious social cost is the cost of compliance; that is, the present and future real resource expenditures necessitated by law.
- The metal finishing regulation is expected to lead to higher input and final product prices. The resulting dead-weight loss of consumers' and producers' surplus constitutes a real social cost and if possible should be quantified.
- The regulation could give rise to some resource unemployment, which translates into lost output. The resulting costs are important and should be quantified.

- Additional resources will be expended on the establishment and enforcement of the metal finishing regulation. This includes government expenditures and private sector expenditures. These costs should also be taken into account.

In reality, however, an accurate assessment of the social costs of the metal finishing regulation is extremely complex because the estimation of demand and supply elasticities, output changes, and price changes for all 150 industries performing metal finishing is very costly, if not impossible. Further, due to the size of the Metal Finishing universe, the estimated small price increase, and the magnitude of the overall compliance investment, the real resource cost will account for more than 95 percent of the total social costs. As a result of the difficulty in the assessment of the dead-weight loss in consumer surplus and the relatively small size of monitoring, implementing, and estimated litigation costs, calculation of the net present value of the resources to be used directly in compliance with the regulation constitutes an appropriate estimation of the total social costs.

To calculate the net present value of the resources to be used directly in complying with the metal finishing regulation, the discounted (using a real discount rate of 10% as recommended by the Office of Management and Budget) stream of operating and maintenance costs was added to the initial investment costs. This present value was then annualized in perpetuity by multiplying by 10 percent.* The annual social cost for Option 1 is estimated as $62 million. Option II annual social costs are estimated to be $138 million.

A regulation may affect innovation, market structure, or productivity in a manner which may impose additional cost but are untraceable in a static, partial equilibrium analysis. In the case or this metal finishing regulation the relative importance of these effects is expected to be minor.

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* Formula: Annual Social Cost = .1 (Investment Cost) + (Annual Operating and Maintenance Cost)

IX. NEW SOURCE PERFORMANCE STANDARDS/ PRETREATMENT STANDARDS FOR NEW SOURCES

The Federal Water Pollution Control Act of 1972 (the "Act") requires that New Source Performance Standards (NSPS) represent the best available demonstrated control technology, processes, and operating methods. Where practicable, no pollutant discharge at all is supposed to be allowed. Where pollutant discharge is unavoidable, these standards are to represent the greatest degree of effluent reduction achievable. NSPS applies only to direct dischargers.

Pretreatment Standards for New Sources (PSNS) will regulate indirect dischargers. The Act states that pretreatment standards shall prevent the discharge to a publicly-owned treatment works (POTW) of any pollutant that may interfere with, pass through, or otherwise be incompatible with the POTW. The amendments to the Act further stipulate that industrial discharges must not interfere with use and disposal of municipal sludges.

Both NSPS and PSNS apply specifically to new sources. New sources are defined as any building, structure, facility, or installation that discharges pollutants and for which construction is started after proposal of the relevant standards. Captive shops and job shops may be regulated under either NSPS or PSNS.

One option was selected for all new source standards. The NSPS/PSNS treatment system consists of the Option 1 end-of-pipe treatment system (described earlier in this report) plus in-plant controls for cadmium. In-plant controls could include evaporative recovery, ion exchange, and recovery rinses. The purpose of these in-plant controls is to reduce cadmium concentration levels in the raw waste stream.

Due to the nature of this option, only new sources that perform cadmium plating operations will incur additional compliance requirements beyond the proposed BPT/BAT/PSES standards. EPA estimates that between 13 and 16 percent of existing sources plate with cadmium. This information is presented in Exhibit IX-1. It is likely, therefore, that the NSPS/PSNS requirements will concern only a small segment of the metal finishing population.

EXHIBIT IX-1
Prevalence of Cadmium Platers
Amongst Metal Finishers*

	Metal Finishing Subcategory	
	Captives	Job Shops
Percent Cadmium Platers	13.0	16.7

*Source: March 5, 1981 memo from Mr. Jack Nash to Mr. Richard Kinch.

Information collected on the existing cadmium users indicates that they are generally larger and more diverse than non-cadmium users**, specifically:

- Job shop cadmium platers are generally much larger than job shops that do not plate with cadmium.
- Job shop cadmium platers use twice as many types of metals as non-cadmium platers
- Indirect discharging captive cadmium platers consume twice as much water as either their direct discharging counterparts or the non-cadmium users.
- Direct discharging cadmium platers use less water than all other types of captives, but they generally employ more people and work with more metals.

The incremental cost to new sources of controlling cadmium was used as the basis for measuring these standards' competitive effects. Annual control costs were calculated for five different water flow categories. The average cost results are presented in Exhibit IX-2. The data indicates that a plant's annual costs of cadmium control will vary between $17,800 and $24,100.*** These costs are insensitive to a plant's water flow volume; i.e., unlike the existing source standards, there is not a strong functional relationship between a plant's water flow and compliance costs.

** This information is based on two memos. The first is dated March 5, 1981 and is from Mr. Jack Nash to Mr. Richard Kinch. The second is dated May 1, 1981 and is from Mr. Lior Samuelson to Mr. Art Berman.

*** Annual costs are derived from investment cost data in the Technical Development Document. They are annualized according to information contained in the 1976-77 Survey of Metal Finishers.

EXHIBIT IX-2
Incremental NSPS/PSNS Annual Costs by Metal Finishing Plant Water Flow Category
(in 1980 $)

Plants With Metal Finishing Flow (GPD)	Incremental Annual Costs of Option 3
<1,000	$ 21,924
1,000-10,000	18,802
10,000-50,000	21,791
50,000-500,000	17,811
>500,000	24,090

Source: Technical Development Document

The cost effects for five plant sales categories due to NSPS/PSNS requirements were calculated by the following three step process:

- For each plant sales category, model plants were clustered according to water flow.*
- Within each sales category, cost effects were calculated for each water flow cluster by dividing the incremental Option 3 compliance cost by plant sales. This approach is similar to the one used to measure economic impacts of Options 1 and 2 on the captive metal finishing population.
- A weighted average cost effect was calculated for each plant sales category based on the relative importance of the water flow clusters.

The results of these calculations are presented in Exhibits IX-3 to IX-8. The cost effects range from .04 percent for the largest plants to 2 percent for the smallest. In general, as plants' sales volumes grow larger, the cost effects become very small. In addition, the cost effects for nearly 90 percent of the plants (assuming that new sources have a size distribution equivalent to existing sources) are .7 percent or less.

* Source: 1976-77 Survey of Metal Finishers.

EXHIBIT IX-3
NSPS/PSNS Cost Effects for Plants With Sales = $1 Million
(in 1980 $)

Percent of All Existing Plants	Metal Finishing Flow (GPD)	Percent of $1 Million Plants With This M.F. Flow	Incremental Annual/ Option 3 Cost	Percent Cost Effect
11%	<1,000	22	$ 21,924	2.2%
	1,000-10,000	45	18,802	1.9
	10,000-50,000	26	21,791	2.2
	50,000-500,000	6	17,811	1.8
	>500,000	1	24,090	2.4

EXIIBIT IX-4
NSPS/PSNS Cost Effects for Plants With Sales = $3 Million
(in 1980 $)

Percent of All Existing Plants	Metal Finishing Flow (GPD)	Percent of $3 Million Plants With This M.F. Flow	Incremental Annual/ Option 3 Cost	Percent Cost Effect
23.2%	<1,000	14	$ 21,924	0.7%
	1,000-10,000	44	18,802	0.6
	10,000-50,000	25	21,791	0.7
	50,000-500,000	11	17,811	0.6
	>500,000	6	24,090	0.8

EXHIBIT IX-5

NSPS/PSNS Cost Effects for Plants With Sales = $7.5 Million
(in 1980 $)

Percent of All Existing Plants	Metal Finishing Flow (GPD)	Percent of $7.5 Million Plants With This M.F. Flow	Incremental Annual/ Option 3 Cost	Percent Cost Effect
14.8%	<1,000	8	$ 21,924	0.3%
	1,000-10,000	26	18,802	0.3
	10,000-50,000	30	21,791	0.3
	50,000-500,000	32	17,811	0.2
	>500,000	4	24,090	0.3

EXHIBIT IX-6
NSPS/PSNS Cost Effects for Plants With Sales = $25 Million
(in 1980 $)

Percent of All Existing Plants	Metal Finishing Flow (GPD)	Percent of $25 Million Plants With This M.F. Flow	Incremental Annual/ Option 3 Cost	Percent Cost Effect
35.8%	< 1,000	6	$ 21,924	0.09%
	1,000-10,000	19	18,802	0.08
	10,000-50,000	30	21,791	0.09
	50,000-500,000	41	17,811	0.07
	> 500,000	4	24,090	0.10

EXHIBIT IX-7

NSPS/PSNS Cost Effects for Plants With Sales >$50 Million

(in 1980 $)

percent of All Existing Plants	Metal Finishing Flow (GPD)	Percent of $50 Million Plants With This M.F. Flow	Incremental Annual/ Option 3 Cost	Percent Cost Effect
15.2%	<1,000	2	$ 21,924	0.04%
	1,000-10,000	11	18,802	0.04
	10,000-50,000	20	21,791	0.04
	50,000-500,000	51	17,811	0.04
	>500,000	16	24,090	0.05

EXHIBIT IX-8
NSPS/PSNS Average Cost Effects
(in 1980 $)

Sales Category	Percent of Existing Plants in Sales Category	Average Cost Effects Due to Option 3 Costs
1mm	11.0%	2.0%
3mm	23.2	0.7
7.5 mm	14.8	0.3
25mm	35.8	0.08
>50mm	15.2	0.04

Based on the available data, it does not seem that the additional costs to comply with the NSPS/PSNS standards will erect significant entry barriers or create competitive disadvantages. The main reasons are the following:

- The incremental cost of compliance with Option 3 is small. (Between 0.04 percent and 2.0 percent of the value of sales).

- Only a small percentage of the metal finishing universe uses cadmium. Assuming that this trend holds for new source metal finishers, the vast majority of plants will have no compliance requirements at all due to NSPS/PSNS cadmium controls.

- In some processes, cadmium plating may be substituted for by other metals. This will relieve these new sources of NSPS/PSNS cadmium controls. In cases where substitution is not possible due to the characteristics of cadmium, cost can be passed through as a result of inelastic demand.

In general, the decision of a firm to enter into the market for metal finishing will be insensitive to the incremental burden of NSPS/PSNS. For captives, metal finishing is an input into the production process. As such, they perform metal finishing in-house to ensure continuous supply, to minimize work flow disruptions, and to lower transportation and packaging costs. If the relative costs of NSPS/PSNS were high, captives could decide to obtain finishing services from existing job shops. New job shop sources will have the same effluent guideline requirements as existing sources unless the new plants use cadmium. The decision to use cadmium will be dictated by the demand for cadmium plating. Elastic demand will mean a high probability of no cadmium use while inelastic demand means little or no competitive impacts.

X. LIMITS OF THE ANALYSIS

The purpose of this chapter is to summarize the issues that bear upon the "power" of the findings presented herein. The data and analytic constraints must be understood in order for the estimates of industry impacts to be held in perspective. Accordingly, the applicability of the results rests with how well the data, logic and assumptions of the models reflect reality.

The focus of this chapter are the major limitations involving study issues relating to the:

- Quality and quantity of the data
- Agency survey updates on equipment in place
- Type of models used.

1. QUALITY AND QUANTITY OF THE DATA

A major strategic consideration in the planning of this study was the appropriate source of information. Agency budgetary and timing constraints regarding new financial and economic survey work necessitated the use of data from prior analyses. This decision may have a bearing on the findings of this study. The Economic Impact Analysis relies on data obtained in the 1976-77 Survey of Metal Finishers. The forecasted impacts may be sensitive to any change in the economic and/or financial characteristics of the Metal Finishing universe between 1976-77 and 1982.

2. AGENCY SURVEYS ON EQUIPMENT IN PLACE

The Agency conducted two surveys of the Metal Finishing universe. The purpose of the surveys was to update information on the proportion of metal finishers that would require additional pollution control equipment in order to meet proposed BAT regulations. The survey of direct dischargers* was conducted on a sample derived from the NPDES permit records, while the surveys of indirect

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* The survey's sample design and selection procedure is described in an August 20, 1981 memorandum from Mr. Richard Kotz to Mr. David Pepson. The results of the survey are contained in a memorandum from Mr. Henry D. Kahn to Mr. David Pepson

dischargers* relied on the technical contractor's data base. The projected magnitude of compliance costs and plant closures is sensitive to any changes in the results of the surveys due to sampling or data base biases.

3. TYPE OF MODELS USED

Two distinct models were used to analyze the economic impacts. In general, the design of the models was constrained by data availability. The job shop model is essentially a capital budgeting closure analysis that assumes full cost pass through. Different assumptions on the elasticity of demand, interest rates, and the model plants' financial condition may yield different results.

The model used to analyze the impacts on the captive sector assumes various critical price increase limits. Any plant projected to require a greater price increase is considered a candidate for closure. A change in the critical price limits would alter the results of the analysis. In addition, the captive analysis assumes a full cost pass through. A precise prediction of price and output changes due to the regulation is not possible due to the complexity of the Metal Finishing universe. The approach taken here therefore, limits somewhat the accuracy of the forecasts.

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* Results of these surveys are described in a July 30, 1981 memorandum and a December 3, 1981 memorandum from Mr. Richard Kinch to Mr. Art Berman.

APPENDIX A

INPUT-OUTPUT ANALYSIS

This appendix first sets out a framework within which the interrelationships between consumption, production and metal finishing requirements can be measured. Then a method of quantifying the price relationships of the sectors in an economy, the input-output price model, is discussed.

All economic activities can be divided into two components, final demand and intermediate production. Final demand includes the personal consumption expenditures of consumers, the expenditures of business for capital goods replacement and/or augmentation, the expenditures of government at all levels, and the net exports. Intermediate production represents the inter-industry transactions necessary to produce the final goods and services. The inter-industry model, termed "input-output analysis", developed by Wassily Leontief [1] and recently estimated for the year 1972 by the Department of Commerce, provides the required framework [2] for estimating and analyzing the above mentioned interrelationships.

The basic input-output structure is developed by dividing the productive and final demand activities of an economy into a number of sectors, which are arrayed in matrix form. The distribution of the sales and purchases of each industry is then estimated for each sector during a 1-year period. As an example, Table A-1, panel (a), shows all economic activities divided into three producing sectors and one component of final demand. Reading across the rows, one finds the sales (in dollars) of the output of the sector named at the beginning of the row to the sector named at the head of each column. Or, reading down the column, one finds the purchases by each sector named at the head of the column from the sector named at the beginning of the row. Final demand can be further disaggregated into the components used in the national income accounts. Thus, the total final demand for the output of an industry is the sum of those components:

$$Y = C + I + G + T, \qquad (1)$$

Table A-1. Example of Input-Output Tables

(a) Transactions table, X matrix (Dollars)

Producing sectors	Consuming sectors: agriculture	Consuming sectors: manufacturers	Consuming sectors: services	Total inter mediate output	Total final demand	Gross Output
Agriculture	40	80	0	120	80	200
Manufacturing	40	40	20	100	300	400
Services	0	60	20	80	120	200
Total inter-mediate inputs	80	180	40			
Value added	120	220	160		500	
Gross inputs	200	400	200			

(b) Direct requirements table, A matrix (Dollars/Dollars)

Producing sectors	Consuming sectors: agriculture	Consuming sectors: manufacturers	Consuming sectors: services
Agriculture	0.20	0.20	0
Manufacturing	0.20	0.10	0.10
Services	0	0.15	0.10
Value added	0.60	0.55	0.60
Total	1.00	1.00	1.00

(c) Total requirements (direct and indirect) table, S matrix (Dollars/Dollars)

Producing sectors	Consuming sectors: agriculture	Consuming sectors: manufacturers	Consuming sectors: services
Agriculture	1.33	0.30	0.03
Manufacturing	0.30	1.20	0.13
Services	0.05	0.20	1.13

where*

$Y =$	$[y_i]$	final demand for the output of industry i, where i = 1....n,
$C =$	$[c_i]$	personal consumption expenditure component of final demand for industry i output,
$I =$	$[i_i]$	private investment expenditure component of final demand for industry i output,
$G =$	$[g_i]$	government expenditure component of final demand for industry i output, and
$T =$	$[t_i]$	net export component (exports minus imports) of final demand for industry i output.

The gross output of an industry is the sum of its sales to other industries and to final demand:

$$Z = XL + Y, \tag{2}$$

where

$Z =$	$[z_i]$	gross output of industry i,
$X =$	$[x_{ij}]$	sales of industry i to industry j, where j = 1....n, and
$L =$	n	dimensional unit vector.

Analogously, the gross input of industry is the sum of its purchases from other industries and of value added:

$$Z = X'L + V, \tag{3}$$

where

$V =$	$[v_i]$	value added by industry i, and
$X^i =$	$[Xji]$	purchases of industry from other industries.

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* Square-bracketed, lower-or upper-case subscripted variables denote vectors or matrices.

Gross national product is measured as the sum of final demand (expenditure approach) or the sum of value added (income approach).

Up to this point, the input-output table is essentially a system of accounting identities. However, in situations where producers are regarded as having only a limited choice regarding factor (i.e., input) intensities and where adjustments to shifts in demand take the form of quantity (i.e., output) rather than price adjustments, the transactions table can be utilized to develop a general set of production coefficients. Specifically, a set of technical coefficients can be derived from the transactions table. A technical coefficient is defined as the dollar input purchases from industry i per dollar output from industry j, or

$$A = [a_{ij}], \qquad (4)$$

where

$a_{ij} = x_{ij}/zj.$

Thus, continuing with our example in Table A-1, panel (b), the values in each column represent the composition of input to the industry named at the head of the column. To produce $1.00 of output, the manufacturing sector requires $0.20 of inputs from agriculture, $0.10 from manufacturing, $0.15 from services, and $0.55 of valued added.

Substituting the value of x_{ij} from equation (4) into equation (2) yields the result

$$Z = AZ + Y. \qquad (5)$$

This is equivalent to

$$(I-A)Z = Y, \qquad (6)$$

where

I = the identity matrix.

From equation (6) one can find the "total requirements matrix," S

$$Z = SY, \qquad (7)$$

where

$S = [s_{ij}] = [I-A]^{-1}.$

Each s_{ij} represents the dollar output of industry is required both directly and indirectly per dollar of final demand from industry j.

In Table A-1, panel (c), the s_{ij} elements of the hypothetical economy are shown. Reading down the column, each entry represents the output of the industry named at the beginning of the row per dollar of final demand from the industry named at the head of the column. Thus, to deliver $1.00 of manufactures to final demand requires $0.30 of output by the agriculture sector, $1.20 by manufacturing (the $1.00 for final demand plus the additional manufacturing output required to produce the required output of all three sectors), and $0.20 of the output of the services sector.

The three basic input-output tables thus provide the framework for analyzing the interrelations in an economy. To summarize:

1. The transactions table, X matrix, shows the flows between sectors per unit of time;

2. The direct coefficients table, A matrix, indicates the direct output requirements of each sector to produce one dollar's worth of output by every other sector; and

3. The total requirements coefficients table, S matrix, indicates the total (direct and indirect) output of each sector required to deliver one dollar's worth of output of every other sector to final demand.

The Bureau of Economic Analysis (BEA), U.S. Department of Commerce has developed several input-output tables of the U.S. economy. The latest, a 478-producing-sectors table based on the structure of production for 1972, has been employed in this study [2].

Table A-2. Example of Diagrregated Personal Consumption Expenditures Tables

(a) Industrial composition of personal consumption expenditures table, U matrix (Dollars)

Producing sectors	PCE item 1	PCE item 2	PCE item 3	Total final demand
Agriculture	0	80	0	80
Manufacturing	200	0	100	300
Services	80	20	20	120
TOTAL(E)	280	100	120	500

(b) Distribution of the industrial composition of personal consumption expenditures table, B matrix (Dollars/Dollars)

Producing sectors	PCE item 1	PCE item 2	PCE item 3
Agriculture	0.00	0.80	0.00
Manufacturing	0.71	0.00	0.33
Services	0.29	0.20	0.17
	1.00	1.00	1.00

(c) Total requirements personal consumption expenditures table, K matrix (Dollars/Dollars)

Producing sectors	PCE item 1	PCE item 2	PCE item 3
Agriculture	0.22	1.07	0.25
Manufacturing	0.89	0.27	1.02
Services	0.47	0.27	0.36

2. PERSONAL CONSUMPTION EXPENDITURES INTERRELATIONSHIPS

One drawback of input-output tables in terms of the objective of this study is their lack of resolution in the final demand sectors. Specifically, personal consumption expenditures are usually represented by a single column vector. Because the purpose of the impact model is to identify interrelationships between personal consumption expenditure items and the requirements for materials produced by the affected sectors, such as metal finishing requirements, this vector must be disaggregated into a set of consumer expenditure items. Unpublished BEA data used in developing the 1972 input-output table were used to develop a "bridge" between the 478 producing sectors in the input-output table and 477 personal consumption expenditure items.

Assuming there are m consumer products, one can define aggregate expenditures on these products as

$E = [e_m]$ the total dollar expenditure on each consumer product at retail prices. (8)

The Personal Consumption Expenditure (PCE) bridge is the allocation of the PCE vector among the m consumer expenditure items:

$$C = UL, \qquad (9)$$

where

$C = [c_i]$ the personal consumption expenditure component of final demand for industry i output,

$\overline{L} = [l_i]$ m dimensional unit vector, and

$U = [u_{im}]$ the dollar amount of final demand sales from sector i required for production or distribution of consumer product m.

Using the hypothetical economy above, suppose all final demand was for three consumption goods which could be disaggregated as shown in Table A-2, panel (a).

The bridge can be converted into a set of fixed coefficients in a manner similar to that employed in developing the direct coefficients:

$$B = b_{im} = \frac{U_{im}}{e_m}, \qquad (10)$$

where

b_{im} = dollar of final demand sales from sector i directly required per dollar expenditure on consumer product.

The distribution of the industrial composition of each expenditure item in the hypothetical economy is shown Table A-2, panel (b).

Last, from equations (7) and (10) we can create a matrix of the total output of each sector required per dollar of PCE on each item:

$$K = SB. \qquad (11)$$

The final matrix, Table A-2, panel (c), shows the output (in dollars) required by each industry named at the beginning of the row to produce and deliver one dollar's worth of the personal consumption expenditure item named at the head of the column.

In this hypothetical economy, private investment, government expenditures, and net exports are zero. Therefore, from equation (1) it is apparent that aggregate PCE expenditures are assumed to equal aggregate income, i.e., C = Y. Therefore, equations (7), (9), and (10) can be combined to state the further requirement that total production in the hypothetical economy equals the sum of the output requirements of all PCE items; i.e.,

$$Z = SY = SU\bar{L} = SBE,$$

or

$$Z = KE. \qquad (12)$$

So the effect of a 10 percent price increase in manufacturing has been a 2.5 percent increase in agriculture prices and a 1 percent increase in the price of services.

Using the share of final demand accounted for by each sector, a cost of living index can be computed. To illustrate this idea, recall the total final demand column from Table A-2, panel (1), in which the sector components of personal consumption expenditures were as follows: agriculture, 80; manufacturing, 300; services, 120. Thus, total final demand, or personal consumption expenditures, is 500, so the relative share for each sector is, respectively,

$$\frac{80}{500}, \frac{300}{500} \text{ and } \frac{120}{500}.$$

The respective prices from the preceding example are $p_1 = 1.025$, $p_2 = 1.10$ and $p_3 = 1.01$, so a cost-of-living index, C , can be obtained as follows:

$$c = 1.025 \frac{80}{500} + 1.10 \frac{300}{500} + 1.01 \frac{120}{500}$$

or

$$c = 1.0664$$

Thus, the increase in the cost of living as a result of a 10 percent price increase in manufacturing, was 6.6 percent.

4. ESTIMATES OF PRICE IMPACTS OF EPA REGULATIONS

The new level of prices for the 477 PCE items due to the proposed EPA regulations are determined following the increases of the price level of the metal finishing universe (SIC's 34, 35, 36, 37, 38, 39). Exhibit A-3 indicates the estimated price increases for each 2-digit SIC. The price impact on the major components of total final demand in the economy is computed based on the price increase in the metal finishing universe.

3. THE PRICE SYSTEM

Input-output analysis offers a method of quantifying the price relationships of the sectors in an economy. Since the cost of any sector's output is composed of the costs of the materials inputs purchased from other sectors and such items as wages, profits, taxes, and depreciation which are a part of value added, there are implied price relationships in an input-output table. By defining unit price equal to unit cost, the price relationships between the price of different goods can be expressed as:

$$
\begin{aligned}
p_1 &= a_{11}p_1 + a_{21}p_2 + \dots\ a_{n1}p_n + v_{1}1_{1} \\
p_2 &= a_{12}p_1 + a_{22}p_2 + \dots\ a_{n2}p_n + v_2\ {}_2 \\
&\ \ \vdots \\
p_n &= a_{1n}p_1 + a_{2n}p_2 + \dots\ a_{nn}p_n + v_n\ {}_n
\end{aligned} \qquad (13)
$$

where

p_i = the price of good i,

a_{ij} = the technical coefficients,

v_i = the share of primary inputs, and

i = the price of primary inputs.

By using the equation system (7), the effects of a price change in one sector upon the relative prices of every other affected sector's output can be calculated assuming each industry passes on its increased costs plus the rise in costs of inputs purchased from other industries to final demand. For the exposition of the input-output price model, refer to References 4 and 5.

An example of the procedure for determining price impacts on the value of final demand is shown below for the three sector economy shown in Table A-1. It is assumed here that prices of all sectors and all primary inputs in the base periods are equal to unity for the sake of simplicity. Further, suppose the price level in manufacturing increases 10 percent due to the increased costs necessary to comply with the proposed standard. The problem is to determine the new level of prices for agriculture and services.

When we assume that the prices of primary inputs in other sectors (i.e., Φ_1 and Φ_3) are not permitted to change, the relationship (13) for the three sector economy can be easily solved as below by first transposing all the know elements in each of the three equations to the right hand side and the unknown variables (and their coefficients) to the left hand side. Given our assumption, the "unknowns" are P_1, P_3, and Φ_2, and all other elements are known or assumed known. Thus, equation (13) for a three sector economy, with our stated assumption, may be written as:

$$p_1 = a_{11}p_1 + a_{31}p_3 + (a_{21}p_2 + v_1\Phi_1)$$

$$v_2\Phi_2 = -a_{12}p_1 - a_{32}p_3 + (1 - a_{12})\ p_2$$

$$p_3 = a_{13}p_1 + a_{33}p_3 + (a_{23}p_2 + v_3\Phi_3)$$

and solved as follows:

$$\begin{bmatrix} p_1 \\ \Phi_2 \\ p_3 \end{bmatrix} = \begin{bmatrix} (1 - a_{11}) & 0 & - a_{31} \\ a_{12} & v_2 & a_{32} \\ -a_{13} & 0 & (1 - _{33}) \end{bmatrix}^{-1} \mathbf{X} \begin{bmatrix} a_{21}p_2 + v_1\Phi_1 \\ (1 - a_{12})\ p_2 \\ a_{23}p_2 + v_3\Phi_3 \end{bmatrix}$$

$$\begin{bmatrix} p_1 \\ \Phi_2 \\ p_3 \end{bmatrix} = \begin{bmatrix} 0.8 & 0 & 0 \\ 0.2 & .55 & .15 \\ 0 & 0 & .90 \end{bmatrix}^{-1} \text{X} \begin{bmatrix} .2(1.1) + .6(1.0) \\ .8(1.2) \\ .1(1.1) + .8(1.0) \end{bmatrix}$$

$$= \begin{bmatrix} 1.25 & 0 & 0 \\ -.455 & 1.818 & -.303 \\ 0 & 0 & 1.11 \end{bmatrix} \text{X} \begin{bmatrix} .82 \\ .88 \\ .91 \end{bmatrix} = \begin{bmatrix} 1.025 \\ .951 \\ 1.0.0 \end{bmatrix}$$

Thus

$p_1 = 1.025$

$p_3 = 1.011$, and

$p_2 = 1.10$ by assumption,

EXHIBIT A-3

Estimated Price Increases For
2-Digit SIC's (In Percent)

SIC	Option I	Option II
34	0.3	0.9
35	0.3	0.9
36	0.1	0.3
37	0.1	0.2
38	0.1	0.2
39	0.1	0.3

EXHIBIT A-4

Estimated Total Price Impact of EPA BATEA
Metal Finishing Regulations or Principal
Final Demand Components

Final Demand Sectors	Percentage Price Increase	
	OPT I	OPT II
Personal Consumption Expenditures	0.01	0.02
Gross Private Fixed Capital Formation	0.005	0.01
Net Exports	0.01	0.02
Total Federal Government Purchases	0.007	0.01

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1. Leontief, Wassily, Input-Output Economics, Oxford University Press, New York, 1966.

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3. United Nations, Problems of Input-Output Tables and Analysis, New York, 1966.

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