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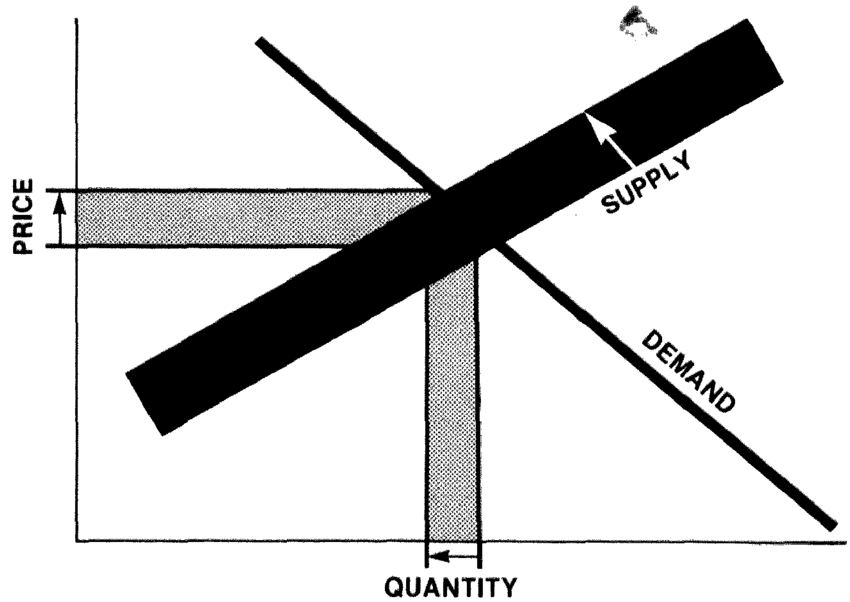
Economic Analysis of Pretreatment Standards for Existing Sources of the Electroplating Point Source Category



U.S. ENVIRONMENTAL PROTECTION AGENCY
Office of Analysis and Evaluation
Washington, D.C. 20460

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Economic Analysis of Pretreatment Standards for Existing Sources of the Electroplating Point Source Category

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Prepared for:

Office of Analysis and Evaluation
U.S. Environmental Protection Agency
Washington, D.C. 20460

PREFACE

The attached document is a contractor's study prepared for the Office of Analysis and Evaluation of the Environmental Protection Agency (EPA). The purpose of the study is to analyze the economic impact which could result from the application of pretreatment standards established under section 307(b) of the Federal Water Pollution Control Act, as amended.

The study supplements the technical study, Development Document for Existing Source Pretreatment Standards in The Electroplating Point Source Category, August 1979, and the earlier Development Documents supporting the issuance of interim final and final regulations under section 307(b). These documents survey existing and potential waste treatment control methods and technologies within particular industrial point source categories and support the proposed pretreatment standards based upon an analysis of the feasibility of these standards in accordance with the requirements of section 307(b) of the Act. The investment and operating costs associated with alternative control and treatment technologies are presented in Supplement B to the Development Document which is available for inspection in Room 2922, EPA Public Information Unit, 401 M Street, S.W., Washington, D.C., 20460. 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 compliance in terms of product-price increases, effects upon employment and the continued viability of affected plants.

The study has been prepared with the supervision and review of the Office of Analysis and Evaluation of EPA. This report was submitted in partial fulfillment of Contract 68-01-3996 by Booz, Allen & Hamilton Inc.

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EXECUTIVE SUMMARY

EXECUTIVE SUMMARY

This report presents an economic impact analysis of the metalfinishing industry. The economic impact is that due to capital investments in water pollution abatement technology. The primary measure of economic impact is the number of potential plant closures due to these requisite capital investments.

For this summary, the following four points will be developed:

- Definitions and scope of the study
- Data gathering and analytic methodologies
- Descriptive information on the industry
- Presentation of key findings (impacts).

1. THE STUDY IS RESTRICTED TO MUNICIPAL DISCHARGERS IN THREE METALFINISHING PRODUCTION SECTORS

This report covers firms that belong to, or perform processes common to the metalfinishing industry. These firms are specifically involved with a discrete number of production processes defined by the EPA as falling within the Electroplating Point Source Category, and hence, regulated under this guideline. The scope of the study is limited to those establishments which perform one or more of the following:

Electroplating of common metals

Electroplating of precious metals

Anodizing

Coatings, i.e., phosphating, chromating or immersion plating

Chemical etching, milling and engraving

Electroless plating

Printed board manufacturing.

The regulations discussed in this report are EPA's Pretreatment Standards for Existing Sources in the Electroplating Point Source Category. Firms governed specifically by Pretreatment Standards are those firms that now discharge their effluent wastewater to a sewer that requires chemical/biological treatment by a municipal or publically owned treatment works (POTW). Such firms are also called indirect dischargers. In sum, the focus of study is that universe of metalfinishing firms performing regulated processes that discharge to POTW's and face compliance with Pretreatment Standards.

The universe of metalfinishing firms is composed of three production sectors. They are:

<u>Job Shops</u>--Independent, small (often family run) operations that typically plate with copper, nickel, chromium and zinc.

Printed Board Manufacturers--Independent producers of wire or circuit boards whose products involve copper and electroless plating.

Captive Operations--Production centers, found within manufacturing firms, that provide finishing services to the products of the parent company.

These three sectors are studied independently in the body of the report. Each is described as an economic entity; costed for its pretreatment technology, and analyzed for its expected impacts.

2. SURVEYS AND AUTOMATED IMPACT ROUTINES WERE THE PRIMARY DATA GATHERING AND ANALYTIC METHODOLOGIES OF THE STUDY

This study is distinguished by the fact that virtually all descriptive and analytic data came from primary sources. Primary sources in this case are members of the industry sectors for information pertinent to finances, production processes and market conditions. Similarly, on the technical side, primary sources included pollution control equipment suppliers for supplemental information on treatment components and their costs.

There were three separate data gathering surveys. The groups surveyed were:

Independent suppliers of metalfinishing services, i.e., the job shops

Independent producers of metal clad wiring or printed circuit boards

Individual manufacturing establishments with in-house metalfinishing capabilities, i.e., captive operations.

All survey methodologies are written up in detail in Chapter I and in Appendices A, B and C of this report. Reviewing them here serves to set the findings of the next section in perspective.

Job shops were contacted by mail in the winter of 1976. Almost half of all listed metalfinishing firms in the Dun's Market Identifiers File were sent a questionnaire (2,221 of 5,551). Returns came back from approximately 900 cases. Usable mail returns numbered 444 of which 205 qualified as plant models for purposes of this report.

Captives were also contacted by mail in the early spring of 1977. This was a population mailing to some 8,800 firms in the *Products Finishing* subscription list that met two criteria. They were not independent job shops, and they provided data to *Products Finishing* in the past suggesting a regulated process was performed at the plant. Returns came back from some 3,400 cases of which some 1,600 were used for analysis.

Printed circuit board manufacturers were identified through a two-step process. Underwriters Laboratories furnished a listing of some 600 establishments or corporations that had submitted a printed board product for testing. Their listing was cross-checked against the Dun's Market Identifiers File and produced some 300 matches. Financial reports were ordered on all yielding some 175 reports. These were screened and 100 firms contacted for detailed information.

This completes the brief description of the three sample segments that define the industry of interest.

In addition to the primary data gathering surveys of these industrial sectors comprising the industry, some small-scale surveys were conducted to gather supplemental information:

Telephone interviews with commercial lending officers to verify the appropriateness of key financial criteria utilized in the automated financial closure routine.

Telephone interviews with suppliers of pollution abatement systems for the metalfinishing industry. Of interest here was the correspondence of computer generated equipment costs with professional quotations.

Telephone follow-up interviews with a sub-set of study respondents to clarify the key financial data of the study. This effort established that the base year of the study was a "typical" year for the industry as a whole.

Three additional study methodologies were required: a method for applying the technical contractor's costs, a means for predicting a financially vulnerable plant, and a method for extrapolating closure results from the sample to the population.

Costs were developed by the Technical Contractor for the Agency's Effluent Guidelines Division, using an automated cost program developed specifically for this industry. From the early returns to BAH's job shop questionnaire, 82 actual plants providing detailed technical-production data were selected for costing. Those 82 represented a full distribution of job shops along key study dimensions:

- Processes
- Water use
- Employment
- Size
- Location
- Lines
- Sales

While additional returns also could have been used for technical review and costing the 82 were judged a full and adequate data base.

Regression equations for unit costs as well as flow allocation rules per component were then derived by BA&H. This provided the analytic tools for assigning costs to all other plant models. A plant model was operationalized as any survey respondent providing sufficient technical and financial data so that the plant could be costed and tested for closure. There were 205 job shops, 40 printed board manufacturers, and more than 600 captives which are plant models and serve as closure test cases.

Closures were calculated by an automated financial routine for both job shops and printed boards. Captives, because their investment decision is unique and because no detailed income statements were requested, were handled through a different analysis. The financial closure routine uses reported income and balance sheet data to compute a present cash flow situation and a projected cash flow situation after the investment. Two criteria must be satisfied for a firm to satisfy the closure test. Its future coverage ratio must be at least 1.5 to support securing a bank loan or failing that, the owner might choose to increase his equity to help purchase the equipment as long as his net compensation (salary, bunus, and profit after taxes) is at least $15,000.

Closure rates for the population were determined to be the same as the overall sample closure rate. Tests were run to identify significant differences in closure rates by the size of the firm (i.e., testing by employment, sales and water use). No significant differences were found. Additional tests were run between survey respondents and non-respondents and between the model and non-model plants to test for systematic differences. Again, none were found that affected closure rates. Therefore, the closure rate found in the plant model analysis is extrapolated directly to the universe to project total industry impacts.

This finishes the discussion of how the study proceeded methodologically. Summaries of major findings appear in the next section.

3. THE INDUSTRY CONSISTS PRIMARILY OF SMALL OPERATIONS MEASURED BY SALES, EMPLOYMENT AND WATER USE

The following three sections provide summary descriptions of selected descriptive data on each segment. Data are presented first for all firms within the sector and then for just the regulated indirect discharging segment of the sector.

(1) Almost 3,000 Job Shops Are In the Electroplating Point Source Category

The data base of the 1977 Dun's Market Identifiers File and the 1972 U.S. Census of Manufacturers estimate the population of job shops at approximately 5,000 firms.

By the patterns of responses to the job shop survey (Appendix A) more than half, or 2,941 firms do processes covered by these regulations. Of this number more than 90%, or 2,734 comprise the indirect discharging segment, and are the main focus of study.

On the basis of total employment, these 2,941 firms employ 69,700 people of which 52,275 are production employees in wetmetalfinishing. For the indirect discharging segment the numbers are 62,800 and 46,800 respectively.

Only 14% of the job shops sell $1 million or more annually with 72% of all firms selling $0.5 million or less a year. Average sales at the plants are $580,000 with total industry output estimated at $2.1 billion annually. Indirect dischargers are estimated to generated $1.9 billion in sales.

At the plant level, a job shop uses water on average at the rate of 38,700 gallons per day of which 83% or 32,300 gallons per day is water used directly in metalfinishing production processes. For the industry as a whole, total plant water use is on the order of 114 million gallons per day with 95 million gallons per day taken by production processes. For indirect dischargers the values are 109 million gallons with 88 million gallons per day for production processes.

(2) Printed Board Manufacturers Are A Small Segment of the Industry

Given that process group H of the regulations of the Electroplating Point Source Category is for printed board manufacturers all identified firms in the population (400) are affected by this guideline, with 327 estimated to be indirect dischargers.

Printed board shops are reported to be, on average, larger than the typical job shop. Mean total employment is 60 men with 35 in production finishing. For the industry as a whole, this accounts for some 23,300 people with 13,700 part of producing the printed boards. For the indirect discharging segment only these 327 producers employ 20,600 people with 11,900 people in board production.

These independent manufacturers have larger per plant sales than do the job shops. Only 35% sell under $0.5 million annually with 43% selling over a million. Plant sales on average are $1.5 million with total industry sales estimated at $610.4 million. Indirect dischargers have annual sales estimated at $494 million.

The mean total plant water use of this sector is 21,900 gallons per day. Of this amount, 86% or 18,800 gallons per day are from production processes. For the industry as a whole, 8.7 million gallons per day are used of which 7.5 million gallons are for metal-finishing processes. For indirect dischargers the figures are 7.2 million and 6.1 million, respectively.

(3) Captive Operations Drive the Demographics of the Industry

Survey results suggest that 47% of all captive operations do processes covered by these regulations. This defines a population of 6,077 firms, of which 4,722 are indirect dischargers.

Mean total employment of these firms is 660 men for a plant work force of slightly below 4 million men. But with 20 men per firm assigned to metalfinishing, the production workforce is estimated to be 117,500. Indirect dischargers represent 2.9 million people with 87,000 in wet metalfinishing.

Total sales at the plant level average $20.1 million. Of this amount, however, 54% reflects sales of goods with metalfinishing. Therefore, sales of metalfinished goods are $10.9 million. Given that the finishing cost of these goods does not exceed 10% of the total production cost, the value added by metalfinishing is estimated at $1.1 million per plant. For the total industry, this is $6.7 billion annually. For the indirect discharging segment, metalfinishing is a $5.1 billion industry.

In terms of plant water use, a firm with a captive operation uses 808,000 gallons per day. Of this total, 35% or 277,000 gallons is used by the captive finishing operation. On a daily basis, all 6,077 establishments with captives use 4.9 billion gallons with the captive operations requiring 1.7 billion gallons. Indirect dischargers should account for 3.8 billion gallons with 1.1 billion gallons used in finishing operations.

4. COMPLIANCE WITH THE PRETREATMENT STANDARD COULD AFFECT SOME TWENTY PERCENT OF ALL INDEPENDENT ESTABLISHMENTS AND THREE PERCENT OF THE CAPTIVE OPERATIONS

The points listed below capture the key estimates and findings of the study. All costs and impacts reported below are only for the indirect discharging sector of each industry segment.

For plants whose metalfinishing process water flow is below 10,000 GPD the treatment technology for pretreatment is:

Destruction of cyanide amenable to chlorination by single stage chlorination

- Precipitation and clarification of lead, cadmium and cyanide.

For plants above the 10,000 GPD process water level, the treatment technology consists of:

- Oxidation of cyanide in two stage alkaline chlorination
- Reduction of hexavalent chromium (where necessary)
- Precipitation and clarification of cadmium, lead, copper, nickel, chromium, zinc and silver.

Total investment costs for the three sectors to meet Pretreatment standards are $1,340 million. Of this total, jobbers face $187.6 million, printed board $18.5 million and captives $1,134.4 million. On a ten-year annualized basis, the total for the industry is $493.9 million. Again for jobbers, printed board makers and captives, the figures are $62.5 million, $6.8 million and $424.6 million, respectively.

Closures are possible in 19% of the job shops and in 3% of the printed board firms. No closures are predicted in captive operations although 3% might divest the operation and purchase finishing from jobbers. On an overall basis, 17% of the independent operations and 9% of all operations within the Electroplating Point Source Category may close as a result of pretreatment standards. Other economic effects rest with price rises and unemployment. Jobbers are expected to increase price 7% and printed board makers 2%. Unemployment in the job shop sector could be 9,650 persons and 321 positions in the printed board industry. This corresponds to 14% and 1.3% of the jobs in each sector.

No measurable impact on balance of trade levels or on communities is anticipated because finishing is neither an international commodity nor a major regional employer.

Price impacts on the finished goods due to capital investment in pretreatment equipment are expected to be on the order of 1%. Given that no industrial sector attributes more than 10% of the cost of the finished good to metalfinishing, cost increases of up to 10% in finishing should be reflected in small point of sale price increases.

All impacts were computed on the basis of two sources of capital; commercial bank loans, and a special loan program such as the SBA. Were a special loan program readily accessible to the metalfinishing industry, job shop closure rates could be one-fourth that predicted by regular financing.

*   *   *   *   *

This completes the discussion of the key points of the study. The subsequent chapters of the report provide the substance of each issue presented herein.

I. STUDY METHODOLOGY

I. STUDY METHODOLOGY

This chapter presents the several study methodologies developed for assessing the impact of pollution control capital investments on the metalfinishing industry.

As noted in the prior Executive Summary, the study focuses on indirect dischargers; i.e., those firms now discharging effluent wastes into a publically owned sewer system. In addition, the relevant firms are only those now performing finishing processes defined within the Electroplating Point Source Category. This restricts the industry of interest to all independent metalfinishing job shops, Printed Board makers, and general manufacturing establishments with internal finishing operations (captives) covered by this regulation.

Analytically, the study requirements are captured by the following questions:

> How many such firms are there?
>
> What are their present economic, market and production characteristics?
>
> What type of (pre)treatment system must they install?
>
> What are the costs of such systems?

How will making such investments affect the structure and operating economies of the industry?

These questions are covered for each industry segment in sections A, B and C in this chapter.

1. FIVE SEQUENTIAL OPERATIONS DEFINE THE STUDY

An overall study plan for conducting the analysis was developed. It consists of the following five sequential steps:

Survey the segments of the industry to gather descriptive information

Designate a group of survey respondents as model plants against which costs can be arrayed and impacts assessed

Develop pretreatment pollution control costs through modelling and verify the applicability of those estimates for specific cases

Design a tool capable of incorporating relevant fiscal and cost data such that accurate predictions of financially impacted firms can be made

Establish a means for scaling sample based observations to the universe of affected firms.

2. EACH SEQUENTIAL OPERATION OF THE STUDY REQUIRED ITS OWN DATA GATHERING OR APPLICATION METHODOLOGY

This study is a fresh look at the industry. None of the descriptive information on the size, composition or economics of metalfinishing, whether available through secondary sources or prior studies has been used here. The goal of the study was to generate new data throughout. The methods for gathering or applying data for each segment of the industry, metalfinishing job shops, printed board makers and captive metalfinishers are presented on the following pages.

A. THE SURVEY OF INDEPENDENT (JOB SHOP) METALFINISHING ESTABLISHMENTS

This section describes the method and design of the survey of metalfinishing job shops. Also presented here are the strategy and results of a follow-up phone survey to non-respondents. The manner in which these results were used to generate the estimate of the regulated population is also presented. In Appendix A the survey instrument and the raw field data appear.

1. Design

The approach taken in this survey was a mail questionnaire followed by a follow-up telephone interview to a sample of establishments not responding to the mail phase. A mail, rather than a telephone or personal survey, was planned because of the nature of the data elements sought in the inquiry. Detailed and comprehensive information regarding production line configurations, water usage, employment statistics, and financial data were needed. Such figures are not normally readily accessible in an interview situation and often require review and consultation with others. The mail approach affords respondents an opportunity to search out and to consider thoughtfully their written replies. Previous studies among members of this industry show that respondents can and do answer even the most detailed and searching questions in a mail survey. The telephone follow-up with non-respondents was included as an essential second step to determine whether or not these establishments differed along key parameters from those responding to the mail survey. Because plant size differences were noted between mail respondents and telephone respondents, a means of weighting mail results to reflect population parameters was developed.

2. Method

Firms providing electroplating and metalfinishing services are listed in SIC (Standard Industrial Classifications, Office of Management and Budget) 3471 and 3479. Therefore, the universe under investigation in the study was defined as all firms listed in the two SIC's that currently performed those manufacturing processes covered by the regulations.

The most recent and complete listing of such firms available at the start of the study was the Dun's Market Identifiers File (DMI) purchased by the U.S. EPA from Dun and Bradstreet. Contained in the DMI were 5,551 names of organizations whose primary SIC is either 3471 or 3479.

This listing of 5,551 was ordered first by the size of the company (using number of employees) and then, within size categories, ordered by state and then alphabetically.

A survey design was employed that systematically sampled from the universe using a fixed interval and a random starting point. By employing a 2.5 interval and going through the list, a sample universe of 2,221 establishments was derived.

3. The Instrument

Prior analyses, client discussions, and coordination with the metalfinishing industry reinforced the conclusion that considerable information was needed for systematic economic impact analysis. The data would have to be gathered via the mail. The instrument had to be a convenient self-administered questionnaire. To this end, the following developmental steps were followed. The study team:

Solicited descriptors of technical and production variables from the technical contractor. In this way, data would be gathered from which pollution control costs could be developed.

Provided drafts of the instrument to the industry's association, the NAMF (National Association of Metal Finishers). Their comments contributed directly to the form, content, and length of the final instrument.

Reviewed the early drafts with Booz, Allen's sampling survey division, National Analysts. Their contribution went far beyond the duties of administering, coding, and scoring the returns. On early drafts, they reviewed critically the language, format, and lucidity of all items.

Prior to the first mailing the instrument was tested on a subsample of 12 firms located in New Jersey. This effort was conducted to ensure that directions were self-explanatory, items clear, and data obtainable. Valuable information was gathered by sitting with a respondent and "walking him through" all items. Several changes in the instrument's form and length were made as a result of this pre-test.

4. Execution

At the end of this development phase the final instrument was 14 pages long and covered the topics of:

- Production activities
- Market conditions
- Technical operations
- Financial conditions
- Treatment requirements
- Investment options

In October, 1976, all 2,221 establishments were mailed a questionnaire with cover letters from both the NAMF and the Agency. A postage paid return envelope was enclosed. Replies were monitored as received by National Analysts and when the response levels diminished to fewer than two to three a day, a second mailing went out to the non-respondents. Again, a cover letter and a return envelope accompanied each questionnaire.

5. Follow-up

The results of mailing to 2,221 are shown below.

Result	Number of Sample Plants	
Respondents	687	
Subject to regulation		444
Out of scope		243
		687
Undeliverables or Not Classified	154	
Undeliverables		143
Not Classified		11
		154
Nonrespondents	1380	
Total Sample	2221	

Replies from 687 cases yielded a 31% response rate and gave a rich analytical data base. But 1380 cases did not answer and a follow-up telephone survey was designed to determine whether non-response bias existed.

The telephone follow-up survey of the mail non-respondents was conducted according to a sample stratified by employment at the plant location as given by D&B. The weights, which are used to extrapolate the telephone survey results to the entire group of mail nonrespondents, are computed by taking the reciprocal of the probability of selection within strata and then adjusting for nonresponse to the telephone survey. For each stratum, the probability of selection is determined by the ratio of the number of plants in the telephone sample to the number of mail nonrespondent plants. The adjustment factor, which is multiplied by the reciprocal of the selection probability to obtain the weight, is computed by adding unity to the ration of telephone nonrespondents to the number of telephone respondents plants in the same stratum. This factor adjusts the telephone respondents to account for telephone nonrespondents, and is given by the equation:

$$\text{Weight} = \frac{\text{No. of mail non-respondents}}{\text{No. in telephone sample-No. of telephone non-respondents}}$$

Quantities necessary to complete these computations are given in the summary table below:

Table I-1

Sample Strata Weights

D&B Employment Strata	Mail Nonrespondents	Telephone Sample	Telephone Nonrespondents	Weight
1 (1-4)	378	124	8	3.26
2 (5-9)	289	57	6	5.66
3 (10-19)	267	47	7	6.68
4 (20-49)	208	19	1	11.55
5 (50-99)	70	20	2	3.88
6 (100-249)	24	6	1	4.68
7 (250+)	6	2	1	6.00
8 (zero)	10	3	0	3.33
9 (missing)	127	42	2	3.18
	1,379*	320	28	

* Note that the total of mail nonrespondents in this table does not agree with the same total in the previous table. This minor discrepancy is due to one case being missing from the file on which the weights are based.

The results of the mail and telphone survey were extrapolated to the factor sample by applying the weighting to each of the 444 in-scope mail responses. A second extrapolation to the entire D&B sampleing frame is accomplished simply by multiplying by (5551/2221). This yields a final estimate of the total population of independent job shops falling within this regulation. This estimate is arrayed below.

Table I-2

Total Number of
Metalfinishing Job Shops*

Size of Firm**	Total	POTW***
1-4	1,156	1,045
5-9	682	658
10-19	546	524
20-49	357	339
50-99	159	142
100-249	41	26
Total	2,941	2,734

* Covered by Electroplating Point Source Category Regulation

** Measured by wetmetalfinishing production employees

*** Discharging to Publicly Owned Treatment Works

B. THE PRINTED BOARD MANUFACTURERS SURVEY

This section presents the method and design of a data gathering survey of independent manufacturers of Printed Boards. The instrument used and the raw data are contained in Appendix B.

1. Design

If all independent Printed Board Manufacturers (PBM's) fell within one or two generic SIC 4-digit classifications structuring their survey would have been straightforward. Although many PBM's do appear in SIC 3679 (Electronic Components, not elsewhere classified) two problems are obvious with tapping that data source:

- Many firms in SIC 3679 produce products far different from printed circuit boards, e.g., phonograph needles, earphones, relays
- Known producers of printed boards do not necessarily assign their firm to SIC 3679. Many use SIC's 3643, 3691, 2511, 5065, 5081.

The approach developed for targeting a sample from an estimate of the population was the following:

- From Underwriters Laboratories a listing of all manufacturers of printed board products was obtained. This listing numbered some 600 company names
- Dun and Bradstreet submitted the UL list to their files and generated a DMI list of 508 "matches." This list of 508 contained firms that were branches, headquarters and independent locations.
- Paring the list still further to just the independent producers yielded 357 names. For analytic

purposes this defined the population of interest. Subsequent analysis suggested a somewhat higher estimate of the universe, set at 400.

2. Method

With access to the DMI list of more than 350 firms, data were available that could enable either a mail or phone survey to be conducted.

Of primary importance to the survey effort was to obtain sufficient financial data for the automated closure routine. The mail survey to jobbers had succeeded in generating financial data, but 6 to 8 weeks for a mail effort were not available. In addition, there was little reason to expect that a complete telephone survey which also sought financial data could be successful.

The study method, then, was a synthesis of two methods. A phone survey was part of the design because it yields data immediately, but financial items would not be sought in the interview but obtained directly from the Dun's reports.

The latest financial reports on approximately half the identified population were purchased. This yielded a randomly generated group of 190 firms all possessing financial records. Perusal of these records showed slightly more than 100 provided values for enough account categories to develop complete and consistent balance sheets as well as sales and profit data. This was the sample sub-group of primary interest, and the group targeted for first contact.

All firms for which satisfactory financial records existed were defined as the segment of the universe to be contacted. This pre-screening of the sample assumed two risks. One, there is a certain probability of under-representing smaller firms since they seem to be less likely to volunteer their statements to D&B. A second is the possibility that those firms offering data are overstating their condition since no validation or certification of the records is offered by D&B. While these biases could be self-canceling, the fact remains that the sample is neither fully stratified nor randomly drawn. However, it was the best available under the circumstances.

3. Execution

A telephone interview guide (Appendix B) was developed by Booz, Allen & Hamilton and the client. In addition, the Technical Contractor was consulted for guidance on the production and process items. Brevity guided the effort. Each interview took fewer than 20 minutes to complete.

A team of special Booz, Allen & Hamilton consultants, working for a week, made all the calls. Each call went directly to the individual shown on the D&B listing as the owner, president or chief officer of the establishment.

Calls from the list of 190 continued until 100 interviews were completed. Reviewing all financial and technical data for accuracy yielded a sub-sample of 40 plant models that were used for estimating compliance burdens and closure rates for the population.

C. SURVEY OF MANUFACTURING ESTABLISHMENTS WITH IN-HOUSE CAPTIVE METALFINISHING OPERATIONS

This section presents the issues involved in the design and execution of a data gathering effort in the captive metal-finishing sector. Of specific interest here are the special considerations of this sector that delineated the study approach. Appendix C contains the study instrument and all the raw field data.

1. Design

As in the study of the Printed Circuit Board industry, the key starting point in the survey of captive operations was to define the universe. Essential to any sample design is knowing the totality of all cases defining the population from which a sample can be drawn.

The difficulty with respect to targeting a study of captives is that any manufacturing establishment that produces a durable good might have applied surface finishing covered by these regulations. Consequently, establishments with captive operations could appear throughout the industrial manufacturing sectors covered by the U.S. Census of Manufactures. This defines a universe in the hundreds of thousands.

Resolution of this problem was provided through contact with the publishers of Products Finishing magazine. People knowledgeable about this industry, including the magazine's publisher, maintained that it was widely read in the industry; that its subscription list includes the vast majority of establishments involved in metalfinishing; and prior surveys by the magazine had already recorded the primary finishing processes of the subscribers. An added reason for working with the Products Finishing list was that it served as the source data for the National Commission on Water Quality's estimate of 60,000 - 80,000 captive operations. The list, therefore, was regarded as the best single estimator of the universe of establishment with captive operations.

Procedurally, the survey of the captives was done as follows:

- Names and addresses of firms were not to be seen by the Agency, or by BA&H. Mailing labels were provided under the assurance that company names would not be recorded in any fashion.

Mailing was to occur at a single point, with no means for second mailings, follow-ups or subsequent contact.

Both conditions were met.

2. Method

In October 1976, Products Finishing provided Booz, Allen a card deck containing 21,975 records, each record representing one firm. From the code sheet accompanying the deck, it was possible to delete all establishments whose primary SIC was either 3471 or 3479. This eliminated all job shops from the population. Next, firms doing painting only, and all firms doing only finishing processes outside the Electroplating Point Source Category were eliminated. This yielded a sub-set of subscribers which, on the basis of information provided to Products Finishing magazine, should be manufacturing plants with in-house finishing operations doing finishing processes under this regulation. There were 8,874 such establishments that defined the population of interest.

The months of January and February 1977 were spent in developing the questionnaire instrument. Several key decisions were made:

> Detailed financial information would not be requested in the instrument because of the size of some of the parent corporations, e.g., Ford Motors, General Electric.
>
> Detailed line descriptions and production process information were also omitted because treatment costs could be modelled by process water use coupled to generic finishing processes, e.g., anodizing, chromating, common metals plating.
>
> Freedom to divest the in-house operation was judged a key factor so special attention was given to the captive operation, relevance of the operation to on-going production schedules, the availability of outside finishing and the probability of changing finishes or doing without metalfinishing altogether.

The instrument (See Appendix C) went through five versions before it was ready for mailing. Copies went to several outside sources for critical comments. Providing their critiques were Products Finishing editors, a director of environmental engineering at a major corporation and an academic researcher familiar with the industry. By early March, 1977, the survey was ready to mail.

3. Execution

On March 2, 1977 questionnaires were mailed to each of the 8,874 establishments targeted as the relevant population. The date requested for return was March 25. Due to the fact that several firms called explaining that the questionnaire reached the "right" individual as late as March 20-21, the survey was kept open until April 8, 1977.

Questionnaires were received from 3,450 firms in the sample for a response rate of 39%. The most interesting finding from the returns is that 1,836 respondents (53%) said they did not do a finishing process listed for the Electroplating Point Source Category. There were 1,614 returns that yielded full and useful data.

*   *   *   *   *

This completes the discussion on the three surveys done for this economic analysis of the metalfinishing industry.

3. POLLUTION CONTROL COSTS WERE DEVELOPED BY COMPUTER APPLICATION OF FIELD DATA AND THEN MODELLED FOR ECONOMIC IMPACT ANALYSIS

Appendix F to this report presents the logic, data requirements and assumptions of the computer model developed by the Technical Contractor for costing a Pretreatment Technology for the metalfinishing industry. The focus of this section is restricted to the method employed by Booz, Allen to synthesize these costs for use in the economic impact analysis.

(1) The Technical Contractor Developed Pollution Control Costs for 74 Job Shops

When some 300 job shop survey questionnaires had been returned, they were reviewed for diversity, completeness of data and representativeness. Eighty-two plants were chosen which provided sufficient data for costing and which represented at least three to four other returns. These 82 plants were considered "model plants" for costing purposes and for their cross-sectional representation of the industry.

The 82 plant records were submitted to the Technical Contractor for costing. Due to inconsistencies and/or omissions on 8 records, costs were developed on 74 plants. The technical contractor returned to BAH very detailed cost estimates for all 74 plants. Each estimate illustrated the changes in costs under assumptions of different water use and compliance requirements.

(2) Rules Were Developed for Relating the Equipment Needs of the 74 Plants to the Plant Models Used for Impact Analysis

More than 240 job shop respondents provided the data needed for the fiscal-economic impact work; of the 240 some 40 also were from the original costing group of 74. Given that the goal of the analysis was to model impacts on a large sample of plants, BAH worked with the Agency and the technical contractor in relating the costs developed for the 74 plants to cost equations for all other usable plant models. Inspection of the proudction operations of the 74 plants yielded one set of decision rules for determining any plant's pollution abatement needs.

Plants involved only in sulfuric acid anodizing, and/or nonelectroplating metalfinishing operations (except chromating and bright dipping) were likely to require pH adjustment only to meet BPT requirements.

Plants involved only in copper, tin, cadmium, zinc, precious metalplating or bright dipping or a combination thereof were likely to require cyanide destruction and pH adjustment equipment.

Plants involved only in chromium plating, chromic acid anodizing, chromating or a combination thereof were likely to require hexavalent chromium reduction and pH adjustment equipment.

Other plants doing combinations of these operations were likely to require all three major systems: cyanide destruction, hexavalent chromium reduction, and pH adjustment.

Line segregation is a cost element if at least two pieces of control equipment are required. The cost of line segregation is halved if only two pieces are specified or if at least one piece of equipment is already in place.

All plants plating with metals regulated under this guideline will be required to treat the metals bearing stream with clarification filtration equipment.

(3) <u>Rules Were Also Established for Allocating Flow Volumes Through Each Component</u>

Inspection of the 74 model plants revealed that different types of finishing operations have characteristic flow levels to their pollution control equipment. This breakdown also appears in Appendix G.

The decision rules for allocating metalfinishing process water flow to the various waste treatment components appear below:

Plants requiring installation of cyanide destruction and pH equipment tend to have about 56% of their metalfinishing water flowing to the cyanide destruction unit.

Plants requiring installation of hexavalent chromium reduction and pH adjustment equipment tend to have about 23% of their metal-finishing water flowing to the chrome reduction unit.

Plants requiring installation of systems fall into two categories:

Plants which perform more than six operations tend to have about 62% of their metalfinishing water flow in the cyanide destruction unit and about 4% of their metalfinishing water flowing to the hexavalent chromium reduction unit.

Plants with six or fewer operations tend to have about 8% of their metal-finishing water flow to the cyanide destruction unit and about 10% flowing to the hexavalent chromium reduction unit.

In all cases all the metalfinishing water flows through the pH adjustment unit.

(4) <u>Cost Equations Per Component Were Developed as a Function of Flow</u>

Using the costs per component provided by the Technical Contractor (fully built-up reflecting site preparation and installation), and applying the flow allocation rules per component shown above, a series of predictor cost equations was derived. Exhibit I, on the following page, presents these equations. Data are presented for the costs, and then for the results of a regression using the formula against the flow data of 74 plants.

The equations account for between 60 and 80% of the variability betweeen investment cost estimates and volume of water treated in their appropriate regression of flow.

The pH adjustment equation was derived from the computer model cost estimates as well as from industry sources such as manufacturers and distributors of neutralization systems.

Sludge haul and treatment costs were computed at \$.25 per gallon applied to 1% of the total flow into the clarifier-filter.

EXHIBIT I

U.S. Environmental Protection Agency

EQUATIONS RELATING ESTIMATES OF INVESTMENT FOR
WATER TREATMENT WITH GALLONS PER HOUR OF WATER TREATED

Subsystem	Equation*	Correlation Statistic
Hexavalent Chromium Reduction	Investment ($) = 8,400 $GPH^{0.17}$	0.8
Cyanide Destruction	Investment ($) = 19,000 + 15.2 GPH	0.9
pH Adjustment	Investment ($) = 14,700 + 1.0 GPH	--
Line Segregation	Investment ($) 210 $GPH^{0.5}$	0.9
Clarifier	Investment ($) = $16,000 $GPH^{0.15}$	
Diatomaceous Earth Filter	Investment ($) = $4,065 $GPH^{0.33}$	

* Notes on Equations

1. Investment value in 1977 dollars.
2. GPH is the metalfinishing water to specific unit.
3. GPH is the total metalfinishing water of the plant.

Source: Booz, Allen & Hamilton Inc.

4. CLOSURES IN THE JOB SHOP SECTOR AND IN PRINTED BOARD MANUFACTURING WERE PREDICTED FROM AN AUTOMATED CLOSURE ROUTINE

A firm is labeled a potential closure if, for a given pollution control system under a set of assumptions about price increases and capital costs, the firm cannot finance the investment through cash flows or through securing a loan.

It is clear that such a determination requires information on multiple variables; e.g.,

- Cost of capital
- Payback period
- Depreciation schedules
- Capital needs
- Price increases

and the capacity to alter any one of them at will. An automated model of plant behavior was needed that captured both alternate policy options and fiscal conditions at the plant level. Working with an automated routine capable of reflecting changes to these objective functions was an important part of conducting a systematic industry impact study. The method by which the closure routine developed and its special features appears below. This primary routine was utilized in predicting closures for the independent metalfinishing job shops, and for the Printed Board Manufacturers. The closure methodology for the captive sector is significantly different and presented in the next major section.

(1) Calculating Costs and Modeling the Plant's Freedom to Raise Prices Are Two Key Determinants of Closure

Two operations in the closure routine are particularly pertinent to the estimation of industry impacts. One is the calculation of requisite price increases needed to cover the incremental costs of pollution control. The second is the modeling assumption of how much of the new cost can be reflected as increased price. The discussion here is limited to pricing practice in the industry.

There are basically two models to pursue.

Pricing will be uniform in the industry with price limits set by either the least cost, average cost or marginal (high) cost producer.

Pricing will be plant specific with each producer raising his prices by precisely the amount needed to cover costs independent of the pricing decision of his known competitors.

The choice of price scenario is pivotal to both the magnitude and thereby to the significance of impacts predicted for the industry. While it is not known through our surveys whether one or the other scenario universally holds, there is a strong basis for arguing that it is the latter of the two scenarios.

> Uniform pricing in which incremental cost pass throughs are limited by one type of producer is found in those industries with many anonymous producers of undifferentiated goods; i.e., agriculture. Here the more efficient high volume producers directly influence the market price of the product. Metalfinishing is characterized by a large number and variety of producers some offering specialized services to a few steady customers, others performing multiple services to a rapidly changing, diverse customer base. The assumption of uniform pricing across the industry would not be applicable.

Given the choice of an individualistic pricing model, the second key assumption involves determining how much of an incremental cost can be passed through to a customer as a price increase. Respondents provided data on their pricing history and not only does it confirm the assumption of plant specific pricing behavior, it helps establish the ceiling on probable future price increases.

After recent price increases only 27.5% of the plants reported volume declines.

Metalfinishers provided data on their estimated future price increase; not only was there a large range in values (0 - 50%), arguing further for the lack of price leadership, but the sample mean of 12.8% exceeds the estimated average price increase for the industry to come into compliance.

Metalfinishers also provided data on their customers' reactions to price increases. These data (pp 024-027 Appendix A) show clearly that in the face of price increases most customers cannot shift to captives, or eliminate finishing on their products or start their own finishing lines in-house.

For the purposes of this analysis each job shop plant model will increase price by precisely the amount of its incremental cost. This allows each plant to increase revenues by the same amount as its annual costs of compliance. This is operationalized in the closure routine as the "full cost pass through" condition. For the sample as a whole (205 plant models) this pricing assumption yields an average, sales weighted, price increase of 7.0 percent.

(2) Cost of Capital for the Pollution Control Loan Is a Related Study Parameter of Importance

The interest rate that metalfinishers would be charged for a loan is another key analytic variable. At the time of the survey, and in subsequent reviews with loan officers, the interest rate charged by a commercial bank was known to be in the 8% to 12% range, depending primarily on prior borrowings and profitability of the firm. Initially, the interest rate for purposes of the study was 10%; however, critics suggested a higher rate would more appropriately reflect trends and conditions in money and credit markets. Accordingly, for this final economic impact analysis the cost of capital was set at 12%. Although fluctuations in interest rates will continue, and selecting any one value may be outmoded by the time a report appears in print, one very important feature of this analysis must be borne in mind:

> The principal measure of plant vulnerability employed in this industry impact analysis is the plant's coverage ratio: a measure of the ratio of cash generated to obligations. Increases in interest rates are reflected in both parts of the ratio, and projected impacts are relatively insensitive to changing levels to the cost of capital.

(3) Two Unknowns in the Closure Model Are the Investment Decisions of Owners and Bankers

Although specifying the financial variables for a closure analysis is straightforward, it is considerably more difficult to assign "absolute" minimum values for these variables in predicting candidates for closure. This is particularly true in applying profitability standards because little is known about the minimum profit expectations of small businessmen such as independent metalfinishers.

The data as reported in the survey provide a departure point. Typical profits and owner's compensation were calculated on the sample and used to develop profitability criteria for predicting closures. A firm was considered to show inadequate profitability (and, hence, appear as a candidate to close) if:

It made no profit, i.e., profit after tax was less than zero

Profit after tax plus owners compensation per owner who works full time was less than the cutoff value--selected to be $15,000, or the median family income in 1976.

These profitability values are based on the sample returns and include a combined assessment of:

Evaluation of the decision from a general corporate point of view

Assessment of the likely reaction of a small business that is owned and operated by an individual or, at most, a small group of people who:

Have other opportunities for both their investment and time, namely they could own another business or invest in real estate and work full time for a salary elsewhere

Consider, from their unique situation, the increased risk in owning their own business versus the independence, etc., of being their own bosses.

Credit rules applied by bankers to loan applicants, on the other hand, are well defined and easily described. In practice, issues such as longstanding banking relationships and personal guarantees are important. There are minimum standards of quality that bankers apply to the projected financial performance of a loan applicant and a large number of financial ratios taken into consideration. For purposes of this model one variable, coverage ratio is calculated to represent the firm's credit worthiness. It is clear that selecting one loan criterion variable is a simplification for modeling purposes. However, coverage ratio is an excellent measure of a firm's cash flow situation and capacity to support further debt.

In the model, a firm was judged to be unable to obtain a bank loan if its coverage ratio was less than 1.5. This is fairly liberal, assuming the personal guarantee of the owner that is typical for metalfinishing and other small industries. A coverage ratio of 2.0 is the standard minimum without the owners' personal guarantee. Banks would be extremely hesitant to lend to a firm with a coverage ratio approximating 1.0. Firms at a 1.0 coverage ratio have a projected cash flow that is exactly equal to operating costs plus loan payments; this cash flow would not provide for temporary business downturns or other considerations of risk.

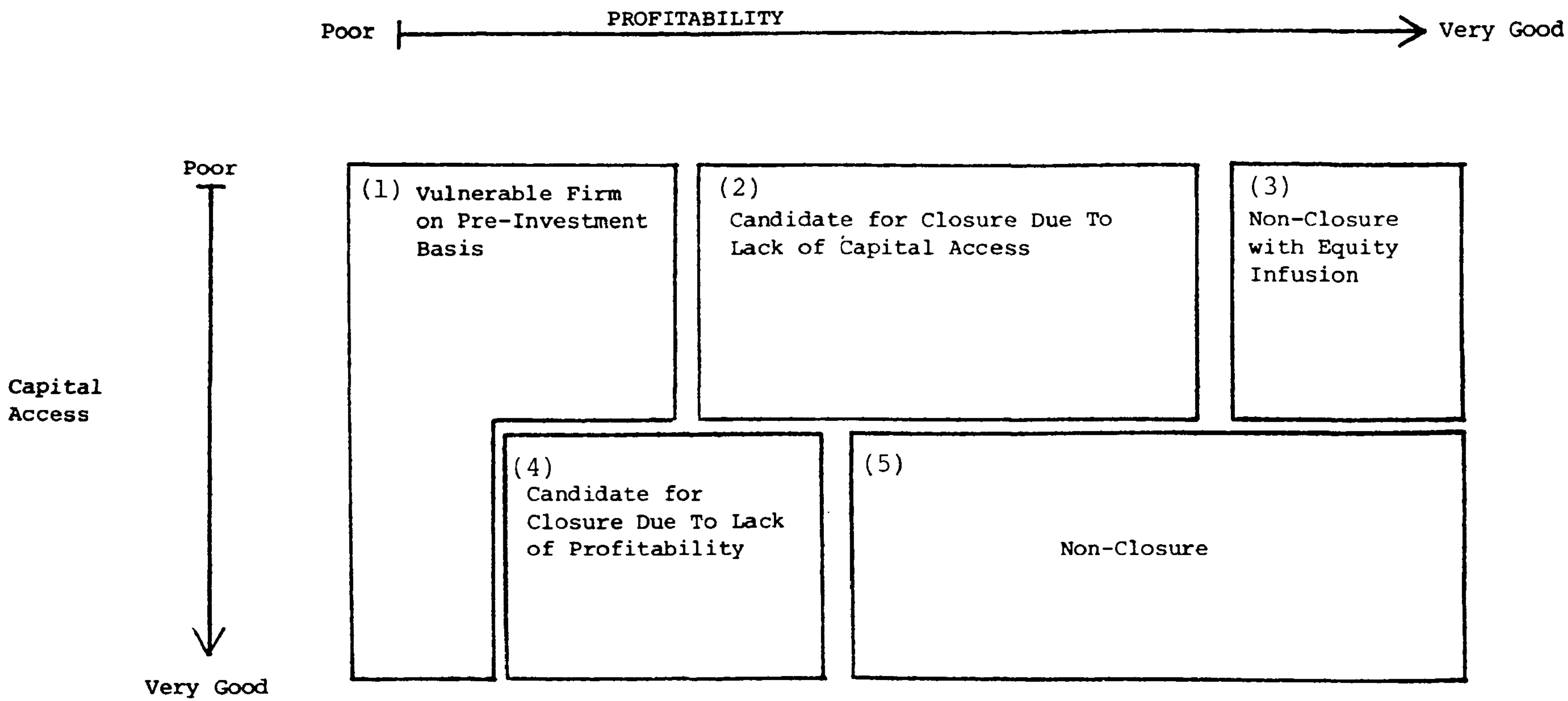
(4) Three Types of Closures and Two Types of Non-Closures Are Predicted

Consideration of the profitability and capital access measures and values lead to the five classifications of pre and post-investment firms illustrated in Exhibit II, following this page. The classifications are based on the possible combinations of profitability and capital access, which range from a firm's being rated poor in both categories--the upper left hand corner of the illustration--to a firm's being rated very good in both categories--the lower right hand corner of the illustration. The five categories are defined as follows:

EXHIBIT II

U.S. Environmental Protection Agency

CLASSIFICATION OF FIRMS WITHIN THE FINANCIAL CLOSURE METHODOLOGY



Baseline Closure Candidate (1)--Those firms that on both a current and projected basis showed inadequate profitability, which implies that they are candidates for closure regardless of the installation of pollution control equipment.

Candidate for Closure Due to Lack of Capital Access (2)--Those firms that have coverage ratios under 1.5 and that would require prohibitively large equity infusions to secure loans.

Non-Closure With Equity Infusion (3)--Those firms that have poor capital access but could obtain loans with an investment of a reasonable amount of additional equity by the owner on a one-time basis. In the model the equity infusion rule is invoked by either purchasing it outright, or enabling the coverage ratio to reach 1.5. The test only "saves" the firm if the return to the owner is at least $15,000.

Candidate for Closure Due to Lack of Profitability (4)--Those firms that could secure a loan but which might not because of inadequate projected profitability.

Non-Closure (5)--Those firms with both adequate profitability and adequate capital access.

Classification of the 205 selected plant models into those five categories is the basis for extrapolation of candidates for closure to the entire industry.

5. A CAPTIVES CLOSURE ANALYSIS IS BASED ON OPERATIONAL RATHER THAN FINANCIAL CONSIDERATIONS

It is presumed that a manufacturing establishment invests in its own in-house finishing operation for reasons of operational efficiency; i.e., it costs less to do it in-house, production functions do not allow shipping goods out for finishing and then carrying inventory, or there are no acceptable outside finishing services. A closure decision for such plants has to be viewed, therefore, in light of the operating constraints of the production cycle:

Cost of the pretreatment system relative to prior capital investments in metalfinishing

Age and size of the in-house finishing operation with respect to its capital replacement requirements

Operating budget for finishing with respect to its proportion of total value added by finishing

Importance of the finishing operation with respect to the total production flow.

In sum, the closure test for captive operations is whether a firm is "free" to divest its captive operations.

The analysis focuses on the likelihood that a firm could economically as well as operationally divest itself of its finishing given its present commitment to the process. Firms likely to divest rather than make the investment in requisite treatment systems are those which among other things:

Have the freedom to send out finishing work or produce goods with an alternate finish

Produce relatively few metalfinished goods, and for which the added value of finishing is minor.

(1) Seven Variables Are Key to the Captives Closure Model

Given that the rationale for a captives closure is based on "freedom to divest", the study requirement was to gather the data capable of identifying such firms. There are seven key information items that permit this analysis. They are the following:

Plant value added by metalfinishing: computed as the product of the respondent's answers to three items:

- Annual sales at the plant
- Percent of goods receiving metalfinishing
- Cost of metalfinishing as percent of the total cost.

Corporate value added by metalfinishing: computed as the product of answers to the following:

- Annual sales of corporation
- Percent of goods receiving metalfinishing
- Cost of metalfinishing as a percent of the total cost

Estimated pollution control annualized cost: computed from flow rates, metals present, production processes and value of equipment in place

Estimated annual increase in the metalfinishing budget: computed as the ratio:

$$\frac{\text{Estimated pollution control cost}}{\text{Metalfinishing annual budget}}$$

Estimated increase in metalfinishing value added due to the cost of the pollution control equipment computed as the ratio:

$$\frac{\text{Estimated pollution control cost}}{\text{Plant value added by metalfinishing}}$$

Estimated increase in sales price of goods receiving metalfinishing due to the cost of the pollution control equipment: computed as the term:

$$\frac{\text{Pollution control cost}}{\text{Sale at plant}} \times \text{Percent of all goods receiving metalfinishing}$$

Estimated risk factor, which is the incremental increase in the metalfinishing equipment base represented by the investment in pollution controls: computed as the ratio:

$$\frac{\text{Pollution control capital cost}}{\text{Replacement value of metalfinishing equipment}}$$

(2) The Seven Variables Yield Five Important Matrices

Data from the seven variables permit distribution of all respondents along a scoring dimension. Combining two scoring dimensions yields a matrix. All respondents can then be assigned to a specific cell in a matrix. Five unique matrices were considered particularly important for characterizing captives operations. They are:

Plant sales x value added

Plant sales x WMF employment

Value added x WMF employment

Plant value added x plant sales

Value added x risk factor.

(3) Those Operations that Fall Consistently in Certain Cells Are the Candidates to Divest the Finishing Operation

From the preceding, a working hypothesis for identifying a closure is that a closure should occur in:

Any plant for which the pollution control cost is large with respect to the plant value added by finishing; as well as large with respect to the total prior capital investment in finishing.

The sample of respondents is cast in succession across the five tables holding the results of the prior run constant. This yields the number of captives with low value added and low sales, high investment, high risk and high price increase. Running the analysis sequentially yields the estimate of all cases that fit all the criteria. The analysis is not applying a closure model, as much as it is building a closure profile.

6. METHODS FOR LINKING SAMPLE CLOSURE RATES TO THE POPULATION WERE TESTED: THE METHOD USED IS EXTRAPOLATING BY DIRECT PROPORTIONALITY

A critical issue in a sample survey study is establishing the link between sample findings and the population. In normal survey work, this is handled by the techniques of sampling design and inferential statistics. In economic impact analysis the problem of linking the sample to the population is particularly acute because survey results have to reflect the probable economic viability of an entire industry. Therefore, it is necessary to establish that:

Sample selection is unbiased

Respondents are similar to non-respondents

Test cases, e.g., model plants used for the closure analysis reflect the wider sample

Model plant findings, e.g., closure rates, can be extended systematically to the population.

The first three concerns are covered both in prior points in this chapter as well as in Appendix D. The focus of this section is the last point: the derivation of the method for extrapolating sample plant closure rates to the total industry. Analytically, the steps undertaken to derive the method were the following:

Identifying the elements that distinguish closures from non-closures

Testing the predictive power of those distinguishing elements

Establishing the mechanism that serves to extrapolate sample findings.

(1) Comparison of Model Plant Closures With Non-Closures Identified 26 Potential Discriminating Variables

During the period that the automated closure routine was being developed, closures were computed manually for a subset of 36 model plants. These 36 plants were chosen at random from all models on which there were complete and consistent financial statements.

All variables on which data had been gathered were examined to compare and contrast probable closures and non-closures. Additionally, new variables were created for the analysis built from the ratios of technical to economic and financial measures.

Applying tests for differences between means, 26 variables were identified that had the capability to separate a plant judged likely to close from one that should not.

Exhibit III, on the following page, presents these data. Nine of these variables seemed particularly promising for further analysis because their mean differences were statistically significant at the .95 confidence level.

Of these nine "best" potential discriminators, only one (metalfinishing employment) covers the entire sample. All the remaining variables are plant-specific calculations which cannot serve as general links from sample results to industry results.

(2) Results of a Multiple Step-Wise Regression Yielded Three Variables Capable of Linking Sample Results to the Population

Building on the preceding, a step-wise multiple regression was run on these nine plus 9 additional potential predictors of a closure. All 18 potential

EXHIBIT III

U.S. Environmental Protection Agency

t-STATISTICS* FOR ECONOMIC AND FINANCIAL VARIABLES
TESTED COMPARING CLOSURES AND NON-CLOSURES
(n = 36)

Sales	-1.45
Total Employment	-0.83
Metal Finishing Production Employment	-1.87 •
Total Production Employment	-0.97
-Percent Metal Finishing	-1.38
Water Use, Total	0.32
Water Use, Metal Finishing	1.42
Coverage Ratio	-2.03 •
Fixed Asset Turnover	-0.58
Cash Flow/Sales	-0.72
Cash Flow/Total Assets	1.56
Profit After Tax/Sales	-1.62
Profit After Tax/Total Assets	-2.37 •
Profit After Tax/Net Worth	-0.53
Profit After Tax and Owners Compensation/Net Worth	0.52
Cash Flow/Capitalization	-2.32
Current Ratio	-0.37
Debt Percent	0.96
Debt/Equity	1.49
Borrowing Power**	-3.05 •
Sales/Total Employment	-1.06
Fixed Assets/Total Employment	0.71
Water Use, MF/MF Employment	2.43 •
Water Use, MF/Sales	2.55 •
Water Use, MF/Total Assets	2.11 •
Water Use, MF/Net Worth	2.39 •

*The t-statistic applies to the difference between the mean values for the subsamples of probable closures and non-closures across the variables listed above. Negative statistics result where the mean for probable closures is less than the mean for non-closures.

**Net Worth minus long term debt, i.e., the amount of additional debt that would yield a debt-to-equity ratio of 1.0.

Note:

•Significant at the 95 percent confidence level for n1+n2-2 degrees of freedom, where n1=the number of probable closures and n2=the number of non-closures.

predictors were selected for strength of their t-value. The dependent measure chosen for the regression was borrowing power because its t-value was large (-3.05) and because it is the closest surrogate measure of the firm's capacity to make an investment in pollution control equipment. Ideally, the test would be run against known closures, but in forecast work that is the main unknown variable rather than the known discriminator variable.

A step-wise regression has the capability to select from among a cluster of independent variables that one, single variable which, by itself, best predicts to the dependent variable. Holding that first variable constant, the program searches for the second next best independent variable, which in combination with the first, predicts to the dependent variable. The program continues in this step-wise fashion until 100% of the variance about the criterion variable is explained, or until the combined net predictive power of all the independent variables is exhausted. The results of the regression appear in Table I-4, on the following page. Several outcomes of the regression are quite important:

> Total employment was the very poorest predictor

TABLE I-3

RESULTS OF MULTIPLE REGRESSION

ALL CLOSURE
FILE DATA4 (CREATION DATE = 03/10/77) EPA-BA&H METAL FINISHING STUDY- FINANCIAL UPDATE

* M U L T I P L E   R E G R E S S I O N * * * * *

DEPENDENT VARIABLE.. BORROW BORROWING POWER

SUMMARY TABLE

VARIABLE		MULTIPLE R	R SQUARE	RSQ CHANGE	SIMPLE R
DOLLAR	SALES IN DOLLARS	0.69448	0.48230	0.48230	0.69448
DBPR	DEBT PERCENT	0.80929	0.65496	0.17266	-0.36603
XPATSAL	ADJ PAT-SALES	0.81518	0.66451	0.00956	0.17097
XPATASS	ADJ PAT-TOTAL ASSETS	0.82572	0.68181	0.01730	0.04631
XCFCAP	ADJ CASH FLOW CAPITALIZATION	0.82950	0.68806	0.00625	-0.02421
WFEMP	WET FINISHING EMPLOYMENT <TOTAL>	0.83169	0.69170	0.00364	0.62868
MFWTA	METAL FINISHING WATER TOTAL ASSETS	0.83237	0.69284	0.00113	-0.02644
MFWSAL	METAL FINISH WATER- SALES	0.84690	0.71723	0.02440	-0.00503
MFWDAY	—	0.84966	0.72193	0.00469	0.29379
MFWNW	METAL FINISHING WATER- NET WORHT	0.85663	0.73382	0.01189	-0.09856
FATURN	FIXED ASSET TURNOVER	0.85887	0.73765	0.00384	-0.02408
PCOV	PROJECTED COVERAGE RATIO	0.85944	0.73864	0.00099	0.31489
XCFTA	ADJ CAS FLOW-TOTAL ASSETS	0.85979	0.73924	0.00060	-0.01223
MFWWFE	METAL FINISH WATER- W F EMPLOYMENT	0.85994	0.73950	0.00025	0.00674
SALTEMP	SALES-TOTAL EMPLOYMENT	0.86008	0.73974	0.00024	0.06592
DBEQR	DEBT EQUITY RATIO	0.86016	0.73987	0.00013	-0.29170
TEMP	TOTAL EMPLOYMENT	0.86020	0.73994	0.00007	0.61504
(CONSTANT)					

Total sales is the single best predictor

Of the 10 best predictors, 3 are sample-wide data items:

- Sales
- Wetfinishing employment
- Wetfinishing water.

These three, however, are only the first, sixth, and ninth best predictors. All the others are plant specific calculations which cannot link sample findings to industry parameters.

Based on the preceding, three sample variables have been identified as appropriate and potentially useful for projecting sample closure results to the population. The next step was to test their predictive power.

(3) Chi Square Analysis Rejected the Use of Any of the Three Variables as Predictors of Closure

Later in the analysis, model plant closures were available under a variety of price, cost, and regulatory scenarios. These closure results were then arrayed as a function of sales, wet metalfinishing employment, and metalfinishing (process) water use intervals. In addition, cross tabulations on these variables were run so that closure levels within cells could be tested. A Chi Square analysis revealed that there was no systematic movement of closure rate by sizing interval. This means that the probability of a plant's closing is independent of how large that firm is with respect to its sales, production employment or process water use.

Four summary conclusions are particularly relevant for the remainder of this analysis:

> Using plant descriptor variables (i.e., sales, people, water) to array closure levels is only a data organization mechanism; no predictive capacity is intended.
>
> Because data for both the sample and the population can be organized around these three basic descriptor variables, they are highly useful for the display of all findings.
>
> Because closure rates are insensitive to changes in the descriptor variables, no means of making differential or weighted extrapolation by size is suggested.
>
> Overall closure rates for the sample must stand for the presumed closure rate of the population.

*   *   *   *   *

This completes the presentation of the study methodology. Industry description is contained in the next chapter.

II. THE INDUSTRY

II. THE INDUSTRY

This section of the report presents some of the descriptive information on the metalfinishing industry that was gathered through the surveys. Metalfinishing is an extremely common production operation with hundreds of finishing processes commonly used. But not all finishing processes are relevant here since the scope of this analysis is limited to the processes enumerated under the Electroplating Point Source Category:

- Electroplating of common metals
- Electroplating of precious metals
- Anodizing
- Coatings, i.e., phosphating, chromating or immersion plating
- Chemical etching, milling and engraving
- Electroless plating
- Printing board manufacturing.

Not only is the scope of this study limited to those sectors of the industry doing the seven specific metalfinishing processes, it is also limited to those individual firms that are Indirect Dischargers. These are firms that discharge their spent liquid wastes to a municipal sewer or Publicly Owned Treatment Works (POTW's). All such firms are to comply with the promulgated Pretreatment Standard, and are the sole focus of analysis. The balance of the industry discharges its wastes directly to surface waters and are identified as Direct Dischargers. They are beyond the scope of this effort.

In the industry description that follows the distinction is drawn clearly between types of dischargers. The distinction must also be drawn between the separate economic entities or industry segments that comprise the metalfinishing industry. There are three:

Independent metalfinishing job shops (referred to hereafter as the job shops). These are often fairly small operations averaging fewer than 10 production employees and selling below $600,000 annually. These firms cluster in the major manufacturing areas, and there are some 2,900 such firms of which approximately 2,700 are covered here.

Independent manufacturers of Printed Circuit Boards (referred to hereafter as Printed Boards) are also relatively small businesses. Typically, these firms have some 30 production employees and tend to cluster in areas noted for electronic goods manufacture. The industry is quite small, estimated to be 400 firms altogether of which 327 are of interest.

Captive metalfinishing operations (referred to hereafter as captives) are in-house operations found in many durable goods manufacturing establishments. Although found in firms of several hundred to thousands of employees, the captive operation itself is comparable in size to a job shop employing some 20 men. There are an estimated 6,000 such operations doing processes covered under the Electroplating Point Source Category of which some 4,700 are Indirect Dischargers.

In the next two major sections, the demographics of these three industry segments will be presented. Primary focus is given to the job shop sector: see Appendices B and C for supplemental descriptions of the Printed Board and captive sectors.

1. THE SIZE AND ECONOMIC VISIBILITY OF THE METALFINISHING INDUSTRY IS DRIVEN BY THE CHARACTERISTICS OF THE CAPTIVES SECTOR

In this section the demographics of the metalfinishing industry performing processes covered by the regulations of the Electroplating Point Source Category are presented.

(1) Job Shops Are Small Producers Numbering Below 3000 Establishments

Census of Manufactures uses two SIC codes (3471 and 3479) to group manufacturing establishments whose primary line of business is metalfinishing. These firms are the independent producers or the job shop sector of the industry.

Prior reports have maintained a distinction between these two SIC groups. This was due to the fact that firms in SIC 3471 are major consumers of common plating metals (i.e., copper, zinc, nickel, chromium) whereas firms in SIC 3479 are distinguished by their technical production processes (anodizing, phosphatizing, precious metal plating, etching, etc.). The guidelines for the industry promulgated by the Agency (July 1977 and September 1979) reinforced this distinction by establishing standards for each separate process group:

A - Electroplating of common metals

B - Electroplating of precious metals

C - (Reserved)

D - Anodizing

E - Coatings

F - Chemical etching

G - Electroless plating

H - Printed Circuit Board manufacturing.

Isolating the sectors in this fashion serves the requirements of effluent regulation because it allows a modular approach to issuing industry guidelines. Maintaining these separate groupings for economic impact purposes is unwarranted because at the plant level such process distinctions are blurred.

- Very few firms, regardless of being classified in SIC 3471 or 3479, perform just one metalfinishing process (A through H).
- Most firms perform two or more separate processes and may derive revenues equally from each. This precludes assigning a multiprocess plant to just one process group.
- Effluent characteristics of the various process groups do contain unique contaminants, but identified pollution abatement technologies do not vary by these contaminants. Costs are driven more by flow volumes than by type of chemical found in the wastes.
- The only exception is process group H, Printed Board manufacturers, which is treated as an independent economic entity.

For the above cited reasons, there is no analytic purpose served in maintaining six process distinctions (A through G). Findings and impacts on the job shop sector of the metalfinishing industry are reported irrespective of the distribution of production processes within the sector.

The summary characteristics of the job shop sector (both direct and indirect dischargers) are the following:

> Both the data base of the 1977 Dun's Market Identifiers File and the 1972 U.S. Census of Manufactures estimate the population of job shops at approximately 5,000 firms. By the pattern of responses to the job shop survey (Appendix A), more than half, or 2,941 firms, do processes covered by these regulations. Of this number, 2734 are indirect dischargers. On the basis of total employment, these 2,941 firms employ 69,700 people of which 52,300 are production employees in wetmetalfinishing. Indirect dischargers employ 62,800 with an estimated 46,800 in wetmetalfinishing production.
>
> Only 14% of the job shops sell $1 million or more annually with 72% of all firms selling $0.5 million or less a year. Average sales at the plants are $580,000 with total industry output estimated at $2.1

billion annually. Indirect dischargers have mean sales of $675,000 and estimated annual sales of $1.9 billion.

At the plant level, a job shop uses water on average at the rate of 38.700 gallons per day of which 83% or 32,300 gallons per day is water used directly in metalfinishing production processes. For the industry as a whole total plant water use is on the order of 114 million gallons per day with 95 million gallons per day taken by production processes. Again, for the indirect discharging segment total water use is 105 million gallons per day with 88.3 million gallons taken by production processes.

(2) Printed Circuit Board Manufacturers Are a Small But Relevant Sector of the Industry

Presently, no single industrial classification available through Census of Manufactures covers adequately independent producers of Printed Circuit Board (PB's). Census data (1972) for the industry appear confined to SIC 3679 (Electronic Components not elsewhere classified) which account for some 1,800 independent establishments with total sales of $3.0 billion. But included in this estimate of establishments are producers of many non-PB products; phonograph needles, magnetic recording media, relays, transducers, earphones and headsets. Identifying just the PB segment from census data is not possible.

The survey of this sector, as described in the methodology section estimated the total population of independent Printed Board firms at 400. Key descriptive parameters of this segment appear below.

- Given that process group H of the regulations of the Electroplating Point Source Category is for Printed Board manufacturers, all identified firms in the population (400) are affected by this guideline.
- Printed Board shops are reported to be, on average, larger than the typical job shop. Mean total employment is 60 people with 35 in production finishing. For the industry as a whole this accounts for some 23,000 people with 13,7000 people producing the Printed Boards. Indirect dischargers are estimated to employ 20,000 people with 11,900 in production.
- These independent manufacturers have larger per plant sales than do the job shops. Only 34% sell under $0.5 million annually with 43% selling over a million. Plant sales on

average are $1.5 million with total industry sales estimated at $610.4 million. Indirect dischargers should account for $494 million. The mean total plant water use of this sector is 21,900 gallons per day. Of this amount 86% or 18,800 gallons per day are from production processes. For the industry as a whole 8.7 million gallons per day are used of which 7.5 million gallons are for metal-finishing processes. Again, indirect dischargers use 7.1 million gallons of which 6.1 million gallons are for metalfinishing processes.

(3) <u>The Captives Sector Drives the Economic Description of the Industry</u>

Manufacturing establishments that house their own internal (captive) metalfinishing operations tend to be very large firms. The magnitude of the captives' contribution to the metalfinishing industry is illustrated below. Again, first by the total sector and then for the indirect discharging segment only.

Survey results suggest that 47% of all captive operations do processes covered by these regulations. This defines a weighted adjusted population of 6,077 firms. Of this number, 4,722 are projected to be indirect dischargers.

Mean total employment of these firms is 660 people for a plan work force of slightly below 4 million people. But with 20 people per firm assigned to metalfinishing, the production forces is some 117,000 people. Indirect dischargers account for some 2.9 million people and 87,000 production employees.

Total sales at the plant level are $20.1 million. Of this amount, however, 54% reflects sales of goods with metalfinishing. Therefore, sales of metalfinished goods are $10.9 million. Given that the finishing cost of these goods was found not to exceed 10% of the total production cost, the value added by metalfinishing is estimated at $1.1 million per plant. For the total industry, this is $6.7 billion annually. For the indirect discharging segment sales are $5.0 billion annually.

In terms of plant water use, a firm with a captive operation uses 808,000 gallons per day. Of this total, 35% or 277,000 gallons is used by the captive finishing operation. On a daily basis, all 6,077 establishments with captives use 4.9 billion gallons with the captive operations requiring 1.7 billion gallons. Indirect dischargers account for 3.8 billion gallons with the finishing operation taking 1.1 billion gallons daily.

2. <u>ALMOST ALL INDEPENDENT METALFINISHERS AND SLIGHTLY MORE THAN HALF THE CAPTIVES WILL BE AFFECTED BY PRETREATMENT REGULATIONS</u>

Identifying just that portion of the industry discharging to a municipally owned sewer (POTW) is the second key step in setting up the economic impact analyses of the pretreatment regulations. If a firm only discharged its effluent wastes to a sewer or to a navigable body of water, the problem would be straightforward. But many firms discharge in a manner that combines the options, as summarized below.

Some captives report their effluent going to a holding tank then to the POTW. Others report using lagoons or settling beds, while others report using both the river and the POTW. Although 58% of all relevant respondents report discharging to the POTW only, fully 77% of the sample ultimately passes its discharge to the

POTW. Therefore subpopulation of interest for captives is 77.7% of 6,077 or 4,722 firms subject to pretreatment regulations.

Printed Board makers reported fewer discharge options. Of the sample, 4% discharge directly to navigable waters, 13% to leaching ponds, 2% wouldn't say and 81% discharge to the POTW. Of the total estimated population of 400 PB manufacturers, 327 are identified as subject to this pretreatment regulation. (This value is not strictly 81% of 400 because all the larger firms were known to be indirect dischargers.)

Job shops report the proportion of dischargers to POTW's over a range from 63% to 96% depending on the size of the firm. The overall figure weighted by the size of all firms is that 93% of the industry is covered by pretreatment regulation. This yields a population of interest of 2,734 (93% of 2,941).

For ease of presentation, Tables II-1, 2 and 3 on the following pages array the three industry populations for analysis. To help illustrate the relative size of each population, data are arrayed by a sizing measure; the

TABLE II-1

Total and Production Employment
in All Job Shops and in the
Indirect Discharging Segment Only

All Dischargers

Size of Firm	Number of Firms	Total Employment	Production Employment
1-4	1,156	9,300	3,500
5-9	682	10,900	5,800
10-19	546	12,300	10,200
20-49	357	15,400	13,600
50-99	159	14,100	12,000
100-249	41	7,700	7,200
Total	2,941	69,700	52,300

Indirect Dischargers

Size of Firm	Number of Firms	Total Employment	Production Employment
1-4	1,045	8,460	3,100
5-9	658	10,600	5,200
10-19	524	11,700	9,100
20-49	339	14,500	12,200
50-99	142	12,600	10,800
100-249	26	4,860	6,400
Total	2,734	62,800	46,800

TABLE II-2

Total and Production Employment
in All Printed Board Manufacturers
and in the Indirect Discharging
Segment Only

All Dischargers

Size of Firm	Number of Firms	Total Employment	Production Employment
1-4	16	450	50
5-9	62	520	460
10-19	78	2,080	1,200
20-49	171	10,850	5,600
50-99	57	6,200	4,200
100-249	12	2,070	1,600
250+	4	1,150	550
Total	400	23,300	13,700

Indirect Dischargers

Size of Firm	Number of Firms	Total Employment	Production Employment
1-4	13	400	40
5-9	50	470	370
10-19	63	1,780	1,060
20-49	139	9,200	4,680
50-99	46	5,500	3,560
100-249	12	2,070	1,600
250+	4	1,150	550
Total	327	20,600	11,900

TABLE II-3

Total and Production Employment
in All Captive Operations and
in the Indirect Discharging Segment Only

All Dischargers

Size of Operation	Number of Captives	Total Employment*	Production Employment*
1-4	2,372	742	4.6
5-9	1,164	477	6.6
10-19	1,103	772	14.5
20-49	955	858	28.4
50-99	271	521	18.3
100-249	157	333	24.1
250+	55	140	21.0
Total	6,077	3,840	117.5

Indirect Dischargers

Size of Operation	Number of Captives	Total Employment*	Production Employment*
1-4	1,833	586	4
5-9	884	378	5
10-19	884	613	11
20-49	748	632	21
50-99	203	370	13
100-249	131	258	19
250+	39	92	14
Total	4,722	2,930	87

* In thousands

number of wetmetalfinishing employees. This serves to show how tightly clustered each industry is to the smaller end of the scale. Most finishing firms or operations are truly small with respect to total wetfinishing production employment.

Now that the key sizing descriptors of the metalfinishing industry have been developed and displayed, the balance of this chapter will be devoted to characterizing the operations and general market economics of each sector.

3. MOST METALFINISHING FACILITIES PERFORM BASICALLY SIMILAR FINISHING OPERATIONS IN WHICH PROCESS WATER FLOW IS KEY TO APPRECIATING POLLUTION ABATEMENT NEEDS

This section provides a brief introduction to the manufacturing processes of the industry. The purpose is to describe metalfinishing generically, to illustrate the prevalence of specific processes across sectors, and to introduce the pollution control requirements of the industry. All of this information is presented in greater detail in Chapter III, Pollution Abatement Requirements and Costs.

(1) Metalfinishing Is a Process of Applying a Coating to a Base Substance in an Aqueous Medium

The electroplating industry applies a surface coating typically by electrodeposition to a base material in order to enhance its corrosion protection, heat resistence, anti-frictional characteristics or decorative appearance. The electroplating of common metals includes the processes in which a ferrous or nonferrous basis material is electroplated with copper, nickel, chromium, zinc, tin, lead, cadmium, iron, aluminum or combinations thereof. Precious metals electroplating includes the processes in which a ferrous or nonferrous basis material is plated with gold, silver, palladium, platinum, rhodium, or combinations thereof.

Electroless plating on metals is not a separate industry but an integral part of a number of industries, such as aircraft manufacture and repair, shipbuilding, automotive and heavy machinery. It is associated, in general, with industries whose products have to withstand unfavorable conditions or significant wear and abrasions. Electroless plating on plastics for both functional and decorative purposes is most prevalent in several major industries: automotive, furniture, appliance and electronics.

(2) Plating and Finishing Processes Occur in Production Lines

For the purpose of this document, a plating line is defined as a row of tanks in which one or more coatings are applied. A process is the accumulation of steps required to bring about a plating result. A rinse is a step in a process used to remove excess solution from the work following immersion in a process bath. A rinse may consist of several steps such as successive countercurrent rinsing or hot rinsing followed by cold rinsing.

Conceptually, an electroless or electroplating line may be broken down into three steps: pretreatment involving the preparation of the basic material for plating, actual application of the plate and the post-treatment steps. As discussed previously, the electroplating or electroless processes apply a surface coating for functional or decorative purposes. In electroplating, metal ions in either acid, alkaline or neutral solutions are reduced on cathodic surfaces, which are the workpieces being plated. The metal ions in solution are usually replenished by the dissolution of metal from anodes or small pieces contained in inert wire or expanded metal baskets. Replenishment with metal salts is also practiced, especially from chromium plating. In this case, an inert material must be selected for the anodes. Hundreds of different electroplating solutions have been adopted commercially, but only two or three types are utilized widely for a particular metal or alloy. Cyanide solutions are popular for copper, zinc, brass, cadmium, silver and gold, for example, yet non-cyanide alkaline solutions containing pyrosphosphate or another agent have come into use recently for zinc and copper. Zinc, copper, tin and nickel are plated with acid sulfate solutions, especially for plating relatively simple shapes. Cadmium and zinc are sometimes electroplated from neutral or slightly acide chloride solutions.

The electroplating process is basically an oxidation reduction reaction. Typically, the part to be plated is the cathode, and the plating metal is the anode. Thus, to plate copper on zinc parts, the zinc parts are the cathodes, and the anode is a copper bar. On the application of electric power, the copper bar anode will be oxidized, dissolving it in the electrolyte (which could be copper sulfate):

$$Cu = Cu^{++} + 2e^-$$

The resulting copper ions are reduced at the cathode (the zinc part) to form a copper plate:

$$Cu^{++} + 2e^- = Cu$$

With one exception, notably chromium plating, all metals are electroplated in a similar manner. In chromium plating, the typical anode material is lead, and the chromium is supplied to the plating baths as chromic acid.

(3) Wastewater Contaminants Requiring Treatment Come From All Steps of the Production Processes

Wastewater from plating processes comes from cleaning, surface preparation, plating, and related operations. The constituents in this wastewater include the basis material being finished as well as the components in the processing solutions. Predominant among the wastewater constituents are copper, nickel, chromium, zinc, lead, tin, cadmium, gold, silver, and platinum metals, as well as ions of phosphates, chlorides, and various metal complexing agents.

A large proportion (approximately 80%) of the water usage in plating is for rinsing. The water is used to remove the process solution from the surface of the work pieces. As a result of this rinsing, the water becomes contaminated with the constituents of the process solutions and is not directly reusable. Dilute rinse water solutions of various process chemicals result from each operation.

(4) Finishing Processes Appear with Similar Frequency in Each Sector

Interesting parallels exist between the captives and jobbers with respect to their basic production processes. Fully three-quarters (77%) of all job shops work with common metals (copper, nickel, chrome, zinc). Not quite one-quarter (24%) do electroplating of precious metals with another one-quarter (24%) indicating that they do anodizing. More than half (55%) do a coatings process. These are not mutually exclusive categories. Any one shop can do more than one process and the majority do. Typically, a plater of heavy metals also does chromating, perhaps combining the chromating with a bright dipping operation. Almost every facility plating with heavy metals also indicated the finishing operations of polishing, buffing and grinding.

Captives also report heavy usage of the four common plating metals. Most frequently reported are nickel and copper, indicated by 63% and 51% of the sample respectively. Gold and silver are also reported for almost one-quarter of the sample (24% and 18% respectively). Coatings, particularly phosphating and chromating, appear in approximately half the respondents (56% and 49% respectively).

Clearly, irrespective of economic sector, metal-finishing processes assume a specific hierarchy; heavy metal plating, coatings (phosphating, chromating) followed by anodizing and precious metals plating.

Printed Board manufacturers, due to the more specialized nature of their product show a different array of metals usage. Almost all respondents (85%-95%) are heavy users of copper, nickel, gold and solder. Chromium is used in only 13% of the cases. Showing up in printed board operations is a much higher prevalence of tin (72%) than in the other sectors, and the presence of chelates (26%).

(5) Total Water Requirements of Metalfinishing Process Operations Are a Small Portion of Daily Industrial Demand

On a daily basis, the independent producers require approximately 114 million gallons of total plant water. Of this total, some 80% is required for metalfinishing process operations, yielding a total finishing water usage of 95 MGPD. Of this total, 88 MGPD goes to POTW's.

Manufacturing plants with captive operations use finishing water at a rate that is an order of magnitude greater than for jobbers. On a daily basis, captives are estimated to use a total of 4.9 billion gallons, of which 35% is used in metalfinishing operations. This yields a process water use of 1.7 BGPD, of this total, 1,163 MGPD goes to POTW's. Printed Board makers account for an additional 8.7

MGPD of which 7.5 MGPD is for process water. This contributes an additional 6 MGPD to POTW's. The metalfinishing industry as a whole demands a total of 5.0 BGPD of which 1.8 BGPD is process water and 1.3 BGPD going to POTW's. As a basis of comparison, 1975 Census data show a total national industrial water use of 63.6 BGPD. The metalfinishing industry, then, accounts for 7.7% of all industrial water, with metalfinishing process water representing 2% of the daily national total.

Focusing the discussion on water use in the industry serves two ends. It illustrates the volumes, in absolute terms, of effluent wastes generated by metalfinishing. It serves as well to illustrate that at the plant level there will be a core group of contaminants to be treated irrespective of the unique processes performed at the plant. Costs for the pollution abatement systems required for pretreatment will be shown to rest primarily with volumetric flows through the treatment components, rather than with processes or base materials plated or finished.

4. LOCAL MARKET CONDITIONS COUPLED WITH THE FIRM'S FINANCIAL CONDITION WILL AFFECT COMPLIANCE AND CLOSURE RATES

Selected data from the job shop survey are presented here because they illustrate two major determinants of pretreatment investment impacts on the industry:

- General financial condition of firms
- Market demand and price behavior for the industry.

This first point serves to illustrate the general cash flow situation of firms or their capacity to support further debt. The second is important because it reinforces the understanding of firms' pricing freedoms and behaviors.

(1) Few Job Shops Appear To Be in a Strong Cash Flow or Profitability Situation

The tables presented below are from the job shop survey and are sample specific findings. While highly indicative of industry conditions, no attempt to extrapolate these data to the population has been made. As used throughout these tables, the term SD stands for standard deviation, e.g., the dispersal of values about a computed average. The letter "K" represents "thousands."

Of the 344 firms providing profit data, the mean profit before tax was $30.1K (SD = $95K) and the mean after tax profit was $15.6K (SD = $42K).

Not all plants providing financial information had a profit in 1975. There were 60 plants reporting an operating loss, an average of $4.4K (SD = $23.7) before tax, and an after tax loss of $3.4K (SD = $16.3).

In reconstructing balance sheet information from the sample, data are available for approximately 300 respondents. Information is arrayed in Table II-4 below for the total sample, and then for three collapsed size intervals.

TABLE II-4

Typical Balance Sheet Items

Item / Size	Total Sample	(SD)	Employment 1-19	20-99	100+
		(000's Dollars)			
Current Assets	$200	$524	$103	$253	$1,470
Fixed Assets	176	302	69	277	768
Current Liabilities	115	276	53	170	612
Long-Term Debt	70	192	25	107	453
Net Worth	212	477	102	278	1,688

The table shows a linear relationship between size of firm and magnitude of dollars. To test whether larger firms are more economical, these values can be divided by the mean employment for the intervals to reflect dollars on a per-employee basis. In Table II-5 below, the intervals have been divided by the mean employment (8, 41, and 155 employees).

TABLE II-5

Value of Selected Balance Sheet Items on a Per Man Basis

Item	Dollars Per Man By Size Interval		
	1-19	20-99	100+
	(000's Dollars)		
Current Assets	$12.9	6.2	11.2
Fixed Assets	8.6	6.7	4.9
Current Liabilities	6.6	4.1	3.9
Long-Term Debt	3.1	2.6	2.9
Net Worth	12.8	6.8	10.9

It would now appear that smaller firms are not appreciably different from larger ones in their capital structure. They are quite similar on current assets and net worth.

One other basis for appreciating the capital structure of the industry is to look at a firm's fixed assets and its planned investments in those assets. These data are presented in Table II-6 below. It is interesting to note that all firms attach comparable life to their assets, but the magnitude of those assets is quite different by the intervals.

TABLE II-6

Distribution of Selected Capitalization Items by Size of Firm

Item / Size	Total Sample	Employment 1-19	20-99	100+
		(000's Dollars)		
Building Book Value	$ 96	$ 50	$141	$173
Equipment Book Value	$134	$ 53	$215	$481
Remaining Life of Building	15 yrs.	15 yrs.	16 yrs.	12 yrs.
Remaining Life of Equipment	6 yrs.	6 yrs.	6 yrs.	6 yrs.
Planned (5 year) Building Investment	$ 38	$ 14	$ 62	$105
Planned (5 year) Equipment Investment	$ 12	$ 4	$ 22	$ 15

Once again, converting these tables to a per-employee basis reveals some interesting patterns. Omitting the asset life, we note in Table II-7 below that small firms have invested more in the past and will invest more in their plants (on a per-man basis) than larger plants.

All of the preceding should be sufficient to discourage the use of a single sizing measure as an independent predictor of plant vulnerability or of closure.

TABLE II-7

Selected Capitalization Items on a Per Man Basis

Item	1-19	20-99	100+
	(000's Dollars)		
Building Value	$6.2	$3.4	$1.1
Equipment Value	6.6	5.2	3.1
Next Building Investment	1.7	1.5	.6
Next Equipment Investment	.5	.5	.1

(2) Most of the Firms in the Industry Are Job Shops With Well Established Customer Relationships

No discussion point about the metalfinishing industry receives more attention or is more important than the structure and dynamics of the marketplace. Prior reports, lacking primary data on market conditions built the following paradigm:

> Price competition in the industry is intense because barriers to entry are low and new entrants tend to price low to win business.

Competition is tight and as prices are bid down, prevailing prices can disrupt the profit margins and operating efficiencies of larger shops.

In light of new, incremental costs (pollution abatement expenses), firms could raise prices and maintain business volume if:

- Substitution of other finishes is not feasible.
- Foreign imports cannot pick up the volume.
- Metalfinishing is indispensable to customers' needs.
- Customers are unlikely to invest in captive, in-house finishing.

These reports concluded that demand for plating should be inelastic with respect to price since the above listed conditions probably held true. Prior reports made some additional assumptions about pricing set by least cost producers and modeled price increases on the order of 11% to 16% into industry impact analyses.

Field data can now replace presumption. All of the critical issues on the dynamics of the marketplace were cast into specific survey questions. In this final section characterizing the metalfinishing industry, data will be presented covering:

- Structure of the marketplace
- Pricing behavior
- Customer response to price.

Respondents were asked to describe their firm with respect to their customers, products, and competitors. This set of items was "forced-choice." Two possible answers were given and the respondent had to select the one answer that best fit his firm. There were five items with answers scored as a 'one' or as a 'two.' The specific items and their results appear in Table II-8, on the following page. The predicted pattern for the industry if it were dominated by "pure" job shops should be 2, 2, 1, 2, 1. These firms do show the operating characteristics associated with job shops. The one item that is not as clearly distinguished as the others is Item B, Number of Customers. Job shops were presumed to sell to many different customers and, in aggregate, they do. But a fair number of respondents rely heavily on a few, steady ones. If this proves to be the case for a significant number of firms, the argument can be made for customer loyalty and, perhaps, product specialization. Under such conditions, it is all the more

TABLE II-8

Survey Responses to the "Job Shop" Questions

A. Does your firm specialize in services to a major industry (i.e., automobile, aerospace, etc.) or do you service many different industries?

Specialize in service to an industry	1	23.2%
Service many industries	2	76.8%

B. During the year are most of your sales to a few steady customers or to many different customers?

Few steady customers	1	42.3%
Many different customers	2	57.7%

C. Do your customers send you many different kinds of products (all shapes and sizes) or do you get basically the same products most of the time?

Many different products	1	76.2%
Basically the same products	2	23.8%

D. Do you generally attract customers because you can offer low prices or because you can take on any assignment?

Offer low prices	1	29.2%
Take any assignment	2	70.8%

E. Do you face a lot of competition for your customers or relatively little

Lot of competition	1	72.6%
Relatively little	2	27.4%

likely that a customer will meet the new incremental price increase of his supplier because it is literally his only supplier of finishing services.

More than 90% of the sample provided data on past and future price behavior. Within these several survey questions on price, there were several different study questions:

- Amount of most recent past price increase
- Customer reaction to that past increase
- Estimate of maximum future price increase

The survey data on this issue are arrayed in Table II-9 below.

TABLE II-9

Distribution of Price Behavior by Size of Firm

Price	Total Employment 1-19	20-99	100+
Past Rise	9.4%	8.8%	7.5%
Future Rise	13.6%	11.8%	9.3%

In the past, the sample raised price by 9%; for the future, the sample as a whole estimates price increases of 12% could be sought.

The key item in this section on marketplace behavior is customer response to past price increases. There are not sufficient historical data on the industry to allow a demand coefficient to be derived empirically. One can be imputed from a qualitative assessment of the marketplace data that the survey furnished.

All respondents were asked to judge what their customers might do in response to a price increase. Five customer options were listed, and the respondents circled one code number for each item representing the probability or likelihood of that option. Table II-10, on the following page, presents these data. The value in each cell is the percent of all respondents who selected that likelihood. Data were provided by 426 respondents.

For ease of presentation, the two categories at each end of the scale ("very") have been collapsed.

> 30.6% think customers might buy more from captives; 24.5 think it's likely, with 38.6% saying unlikely. If the "maybe" category is disregarded, then the industry does not expect volume to be displaced to captive operations.

TABLE II-10

METALFINISHERS JUDGMENT OF THEIR CUSTOMERS' REACTIONS TO PRICE INCREASES

	Very Unlikely	Unlikely	Maybe	Likely	Very Likely
Customers might buy more from captives	18.0	20.6	30.6	15.0	9.5
Customers might eliminate Metalfinishing from their products	23.2	18.7	22.1	17.1	12.4
Customers might start their own in-house, captive lines	19.5	22.3	23.0	15.8	11.7
Customers might shop around more for the best price	2.6	2.4	6.7	24.1	59.7
Customers might use some other finish for metal-finishing	10.0	13.9	21.3	23.2	25.8

41.9% are confident that customers could not or would not eliminate metalfinishing from their products. Only 29.5% expect them to do so.

41.8% do not expect their customers to start in-house captive finishing operations. Only 27.5% think it is a strong possibility.

83.8% recognize that their customers would have to shop more for the best price. Only 5% believe that customers would readily meet any price increase.

> 49.0% grant that their customers would consider substituting for metalfinishing. Only 23.9% believe their customers do not have that option.

These data are a clear qualitative statement of the metalfinishers marketplace:

> Metalfinishing in some form is probably indispensable but substitutes are possible. Starting in-house operations in light of rising independent prices is not perceived as a viable customer option.

With respect to demand (in light of price increases), these data suggest that if everyone had to raise prices, business volume would probably not fall off. The elasticity of demand with respect to price is probably highly inelastic.

* * * *

This concludes the presentation of key survey findings with respect to the structure and composition of the independent sector of the metalfinishing industry. Comparable presentations are contained in Appendices B and C for the other sectors. There do not appear to be any striking reversals to industry characterization developed in earlier reports.

Much of the data reinforce prior efforts, although the key application of the data is yet to come. That occurs in Chapter IV when the survey's primary financial data are incorporated in the closure analysis.

III. POLLUTION ABATEMENT REQUIREMENTS AND COSTS

III. POLLUTION ABATEMENT REQUIREMENTS AND COSTS

This chapter defines the technology applicable for pre-treatment, identifies the compliance requirements developed by the Agency and arrays the anticipated costs for each industry sector. In the methodology chapter, the rules for developing investment costs per treatment component were presented. Of interest here is the application of those rules; i.g., the cost allocation program designed to specify components and costs as a function of processes and water use in individual plants.

Five major sections are contained in this chapter. They are:

- Identification of Pretreatment Technologies
- Definition of the Regulation
- Cost Allocation Rules
- Component Costs
- Industry Costs.

1. PRETREATMENT IS REQUIRED FOR THE CONTROL OF CYANIDE, HEXAVALENT CHROMIUM, LEAD, CADMIUM AND OTHER METALS

Individual treatment technologies used in the industry (electroplating, electroless or Printed Boards) are well documented. Among the more common control applications are:

- Chemical reduction of hexavalent chromium
- pH adjustment
- Clarification
- Diatomaceous earth filtration
- Flotation
- Oxidation by chlorine of cyanide
- Oxidation by oxygen
- Deep bed filtration
- Ion exchange
- Evaporation
- Reverse osmosis
- Ultrafiltration
- Electrochemical recovery
- Sludge dewatering.

For Pretreatment, however, the Agency has defined a Best Practicable Pretreatment Technology that consists of the following:

Reduction of hexavalent chromium to the trivalent form and chromium removal from the wastestream

Destruction (oxidation) of cyanide

Precipitation and clarification of specific metals.

This Pretreatment technology is to be applied to all firms discharging to a POTW and performing one or more processes regulated under the Electroplating Point Source Category.

2. PLANT PROCESS WATER VOLUME IS A CRITERION FOR THE APPLICABILITY OF PRETREATMENT REQUIREMENTS

For plants with a daily flow of 38,000 liters (10,000 gallons) per day or more, the promulgated standards limit the discharges of cyanide and the following metals:

- Lead
- Cadmium
- Copper
- Nickel
- Chromium
- Zinc
- Silver.

Additionally, the regulation limits total metals discharged determined as the sum of the individual concentrations of copper, nickel. chromium, and zinc.

Plants with a daily flow of less than 38,000 liters (10,000 gallons) per day have a standard that limits only lead, cadmium, and cyanide. Small water use plants are also exempt from a total chromium limit and are not modeled showing chromium reduction units.

Use of a water based cut-off reflects the Agency's commitment to balancing the economic impact of this regulation while maximizing environmental benefit. It is important to note that there is no firm, quantitative method for computing an optimum cut-off level. However, considerable thought and effort went to arriving at the 10,000 gallon cut-off.

> Major economic hardship is expected to fall on the independent job shops which are fairly small production operations. To be of benefit to the job shops the cut-off level had to be set at a value that covered a sizable number of facilities. A 10,000 GPD level covers almost 50% of all job shops.
>
> Sets of cut-off levels were considered ranging from a 'zero' level to 40,000 GPD; for each level impacts as well as untreated discharge volumes were compared. Comparisons were made between relative increases in untreated flows against relative decreases in plant closure rates. The pattern of data suggested that 10,000 GPD was a useful and appropriate criterion.

As reflected by the above, compliance requirements are targeted, to some measure, to process volume flow. Each scenario (above and below the cut-off) is costed and a range of industry costs and impacts derived. The next section describes the method for applying technical compliance costs to the model plant data base and subsequently to the industry.

3. PRETREATMENT SCENARIOS WERE COSTED FOR PLANTS USING AN AUTOMATED SYSTEM INCORPORATING FLOW ALLOCATION RULES PER TREATMENT COMPONENT

Once the technology is defined and the compliance scenarios articulated, the task becomes one of systematically developing rules for costing abatement systems. The following discussion points explain the costing rationale used in the study.

(1) Application of Technologies Must Fit the Production Processes

Each of the individual treatment technologies can be combined to form systems capable of meeting the proposed limitations on both direct and indirect dischargers. However, the specific elements of a treatment system must be appropriate to the chemical and metal constituents of a plant's process wastewater. Chromium reduction and cyanide oxidation are used only if the wastewater contains chromium or cyanide. Clarification includes pH adjustment, precipitation, flocculation, and sedimentation, which may be carried out in one or more vessels or pits. Chelated wastes, if present, should be clarified separately to prevent the chelates from tying up metals in other waste streams. Sludge drying may be carried out in the sludge drying beds or in a vacuum filter, and contractor removal of sludge may sometimes be replaced with landfilling on company property. In addition, final neutralization (pH adjustment) of the wastewater before discharge may be needed to meet the pH limitation, particularly if nickel salts are removed effectively by clarification at a relatively high pH.

(2) Focus for This Study is End-of-Pipe Technology

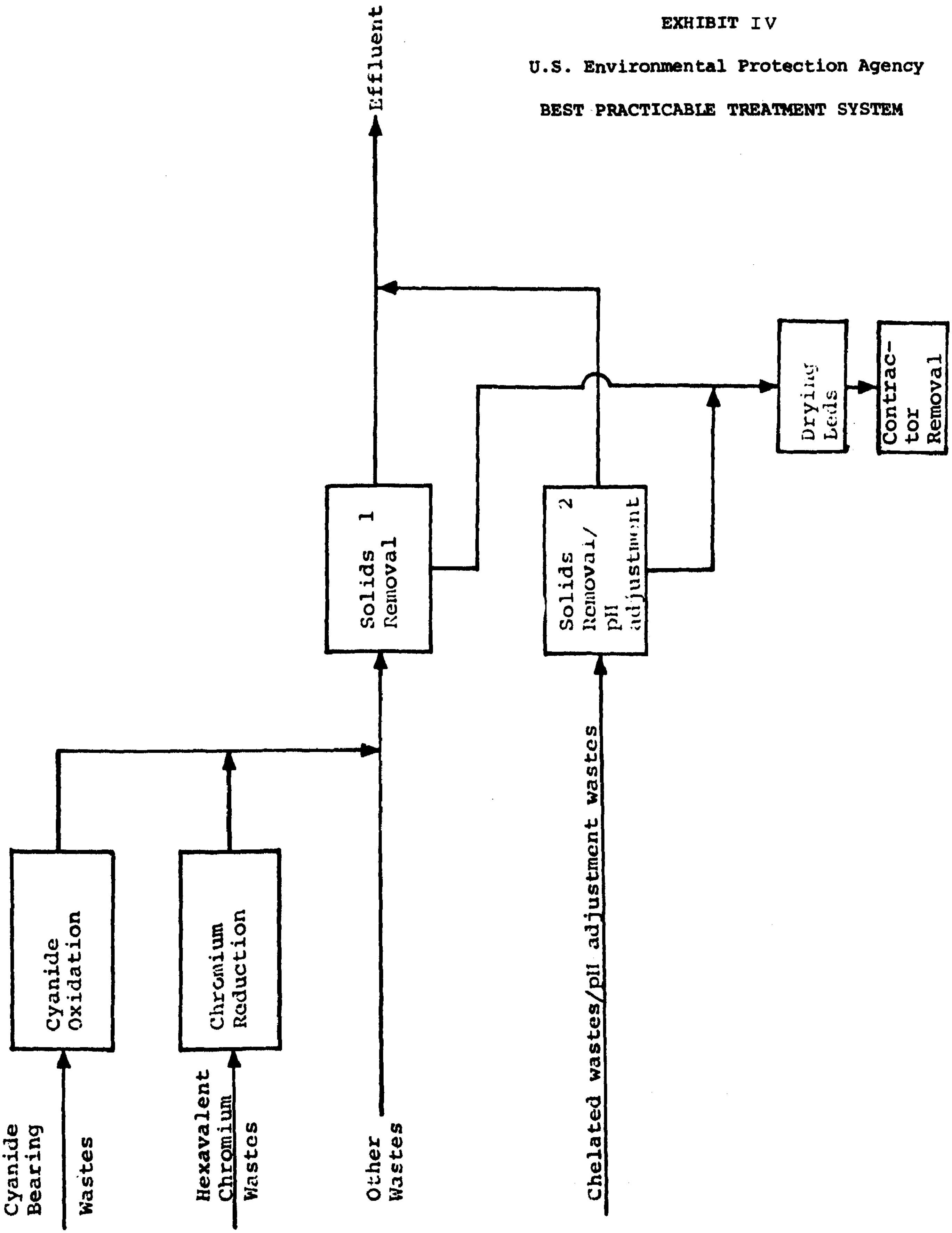
Pollution abatement controls can be introduced as in-line alterations to the production process through the placement of water conservation equipment. Alternatively, controls can be introduced at the end of the production process prior to discharge. It is this latter end-of-pipe approach that occupies this study. A prototypical system appears in Exhibit IV on the next page.

There are many alternative end-of-pipe applications of control technologies. The listing in the prior section should not be viewed as the universal or unchanging definition of control technology applicable to metal-finishing process wastes. Many alternative techniques have been encountered in the field. These alternatives range from the use of a settling lagoon to replace the clarifier to the use of reverse osmosis, ion exchange, membrane filtration, diatomaceous earth filtration, and multiple stage rinsing to reduce discharge of pollutants.

EXHIBIT IV

U.S. Environmental Protection Agency

BEST PRACTICABLE TREATMENT SYSTEM



Although not found as commonly as clarification, most of the individual technologies described earlier are in general use through this industry. The use of any particular component or system will depend on the wastes to be treated, space constraints, funding availability, and other factors which involve management judgment.

(3) Estimating the Industry's Investment Needs Requires Data on Four Key Variables

In the next section the industry's costs are developed and arrayed for purposes of economic impact analyses. At this point, part of the methodology for developing those costs will be presented. A full presentation of the costing routine and logic is found in Appendix G of this report.

Pollution abatement costs were generated for each survey respondent as a function of the following information provided in the questionnaire:

- Metals present in the wastestream
- Process water flow through each discrete finishing operation
- Amount, type and value of existing pollution abatement equipment
- Availability of physical space either inside or outside the plant for locating the prescribed system.

The first two variables are predictors of the type and size of the firm's required pollution abatement components. The second two variables serve as moderators on the total dollar estimate of the prescribed system.

As summarized in the second section of this chapter the majority of finishers use the four common metals plus additional processes in which cyanide frequently is a key agent. This generally requires the application of a Best Practicable Pretreatment Technology that includes:

- Oxidation of cyanide
- Reduction of chromium
- Clarification-filtration of metals.

Before the costs of these individual components comprising this treatment technology are generated, two additional steps occur in the automated cost routine:

- Individual treatment components, if presently in place, override the specification from the program output. This means a plant needing a clarifier receives one if, and only if, one is not present. If the individual components in place are not identified, but their capital replacement is, that dollar value is credited to (e.g., subtracted from) the new estimated cost. In the cost model this is the assumption of full credit for equipment in place. There are no data to test or to prove that field equipment currently perform to the standard, or might not require replacement. But it is clear through the survey data that most equipment is new, sized appropriately and the same components predicted by the costing routine. In the absence of data to the contrary plants are costed only for needed equipment not in place.

Full installed cost of the treatment system depends on the location and ease of the installation. All firms with available exterior space are costed with an outdoor clarifier with attendant estimates of construction and land costs included. If interior space is available and metals removal is required, the system specifies a diatomaceous earth filter.

(4) Pollution Abatement Component Costs Were Developed By Correlating Flow Volumes to Costs

Pollution abatement component costs were generated for each plant model by identifying the key drivers of equipment size and cost. It was found through careful review of the detailed model plants that the best predictor of equipment cost was the requisite size (volumetric capacity) of a component. The key driver of size was the flow through the component in gallons per hour.

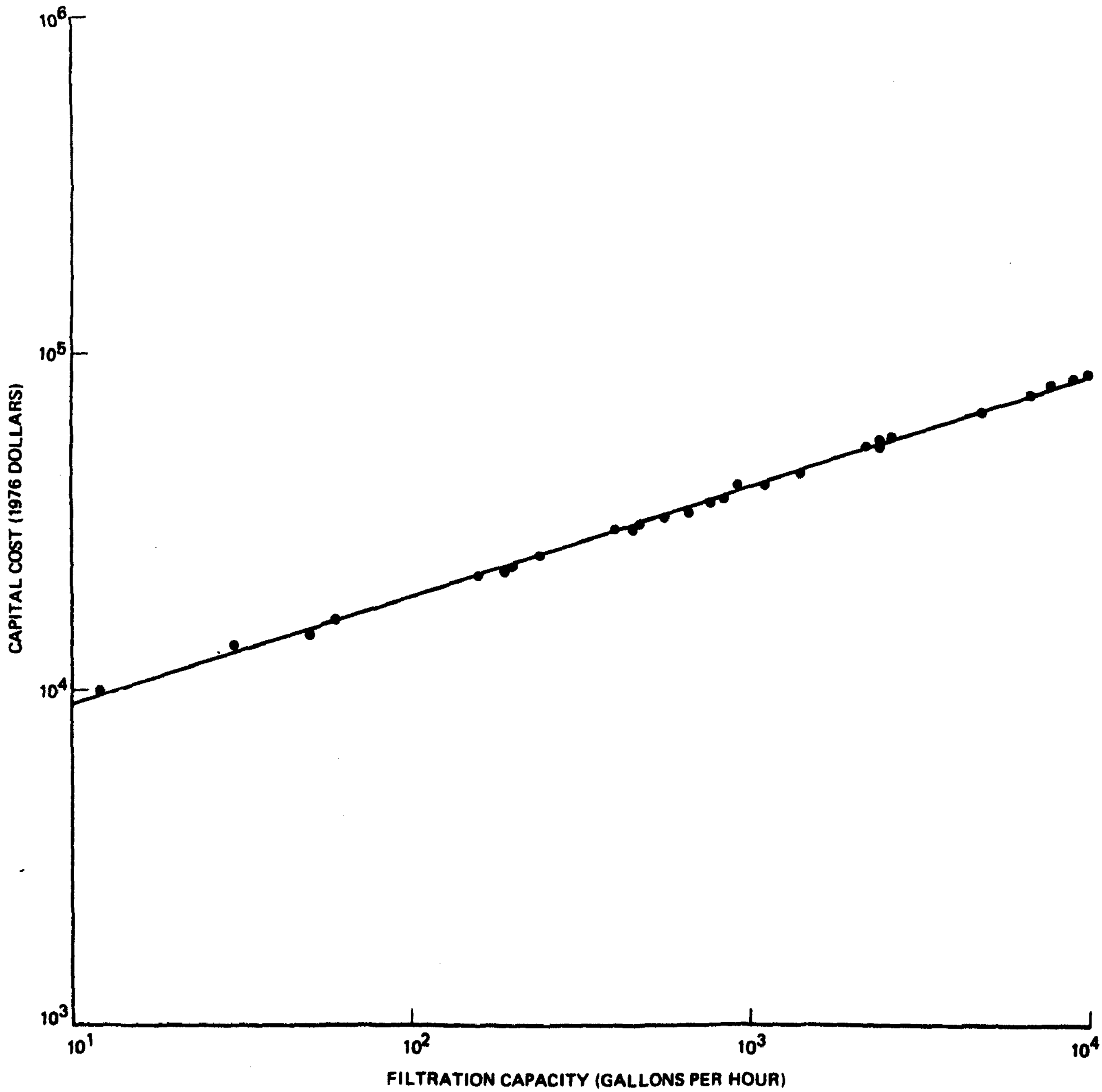
To yield a set of predicator cost equations, it was necessary to array (regress) the costs (fully loaded) developed by the Technical Contractor against a second, continuous variable. In this case the variable is process flow volume.

- As shown in Exhibit V and Exhibit VI, on the following pages, the log of total investment costs for full BPPT requirements correlates somewhat with the log of system capacity.
  - For clarifier plants, the correlation coefficient is about 0.68.
  - For filtering plants, the correlation coefficient is about 0.76.
- The experimental scaling factors are the following:
  - Clarifier plants scale with system capacity with an exponent of 0.46.
  - Filtering plants scale with system capacity with an exponent of 0.47.

EXHIBIT V

U.S. Environmental Protection Agency

CAPITAL COST OF FILTRATION UNITS

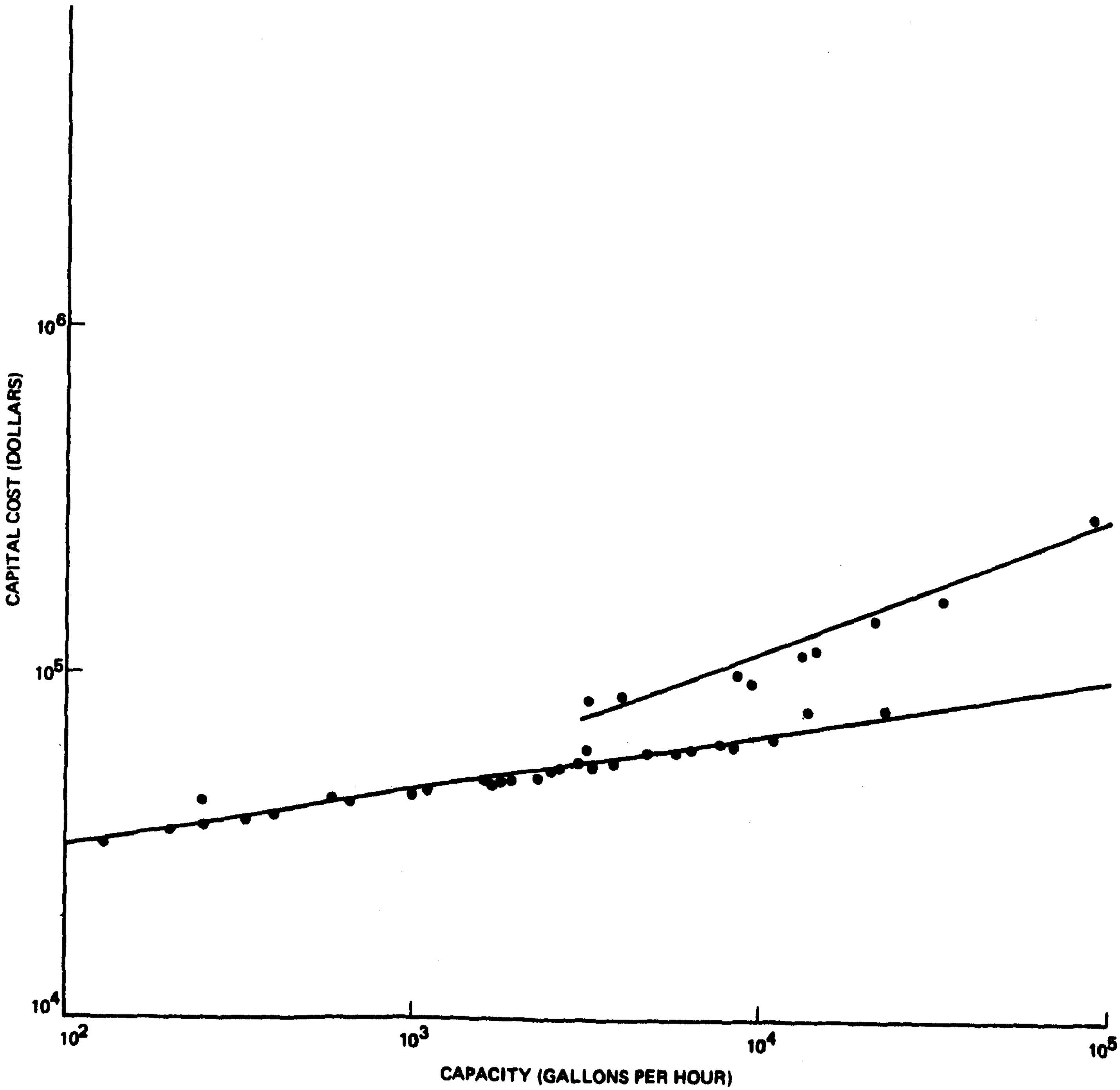


SOURCE: BOOZ, ALLEN & HAMILTON INC.

EXHIBIT VI

U.S. Environmental Protection Agency

CAPITAL COST FOR CLARIFIERS WITH pH ADJUSTMENT



SOURCE: BOOZ, ALLEN & HAMILTON INC.

Both of those scaling factors are slightly less than the 0.6 factor traditionally used; the difference is attributed to the large fixed costs for instrumentation which does not scale with capacity.

The variation of the data points around the least squares regression line is due to the fact that BPT systems may not require all the system components:

- pH adjustment
- Hexavalent chromium reduction
- Cyanide destruction
- Clarification or filtration.

Exhibits VII through X, on the following pages, plot the estimated investment for major BPPT system elements versus the waste water treatment flow of that element. The exhibits show:

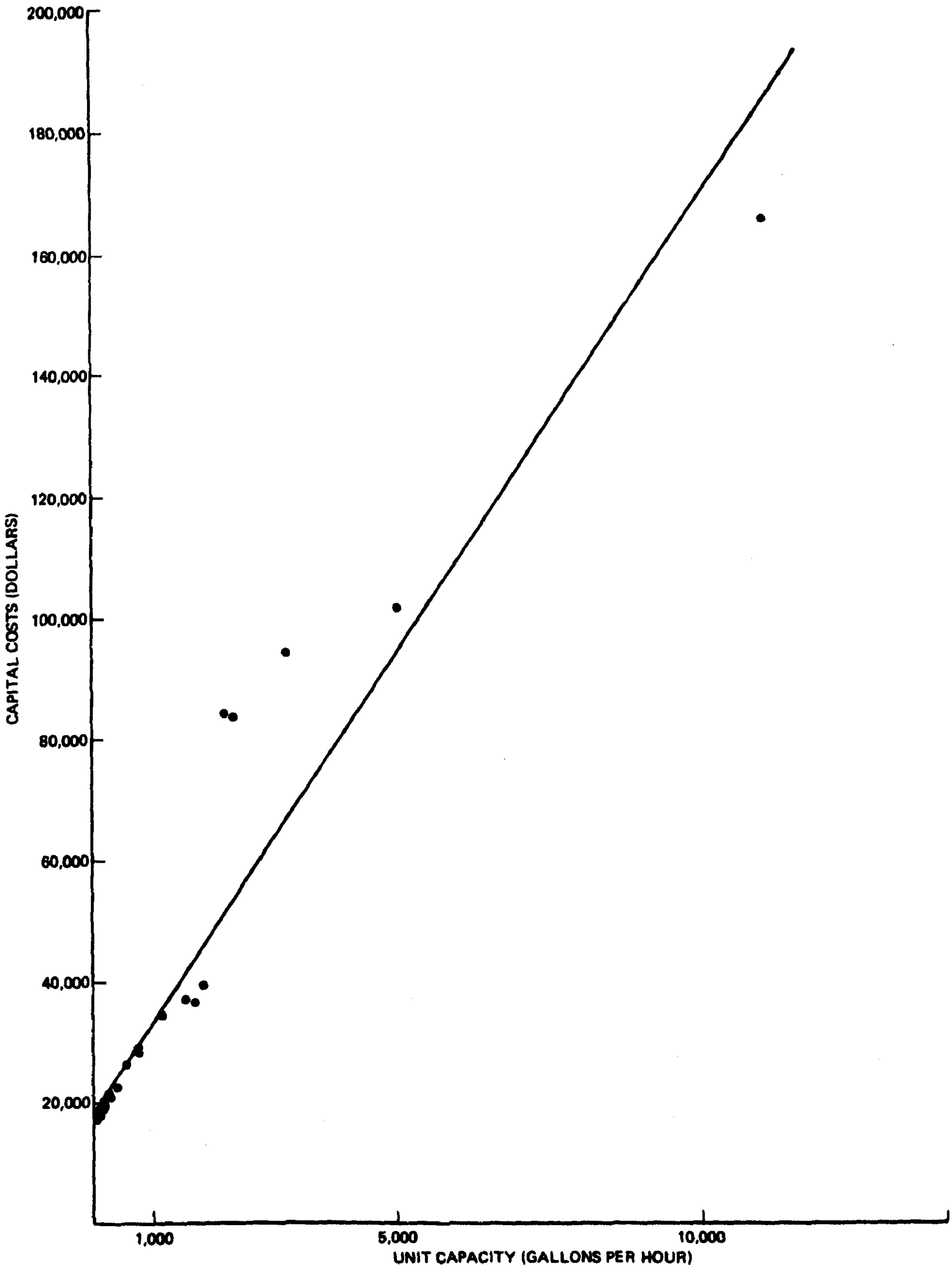
- Correlation of investment versus capacity for cyanide destruction is approximately 0.9.
- Correlation for hexavalent chromium reduction units is about 0.8.

Correlation between investment and flow for the solids removal equipment is also very good, about 0.9.

EXHIBIT VII

U.S. Environmental Protection Agency

CAPITAL COSTS FOR CYANIDE OXIDATION UNITS

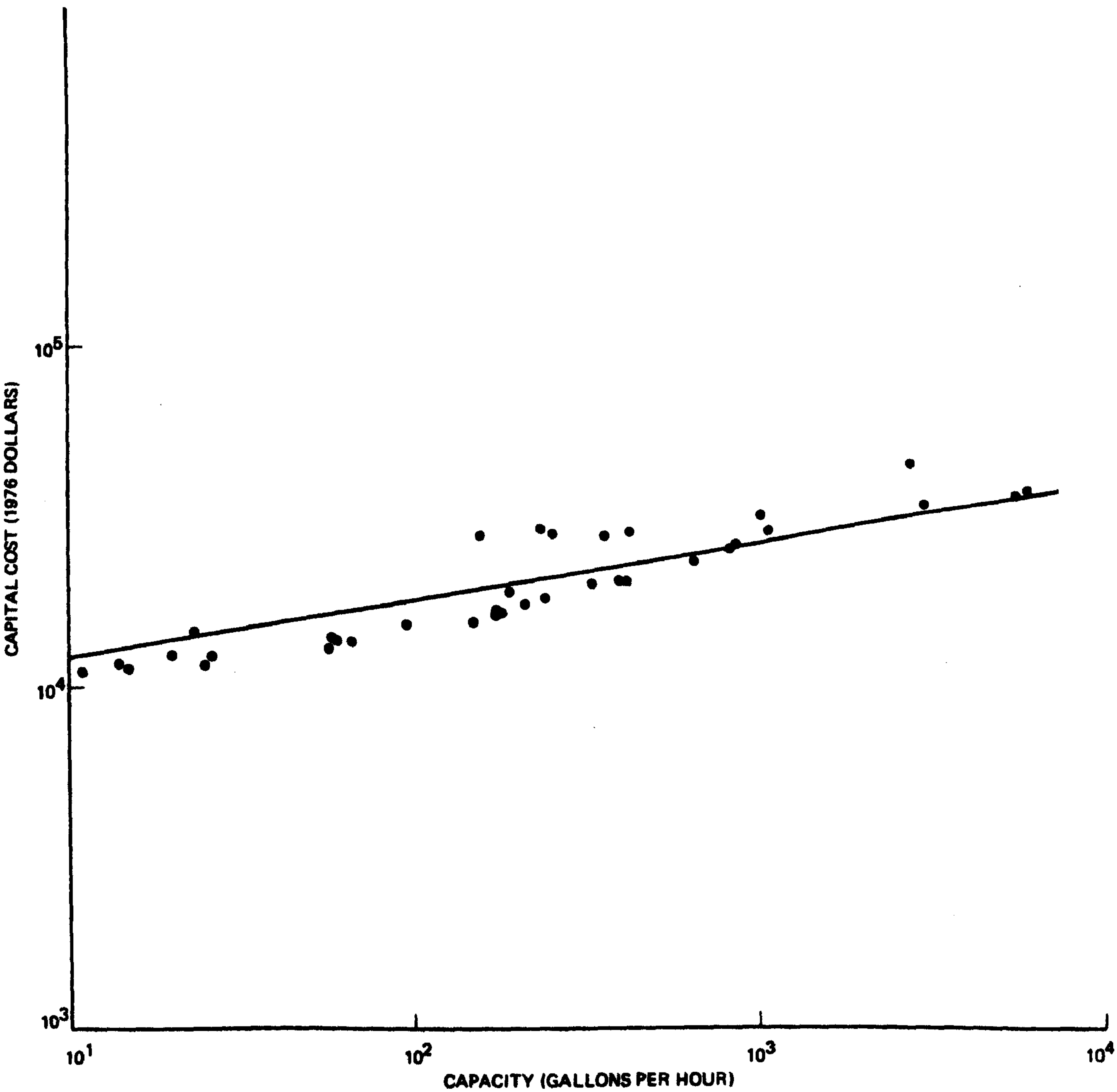


SOURCE: BOOZ, ALLEN & HAMILTON INC.

EXHIBIT VIII

U.S. Environmental Protection Agency

CAPITAL COSTS FOR HEXAVALENT CHROME REDUCTION

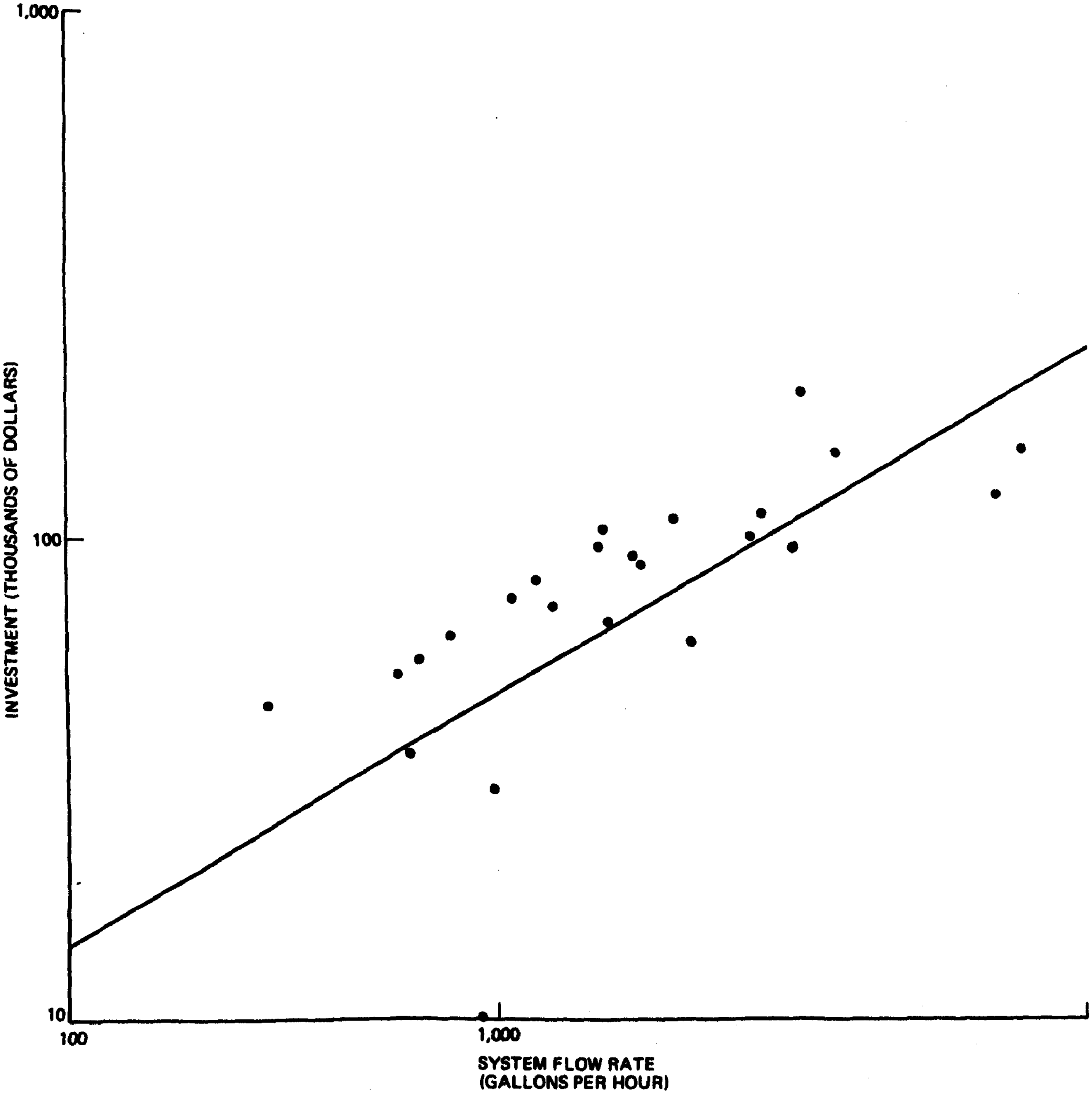


SOURCE: BOOZ, ALLEN & HAMILTON INC.

EXHIBIT IX

U.S. Environmental Protection Agency

RELATIONSHIP OF TOTAL SYSTEM FLOW RATE TO INVESTMENT FOR LEAST COST (1) INDOOR PLANTS-FILTER MODE



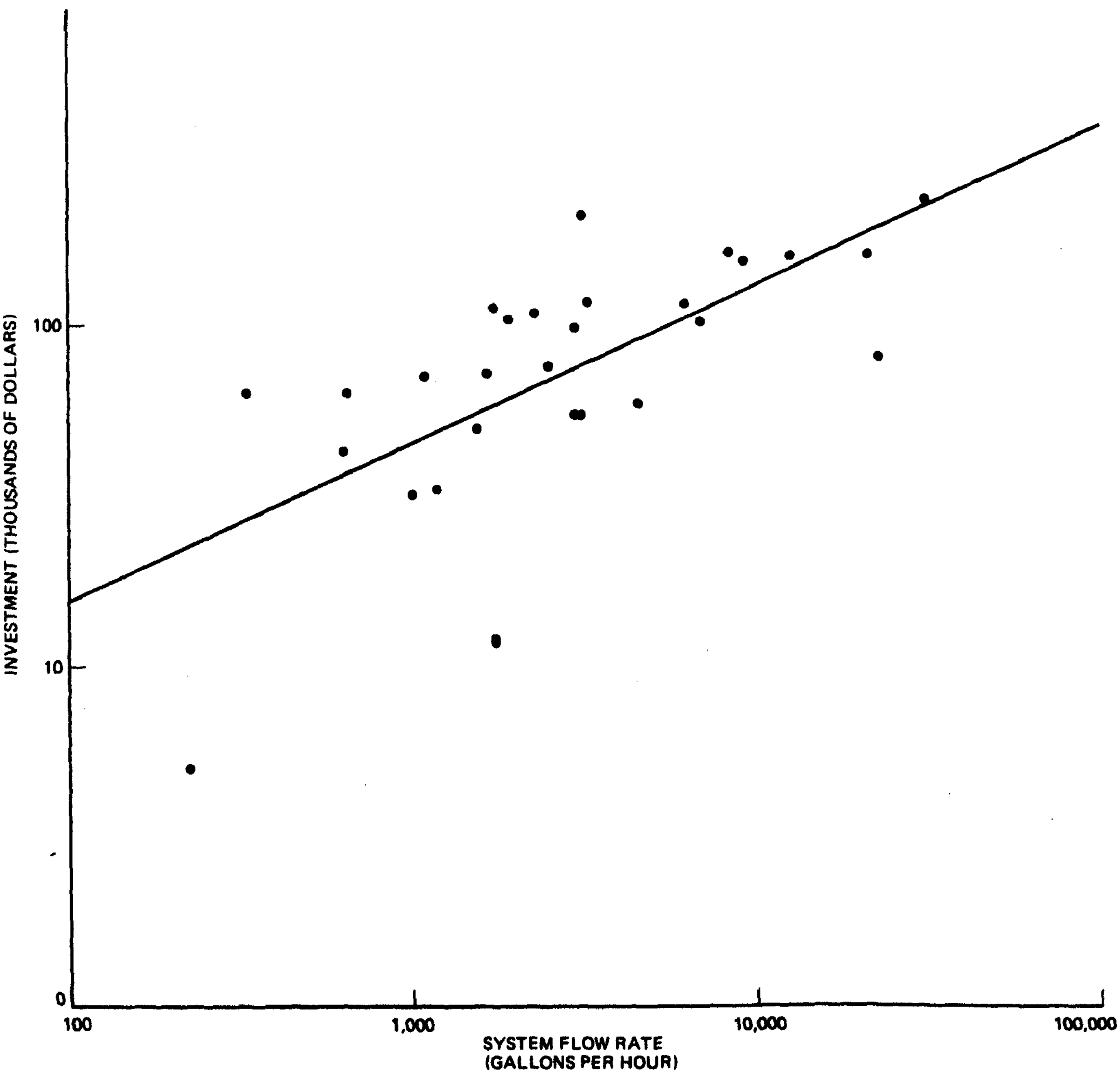
(1) INVESTMENT REPRESENTS BPPT – BPT – NO SMALL PLATER EXEMPTION, NOTHING IN PLACE

SOURCE: HAMILTON STANDARD, BOOZ, ALLEN & HAMILTON INC.

EXHIBIT X

U.S. Environmental Protection Agency

RELATIONSHIP OF TOTAL SYSTEM FLOW RATE
TO INVESTMENT FOR LEAST COST OUTDOOR
PLANTS-CLARIFIER MODE



(1) INVESTMENT REPRESENTS BPPT – BPT – NO SMALL PLATER EXEMPTION, NOTHING IN PLACE

SOURCE: HAMILTON STANDARD, BOOZ, ALLEN & HAMILTON INC.

(5) <u>Given the High Correlation of Flow to Cost, Flow Based Equations Were Programmed into an Automated Costing Routine</u>

All of the prior exhibits on flow volumes to component costs demonstrated strong linear association between the variables.

- The equations account for between 60 and 80% of the variability between investment cost estimates and volume of water treated in their appropriate regression of flow.
- The pH adjustment equation was derived from the computer model cost estimates as well as from industry sources such as manufacturers and distributors of neutralization systems because the computer model did not separate pH adjustment costs from costs for combined pH adjustment/batch clarification equipment.

On a per component basis, the flow relationships to the costs of cyanide destruct units and hexavalent chromium reduction units are both strong: for cyanide units, the average absolute difference is 17%, with the equations 7% lower than reported costs. For hexavalent chromium units, the regression equation predicts costs about 16% higher than generated by the Technical Contractor.

These results, plus the cost comparisons cited in Appendix G, support the use of regression equations for applying characteristic treatment components and costs for all model plants available in the survey.

4. INVESTMENT COSTS FOR 205 JOB SHOPS, 40 PRINTED BOARDS PLUS THE CAPTIVES WERE DEVELOPED AND FORM THE DATA BASE FOR SUBSEQUENT INDUSTRY ECONOMIC ANALYSIS

The principal regulatory scenario was costed for each segment of the metalfinishing industry. For job shops, Printed Board manufacturers, and captives, pollution abatement cost estimates were generated for installing:

Cyanide oxidation, chromium reduction and clarification for firms above the cut-off. Included in the total capital cost is the construction of a sludge drying bed scaled to the volumetric capacity of the clarifier.

Cadmium, lead treatment and amenable cyanide oxidation for plants below 10,000 GPD.

For estimating captives' investments the basic job shop cost method was somewhat altered:

Data on individual processes and line descriptors were not available; however, operations and finishing metals were. This enabled treatment components to be invoked for specific trace metals and chemicals.

Space availability data were not available, the operating decision rule was to assign all captives indoor diatomaceous earth filters.

Specific treatment components already in place were not identified for captives--only their dollar costs. This value was subtracted from the new, projected investment cost before assigning costs.

Sludge removal was handled by costing a sludge drying bed scaled to the plant's discharge volume, plus a sludge contractor haul factor at $.25 per gallon for 20% sludge from the bed.

Summaries of these costs are presented below:

(1) Job Shops for Full Compliance Face Investment Requirements Approaching $75,000 on Average

Two tables are presented below for job shop capital requirements to meet the Pretreatment scenario. Table III-1 distributes the mean investment cost by water use intervals. Table III-2 distributes the cost by metal-finishing employment categories. Either table could serve as a basis for displaying sample and industry costs. For purposes of this report wetmetalfinishing employment intervals will be the primary data display mechanism because it is sensitive to changes in costs, arrays data by a measure that correlate well with other

TABLE III-1

Mean Investment Capital To Meet a Pretreatment System Arrayed Across Water Use Categories (GPD)

Size of Firm	Mean Cost ($000's)
0 - 10,000	20.5
10,000 - 16,000	80.7
16,001 - 20,000	111.1
20,001 - 30,000	126.0
30,001 - 40,000	119.2
40,001+	184.3
	$ 76.1

TABLE III-2

Mean Investment Capital To Meet a System Arrayed Across Metalfinishing Employment Categories

Size of Firm	Mean Costs ($000's)
1 - 4	$ 37.4
5 - 9	70.4
10 - 19	95.3
20 - 49	106.9
50 - 99	170.2
100 - 249	164.9
	$ 76.1

parameters (sales, water-use) and allows the best array of sample findings to the population.

(2) Printed Board Manufacturers Face Pretreatment Costs Somewhat Lower Than Job Shop Costs

The mean capital cost to jobbers for a full Pretreatment system was approximately $75,000. Small firms face a $20,000-$30,000 investment and the larger operations face, on average, a $150,000 expense. Printed Board manufacturers require somewhat different equipment, use less production water and thereby face lower capital costs. Few firms regardless of flow required a hexavalent chromium reduction unit, whereas almost all need a separate clarifier for the chelated waste streams. Table III-3, shown below, arrays the capital costs by the wetmetalfinishing sizing intervals. Most small plants face capital costs in the $20,000-$25,000 range with the largest plants at $100,000. For the sample plants as a whole, the mean capital requirement is estimated to be $56,500.

TABLE III-3

Mean Investment Capital To Meet Printed Board Manufacturers Pretreatment Standards Arrayed Across Metalfinishing Employment Categories

Size of Firm	Average Costs ($000's)
1-4	$ 24.3
5-9	24.3
10-19	21.7
20-49	52.3
50-99	68.4
100-249	118.7
	$ 56.5

(3) Captive Facilities Face Pretreatment Costs That Are Several Times Greater Than Jobbers

Of the total 1,614 respondents to the captives survey, not all provided sufficient data for costing nor are all indirect dischargers requiring a Pretreatment system. There are 497 cases that did not provide water use data. There were also 381 cases that were predicted to face a $0 investment because of prior expenditures for pollution abatement equipment. For purposes of displaying future investments, the 381 prior investment cases were dropped and costs were developed for all cases affected by these regulations. The sample numbers 536.

Table III-4 below presents the total capital cost of a Pretreatment system for captive establishments arrayed against wetmetalfinishing employment categories. The overall mean capital is $250,000 with costs basically linear with respect to employment. One aberration is the 10-19 man interval in which costs are disproportionately high. These sample cases use 4 times the water as the 5-9 man operations and have also made disproportionately little prior investments in pollution controls.

TABLE III-4

Mean Investment Capital to Meet a Pretreatment System Arrayed Across Metalfinishing Employment Categories (536 Captive Facilities)

Size of Operation	# of Cases	Mean Cost ($000's)
1 - 4	181	$ 54.0
5 - 9	115	133.0
10 - 19	106	762.4
20 - 49	93	181.2
50 - 99	23	252.0
100 - 240	12	285.6
250+	6	514.8
	536	$ 251.9

(4) Annualized Costs for A Plant Are Approximately One-Third the Estimated Total Capital Cost

Annual costs reflect interest charges at 12%, with a 10-year payback period. Also included within the annualized figure are costs for the pollution system's utilities, labor and maintenance (averaging 12% of total capital). In addition, a capital cost recovery factor of 2% is included as are depreciation (5 year, straight line) and the annual sludge haul cost. These data are portrayed for each industry sector in Table III-5.

TABLE III-5

Mean Annualized Cost to the Industry
of the Pretreatment Regulation
(Arrayed by Wetmetalfinishing Employment)

	Job Shops ($000's)	Printed Board Makers ($000's)	Captives ($000's)
1 - 4	15.1	3.0	$ 22.4
5 - 9	19.1	3.0	49.3
10 - 19	40.6	3.0	245.8
20 - 49	44.3	5.5	66.8
50 - 99	70.8	6.6	91.3
100 - 249	79.2	11.1	107.6
250+	--	--	202.1
	34.4	5.6	$ 91.2

* * * * *

This completes the presentation of the model plant Pretreatment compliance costs. Closures due to these costs appear in the next chapter.

IV. SAMPLE CLOSURE RESULTS

IV. SAMPLE CLOSURE RESULTS

This chapter presents the calculated closure rates for firms in the metalfinishing industry sample data base. Results for the job shop sectors proceed directly from the automated closure routine, while results for captive operations proceed from an analysis of administrative and structural features of the respondents.

All results presented within this chapter are sample specific: i.e., no industry-wide estimates are offered. In the next chapter, Economic Impacts, sample results are extrapolated to the total industry. In order to make those extrapolations, a method for correcting impacts due to baseline closures as well as a method for yielding weighted population impacts must be developed. This chapter is organized, therefore, into three primary sections:

Baseline closure analysis

Sample closure rates

Extrapolation decision rules.

1. BASELINE CLOSURES INDEPENDENT OF THE FINANCIAL REQUIREMENTS OF POLLUTION ABATEMENT INVESTMENTS CAN BE FACTORED OUT OF THE SAMPLE SO THAT CLOSURE ESTIMATES ARE THOSE DUE TO THE ACT

It is unacceptable to project sample closure rates directly to the population without making a set of necessary corrections. One correction involves taking into account closures that should occur independently of future pollution abatement investments.

Two methods are available for dealing with the manner of probable baseline closures in the existing data base. One, is to compare financial profiles of known closures to those of models and cull sample plants from the data base that match closures. A second design is to review the raw financial data of the models on a "pre-investment basis" and through the application of a decision rule test for the firms unlikely to remain in business independent of investments in pollution controls.

Analytically the first method is the stronger, more desirable approach. However, data retrieval problems coupled to prohibitive cost precluded the effort. The baseline ana-ysis relied, therefore, on the application of a decision rule and the automated closure routine.

Detailed review of the reported financial condition of the job shop sector of the industry revealed how extremely vulnerable the industry as a whole was to incremental capital expenditures. The majority of firms providing detailed financial data showed either a negative pre-tax condition or pre-tax positions that showed poor returns on sales. An analytic decision rule was to impose a minimum capital burden of $100 on all plant models and a 1.0 coverage ratio test to see the effect on the pre-investment closure rates.

Of the 205 plant models assigned the $100 capital burden, 28 or 13.7% of the job shop sample were labelled closures. For the balance of the report, these 28 cases are defined as the baseline closures, leaving 178 plant models on which economic impacts due to the act can be computed.

A comparable test was run on the printed circuit board data base. From the 40 plants that were costed for impact work, 5, or 12.5% of the plant model sample were defined as baseline, pre-investment closures. Impacts are computed then on 35 plant models.

2. SAMPLE CLOSURE RATES CAN SERVE AS STRAIGHT PROPORTIONAL CLOSURE RATES FOR THE POPULATION

Appendix D presents the detailed analysis of the relationship between survey data and population parameters. Within that analysis, several important points were developed:

Model plants and non-model plants show sufficient similarity to allow closures for the models to stand for the sample as a whole.

Total sample respondents show some key differences on sales and net worth values in comparison with the non-sampled universe. There is the suggestion that the sample respondents are financially stronger than the average for the industry.

Due to the oversampling of smaller firms in the telephone follow-up, on average that group of non-respondents is consistently smaller (employment, water use and sales) than the mail respondents. This suggests that the group available for costing may represent the larger production operations but there are no data to suggest that non-respondents are less financially secure firms than the respondents, or would experience significantly different closure rates.

Closures had always been found or presumed to reside within the smaller operations. Although there is a trend within the data to suggest smaller operations are somewhat more likely to be impacted than larger firms, the trend is not statistically significant. Closures are predicted as a constant throughout the sample.

Recent analyses within the Agency arrayed job shop closure rates across water use categories, sales and employment intervals. The result of that Chi Square analysis rejected the hypothesis of independence between rows or columns and left the conclusion that the sample overall result can stand for any row or column by which the sample is arrayed.

All of the preceding supports the approach of representing industry impacts in the same proportion as observed impacts from the plant models.

3. <u>SEVERAL INVESTMENT AND COMPLIANCE SCENARIOS WERE MODELLED FOR BOTH JOBBERS AND FOR CAPTIVE ESTABLISHMENTS</u>

The financial closure model permits plant impacts to be estimated under a variety of different price, cost and investment conditions. As values for these modeling parameters change, so, too, do the attendant closure rates. In order to present useful and representative findings, several decisions were made on freezing these modeling parameters at specific values:

One regulatory scenario was used: full Pretreatment for plants above 10,000 GPD, lesser requirements for those below.

Two financial burden schedules were used: a normal condition of 5 year repayment at a 12% cost of capital, and a special loan program (e.g., SBA) with a 20-year repayment at a 7% cost of capital.

A mid-range cost pass through is allowed. Here each firm raises its prices by exactly that amount corresponding to the incremental annualized cost of the investment.

Equity infusion test in the firms that fail the 1.5 coverage ratio criterion is limited to the one time infusion of capital computed as the total full-time owner's compensation plus profits after tax, minus $15,000.

The parameters were selected to represent the best approximators of probable compliance requirements for the industry and the likely financial constraints on firms.

(1) Job Shops Could Experience Closure Rates in the 5% to 20% Range

In the presentation and discussion of sample results below, each closure condition used the 1.5 coverage ratio, 100% credit for equipment in place and a one-time equity infusion by the owner(s).

For the 205 plant models there was a distribution of impacts reflecting:

- 44 closures
- 28 baseline closures
- 9 equity infusion saves
- 124 non-closures.

In absolute terms, 30% of the closures appear in plants of fewer than 10 full time people, 30% of the closures found in firms of 10-19 people; and another 31% in firms of 20-49 people. Firms of 50 people and above account for the final 9% of the closures.

As a function of water use intervals, 27% of the calculated closures are in firms using up to 10,000 GPD. Comparable closure rates hold for the 10,000 - 25,000 GPD range and for 25,000 - 75,000 GPD. Closure rates, then, are insensitive to linear changes in plant size as measured by employment or water use.

When an SBA-type analysis is run on the 205 models, closure rates drop markedly. With reduced capital costs and five times the loan repayment period, only 11 models are forecast to close for an industry closure rate of 5.4%. As developed in the next chapter the total funding needed through SBA to support such minimal closure rates is in excess of $30 million.

(2) Printed Board Manufacturers Show Sample Closure Rates of 2% - 3%

Forty cases in the sample of 100 Printed Board firms gave all the financial data needed for impact purposes. Of the 40 models, there were 33 indirect discharges: of this number there are 5 baseline closures, 25 non-closures and 1 plant closure. On this basis 2% - 3% of the independent printed board manufacturers should experience plant impacts severe enough to warrant the closing of an operation.

(3) <u>Very Few Captive Operations Are Likely to Divest Their Finishing Production</u>

Under the regulation, 75% of the entire sample of captives face price increases on their finished goods of up to 1%. Another 20% face price increases of between 1% and 10%. Altogether there are 24 cases or 5% of the costed sample that might be impacted through higher requisite prices on their finished goods.

From the analysis of price increases and sales categories, there are 20 with sales below $10 million and 16 with sales of less than $5 million. These 16 models are firms that are relatively small, and by operational definitions the sub-set of plants capable of divesting. A second cross-break of these same cases is against the risk category. Of the 16 cases of interest the pollution control investment increases by 50% the total prior capitalization of 14. This narrows the potentially affected universe to 14 cases or 3% of the sample. These 14 cases are now clearly the smaller operations facing relatively large price increases. In addition, they have relatively few employees in wetmetalfinishing and are the group most able and most economically motivated to divest. For purposes of this analysis 3% of all captive operations stand for the proportion of the industry that might divest their in-house finishing in light of Pretreatment compliance requirements.

*　　*　　*　　*　　*

This concludes the presentation of sample closure results for the three sectors comprising the industry. In the next chapter industry impacts are developed for the total universe of indirect discharges.

V. ECONOMIC IMPACTS

V. ECONOMIC IMPACTS

This chapter extends the closure results of the prior chapter to the population of all firms affected by the metal-finishing regulations. To do so accurately involves distributing closures due to the regulation by a suitable sizing measure: In this case, the wetmetalfinishing employment intervals. It requires also showing industry economic impacts due to the regulation as opposed to closures due to the pressures of the marketplace. In sequence, then, the subjects of this chapter cover:

- Closure rates
- Industry impacts
- Price behavior
- Total compliance burden.

The sample results were presented by job shops, Printed Boards and captives; the industry economic impacts will be presented in the same order.

(1) Job Shops Could Experience a 15% - 20% Loss in Capacity

The first table below, Table V-1, presents total plant closures under the Pretreatment scenario with allowance made for baseline closures. The industry closure rate here is 19.9% on a weighted basis.

TABLE V-1

Total Plant Closures in the Job Shop Sector Under the Regulation Arrayed by WMF Employment Intervals

Size of Firm	Number of Firms		
	Total	Dischargers to POTW	Possible Closures
1-4	1,156	1,045	223
5-9	682	658	141
10-19	546	524	112
20-49	357	339	72
50-99	159	142	30
100-249	41	26	6
	2,941	2,734	584

The total number of plant closings due to the Pretreatment scenarios also represents impacts on sales and employment. In Table V-2, appearing below page, the lost sales and lost employment of the regulation are presented.

TABLE V-2

Sales and Employment Losses Due to the Regulation Job Shop Closures Arrayed by WMF Employment Categories

Size of Firm	Closures	Lost Sales* (Millions)	Lost Employment* (Thousands)
1-4	223	$ 57.3	0.7
5-9	141	44.7	1.2
10-19	112	66.9	1.8
20-49	72	83.3	2.7
50-99	30	55.4	2.3
100-249	6	27.7	0.9
	584	$335.3	9.6

* Taken by multiplying the closures by the mean value for the interval.

This regulatory scenario has the effect of dislodging 15.9% of the industry's production volume and 14.0% of its total employment.

(2) An SBA Loan Program for Job Shops Could Mitigate Impacts Substantially

There is the possibility that individual firms may succeed in their application for special federally supported funds (SBA). In this event, the loan repayment period is extended to 20 years and interest cost reduced to 7%.

Under the regulation and after baseline firms are removed, 9 models or 5% of the cases are predicted to close. On an industry-wide basis, this means 137 of 2,734 job shops discharging to a POTW might close due to Pretreatment requirements. A summary of these impacts appears in Table V-3 below.

TABLE V-3

Sales and Employment Losses Due to the Regulation Job Shop Closures, SBA Financing Arrayed by WMF Employment Categories

Size of Firm	# in Population	# of Closures	Lost Sales (Millions)	Lost Employment (000's)
1-4	1,045	52	$10.7	.2
5-9	658	33	8.3	.2
10-19	524	26	11.6	.3
20-49	339	17	14.7	.6
50-99	142	7	6.2	.5
100-249	26	2	2.0	.3
	2,734	137	$53.5	2.1

SBA financing has the effect of reducing total plant closures by 77% (584 to 137), reducing lost sales by 84% ($335 to $53.5) and lost employment by 78% (9,600 to 2,100).

(3) Printed Board Manufacturers Face Impacts Considerably Below Those Expected in the Job Shop Sector

The presentation of industry-wide impacts for the Printed Board sector will parallel that of the job shops. Under the Pretreatment scenario, closure rates weighted and corrected for baseline closures are 3.1%.

Table V-4, immediately below, arrays closures under the Pretreatment scenario. As was found in the review of job shop closures, there are no significant differences in closure rates by size intervals. The population receives a 3% closure across all sizing intervals.

TABLE V-4

Estimated Plant Closures for Printed Board Makers

Size of Firm	Total	Dischargers to POTW	Possible Closures
1-4	16	13	0
5-9	62	50	2
10-19	78	63	2
20-49	171	139	4
50-99	57	46	2
100-249	12	12	0
250+	4	4	0
	400	327	10

The economic significance of these 10 estimated closures is summarized in Table V-5, below. These data show that as many as 321 people and sales of $9.4 million could be displaced.

TABLE V-5

Sales and Employment Losses for Printed Board Makers

Size of Firm	Possible Closures	Lost Employment	Lost Sales ($000's)
5-9	2	12	$ 500
10-19	2	25	1,100
20-49	4	124	3,800
50-99	2	160	4,000
	10	321	$9,400

Under the regulation, overall closure rates are found to be 3% of the industry. Plant closings account for the loss of 321 positions and sales volume of $9.4 million.

(4) <u>An SBA Loan Program for Printed Board Makers Would Reduce Impacts to Zero</u>

Under the 20 year and 7% interest rate assumptions of an SBA loan program, the total number of model plant closures is 0 out of 40 plants. The industry should experience no disruption were a federally supported loan program in place, and all applicants acceptable.

(5) Impacts In The Captive Sector Are Estimated To Be Small But Measurable

"Closures" for the captive sector were derived through a partially qualitative assessment of firms likely to divest the operation. That analysis identified those firms facing high investment costs, with low plant sales and large predicted price increases (10%+).

Under the regulation, some 14 cases out of 536 indirect dischargers were identified as potential closures. Under the definition of a captives closure this means certain types of operations could stop in-house finishing and purchase the service from suppliers in the job shop market.

In many respects, projecting the captive closures is a worst case scenario: captive operations are probably integral to a plant's production function. Closures probably will not occur.

Table V-6, on the following page, arrays sample captives by wetmetalfinishing intervals and displays the total number of captive closures by interval. Sales and finishing employment losses are projected in Table V-7, following Table V-6.

TABLE V-6

Projected Total Captive Closures by the Regulation

Size of Firm	Number of Firms: Total	Number of Firms: Dischargers to POTW	Number of Firms: Vulnerable Operations
1-4	2,372	1,833	55
5-9	1,164	884	26
10-19	1,103	884	26
20-49	955	748	22
50-99	271	203	6
100-249	157	131	4
250+	55	39	1
	6,077	4,722	140

TABLE V-7

Employment and Sales Effects of Captive Closures Due to the Regulation

Size of Firm	# of Closures	Mean Sales* (Millions)	WMF Employees
1-4	55	$ 15.9	120
5-9	26	13.6	150
10-19	26	29.8	330
20-49	22	45.0	630
50-99	6	17.5	390
100-249	4	19.2	570
250+	1	11.1	420
	140	$152.1	2,610

* Value Added by Finishing

Were these 140 captives to divest their finishing operations, 2,600 wetmetalfinishers would be in the labor pool and some $152.1 million of finishing work added to the demand side of the job shops.

(6) <u>Compliance With The Regulation Represents a Direct But Generally Manageable Economic Impact on The Indirect Discharging Segment of the Metalfinishing Industry</u>

As a summation of the specific industry impacts of the regulation for the metalfinishing industry, Table V-8 below arrays total costs and annual costs for each segment of the industry.

TABLE V-8

Total Economic Impacts of Pretreatment Compliance for the Metalfinishing Industry by the Regulation

Segment	Investment Costs (Millions)	Annual Costs (Millions)
Job Shops	$ 187.6	$ 62.5
Printed Boards	18.5	6.8
Captives	1,134.4	424.6
	$1,340.5	$493.9

A large proportion of the capital and annual cost is incurred in the captives sector. These operations will spend 5 times the amounts projected for the other segments combined. The average estimated capital cost for captive shops is $240,000 and the average estimated capital cost for the job shop is $87,400.

On the macro level, the study findings mean the following:

> Price for metalfinishing goods and services is expected to rise on the order of 7%. This is a level that is required on average by the industry to pass on the incremental annual costs of the abatement system for Pretreatment. The figure is on the order of 2% for Printed Board makers and less than 1% for all other manufacturing establishments with in-house finishing operations.
>
> For the independent segment of the industry (jobbers plus Printed Board makers) 19% of all firms now in business might close as a result of the investment requirement of meeting the Pretreatment standard. Given that demand remains high and that product substitution is unlikely, the following should hold:
>
>> Some new firms will enter the marketplace, perhaps begun by production managers of a captive operation

Each remaining firm in the industry can probably either raise his price more than 7% or expand his production capacity to meet the demand

Predicted closures will be less than calculated if:

- Water use is controlled; reduced by good-houskeeping or engineering changes
- Abatement equipment is homemade rather than professionally supplied
- Production equipment runs past its depreciated life.

Price impacts on the finished goods due to capital investment in pretreatment equipment are expected to be on the order of 1%. Given that no industrial sector attributes more than 10% of the cost of the finished good to metalfinishing, cost increases of up to 10% in finishing should be reflected in small point of sale price increases.

If plant closings do occur, it is not anticipated that they will be felt directly within the community or region. Metalfinishing job shops do not represent a large proportion of the total production employment within any one city. Were closings to occur, some job transfers to the surviving firms would have to occur.

At the national and international level, economic shifts in the domestic metalfinishing industry are not expected to have any noticeable effect on trade balances. A somewhat different condition holds on Printed Board products. This is so for two reasons. First, finished boards are being imported and second, domestic manufacturers send out and then reimport their own finished wiring boards. Depending on trade policies, domestic production of Printed Boards could increase despite the incremental cost of Pretreatment.*

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* "An analysis of the Market for Printed Boards and Related Materials." 1976 Technical Marketing Associates, prepared for the Institute of Printed Circuits.

VI. LIMITS OF THE ANALYSIS

VI. LIMITS OF THE ANALYSIS

The purpose of this chapter is to discuss the issues that bear upon the "power" of the study; the data and analytic constraints that must be made explicit in order for the estimates of industry impacts to be held in perspective. Accordingly, three topics require review:

- Utility of data
- Analytic methods
- Strength of conclusions.

Each point will now be developed in sequence. Key to this review is one central fact: study results derive from a plant-specific microeconomic model. Therefore, the applicability of results rests with how well the data, logic and assumptions of the model mirror the realities of actual plant operations.

1. DATA HAVE TO BE EVALUATED ON THE BASIS OF QUANTITY AND QUALITY

In this section, we treat two data related issues: sources of data and the quality of data.

(1) The Data From the Survey

Appendix D is devoted to an exhaustive review of the development of survey instruments, response rates and sample bias. Here the focus is directed more toward the implications for the analysis of data limitations rather than a review of methodological issues. In this vein, the following needs to be made explicit.

> Although the respondents to the survey provide sufficient data for analysis, the 444 can be viewed as one slice drawn from the population. Had a different set of firms chosen to respond, the results conceivably could be different. Random selection theory says that in enough trials, sample data must converge to the population's parameters. But although sample selection was designed to be random, patterns of respondents might contain biases.
>
> The phone survey to non-respondents was designed to test this issue explicitly. The follow-up effort focused special attention on smaller firms. Finding differences between the respondents and non-respondents was inevitable. But financial data were not sought since they were too sensitive, and no conclusion can be drawn on whether respondents are more or less financially sound than non-respondents.

Identifying 205 plant models for the closure analysis did not fit the rigorous random selection rules for the sample as a whole. These cases were used because they provided all requisite data for analysis, not because they necessarily reflected the sample. Analyses, however, on models and non-models as well as on respondents and the entire balance of the targeted sample suggest that the models are a strong cross-sectional representation of the industry.

Data are from a single point in time. There is little capability to appreciate trends over time or to reflect the changing capacity of any one firm to handle the pollution control investment. An approximator is to cost part of the system as a proxy for investment over time; but this is clearly not the same as having a dynamic closure model that varies sales, profits, taxes, long-term debt and cash flows.

Costs are an important analytic component. We have not utilized the specific computer generated cost estimates of the Technical Contractor. Rather, we have built his cost data into our linear regressions and developed cost equations on a per component (installed) basis. The linear regression is a simplified A to B relationship of cost to water usage. As shown in the Appendix, however, comparisons of cost estimates to outside vendors yield generally good agreement.

(2) Quality of the Data

There are two primary considerations in discussing data quality; their reliability and their validity. Reliability is satisfied by knowing that the same respondent would provide the same response to a question at $Time_2$ that he did in $Time_1$. Resurveying the sample in six months to assess the reliability issue is impossible. But if data are valid, they are, by definition, reliable.

Answering the question of data validity requires exploring a set of data interrelationships. This is an approach to establishing validity by judging how well sets, or independent estimates of the same variable, agree (convergent validity). Examples of efforts to establish the data's validity are presented below:

Data from the survey on specific parameters tend to agree with prior, independent estimates. The sample provided information on employment and sales which, when extrapolated to the population, are not significantly different from estimates on the same variables available from the U.S. Department of Census.

Financial data from the survey were compared against comparable data elements available on individual plants through Dun & Bradstreet records. The strong agreement on data items within a group (i.e., model plant data in 1975 and 1977) as well as across groups (i.e., respondents are not significantly different from the balance of the sample universe) supports the presumption of valid response data to the survey.

Throughout the analysis, limitations of the data are cited and the analytic assumptions introduced to the computations are made explicit. In addition, the conscious effort of the analysis has been to control error by making results more, not less conservative. Decision rules were generally established to be more rigorous than they might be in practice. As examples, not plant models were assumed to reduce flow in order to come in below the cut-off; all plants were costed for professionally designed, engineered systems. Both rules may exaggerate compliance costs and probably plant impacts. Industry impacts could also be mitigated if any number of other factors proved to hold in practice: e.g.,

- Owners have capital and access to capital in excess of that allowed by the model
- Owners would reduce their compensation to $10,000 or $7,500 for the one year, not $15,000
- More, rather than fewer, firms have treatment equipment in place
- Most firms engineer their own treatment system or purchase second-hand equipment rather than purchase outright from an industrial waste treatment supplier.

Use of a coverage ratio of 1.5 is a moderately rigorous requirement coupled to the bank's requirement that the owner guarantee the loan. It is quite apparent that many factors go into a bank loan decision. There may be cases where finishers receive loans because of history of repayment and pro-forma's even though the coverage ratio falls below 1.5.

2. THE FINANCIAL CLOSURE METHODOLOGY IS BUILT ON DATA AND LOGIC BUT IS NOT ENTIRELY FREE OF ASSUMPTION

A model is a set of algebraic statements, objective functions and decision rules incorporating data, designed to yield an outcome. Appreciating all ingredients of the predictive model, its input data and algorithms are the key to assessing the quality of the model's output. Without critically reviewing each part of a model, it is not possible to judge the credibility of the model's estimates.

(1) <u>The Capabilities of the Model Are Built From and Complement High Quality Data</u>

Considerable effort was made to balance the analytic requirements of the economic closure model with the quality of the source data available from the field. Just as the pollution control cost program could not generate accurate and complete component costs without a full set of technical information, so too the economic model needed adequate financial data. But certain simplifying steps were taken in the interests of obtaining responses that have to be fully shared and understood.

> No previous year's financial statements were available. Only the sales trend for the firm is known. As a consequence, there is a limitation in the ability to tell if any one firm is at the beginning, middle, or end of a boom or bust.

Completely detailed financial reports could not be requested because of the time limitations of a self-administered survey. The statements were abbreviated and omitted certain line items that might have altered the calculations of debt, profitability, and return.

Coverage ratios, rather than pure cash flow measures, were the key closure criterion. Although the use of coverage ratio as a predictor can be justified, other measures for which we had no data could also have been used. Closure estimates might be different were a different criterion used.

Return to the owner is an important economic criterion and was set using a combination of Profit After Tax plus owner's compensation. Clearly, there are opportunity costs to staying in metalfinishing and to alternative uses of capital. As a consequence, there is no proof that all predicted closures will choose to close, nor that all designated non-closures will opt to make the investment to remain open.

(2) Some Elements of a Full Economic Impact Analysis Have Not Been Included

At this point, there is no impact analysis of new sources: firms likely to enter the marketplace to provide the displaced supply of the closures. To some degree, then, the structural recomposition of the industry cannot be appreciated.

Also omitted, as of now, is the user charge component of pretreatment costs. User charges are to be developed by POTW's and applied through appropriate formulae to the various point sources using the municipal system. That cost component is absent now, and may be factored into subsequent cost/impact analyses. To the extent it increases the costs of compliance for pretreaters, total compliance may be somewhat understated. However, through prior surveys, User Charges are known to be a small component of the total operating expense of a plant and not a prime driver of closures. In a separate report the economic impacts of hazardous waste disposal requirements (RCRA) will be costed and applied to the industry.

(3) Some Assumptions Had to be Made

In the logic and calculations of the financial closure model, a specific set of assumptions had to be made for the sake of analysis. Certainly, this is true for any analysis. In some respects, appreciating the magnitude of the findings is dependent on accepting some of these assumptions:

For the sake of calculating closures, it was necessary to introduce the decision rule of a "one-shot" equity infusion by the individual full-time owners. This was done in order to prevent inclusion of a firm as a closure if it lacked several hundred to several thousand dollars in investment capital. But by so doing, survey results indicating the reluctance of many owners to reduce their compensation were overriden. Again, the actual decision-making preferences of individual firm owners is not known. It is possible that no set of questions could predict that behavior; perhaps the owner himself will not know until the decision is imminent.

All firms with reported equipment in place were not costed for the impact analysis if their equipment matched the treatment requirements of each pretreatment scenario. It is not known whether existing installed equipment performs up to the standards of the equipment costed by the Technical Contractor. If it does not, a certain number of firms might have to be added to the closure analysis and closure estimates could increase.

(4) Baseline Closures Have Been Treated Somewhat Judgmentally

The basic function of the economic impact analysis is to relate the capital burden of abatement compliance to the viability of the industry. Such an analysis requires mechanisms for distinguishing industry impacts due to the Act, from those other market/economic factors that also determine success and closure rates in the industry. This might be accomplished by identifying segments of the industry already quite marginal and likely to close for reasons totally separate from the incremental operating burden of pollution control investments. Such firms are labeled "baseline closures." After this group is factored out of the population, all subsequent closures can be attributed to the effects of compliance.

The method used to cull baseline closures from the sample was to apply a constant capital burden of $100 to all models to test for pre-investment vulnerabilities. This approach eliminated 28 jobbers and 5 Printed Board firms. While there is no proof that these marginal firms truly will close, it is interesting to note that the estimate parallels some other data. These 33 baseline models are 10% of all independent firms. As a percent, this baseline closure rate matches closely the annual turnover rate found in the Dun & Bradstreet industry files for SIC 3471 and 3479 (10% annually 1975-1977).

3. CLOSURE ESTIMATES FROM MODELING ARE QUITE ROBUST AND CAN SERVE AS POPULATION PREDICTORS

It is at this point that the overall assessment of the study effort is drawn. In light of the method selected, the tests applied and the results generated in virtually all respects, the effort met its goals. In sum, the following elements support this conclusion:

Primary field data for characterizing the industry were sought. To this end, three separate surveys were commissioned and executed. Response rates for the mail efforts were on the order of 39% for the captives and 45% for the jobbers. The core data for analysis are, therefore, the largest base for analysis ever available.

Estimates of impacts were to be derived through the application of an automation routine using actual field data of representative plants. This analysis is dependent on three factors:

- Accurate Costs
- Valid financial reports
- Comprehensive variable modeling.

Estimates of pollution abatement costs were verified for internal consistency and external accuracy. They satisified both.

Eliminating probable baseline closures from the sample results has the effect of limiting impacts just to the cost of Pretreatment. Culling the 28 cases from the data base of 234 models yields more than 200 models. Tests of models and non-models, and then respondents to non-respondents established the legitimacy of these 200+ cases for drawing population estimates.

Applying an automated financial closure routine introduces many advantages and a few drawbacks. The primary drawbacks to the routine are two-fold: (1) the model is more a static than a dynamic model, and (2) it is limited to a pure capital decision matrix. The implications are as follows:

- Time trends cannot be appreciated
- Interactive effects of key variables cannot be measured
- "Soft" variables are not part of the routines' specification, i.e., owner's attitudes, local

markets or enforcement policies are not reflected in the logic of the model.

Results of the routine, however, show a basic insensitivity to minor variations in input specifications. As an example, overall closure results are about the same whether sales or profits go up or down 10%, whether price pass through is 5%, 10%, or 15%, or coverage ratio 1.4, 1.5 or 1.6. In sum, the model is robust with respect to alternative variables and insensitive to minor shifts in data values.

All plants, regardless of process water volume, are required to treat their lead and cadmium. Any plant predicted to close might survive if it could productively divest its lead and cadmium plating. There are no data on this possibility, nor does it lend itself to rigorous modeling.

* * * * *

This chapter has presented the limits of the analysis. The Appendices that follow provide detailed discussions on the field survey, the costing model and the study design.

A P P E N D I C E S

A. THE METALFINISHING JOB SHOP SECTOR SURVEY

B. THE PRINTED CIRCUIT BOARD INDUSTRY SURVEY

C. THE CAPTIVE METALFINISHING INDUSTRY SURVEY

D. SAMPLE DESIGN AND SURVEY ISSUES

E. AUTOMATED FINANCIAL CLOSURE METHODOLOGY

F. THE POLLUTION ABATEMENT COST GENERATING PROGRAM

G. VALIDATION OF THE POLLUTION ABATEMENT COST ESTIMATES

APPENDIX A

THE METALFINISHING JOB SHOP SECTOR SURVEY

This appendix presents the survey results, instrument and data for the metalfinishing job shop sector survey and arrays the pooled results of the respondents. In Appendix D, all the validity tests and extrapolation rules are discussed at length so they are not covered here.

For purposes of presentation, this Appendix is organized in three sections:

- Sample results
- Survey questionnaire
- Raw response data

All data, other than capital costs, are presented here so that the reader might appreciate directly the findings and conclusions presented in the text.

1. APPROXIMATELY HALF OF ALL METALFINISHING JOB SHOPS LISTED IN THE DMI ARE PROJECTED TO FALL WITHIN THE REGULATIONS OF THE ELECTROPLATING CATEGORY

More than 5,500 metalfinishing establishments are listed in the DMI. Our projections, based on the survey results, show that 2,941 firms or 54% of the population do regulated processes.

The total size of the universe subject to regulation was derived by extrapolating the survey results in the following manner:

> Eligibility returns from the phone follow-ups were extrapolated to all survey non-respondents.
>
> These data were added to the eligible responses from the mail survey to form the total eligible sample.
>
> Combined results were than multiplied by the original fixed interval sampling value of 2.5 to yield the estimate of the projected population. The data for the extrapolation are presented in Table A-1 below.

Table A-1

Estimate of the Universe of Metalfinishing Job Shops in the Electroplating Category (Arrayed by Metalfinishing Size)

Size Interval	Mail Results	Phone Results	Weighted to DMI	Corrected
1-4	65	53	1,089	1,156
5-9	80	32	643	682
10-19	109	28	515	546
20-49	111	10	337	357
50-99	46	18	150	159
100-249	12	3	39	41
250+	0	0	0	-
Missing	21	0	169	-
Total	444	144	2,941	2,941

The total estimated population of job shops affected by the regulations of the Electroplating Point Source Category is 2,941 firms. The largest cluster of firms is in the 1-4 man interval with almost 40% of the total.

More than 80% of the industry consists of firms employing fewer than 20 men in metalfinishing production.

Table A-2 below, arrays the industry on key descriptive elements. Shown here are employment, sales and plant water use. All entries have been extrapolated by weighted means multiplied by cell frequencies.

Table A-2

Total Industry Employment
Sales & Water Use (000's)

Size Interval	Total Employment	Total Sales	Total Plant Water	
1-4	7.6	$ 30.0	13.9	MGPD
5-9	9.3	22.7	15.3	
10-19	11.6	27.9	17.7	
20-49	16.2	42.1	38.7	
50-99	13.4	28.1	22.6	
100-249	7.0	19.2	5.7	
	65.3	$170.0	113.9	

This extrapolation yields an industry picture as follows:

65,000 people work in job shops with an average shop having 22 employees

Sales for the industry are $1.7 billion with the average shop selling slightly more than a half million ($580,000).

On a daily basis the industry uses 114 million gallons of which 90 million is for metalfinishing production use.

2. SAMPLE FINDINGS PROVIDE A VALUABLE APPRECIATION OF THE METALFINISHING INDUSTRY AND ITS PROBLEMS

A respondent was included in the study if he performed any of the following processes:

- A--Electroplating (common metals)
- B--Precious metals
- C--Reserved
- D--Anodizing
- E--Coatings
- F--Etching, engraving
- G--Electroless plating
- H--Printed Circuit Boards

To clarify our understanding of the mix and prevalence of these production processes, each survey respondent was asked to check off all metalfinishing processes performed at his plant.

Fully 77% of all survey respondents do at least electroplating of common metals. The second most frequent process is Coatings (55%), followed by Polishing and Grinding (44%).

Regardless of the size of an establishment, these same three processes occur most frequently. Table A-3, on the following page, arrays the processes against the entire sample, and then by the six size intervals.

Table A-3

Frequency of Performed Process
By Size of Firm

		Firms With Employment of					
Processes	Total Sample	1-4	5-9	10-19	20-49	50-99	100-249
Electroplating	77.7%	71.9%	77.6%	77.1%	82.9%	71.7%	76.9%
Precious	23.6	23.4	31.8	14.4	28.8	23.9	15.4
Anodizing	23.9	12.5	17.6	22.0	35.1	30.4	38.5
Coatings	55.3	35.9	49.4	59.3	64.0	65.2	46.2
Etching	24.5	18.8	22.4	21.2	27.9	39.1	23.1
Printed Boards	2.4	1.6	5.9	--	2.7	2.2	7.7
Polishing	44.0	57.8	38.8	41.5	47.7	32.6	53.8
Number of Respondents	440	67	85	118	111	46	13

Exploring the potential significance of production processes resulted in cutting the data in two ways:

Separating single versus multiple process firms

Identifying total number of processes done

On the first point, the data showed that only 19% of the sample (82 firms) did just one process. Of these 82 firms doing just one process, 50 (61%) do just electroplating.

More than three-quarters of the sample does no more than three separate production processes.

(1) Ownership Patterns Both Describe the Industry and Affect the Decision Rules of the Impact Analysis

Prior economic impact analyses modeled owner-investment decision making with respect to meeting the costs of pollution abatement controls. In these analyses, the following assumptions were made:

> That an owner would reduce his compensation to stay in business
>
> That his compensation was large enough to allow a significant equity infusion
>
> There were sufficient numbers of owners willing to do so to make a difference in the estimated closure rates.

The survey provides data on all these items. Since the variable "ownership structure" pertains first to an understanding of the industry's composition, and then to an appreciation of the potential economic impacts upon it, data are ordered by:

- Ownership patterns
- Owner's compensation
- Owner's attitudes

For the entire sample, the median number of owners in a firm is 2, of whom 1.5 work at the establishment full time. Individuals own about one-third of the firms (31%) as do families (34%) and small groups (31%). Fully 90% of all firms are owned by four people or fewer.

Larger firms tend to be owned by families or groups whereas smaller establishments are much more likely to be held by an individual, small business man. Ownership patterns are presented in Table A-4 below.

Table A-4

Ownership Patterns by Size of Metalfinishing Establishment

Size / Ownership	Total Employment 1-4	5-9	10-19	20-49	50-99	100-249
Individual	52.5%	32.9%	33.6%	22.0%	18.6%	25.0%
Family	27.1	38.0	29.0	37.0	41.9	-0-
Small Group	18.6	26.6	33.6	38.0	27.9	41.7
Another Firm	1.7	1.3	2.8	2.0	11.6	33.3
Total	99.9%	98.8%	99.0%	99.0%	100%	100%

In order to characterize more accurately individual owner's compensation, the number of owners working full time in each type of establishment must be identified. Data were gathered on total number of owners, those working full or part time, and the dollar value of the owner's compensation. One assumption that must be made for this analysis is that the bulk of the value given for owner's compensation is distributed evenly across each owner working full time. To the extent that owners working part time at the facility draw sizable portions of the reported compensation, our estimates will overstate the full-time owner's compensation.

Table A-5, below, arrays firms by size, total number of owners and the reported total compensation for all owners.

Table A-5

Owner's Compensation by Firm Size and Number of Owners

		Total Employment					
		1-4	5-9	10-19	20-49	50-99	100-249
		(Total Owner's Compensation $000's)					
Individual	1	$17.1	$26.1	$26.1	$37.2	$ 45.3	$ 66.1
	2	23.5	25.2	48.0	56.3	58.0	-0-
Family	3	35.6	36.3	36.3	77.1	82.3	-0-
	4	74.5	34.7	37.6	69.7	61.1	-0-
	5	-0-	70.1	40.9	46.7	103.1	-0-
Small	6	-0-	22.5	36.0	30.0	-0-	-0-
Group	7	-0-	-0-	-0-	86.4	-0-	-0-
	8+	-0-	-0-	-0-	-0-	98.6	453.0

From related calculations on the survey returns, the number of full-time owners by type of establishment is the following:

> Virtually all firms owned by one person have just one full-time owner. Therefore, compensation for full-time owners will remain the same as the first line of Table A-5.

For all firms owned by families, e.g., those having 2, 3, and 4 owners, the mean number of full time owners is 1.79 (S.D. = 0.9). These data range from 1.6 full-time owners in small shops to 2.1 in the largest.

In firms owned by small groups, e.g., those with 5, 6, 7, or 8+ owners, the mean number of full-time owners is 2.3 (S.D. = 1.4).

By introducing these corrective terms for full-time ownership, Table A-5 can be recomputed to yield the mean compensation for each full time owner across the different firm size categories. In Table A-6, below, the reported total owner's compensation has been recomputed to yield the individual full-time owner's compensation.

Table A-6

Total Annual Compensation for Individual Owners Working Full Time

Size / Ownership	Individual Owner's Compensation					
	1-4	5-9	10-19	20-49	50-99	100-249
1	$17.1	$26.1	$26.1	$37.2	$45.3	$66.1
2	14.4	15.6	25.8	30.6	28.1	-0-
3	21.8	22.5	19.5	41.9	39.9	-0-
4	45.7	21.5	20.2	37.8	29.6	-0-
5	-0-	39.8	21.0	20.1	26.9	-0-
6	-0-	22.5*	36.0*	30.0*	-0-	-0-
7	-0-	-0-	-0-	37.2	-0-	-0-
8	-0-	-0-	-0-	-0-	25.8	98.4

*Unadjusted

259-718 O - 78 - 13

(2) Owner Attitude Data Do Not Support the Assumption of Reduced Compensation To Stay in Business

There were 286 respondents who answered the item: "What is the likelihood that you might reduce the owner's compensation to help secure a bank loan (for a wastewater treatment system)?"

The scoring ranged from "very unlikely" to "very likely." Presented below is a summary of attitudes:

> For all 286 respondents, 183 or 64% said it was very unlikely, or unlikely. Only 46 or 16% scored it likely or very likely.
>
> Splitting the sample by size or type of firm did not change the response pattern by much:
>
> > 88 respondents (31%) already have some treatment equipment in place. Fully 68% of them say it was very unlikely or unlikely that they would reduce compensation to help pay for more.
> >
> > 198 respondents (69%) have nothing in place. Of these 198, 133 or 67% also say it is very unlikely or unlikely they would reduce compensation to pay for a system.
> >
> > Owners of larger firms are just slightly more likely to consider reducing their compensation than are owners of smaller shops. On the following page, is a summary table of the responses to the question by size of firm. The answers "unlikely" or "very unlikely" have been recombined to a single "No" response. There are only 272 rather than 286 cases because 14 respondents gave no employment size data.
>
> Table A-7, on the following page, summarizes just the negative attitudes.

Table A-7

Proportion of Sample Indicating Reluctance
To Reduce Owner's Compensation

	1-4	5-9	10-19	20-49	50-99	100-249	Total
Number Answering	31	52	73	74	33		272
Combined "No's"	20	30	48	46	23		174
Percent	64.5	57.6	65.7	62.1	69.7	77.7	64%

This presentation of owner attitudes toward compensation reduction must close with a caveat. People who returned the questionnaire could have had many different motivations for participating, two of which could be:

> They were sufficiently on target with abatement requirements that they felt comfortable describing themselves to the EPA.
>
> They felt themselves so vulnerable that the survey provided them a vehicle to bring their plight to the attention of the agency.

There is a strong possibility that the responses to the item on reducing owner's compensation are biased: biased in the direction of showing vulnerability to the regulations through restricted personal freedoms to absorb the incremental costs of compliance. It is not surprising that many reported they would not or could not reduce their compensation if many respondents judge the compliance process as punitive, burdensome, and disruptive.

*   *   *   *

This concludes the summary of selected survey findings. The next sections contain the survey instrument and the study data.

NATIONAL ANALYSTS
Division of Booz, Allen & Hamilton
Philadelphia, Pa.

Study #1-537
Fall, 1976

METALFINISHING STUDY

Respondent's Name: ______________________________

Title: ______________________________

Organization: ______________________________

Street Address: ______________________________

City: ________________ State: __________ Zip: __________

Instructions

There are six sections in this questionnaire dealing with your firm; its products, markets and operations. Please answer all questions in each section. If you are not certain about a question perhaps one of your staff knows the answer. Make every effort to return the completed questionnaire to us as soon as possible. A postage paid return envelope is provided. If you have questions that we can answer, feel free to place a collect call to Mr. Nat Greenfield at the Booz, Allen Office in Washington. He can be reached at (202) 293-3689.

For purposes of confidentiality, please answer the following question. Do your answers include material you consider confidential, and that you do not wish revealed to anyone? (CIRCLE APPROPRIATE CODE)

Yes	1
No	2

SECTION 1: PLANT DESCRIPTORS

The four questions in this section deal with the products and characteristics of your firm. Your answers are important to our understanding of the diversity of the metal-finishing industry.

1. From the list of metalfinishing activities shown below, please circle the codes for all the activities normally performed in your firm.

	(CIRCLE CODES)
Electroplating of common metals (for example, copper, nickel, zinc, chromium, cadmium)	1
Electroplating of precious metals (for example, gold, silver, platinum)	2
Anodizing	3
Coatings (for example, chromating, phosphating, or immersion plating)	4
Chemical etching, milling, and engraving	5
Printed circuit boards	6
Polishing, grinding	7
Other (Please Explain):	0

NOTE

IF YOUR SHOP ONLY DOES POLISHING AND GRINDING WITH NO WET METALFINISHING PROCESSES, THEN ANSWER NO FURTHER QUESTIONS AND PLEASE MAIL BACK THE QUESTIONNAIRE IN THE SELF-ADDRESSED ENVELOPE.

2. Please indicate the total number of people working full-time at this location. Then give us the number of employees working just on the wet metalfinishing lines by each shift.

	(PLEASE WRITE NUMBER OF EMPLOYEES HERE)
Total # of full-time people =	
Shift 1 wet metalfinishing production employees =	
Shift 2 wet metalfinishing production employees =	
Shift 3 wet metalfinishing production employees =	

3. Please describe your physical plant in terms of the following uses of floor space (in square feet).

	(PLEASE WRITE IN NUMBER OF SQUARE FEET)
Total area of the plant	
Total area used by all production operations	
Total area used by wastewater treatment facilities	
Total area available for expansion inside the plant	
Total area available for expansion outside the plant	

4. Many shops in the metalfinishing industry that discharge an effluent may already be covered by a regulatory agency. Which of the following types of authorities regulate your effluent?

	(CIRCLE ALL THE CODES THAT APPLY)
Local (including city, county or region)	1
State	2
None of the above	9
Don't know	V

SECTION 2: MARKET CONDITIONS

The five questions in this section deal with the market in which your firm operates. Your answers to these questions will help us understand how competitive the metal-finishing industry is.

1. Each of the following items has two possible answers. Indicate only the one that best fits your firm. You may find that sometimes both answers are true, or that neither is quite right. Try to select just the one that comes the closest. (PLEASE CIRCLE CODE NUMBER)

A. Does your firm specialize in services to a major industry (i.e., automobile, aerospace, etc.) or do you service many different industries?

Specialize in service to an industry	1
Service many industries	2

B. During the year are most of your sales to a few steady customers or to many different customers?

Few steady customers	1
Many different customers	2

C. Do your customers send you many different kinds of products (all shapes and sizes) or do you get basically the same products most of the time?

Many different products	1
Basically the same products	2

D. Do you generally attract customers because you can offer low prices or because you can take on any assignment?

Offer low prices	1
Take any assignment	2

E. Do you face a lot of competition for your customers or relatively little?

Lot of competition	1
Relatively little	2

F. Do you think captive operations also compete for your customers?

Yes, they do	1
No, they don't	2

2. The last time you raised your price (for whatever reasons) what percent price increase did that represent?

__________%

3. As a result of that price increase, did your business volume fall or remain the same?

Fell off	1
Remained the same	2

4. Today, IF YOU AND ALL YOUR COMPETITORS had to raise prices, how much do you think you could raise them before your business might be badly hurt? (PLEASE GIVE YOUR ANSWER AS A PERCENT)

__________% Price Rise

5. If business fell after a price increase, your customers could be doing several different things. Below is a list of five things they might do. Please judge how likely each one is by circling a number next to each possibility.

	Very Unlikely	Unlikely	Maybe	Likely	Very Likely
Customers might buy more from captives	1	2	3	4	5
Customers might eliminate metal-finishing from their products	1	2	3	4	5
Customers might start their own inhouse, captive lines	1	2	3	4	5
Customers might shop around more for the best price	1	2	3	4	5
Customers might use some other finish for metalfinishing	1	2	3	4	5

SECTION 3: PRODUCTION OPERATIONS

The fourteen items in this section will help us understand the different activities that occur in metalfinishing plants. We are aware that many shops handle many different operations. Sometimes you may have to give us your best estimate for some of the questions.

1. Altogether how many total hours per day are spent in wet plating and/or wet finishing operations:

__________Hours/Day

2. Altogether how many days per week are spent in wet plating and/or wet finishing?

__________Days/Week

3. We would like to know the degree of automation in your operation. From the list below, please circle the code that best fits your plant.

Programmed control	1
Fully automated	2
Semi-automated	3
Manual	4

4. From the list of electroplating operations shown below, please check off all the ones that you normally do.

Electroplating

A.
_____Copper
_____Nickel
_____Chromium
_____Cadmium
_____Zinc
_____Solder
_____Lead
_____Tin
_____Gold
_____Silver
_____Platinum metal group
_____Iron
_____Brass
_____Bronze
_____Other (write in)
____

From the list of other metalfinishing operations shown below, please check off all the ones that you normally do.

Other Finishing Processes

B.
_____Anodizing
_____Coloring
_____Phosphating
_____Chromating
_____Electroless on plastics
_____Electroless on metals
_____Chemical milling
_____Non-aqueous plating
_____Bright Dip
_____Chemical Etching
_____Electrochemical Milling
_____Stripping

For each metalfinishing operation checked off above, please indicate the metals you etch, mill, strip, or plate electrolessly.

C.
_____Copper
_____Nickel
_____Chromium
_____Cadmium
_____Zinc
_____Solder
_____Lead
_____Tin
_____Gold
_____Silver
_____Platinum metal group
_____Iron
_____Brass
_____Bronze
_____Other (write in__________________)

5. How many cleaning, plating, finishing and rinse tanks do you have on your floor(s)?

____
# of Process Tanks

6. How many separate production lines do you have set up normally to handle your metalfinishing operations?

____
# of Production Lines

7. For each production line identified above, we would like a description of what is finished and how it is done. Please enter the finishing sequence (i.e., copper, nickel, chrome), whether rack or barrel, time, and the total number of tanks set up for the line. An example has been provided as a guide.

Line #	Plating/Finishing Sequence	Rack or Barrel (Circle One)	Hours/Day in Operation	Total Tanks on the Line
Example	Copper, nickel, chrome	R B	8	10
1		R B		
2		R B		
3		R B		
4		R B		
5		R B		
6		R B		
7		R B		
8		R B		

8. For each production line, we would like a description of how you finish the products run on that line. Since different jobs are run on the same line, please use average or typical values for time and thicknesses.

Line #	Immersion Time* (Typical)	Thickness of Finish** Applied or Removed (Typical)	Amperage of Finishing Tanks***
1			
2			
3			
4			
5			
6			
7			
8			

* In minutes
** In mils or thousandths
*** Put NA if not applicable

9. If you have any data on area plated or finished, it would be very useful to us in our effort to describe industry operations. Please write in your area data below, or attach it to the back of the questionnaire.

Line	Area Plated, Finished or Removed Area in sq. units / Unit Time
1	____________
2	____________
3	____________
4	____________
5	____________
6	____________
7	____________
8	____________
Total Plant	____________

10. Please fill in the table below showing your plant's water use for a typical day during 1975. Use gallons per day (GPD) if available. If your information is in cubic feet, please note it in the table.

Water Use	GPD
Total Plant	
Metal Finishing Processing Water	
Other: Cooling	
Boiler	
Sanitary	

11. Now please indicate where your discharge water goes.

A. (CIRCLE THE CODE WHICH BEST DESCRIBES YOUR ANSWER)

Municipal sewer system	1
River, lake, pond, other	2
Both	3

B. Do you have the option of switching from your present means of water discharge to another?

Yes	1
No	2

If yes, please describe the nature of your option:____________________

____

12. If you discharge to a municipal sewer system, would you please write in your 1975 total sewer costs and the name of the agency, department, or authority that sets the formula for sewage rates?

$____________ Sewer Costs   ____________________ Agency Name

13. How many pounds of sludge do you produce a month?

\# of Pounds/Month:____________

14. How is the sludge disposed?

	(CIRCLE ALL THE CODES THAT APPLY)
Land fill	1
Into water or sewer	2
Incinerator	3
Lagoon	4
Trash pickup	5
Other (Write in):	0
Don't know	V

SECTION 4: FINANCIAL ISSUES

The four questions in this section deal primarily with the financial condition of firms in the industry. Most of the items can readily be answered by using your 1975 balance sheet and profit-and-loss statement. Remember that your answers will be held strictly confidential, if you indicate so.

1. Would you please indicate how your firm is organized?

Who owns it?	(CIRCLE CODE NUMBER)	How many owners are there?	How many of these owners work: Full-time	Part-time
An individual	1			
A family	2			
A small group	3			
Another firm	4			
Other (PLEASE WRITE IN):	0			

2. From 1972 to 1975, how would you describe the changes in your annual sales? (CIRCLE THE CODE NUMBER)

Sales were increasing steadily	1
Sales were decreasing steadily	2
Sales moved in cycles	3
Sales were about the same	4

3. For the six items shown below, please enter the 1975 year-end values from your profit-and-loss statement (or best estimate).

	1975 Dollars
1. Sales	$
2. Rent or lease payments	$
3. Owner's/officer's compensation (include salary, bonus, and dividends)	$
4. Depreciation (building and equipment)	$
5. Profit before tax	$
6. Profit after tax	$

4. Listed below are five items found in your balance sheet. Please enter the 1975 year-end values (or best estimates).

	1975 Dollars
1. Current assets	$
2. Fixed and other assets	$
3. Current liabilities (include accounts payable, working capital loans from banks, etc.)	$
4. Long-term debt	$
5. Company net worth	$

5. Many shops have made capital investments in their plant (e.g., building, land, and production equipment). From your balance sheet, please enter the book value shown for these assets, and indicate how much more you plan to invest over the next five years (please do not include planned investments for pollution control equipment).

	Book Value	Remaining Life	Expected Investment Over Next Five Years
a. Building	$	yrs.	$
b. Production equipment	$	yrs.	$
c. Land	$		$

SECTION 5: WASTEWATER TREATMENT SYSTEM

NOTE

ONLY FIRMS HAVING A WASTEWATER TREATMENT SYSTEM NOW (OR EXPECTING TO HAVE ONE IN THE NEXT SIX MONTHS) NEED TO COMPLETE THIS SECTION. ALL OTHERS MAY GO ON TO SECTION 6.

This section will let us see how many firms already have invested in a pollution control system. It also will clarify the industrywide effects the guidelines could have on metalfinishers.

1. Shown below are the features of a wastewater treatment system. Please circle the code number for each feature that makes up your system.

pH adjustment	1	Lagoon	6
Flow equalization	2	Separate cyanide stream	7
Chromium reduction	3	Separate hexavalent-chrome stream	8
Cyanide destruction	4	Countercurrent rinse	9
Precipitator-clarification	5	Reverse osmosis, evaporation, ion exchange or other advanced treatment technologies	0

2. Please provide the following information about your wastewater system.

A. How much did it cost to purchase and install?

$____________

B. In what year did you make the last major addition to the system?

Year:_________

C. What is its designed treatment capacity? Please record in gallons per day.

Gallons/Day Capacity:__________

D. How much does it cost each year to operate? (Include costs for labor, energy, chemicals and upkeep.)

Annual Cost to Operate $___________

F. Did you contract for any part of the design, construction and installation of the system or did you do it all yourself?

	(CIRCLE CODE NUMBER)
Contracted for some	1
Did all myself	2

G. Did you reduce your water use to put in the system?

	(CIRCLE CODE NUMBER)
Yes	1
No	2
Don't know	V

NOTE

IF YOU MAY HAVE TO UPGRADE OR EXPAND YOUR WASTEWATER SYSTEM IN THE NEAR FUTURE (I.E., 2 TO 3 YEARS), PLEASE GO ON AND COMPLETE SECTION 6. IF YOUR EXISTING SYSTEM COMPLIES FULLY WITH THE REGULATIONS, YOU HAVE FINISHED THE QUESTIONNAIRE. YOU ARE INVITED TO ADD COMMENTS ON THE BACK PAGE BEFORE MAILING THIS BACK TO US IN THE ENCLOSED SELF-ADDRESSED ENVELOPE.

SECTION 6: INVESTMENT OPTIONS

NOTE

FIRMS HAVING NO WASTEWATER TREATMENT SYSTEM NOW, AND FIRMS THAT MIGHT ADD TO THEIR SYSTEM IN THE FUTURE ARE REQUESTED TO FILL IN THIS SECTION.

The five questions in this section help us understand how the guidelines will affect you, and the entire industry. Remember that your answers will be kept strictly confidential if you wish. We are not asking what your firm will spend for pollution control. We only want to know how you are approaching the investment decision.

1. You may have an estimate for the design, purchase, and installation of a new wastewater system or to add to the one you already have. If so, please write in that estimate below.

   $__________

2. Purchasing a wastewater system could depend on the ability of your firm to raise capital. From the list below please circle <u>all</u> the code numbers for sources of capital open to you for the purchase.

Source of Capital	(CIRCLE ALL CODES THAT APPLY)
Profits (cash flow) from the business	1
Personal funds (increase equity)	2
Loan from customers/suppliers	3
Small Business Administration Loan	4
Commercial bank loan	5
Other (PLEASE SPECIFY):	0
None	9

3. Purchasing a system could also depend on having a place to install it. From the list below please circle the code number(s) of the spaces available for a system.

	(CIRCLE ALL THE CODES THAT APPLY)
On presently available floor space	1
On space presently used for plating or finishing operations	2
On specially constructed facility in the plan, e.g., balcony	3
Outside the plant on my property	4
Outside the plan on land I would have to buy	5
No place to put it	6

4. If you lacked space to add to, or to install, a wastewater system, several options might be open to you. Below is a list of three possibilities. Please judge how likely each one is by circling a number next to each possibility.

		Very Unlikely	Unlikely	Maybe	Likely	Very Likely
a.	Take out a production line to free up floor space	1	2	3	4	5
b.	Pay to alter the facility, for example, by knocking out walls or building a balcony	1	2	3	4	5
c.	Pay to relocate to a bigger facility with more floor space	1	2	3	4	5

5. If you had the room to put in a wastewater system, but couldn't raise the capital right now, you might still have several options. Below is a list of four possibilities. Please judge how likely each one is by circling a number next to each possibility.

		Very Unlikely	Unlikely	Maybe	Likely	Very Likely
a.	Add to working capital by selling off some of the assets of the business	1	2	3	4	5
b.	Reduce the owner's compensation to help secure a bank loan	1	2	3	4	5
c.	Close down the business, retire or do something else	1	2	3	4	5
d.	Try to find a buyer for the business, or set up a merger	1	2	3	4	5

SECTION 7: OPINIONS AND IMPRESSIONS

We wish to encourage you to make comments in this section. Please take this opportunity to express your opinions on:

This questionnaire:

The economies of your firm:

The regulatory process:

EPA's policies:

THANK YOU VERY MUCH. PLEASE PUT THIS IN THE SELF-ADDRESSED ENVELOPE AND RETURN TO US.

QUESTION NO.I-1 WHICH OF THESE METAL-FINISHING ACTIVITIES ARE NORMALLY PERFORMED IN YOUR FIRM?

		---- NUMBER OF FULL-TIME PEOPLE ----								--- TOTAL SALES ---					
	TOTAL	1-4	5-9	10-19	20-49	50-99	100-249	250-499	500& MORE	UNDER $100M	$100M -249M	$250M -499M	$500M -999M	$1MIL -2.4	$2.5 MIL+
TOTAL	461	64	85	118	111	46	13			54	89	92	86	49	13
NO ANSWER															
NUMBER ANSWERING	461	64	85	118	111	46	13			54	89	92	86	49	13
	100.0	100.0	100.0	100.0	100.0	100.0	100.0			100.0	100.0	100.0	100.0	100.0	100.0
ELECTROPLATING OF COMMON METALS	358	46	66	91	92	33	10			42	66	75	65	40	10
	77.7	71.9	77.6	77.1	82.9	71.7	76.9			77.8	74.2	81.5	75.6	81.6	76.9
ELECTROPLATING OF PRECIOUS METALS	109	15	27	17	32	11	2			14	27	15	24	12	4
	23.6	23.4	31.8	14.4	28.8	23.9	15.4			25.9	30.3	16.3	27.9	24.5	30.8
ANODIZING	110	8	15	26	39	14	5			6	19	24	25	14	3
	23.9	12.5	17.6	22.0	35.1	30.4	38.5			11.1	21.3	26.1	29.1	28.6	23.1
COATINGS	255	23	42	70	71	30	6			21	53	54	52	30	5
	55.3	35.9	49.4	59.3	64.0	65.2	46.2			38.9	59.6	58.7	60.5	61.2	38.5
CHEMICAL ETCHING, MILLING & ENGRAVING	113	12	19	25	31	18	3			11	18	27	21	16	3
	24.5	18.8	22.4	21.2	27.9	39.1	23.1			20.4	20.2	29.3	24.4	32.7	23.1
PRINTED CIRCUIT BOARDS	11	1	5		3	1	1			1	4	1	3		2
	2.4	1.6	5.9		2.7	2.2	7.7			1.9	4.5	1.1	3.5		15.4
POLISHING, GRINDING	203	37	33	49	53	15	7			32	35	38	40	18	5
	44.0	57.8	38.8	41.5	47.7	32.6	53.8			59.3	39.3	41.3	46.5	36.7	38.5
OTHER	36	2	3	5	13	7	3				4	8	8	7	3
	7.8	3.1	3.5	4.2	11.7	15.2	23.1				4.5	8.7	9.3	14.3	23.1

NATIONAL ANALYSTS
METAL FINISHING STUDY (557-1)
SURVEY PARTICIPANTS

QUESTION NO.1-2A TOTAL NUMBER OF FULL-TIME EMPLOYEES

		NUMBER OF FULL-TIME PEOPLE								TOTAL SALES					
	TOTAL	1-4	5-9	10-19	20-49	50-99	100-249	250-499	500& MORE	UNDER $100M	$100M -249M	$250M -499M	$500M -999M	$1MIL -2.4	$2.5 MIL+
TOTAL	461	64	85	118	111	46	13			54	89	92	86	49	13
NO ANSWER	21									2	4	4	4	2	1
NUMBER ANSWERING	440	64	85	118	111	46	13			52	85	88	82	47	12
	100.0	100.0	100.0	100.0	100.0	100.0	100.0			100.0	100.0	100.0	100.0	100.0	100.0
NONE	3									2		1			
	.7									3.8		1.1			
1-4	64	64								34	10		1		
	14.5	100.0								65.4	11.8		1.2		
5-9	85		85							15	41	9	2		
	19.3		100.0							28.8	48.2	10.2	2.4		
10-19	118			118						1	32	53	12	1	1
	26.8			100.0						1.9	37.6	60.2	14.6	2.1	8.3
20-49	111				111						1	25	59	12	
	25.2				100.0						1.2	28.4	72.0	25.5	
50-99	46					46					1		8	29	4
	10.5					100.0					1.2		9.8	61.7	33.3
100-249	13						13							5	7
	3.0						100.0							10.6	58.3
250-499															
500 OR MORE															
AVERAGE	25	3	7	14	32	70	155			4	10	16	32	66	138

NATIONAL ANALYSTS
METAL FINISHING STUDY (557-1)
SURVEY PARTICIPANTS

QUESTION NO.I-28 NUMBER OF WET METAL-FINISHING PRODUCTION EMPLOYEES ON SHIFT 1

		---- NUMBER OF FULL-TIME PEOPLE ----								--- T O T A L S A L E S ---					
	TOTAL	1-4	5-9	10-19	20-49	50-99	100-249	250-499	500& MORE	UNDER $100M	$100M -249M	$250M -499M	$500M -999M	$1MIL -2.4	$2.5 MIL+
TOTAL	461	64	85	118	111	46	13			54	89	92	86	49	13
NO ANSWER	46	10	9	9	4	2				7	8	9	6	3	1
NUMBER ANSWERING	415	54	76	109	107	44	13			47	81	83	80	46	12
	100.0	100.0	100.0	100.0	100.0	100.0	100.0			100.0	100.0	100.0	100.0	100.0	100.0
NONE	6	3	1							4					
	1.4	5.6	1.3							8.5					
1-4	156	51	49	41	10	1	1			39	47	25	13	1	1
	37.6	94.4	64.5	37.6	9.3	2.3	7.7			83.0	58.0	30.1	16.3	2.2	8.3
5-9	91		26	34	22	4				4	25	28	16	1	2
	21.9		34.2	31.2	20.6	9.1				8.5	30.9	33.7	20.0	2.2	16.7
10-19	90			34	42	13					9	28	25	16	1
	21.7			31.2	39.3	29.5					11.1	33.7	31.3	34.8	8.3
20-49	61				33	20	7					2	25	23	4
	14.7				30.8	45.5	53.8					2.4	31.3	50.0	33.3
50-99	10					6	4						1	5	3
	2.4					13.6	30.8						1.3	10.9	25.0
100-249	1						1								1
	.2						7.7								8.3
250-499															
500 OR MORE															
AVERAGE	11	2	4	7	15	28	45			2	5	8	15	26	40

003

NATIONAL ANALYSTS
METAL FINISHING STUDY (557-1)
SURVEY PARTICIPANTS

QUESTION NO.I-2C NUMBER OF WET METAL-
FINISHING PRODUCTION EMPLOYEES ON SHIFT 2

		NUMBER OF FULL-TIME PEOPLE							TOTAL SALES					
	TOTAL	1-4	5-9	10-19	20-49	50-99	100-249	250-499	500& MORE	UNDER $100M	$100M -249M	$250M -499M	$500M -999M	$1MIL -2.4	$2.5 MIL+
TOTAL	461	64	85	118	111	46	13			54	89	92	86	49	13
NO ANSWER	47	10	9	8	4	1				7	8	9	6	3	1
NUMBER ANSWERING	414 100.0	54 100.0	76 100.0	110 100.0	107 100.0	45 100.0	13 100.0			47 100.0	81 100.0	83 100.0	80 100.0	46 100.0	12 100.0
NONE	249 60.1	54 100.0	63 82.9	69 62.7	48 44.9	10 22.2	1 7.7			44 93.6	59 72.8	54 65.1	40 50.0	6 13.0	2 16.7
1-4	69 16.7		13 17.1	34 30.9	16 15.0	2 4.4	1 7.7			3 6.4	19 23.5	20 24.1	11 13.8	2 4.3	2 16.7
5-9	45 10.9			7 6.4	29 27.1	7 15.6					3 3.7	9 10.8	19 23.8	9 19.6	1 8.3
10-19	31 7.5				13 12.1	18 40.0							9 11.3	17 37.0	2 16.7
20-49	20 4.8				1 .9	8 17.8	11 84.6						1 1.3	12 26.1	5 41.7
50-99															
100-249															
250-499															
500 OR MORE															
AVERAGE	3			1	4	11	26				1	1	4	13	18

004

NATIONAL ANALYSTS
METAL FINISHING STUDY (557-1)
SURVEY PARTICIPANTS

QUESTION NO.1-2D NUMBER OF WET METAL-
FINISHING PRODUCTION EMPLOYEES ON SHIFT 3

		- - - NUMBER OF FULL-TIME PEOPLE - - -								- - - T O T A L S A L E S - - -					
	TOTAL	1-4	5-9	10-19	20-49	50-99	100-249	250-499	500& MORE	UNDER $100M	$100M -249M	$250M -499M	$500M -999M	$1MIL -2.4	$2.5 MIL+
TOTAL	461	64	85	118	111	46	13			54	89	92	86	49	13
NO ANSWER	50	10	9	9	4	1				7	9	10	6	3	1
NUMBER ANSWERING	411	54	76	109	107	45	13			47	80	82	80	46	12
	100.0	100.0	100.0	100.0	100.0	100.0	100.0			100.0	100.0	100.0	100.0	100.0	100.0
NONE	352	54	73	102	87	24	5			46	76	75	65	24	7
	85.6	100.0	96.1	93.6	81.3	53.3	38.5			97.9	95.0	91.5	81.3	52.2	58.3
1-4	25		3	7	11	3	1			1	4	7	7	4	
	6.1		3.9	6.4	10.3	6.7	7.7			2.1	5.0	8.5	8.8	8.7	
5-9	13				9	3	1						6	5	1
	3.2				8.4	6.7	7.7						7.5	10.9	8.3
10-19	14					11	3						2	9	2
	3.4					24.4	23.1						2.5	19.6	16.7
20-49	7					4	3							4	2
	1.7					8.9	23.1							8.7	16.7
50-99															
100-249															
250-499															
500 OR MORE															
AVERAGE	1				1	5	10						1	5	7

NATIONAL ANALYSTS
METAL FINISHING STUDY (557-1)
SURVEY PARTICIPANTS

QUESTION NO.1-2 NUMBER OF WET METAL FINISHING PRODUCTION EMPLOYEES ON SHIFTS 1,2, AND 3

		---- NUMBER OF FULL-TIME PEOPLE ----							--- T O T A L S A L E S ---					
	TOTAL	1-4	5-9	10-19	20-49	50-99	100-249	250-499	500& MORE	UNDER $100M	$100M -249M	$250M -499M	$500M -999M	$1MIL -2.4	$2.5 MIL+
TOTAL	461	64	85	118	111	46	13			54	89	92	86	49	13
NO ANSWER	44	10	9	8	4	1				7	7	9	6	2	1
NUMBER ANSWERING	417	54	76	110	107	45	13			47	82	83	80	47	12
	100.0	100.0	100.0	100.0	100.0	100.0	100.0			100.0	100.0	100.0	100.0	100.0	100.0
NONE	6	3	1							4					
	1.4	5.6	1.3							8.5					
1-4	129	51	39	26	9	1	1			36	38	18	10	1	1
	30.9	94.4	51.3	23.6	8.4	2.2	7.7			76.6	46.3	21.7	12.5	2.1	8.3
5-9	81		36	31	8	2				7	29	20	10		1
	19.4		47.4	28.2	7.5	4.4				14.9	35.4	24.1	12.5		8.3
10-19	96			53	35	6					15	43	20	6	1
	23.0			48.2	32.7	13.3					18.3	51.8	25.0	12.8	8.3
20-49	75				55	16	2					2	38	21	3
	18.0				51.4	35.6	15.4					2.4	47.5	44.7	25.0
50-99	25					20	5						2	18	2
	6.0					44.4	38.5						2.5	38.3	16.7
100-249	5						5							1	4
	1.2						38.5							2.1	33.3
250-499															
500 OR MORE															
AVERAGE	16	2	4	9	20	43	80			3	6	10	20	43	65

006

NATIONAL ANALYSTS
METAL FINISHING STUDY (557-1)
SURVEY PARTICIPANTS

QUESTION NO.I-3A WHAT IS THE NUMBER OF SQUARE FEET OF FLOOR SPACE IN THE TOTAL AREA OF THE PLANT?

		- - - - NUMBER OF FULL-TIME PEOPLE - - - -								- - - T O T A L S A L E S - - -					
	TOTAL	1-4	5-9	10-19	20-49	50-99	100-249	250-499	500& MORE	UNDER $100M	$100M -249M	$250M -499M	$500M -999M	$1MIL -2.4	$2.5 MIL+
TOTAL	461	64	85	118	111	46	13			54	89	92	86	49	13
NO ANSWER	17	4	2	1	5	3				1	2	1	4	2	
NUMBER ANSWERING	444	60	83	117	106	43	13			53	87	91	82	47	13
	100.0	100.0	100.0	100.0	100.0	100.0	100.0			100.0	100.0	100.0	100.0	100.0	100.0
LESS THAN 5,000 SQ. FT.	103	42	43	9	2		1			41	29	9	2		1
	23.2	70.0	51.8	7.7	1.9		7.7			77.4	33.3	9.9	2.4		7.7
5,000 TO 9,999	110	12	31	46	16					9	34	34	9	1	
	24.8	20.0	37.3	39.3	15.1					17.0	39.1	37.4	11.0	2.1	
10,000 TO 19,999	118	6	9	49	41	6				2	23	39	37	5	
	26.6	10.0	10.8	41.9	38.7	14.0				3.8	26.4	42.9	45.1	10.6	
20,000 TO 39,999	65			8	36	14	5			1	1	8	24	21	2
	14.6			6.8	34.0	32.6	38.5			1.9	1.1	8.8	29.3	44.7	15.4
40,000 OR MORE	48			5	11	23	7					1	10	20	10
	10.8			4.3	10.4	53.5	53.8					1.1	12.2	42.6	76.9
AVERAGE	15815	4273	5406	12358	20484	39114	55592			4138	6966	10878	20707	36206	63307

007

NATIONAL ANALYSTS
METAL FINISHING STUDY (557-1)
SURVEY PARTICIPANTS

QUESTION NO. I-3B WHAT IS THE NUMBER OF SQUARE FEET OF FLOOR SPACE IN TOTAL AREA USED BY ALL PRODUCTION OPERATIONS?

		---- NUMBER OF FULL-TIME PEOPLE ----								--- T O T A L S A L E S ---					
	TOTAL	1-4	5-9	10-19	20-49	50-99	100-249	250-499	500& MORE	UNDER $100M	$100M -249M	$250M -499M	$500M -999M	$1MIL -2.4	$2.5 MIL+
TOTAL	461	64	85	118	111	46	13			54	89	92	86	49	13
NO ANSWER	25	6	5	4	5	3				1	4	3	5	1	
NUMBER ANSWERING	436	58	80	114	106	43	13			53	85	89	81	48	13
	100.0	100.0	100.0	100.0	100.0	100.0	100.0			100.0	100.0	100.0	100.0	100.0	100.0
LESS THAN 5,000 SQ. FT.	155	49	58	27	12		2			49	48	24	5		2
	35.6	84.5	72.5	23.7	11.3		15.4			92.5	56.5	27.0	6.2		15.4
5,000 TO 9,999	109	6	19	48	23	3				4	26	34	18	6	
	25.0	10.3	23.8	42.1	21.7	7.0				7.5	30.6	38.2	22.2	12.5	
10,000 TO 19,999	96	3	3	32	45	8	2				11	28	36	10	1
	22.0	5.2	3.8	28.1	42.5	18.6	15.4				12.9	31.5	44.4	20.8	7.7
20,000 TO 39,999	53			5	18	23	5					3	16	24	4
	12.2			4.4	17.0	53.5	38.5					3.4	19.8	50.0	30.8
40,000 OR MORE	23			2	8	9	4						6	8	6
	5.3			1.8	7.5	20.9	30.8						7.4	16.7	46.2
AVERAGE	11750	3146	3970	8956	16253	27363	38857			2679	5118	8298	16179	25862	44695

NATIONAL ANALYSTS
METAL FINISHING STUDY (557-1)
SURVEY PARTICIPANTS

QUESTION NO. I-3C WHAT IS THE NUMBER OF SQUARE FEET OF FLOOR SPACE IN TOTAL AREA USED BY WASTEWATER TREATMENT FACILITIES?

		- - - - NUMBER OF FULL-TIME PEOPLE - - - -								- - - T O T A L S A L E S - - -					
	TOTAL	1-4	5-9	10-19	20-49	50-99	100-249	250-499	500& MORE	UNDER $100M	$100M -249M	$250M -499M	$500M -999M	$1MIL -2.4	$2.5 MIL+
TOTAL	461	64	85	118	111	46	13			54	89	92	86	49	13
NO ANSWER	45	11	9	10	5	6	2			6	8	4	6	3	1
NUMBER ANSWERING	416	53	76	108	106	40	11			48	81	88	80	46	12
	100.0	100.0	100.0	100.0	100.0	100.0	100.0			100.0	100.0	100.0	100.0	100.0	100.0
NONE	165	27	38	42	38	10	1			26	35	37	35	7	2
	39.7	50.9	50.0	38.9	35.8	25.0	9.1			54.2	43.2	42.0	43.8	15.2	16.7
1-99 SQ. FT.	33	6	10	8	8					6	9	5	6	1	
	7.9	11.3	13.2	7.4	7.5					12.5	11.1	5.7	7.5	2.2	
100-499	70	13	18	18	10	4	3			7	18	16	9	3	1
	16.8	24.5	23.7	16.7	9.4	10.0	27.3			14.6	22.2	18.2	11.3	6.5	8.3
500-999	42	5	2	12	13	6	2			4	8	9	9	9	
	10.1	9.4	2.6	11.1	12.3	15.0	18.2			8.3	9.9	10.2	11.3	19.6	
1,000-4,999	89	2	8	23	30	15	5			5	9	19	16	20	7
	21.4	3.8	10.5	21.3	28.3	37.5	45.5			10.4	11.1	21.6	20.0	43.5	58.3
5,000 OR MORE	17			5	7	5					2	2	5	6	2
	4.1			4.6	6.6	12.5					2.5	2.3	6.3	13.0	16.7
AVERAGE	940	157	219	885	1423	2245	1284			219	425	742	1020	2885	2621

009

NATIONAL ANALYSTS
METAL FINISHING STUDY (557-1)
SURVEY PARTICIPANTS

QUESTION NO.1-3D WHAT IS THE NUMBER OF SQUARE FEET OF FLOOR SPACE IN TOTAL AREA AVAILABLE FOR EXPANSION INSIDE THE PLANT?

		---- NUMBER OF FULL-TIME PEOPLE ----								--- T O T A L S A L E S ---					
	TOTAL	1-4	5-9	10-19	20-49	50-99	100-249	250-499	500& MORE	UNDER $100M	$100M -249M	$250M -499M	$500M -999M	$1MIL -2.4	$2.5 MIL+
TOTAL	461	64	85	118	111	46	13			56	89	92	86	49	13
NO ANSWER	33	8	10	3	5	4	2			6	6	2	6	2	2
NUMBER ANSWERING	428	56	75	115	106	42	11			50	83	90	80	47	11
	100.0	100.0	100.0	100.0	100.0	100.0	100.0			100.0	100.0	100.0	100.0	100.0	100.0
NONE	322	43	52	93	77	31	9			38	63	76	56	33	6
	75.2	76.8	69.3	80.9	72.6	73.8	81.8			76.0	75.9	84.4	70.0	70.2	54.5
1-999 SQ. FT.	23	5	5	4	6					6	5	2	6	1	
	5.4	8.9	6.7	3.5	5.7					12.0	6.0	2.2	7.5	2.1	
1,000-2,999	38	4	11	8	8	5				2	9	5	8	6	
	8.9	7.1	14.7	7.0	7.5	11.9				4.0	10.8	5.6	10.0	12.8	
3,000-9,999	32	3	6	7	9	5	1			3	5	5	6	6	4
	7.5	5.4	8.0	6.1	8.5	11.9	9.1			6.0	6.0	5.6	7.5	12.8	36.4
10,000 OR MORE	13	1	1	3	6	1	1			1	1	2	4	1	1
	3.0	1.8	1.3	2.6	5.7	2.4	9.1			2.0	1.2	2.2	5.0	2.1	9.1
AVERAGE	1054	763	795	886	1397	1170	3709			749	673	501	1314	1215	4891

010

NATIONAL ANALYSTS
METAL FINISHING STUDY (557-1)
SURVEY PARTICIPANTS

QUESTION NO.I-3E WHAT IS THE NUMBER OF SQUARE FEET OF FLOOR SPACE IN TOTAL AREA AVAILABLE FOR EXPANSION OUTSIDE THE PLANT?

		- - - - NUMBER OF FULL-TIME PEOPLE							- - - T O T A L	S A L E S - - -				
	TOTAL	1-4	5-9	10-19	20-49	50-99	100-249	250-499	500& MORE	UNDER $100M	$100M -249M	$250M -499M	$500M -999M	$1MIL -2.4	$2.5 MIL+
TOTAL	461	64	85	118	111	46	13			54	89	92	86	49	13
NO ANSWER	47	12	10	6	11	6				7	10	5	8	4	
NUMBER ANSWERING	414	52	75	112	100	40	13			47	79	87	78	45	13
	100.0	100.0	100.0	100.0	100.0	100.0	100.0			100.0	100.0	100.0	100.0	100.0	100.0
NONE	240	36	51	65	50	19	8			34	44	57	43	19	6
	58.0	69.2	68.0	58.0	50.0	47.5	61.5			72.3	55.7	65.5	55.1	42.2	46.2
1-999 SQ. FT.	18	1	6	4	5	1				2	6	6	2	2	
	4.3	1.9	8.0	3.6	5.0	2.5				4.3	7.6	6.9	2.6	4.4	
1,000-2,999	23	5	5	10	2	1				3	4	5	4		
	5.6	9.6	6.7	8.9	2.0	2.5				6.4	5.1	5.7	5.1		
3,000-9,999	52	7	6	15	17	4				4	11	12	10	8	1
	12.6	13.5	8.0	13.4	17.0	10.0				8.5	13.9	13.8	12.8	17.8	7.7
10,000 OR MORE	81	3	7	18	26	15	5			4	14	7	19	16	6
	19.6	5.8	9.3	16.1	26.0	37.5	38.5			8.5	17.7	8.0	24.4	35.6	46.2
AVERAGE	9873	2801	4397	7882	13820	16756	27717			5275	9314	3101	10438	17415	28708

.011

NATIONAL ANALYSTS
METAL FINISHING STUDY (557-1)
SURVEY PARTICIPANTS

QUESTION NO.I-4 MANY SHOPS IN THE METAL-FINISHING INDUSTRY THAT DISCHARGE AN EFFLUENT MAY ALREADY BE COVERED BY A REGULATORY AGENCY. WHICH TYPE OF AUTHORITY REGULATES YOUR EFFLUENT?

		---- NUMBER OF FULL-TIME PEOPLE ----								--- T O T A L S A L E S ---					
	TOTAL	1-4	5-9	10-19	20-49	50-99	100-249	250-499	500& MORE	UNDER $100M	$100M -249M	$250M -499M	$500M -999M	$1MIL -2.4	$2.5 MIL+
TOTAL	461	64	85	118	111	46	13			54	89	92	86	49	13
NO ANSWER	6	5	1							2	2				
NUMBER ANSWERING	455	59	84	118	111	46	13			52	87	92	86	49	13
	100.0	100.0	100.0	100.0	100.0	100.0	100.0			100.0	100.0	100.0	100.0	100.0	100.0
LOCAL	367	40	68	101	92	35	11			41	71	79	72	40	12
	80.7	67.8	81.0	85.6	82.9	76.1	84.6			78.8	81.6	85.9	83.7	81.6	92.3
STATE	167	18	33	37	43	24	7			16	33	27	26	27	6
	36.7	30.5	39.3	31.4	38.7	52.2	53.8			30.8	37.9	29.3	30.2	55.1	46.2
DON'T KNOW	34	12	6	9	4	1				7	7	5	5		
	7.5	20.3	7.1	7.6	3.6	2.2				13.5	8.0	5.4	5.8		
NONE OF THE ABOVE	5		4		1					1	1		2		
	1.1		4.8		.9					1.9	1.1		2.3		

012

NATIONAL ANALYSTS
METAL FINISHING STUDY (557-1)
SURVEY PARTICIPANTS

QUESTION NO.II-1A DOES YOUR FIRM SPECIALIZE IN SERVICES TO A MAJOR INDUSTRY OR DO YOU SERVE MANY DIFFERENT INDUSTRIES?

		---- NUMBER OF FULL-TIME PEOPLE ----								--- T O T A L S A L E S ---					
	TOTAL	1-4	5-9	10-19	20-49	50-99	100-249	250-499	500& MORE	UNDER $100M	$100M -249M	$250M -499M	$500M -999M	$1MIL -2.4	$2.5 MIL+
TOTAL	461	64	85	118	111	46	13			54	89	92	86	49	13
NO ANSWER	12	8	1	2						4	1				
NUMBER ANSWERING	449	56	84	116	111	46	13			50	88	92	86	49	13
	100.0	100.0	100.0	100.0	100.0	100.0	100.0			100.0	100.0	100.0	100.0	100.0	100.0
SPECIALIZE IN SERVICE TO AN INDUSTRY	104	15	15	35	18	10	5			12	16	21	21	10	6
	23.2	26.8	17.9	30.2	16.2	21.7	38.5			24.0	18.2	22.8	24.4	20.4	46.2
SERVICE MANY INDUSTRIES	345	41	69	81	93	36	8			38	72	71	65	39	7
	76.8	73.2	82.1	69.8	83.8	78.3	61.5			76.0	81.8	77.2	75.6	79.6	53.8

013

NATIONAL ANALYSTS
METAL FINISHING STUDY (557-1)
SURVEY PARTICIPANTS

QUESTION NO.11-18 DURING THE YEAR ARE
MOST OF YOUR SALES TO A FEW STEADY
CUSTOMERS OR TO MANY DIFFERENT CUSTOMERS?

		---- NUMBER OF FULL-TIME PEOPLE ----								--- T O T A L S A L E S ---					
	TOTAL	1-4	5-9	10-19	20-49	50-99	100-249	250-499	500& MORE	UNDER $100M	$100M -249M	$250M -499M	$500M -999M	$1MIL -2.4	$2.5 MIL+
TOTAL	461	64	85	118	111	46	13			56	89	92	86	69	13
NO ANSWER	5	1	1	1			1			1				1	
NUMBER ANSWERING	456	63	84	117	111	46	12			53	89	92	86	68	13
	100.0	100.0	100.0	100.0	100.0	100.0	100.0			100.0	100.0	100.0	100.0	100.0	100.0
FEW STEADY CUSTOMERS	193	32	39	60	34	12	7			31	40	39	33	15	4
	42.3	50.8	46.4	51.3	30.6	26.1	58.3			58.5	44.9	42.4	38.4	31.3	30.8
MANY DIFFERENT CUSTOMERS	263	31	45	57	77	34	5			22	49	53	53	33	9
	57.7	49.2	53.6	48.7	69.4	73.9	41.7			41.5	55.1	57.6	61.6	68.8	69.2

014

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NATIONAL ANALYSTS
METAL FINISHING STUDY (557-1)
SURVEY PARTICIPANTS

QUESTION NO.II-1C DO YOUR CUSTOMERS SEND YOU MANY DIFFERENT KINDS OF PRODUCTS OR DO YOU GET BASICALLY THE SAME PRODUCTS MOST OF THE TIME?

		- - - - NUMBER OF FULL-TIME PEOPLE - - - -								- - - T O T A L S A L E S - - -					
	TOTAL	1-4	5-9	10-19	20-49	50-99	100-249	250-499	500& MORE	UNDER $100M	$100M -249M	$250M -499M	$500M -999M	$1MIL -2.4	$2.5 MIL+
TOTAL	461	64	85	118	111	46	13			54	89	92	86	49	13
NO ANSWER	3	1		1	1							1			
NUMBER ANSWERING	458	63	85	117	110	46	13			54	89	91	86	49	13
	100.0	100.0	100.0	100.0	100.0	100.0	100.0			100.0	100.0	100.0	100.0	100.0	100.0
MANY DIFFERENT PRODUCTS	349	41	62	91	90	38	9			36	64	78	67	41	8
	76.2	65.1	72.9	77.8	81.8	82.6	69.2			66.7	71.9	85.7	77.9	83.7	61.5
BASICALLY THE SAME PRODUCTS	109	22	23	26	20	8	4			18	25	13	19	8	5
	23.8	34.9	27.1	22.2	18.2	17.4	30.8			33.3	28.1	14.3	22.1	16.3	38.5

015

NATIONAL ANALYSTS
METAL FINISHING STUDY (557-1)
SURVEY PARTICIPANTS

QUESTION NO.II-1D DO YOU GENERALLY ATTRACT CUSTOMERS BECAUSE YOU CAN OFFER LOW PRICES OR BECAUSE YOU CAN TAKE ON ANY ASSIGNMENT?

		---- NUMBER OF FULL-TIME PEOPLE ----								--- T O T A L S A L E S ---					
	TOTAL	1-4	5-9	10-19	20-49	50-99	100-249	250-499	500& MORE	UNDER $100M	$100M -249M	$250M -499M	$500M -999M	$1MIL -2.4	$2.5 MIL+
TOTAL	461	64	85	118	111	46	13			56	89	92	86	49	13
NO ANSWER	23	7		7	2	3				6	1	5		1	1
NUMBER ANSWERING	438	57	85	111	109	43	13			48	88	87	86	48	12
	100.0	100.0	100.0	100.0	100.0	100.0	100.0			100.0	100.0	100.0	100.0	100.0	100.0
OFFER LOW PRICES	128	19	19	34	30	16	6			19	22	26	20	16	7
	29.2	33.3	22.4	30.6	27.5	37.2	46.2			39.6	25.0	29.9	23.3	33.3	58.3
TAKE ANY ASSIGNMENT	310	38	66	77	79	27	7			29	66	61	66	32	5
	70.8	66.7	77.6	69.4	72.5	62.8	53.8			60.4	75.0	70.1	76.7	66.7	41.7

016

NATIONAL ANALYSTS
METAL FINISHING STUDY (557-1)
SURVEY PARTICIPANTS

QUESTION NO.11-IF DO YOU THINK CAPTIVE
OPERATIONS ALSO COMPETE FOR YOUR CUSTOMERS?

		---- NUMBER OF FULL-TIME PEOPLE ----								--- T O T A L S A L E S ---					
	TOTAL	1-4	5-9	10-19	20-49	50-99	100-249	250-499	500& MORE	UNDER $100M	$100M -249M	$250M -499M	$500M -999M	$1MIL -2.4	$2.5 MIL+
TOTAL	461	64	85	118	111	46	13			54	89	92	86	49	13
NO ANSWER	14	2	3	5	2	1				1	3	2	2	1	
NUMBER ANSWERING	447	62	82	113	109	45	13			53	86	90	84	48	13
	100.0	100.0	100.0	100.0	100.0	100.0	100.0			100.0	100.0	100.0	100.0	100.0	100.0
YES	284	33	41	74	76	37	8			26	49	56	64	35	10
	63.5	53.2	50.0	65.5	69.7	82.2	61.5			49.1	57.0	62.2	76.2	72.9	76.9
NO	163	29	41	39	33	8	5			27	37	34	20	13	3
	36.5	46.8	50.0	34.5	30.3	17.8	38.5			50.9	43.0	37.8	23.8	27.1	23.1

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NATIONAL ANALYSTS
METAL FINISHING STUDY (557-1)
SURVEY PARTICIPANTS

QUESTION NO.II-1 SUMMARY

		---- NUMBER OF FULL-TIME PEOPLE ----								--- TOTAL SALES ---					
	TOTAL	1-4	5-9	10-19	20-49	50-99	100-249	250-499	500& MORE	UNDER $100M	$100M-249M	$250M-499M	$500M-999M	$1MIL-2.4	$2.5 MIL+
TOTAL	461	64	85	118	111	46	13			54	89	92	86	49	13
NO ANSWER	2	1		1											
NUMBER ANSWERING	459	63	85	117	111	46	13			54	89	92	86	49	13
	100.0	100.0	100.0	100.0	100.0	100.0	100.0			100.0	100.0	100.0	100.0	100.0	100.0
TYPE 1 COMPANY	112	5	18	33	31	19	2			3	21	25	25	20	2
	24.4	7.9	21.2	28.2	27.9	41.3	15.4			5.6	23.6	27.2	29.1	40.8	15.4
TYPE 2 COMPANY	5			3	1						1	1	1		1
	1.1			2.6	.9						1.1	1.1	1.2		7.7
ALL OTHER	342	58	67	81	79	27	11			51	67	66	60	29	10
	74.5	92.1	78.8	69.2	71.2	58.7	84.6			94.4	75.3	71.7	69.8	59.2	76.9

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NATIONAL ANALYSTS
METAL FINISHING STUDY (557-1)
SURVEY PARTICIPANTS

QUESTION NO.II-2 THE LAST TIME YOU RAISED YOUR PRICE (FOR WHATEVER REASONS) WHAT PERCENT INCREASE DID THAT REPRESENT?

		---- NUMBER OF FULL-TIME PEOPLE ----								--- T O T A L S A L E S ---					
	TOTAL	1-4	5-9	10-19	20-49	50-99	100-249	250-499	500& MORE	UNDER $100M	$100M -249M	$250M -499M	$500M -999M	$1MIL -2.4	$2.5 MIL+
TOTAL	461	64	85	118	111	46	13			54	89	92	86	49	13
NO ANSWER	22	6	3	4	5	4				1	2	1	4	3	
NUMBER ANSWERING	439	58	82	114	106	42	13			53	87	91	82	46	13
	100.0	100.0	100.0	100.0	100.0	100.0	100.0			100.0	100.0	100.0	100.0	100.0	100.0
LESS THAN 3 PCT.	23	8	5	6	1		1			10	4	2	2	1	
	5.2	13.8	6.1	5.3	.9		7.7			18.9	4.6	2.2	2.4	2.2	
3-7 PCT.	153	13	19	45	40	21	6			11	30	36	30	20	8
	34.9	22.4	23.2	39.5	37.7	50.0	46.2			20.8	34.5	39.6	36.6	43.5	61.5
8-12	193	26	39	45	51	18	5			22	37	37	40	20	5
	44.0	44.8	47.6	39.5	48.1	42.9	38.5			41.5	42.5	40.7	48.8	43.5	38.5
13-17	44	5	10	13	11	3	1			5	9	12	6	5	
	10.0	8.6	12.2	11.4	10.4	7.1	7.7			9.4	10.3	13.2	7.3	10.9	
18-22	19	4	6	4	2					4	6	3	3		
	4.3	6.9	7.3	3.5	1.9					7.5	6.9	3.3	3.7		
23 PCT. OR MORE	7	2	3	1	1					1	1	1	1		
	1.6	3.4	3.7	.9	.9					1.9	1.1	1.1	1.2		
AVERAGE	9.06	9.36	10.33	8.68	9.17	7.79	7.46			8.60	9.36	9.14	9.09	8.02	6.92

020

NATIONAL ANALYSTS
METAL FINISHING STUDY (557-1)
SURVEY PARTICIPANTS

QUESTION NO.II-3 AS A RESULT OF THAT PRICE INCREASE, DID YOUR BUSINESS VOLUME FALL OR REMAIN THE SAME?

		---- NUMBER OF FULL-TIME PEOPLE ----								--- T O T A L S A L E S ---					
	TOTAL	1-4	5-9	10-19	20-49	50-99	100-249	250-499	500& MORE	UNDER $100M	$100M -249M	$250M -499M	$500M -999M	$1MIL -2.4	$2.5 MIL+
TOTAL	461	64	85	118	111	46	13			54	89	92	86	49	13
NO ANSWER	25	7	5	5	4	2				8	2		2	4	
NUMBER ANSWERING	436	57	80	113	107	44	13			46	87	92	84	45	13
	100.0	100.0	100.0	100.0	100.0	100.0	100.0			100.0	100.0	100.0	100.0	100.0	100.0
FELL OFF	120	18	17	27	33	19	4			10	22	22	23	19	1
	27.5	31.6	21.3	23.9	30.8	43.2	30.8			21.7	25.3	23.9	27.4	42.2	7.7
REMAINED THE SAME	315	39	63	85	74	25	9			36	65	70	61	26	12
	72.2	68.4	78.8	75.2	69.2	56.8	69.2			78.3	74.7	76.1	72.6	57.8	92.3
INCREASED	1			1											
	.2			.9											

021

NATIONAL ANALYSTS
METAL FINISHING STUDY (557-1)
SURVEY PARTICIPANTS

QUESTION NO.II-4 TODAY, IF YOU AND ALL YOUR COMPETITORS HAD TO RAISE PRICES, HOW MUCH DO YOU THINK YOU COULD RAISE THEM BEFORE YOUR BUSINESS MIGHT BE BADLY HURT?

		NUMBER OF FULL-TIME PEOPLE								TOTAL SALES					
	TOTAL	1-4	5-9	10-19	20-49	50-99	100-249	250-499	500& MORE	UNDER $100M	$100M -249M	$250M -499M	$500M -999M	$1MIL -2.4	$2.5 MIL+
TOTAL	461	64	85	118	111	46	13			54	89	92	86	49	13
NO ANSWER	37	12	7	6	4	8				6	5	2	4	5	1
NUMBER ANSWERING	424	52	78	112	107	38	13			48	84	90	82	44	12
	100.0	100.0	100.0	100.0	100.0	100.0	100.0			100.0	100.0	100.0	100.0	100.0	100.0
LESS THAN 3 PCT.	38	8	7	11	6	2	2			9	6	4	5	5	1
	9.0	15.4	9.0	9.8	5.6	5.3	15.4			18.8	7.1	4.4	6.1	11.4	8.3
3-7 PCT.	91	5	12	27	21	13	6			4	14	22	15	14	6
	21.5	9.6	15.4	24.1	19.6	34.2	46.2			8.3	16.7	24.4	18.3	31.8	50.0
8-12	128	16	20	30	42	12	2			12	25	29	31	12	3
	30.2	30.8	25.6	26.8	39.3	31.6	15.4			25.0	29.8	32.2	37.8	27.3	25.0
13-17	52	10	7	13	14	5	1			8	13	10	8	5	1
	12.3	19.2	9.0	11.6	13.1	13.2	7.7			16.7	15.5	11.1	9.8	11.4	8.3
18-22	58	7	13	16	12	4	1			5	13	13	10	5	1
	13.7	13.5	16.7	14.3	11.2	10.5	7.7			10.4	15.5	14.4	12.2	11.4	8.3
23 PCT. OR MORE	57	6	19	15	12	2	1			10	13	12	13	3	
	13.4	11.5	24.4	13.4	11.2	5.3	7.7			20.8	15.5	13.3	15.9	6.8	
AVERAGE	12.78	13.90	15.14	12.46	12.20	10.84	9.31			13.46	14.42	13.18	13.09	10.57	8.67

022

NATIONAL ANALYSTS
METAL FINISHING STUDY (557-1)
SURVEY PARTICIPANTS

QUESTION NO.II-5 SCALE RATING OF DEGREE
OF LIKELIHOOD. IF BUSINESS FELL AFTER A
PRICE INCREASE. THE POSSIBILTIES THAT
YOUR CUSTOMERS MIGHT BUY MORE FROM CAPTIVES

		---- NUMBER OF FULL-TIME PEOPLE ----								--- TOTAL SALES ---					
	TOTAL	1-4	5-9	10-19	20-49	50-99	100-249	250-499	500& MORE	UNDER $100M	$100M -249M	$250M -499M	$500M -999M	$1MIL -2.4	$2.5 MIL+
TOTAL	461	64	85	118	111	46	13			54	89	92	86	49	13
NO ANSWER	29	6	5	11	4	1				3	7	5	1	1	
NUMBER ANSWERING	432	58	80	107	107	45	13			51	82	87	85	48	13
	100.0	100.0	100.0	100.0	100.0	100.0	100.0			100.0	100.0	100.0	100.0	100.0	100.0
1-VERY UNLIKELY	83	13	16	20	20	9	2			8	13	18	15	10	3
	19.2	22.4	20.0	18.7	18.7	20.0	15.4			15.7	15.9	20.7	17.6	20.8	23.1
2-UNLIKELY	95	11	14	29	23	11	2			12	15	25	21	11	2
	22.0	19.0	17.5	27.1	21.5	24.4	15.4			23.5	18.3	28.7	24.7	22.9	15.4
3-MAYBE	141	18	24	30	39	20	5			15	25	24	31	19	5
	32.6	31.0	30.0	28.0	36.4	44.4	38.5			29.4	30.5	27.6	36.5	39.6	38.5
4-LIKELY	69	8	15	18	17	3	2			9	17	11	11	6	1
	16.0	13.8	18.8	16.8	15.9	6.7	15.4			17.6	20.7	12.6	12.9	12.5	7.7
5-VERY LIKELY	44	8	11	10	8	2	2			7	12	9	7	2	2
	10.2	13.8	13.8	9.3	7.5	4.4	15.4			13.7	14.6	10.3	8.2	4.2	15.4
MEAN	2.76	2.78	2.89	2.71	2.72	2.51	3.00			2.90	3.00	2.63	2.69	2.56	2.77

023

NATIONAL ANALYSTS
METAL FINISHING STUDY (557-1)
SURVEY PARTICIPANTS

QUESTION NO.11-5 SCALE RATING OF DEGREE OF LIKELIHOOD. IF BUSINESS FELL AFTER A PRICE INCREASE, THE POSSIBILTIES THAT YOUR CUSTOMERS MIGHT ELIMINATE METAL-FINISHING FROM THEIR PRODUCTS

		---- NUMBER OF FULL-TIME PEOPLE ----								--- TOTAL SALES ---					
	TOTAL	1-4	5-9	10-19	20-49	50-99	100-249	250-499	500& MORE	UNDER $100M	$100M-249M	$250M-499M	$500M-999M	$1MIL-2.4	$2.5 MIL+
TOTAL	461	64	85	118	111	46	13			54	89	92	86	49	13
NO ANSWER	30	10	4	9	4	1				3	5	6	2		
NUMBER ANSWERING	431	54	81	109	107	45	13			51	84	86	84	49	13
	100.0	100.0	100.0	100.0	100.0	100.0	100.0			100.0	100.0	100.0	100.0	100.0	100.0
1-VERY UNLIKELY	107	17	22	32	20	13				15	21	18	21	8	1
	24.8	31.5	27.2	29.4	18.7	28.9				29.4	25.0	20.9	25.0	16.3	7.7
2-UNLIKELY	86	5	16	24	27	6	6			5	13	23	20	7	4
	20.0	9.3	19.8	22.0	25.2	13.3	46.2			9.8	15.5	26.7	23.8	14.3	30.8
3-MAYBE	102	11	16	30	23	11	3			9	23	24	16	11	3
	23.7	20.4	19.8	27.5	21.5	24.4	23.1			17.6	27.4	27.9	19.0	22.4	23.1
4-LIKELY	79	12	19	13	18	10	1			13	16	12	17	13	3
	18.3	22.2	23.5	11.9	16.8	22.2	7.7			25.5	19.0	14.0	20.2	26.5	23.1
5-VERY LIKELY	57	9	8	10	19	5	3			9	11	9	10	10	2
	13.2	16.7	9.9	9.2	17.8	11.1	23.1			17.6	13.1	10.5	11.9	20.4	15.4
MEAN	2.75	2.83	2.69	2.50	2.90	2.73	3.08			2.92	2.80	2.66	2.70	3.20	3.08

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NATIONAL ANALYSTS
METAL FINISHING STUDY (557-1)
SURVEY PARTICIPANTS

QUESTION NO.II-5 SCALE RATING OF DEGREE OF LIKELIHOOD, IF BUSINESS FELL AFTER A PRICE INCREASE, THE POSSIBILTIES THAT YOUR CUSTOMERS MIGHT START THEIR OWN INHOUSE, CAPTIVE LINES

		---- NUMBER OF FULL-TIME PEOPLE ----								--- TOTAL SALES ---					
	TOTAL	1-4	5-9	10-19	20-49	50-99	100-249	250-499	500& MORE	UNDER $100M	$100M-249M	$250M-499M	$500M-999M	$1MIL-2.4	$2.5 MIL+
TOTAL	461	64	85	118	111	46	13			54	89	92	86	49	13
NO ANSWER	35	11	5	9	6	1				5	5	8	2	1	
NUMBER ANSWERING	426	53	80	109	105	45	13			49	84	84	84	48	13
	100.0	100.0	100.0	100.0	100.0	100.0	100.0			100.0	100.0	100.0	100.0	100.0	100.0
1-VERY UNLIKELY	90	12	19	26	23	7				12	17	15	22	4	1
	21.1	22.6	23.8	23.9	21.9	15.6				24.5	20.2	17.9	26.2	8.3	7.7
2-UNLIKELY	103	16	11	27	26	11	7			10	20	24	14	14	4
	24.2	30.2	13.8	24.8	24.8	24.4	53.8			20.4	23.8	28.6	16.7	29.2	30.8
3-MAYBE	106	13	20	27	26	12	2			16	20	19	25	9	2
	24.9	24.5	25.0	24.8	24.8	26.7	15.4			32.7	23.8	22.6	29.8	18.8	15.4
4-LIKELY	73	5	19	16	15	9	3			4	19	13	15	11	5
	17.1	9.4	23.8	14.7	14.3	20.0	23.1			8.2	22.6	15.5	17.9	22.9	38.5
5-VERY LIKELY	54	7	11	13	15	6	1			7	8	13	8	10	1
	12.7	13.2	13.8	11.9	14.3	13.3	7.7			14.3	9.5	15.5	9.5	20.8	7.7
MEAN	2.76	2.60	2.90	2.66	2.74	2.91	2.85			2.67	2.77	2.82	2.68	3.19	3.08

NATIONAL ANALYSTS
METAL FINISHING STUDY (557-1)
SURVEY PARTICIPANTS

QUESTION NO.II-5 SCALE RATING OF DEGREE OF LIKELIHOOD. IF BUSINESS FELL AFTER A PRICE INCREASE. THE POSSIBILTIES THAT YOUR CUSTOMERS MIGHT SHOP AROUND FOR THE BEST PRICE

		---- NUMBER OF FULL-TIME PEOPLE ----								--- TOTAL SALES ---					
	TOTAL	1-4	5-9	10-19	20-49	50-99	100-249	250-499	500& MORE	UNDER $100M	$100M -249M	$250M -499M	$500M -999M	$1MIL -2.4	$2.5 MIL+
TOTAL	461	64	85	118	111	46	13			54	89	92	86	49	13
NO ANSWER	21	9	1	8	2					2	3	7		1	
NUMBER ANSWERING	440	55	84	110	109	46	13			52	86	85	86	48	13
	100.0	100.0	100.0	100.0	100.0	100.0	100.0			100.0	100.0	100.0	100.0	100.0	100.0
1-VERY UNLIKELY	12	3	2	2	1	2	1			2	2	3		1	1
	2.7	5.5	2.4	1.8	.9	4.3	7.7			3.8	2.3	3.5		2.1	7.7
2-UNLIKELY	11	1	3	1	4					2	2	2	4		
	2.5	1.8	3.6	.9	3.7					3.8	2.3	2.4	4.7		
3-MAYBE	31	3	10	11	4	2	1			3	6	8	6	1	
	7.0	5.5	11.9	10.0	3.7	4.3	7.7			5.8	7.0	9.4	7.0	2.1	
4-LIKELY	111	13	22	29	29	12	1			16	19	23	22	14	3
	25.2	23.6	26.2	26.4	26.6	26.1	7.7			30.8	22.1	27.1	25.6	29.2	23.1
5-VERY LIKELY	275	35	47	67	71	30	10			29	57	49	54	32	9
	62.5	63.6	56.0	60.9	65.1	65.2	76.9			55.8	66.3	57.6	62.8	66.7	69.2
MEAN	4.42	4.38	4.30	4.44	4.51	4.48	4.46			4.31	4.48	4.33	4.47	4.58	4.46

NATIONAL ANALYSTS
METAL FINISHING STUDY (557-1)
SURVEY PARTICIPANTS

QUESTION NO.II-5 SCALE RATING OF DEGREE OF LIKELIHOOD. IF BUSINESS FELL AFTER A PRICE INCREASE, THE POSSIBILTIES THAT YOUR CUSTOMERS MIGHT USE SOME OTHER FINISH FOR METALFINISHING

		---- NUMBER OF FULL-TIME PEOPLE ----								--- TOTAL SALES ---					
	TOTAL	1-4	5-9	10-19	20-49	50-99	100-249	250-499	500& MORE	UNDER $100M	$100M-249M	$250M-499M	$500M-999M	$1MIL-2.4	$2.5 MIL+
TOTAL	461	64	85	118	111	46	13			54	89	92	86	49	13
NO ANSWER	27	9	4	8	3	1				4	4	5	2		
NUMBER ANSWERING	434	55	81	110	108	45	13			50	85	87	84	49	13
	100.0	100.0	100.0	100.0	100.0	100.0	100.0			100.0	100.0	100.0	100.0	100.0	100.0
1-VERY UNLIKELY	46	6	12	11	9	4	1			9	7	7	11	2	1
	10.6	10.9	14.8	10.0	8.3	8.9	7.7			18.0	8.2	8.0	13.1	4.1	7.7
2-UNLIKELY	64	14	13	16	13	6	1			7	11	14	11	5	2
	14.7	25.5	16.0	14.5	12.0	13.3	7.7			14.0	12.9	16.1	13.1	10.2	15.4
3-MAYBE	98	12	18	24	27	10	3			12	23	16	18	10	4
	22.6	21.8	22.2	21.8	25.0	22.2	23.1			24.0	27.1	18.4	21.4	20.4	30.8
4-LIKELY	107	11	17	29	26	10	6			10	22	27	18	13	4
	24.7	20.0	21.0	26.4	24.1	22.2	46.2			20.0	25.9	31.0	21.4	26.5	30.8
5-VERY LIKELY	119	12	21	30	33	15	2			12	22	23	26	19	2
	27.4	21.8	25.9	27.3	30.6	33.3	15.4			24.0	25.9	26.4	31.0	38.8	15.4
MEAN	3.44	3.16	3.27	3.46	3.56	3.58	3.54			3.18	3.48	3.52	3.44	3.86	3.31

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NATIONAL ANALYSTS
METAL FINISHING STUDY (557-1)
SURVEY PARTICIPANTS

QUESTION NO.III-1 ALTOGETHER HOW MANY TOTAL HOURS PER DAY ARE SPENT IN WET PLATING AND/OR WET FINISHING OPERATIONS?

		---- NUMBER OF FULL-TIME PEOPLE ----								--- TOTAL SALES ---					
	TOTAL	1-4	5-9	10-19	20-49	50-99	100-249	250-499	500& MORE	UNDER $100M	$100M -249M	$250M -499M	$500M -999M	$1MIL -2.4	$2.5 MIL+
TOTAL	461	64	85	118	111	46	13			54	89	92	86	49	13
NO ANSWER	20	5		10	3	1				1	4	3	4	2	
NUMBER ANSWERING	441	59	85	108	108	45	13			53	85	89	82	47	13
	100.0	100.0	100.0	100.0	100.0	100.0	100.0			100.0	100.0	100.0	100.0	100.0	100.0
1 TO 8 HOURS	211	50	62	48	32	8				40	57	37	32	4	
	47.8	84.7	72.9	44.4	29.6	17.8				75.5	67.1	41.6	39.0	8.5	
9 TO 16	149	9	20	47	45	16	3			12	23	40	30	16	6
	33.8	15.3	23.5	43.5	41.7	35.6	23.1			22.6	27.1	44.9	36.6	34.0	46.2
17 TO 24 HOURS	81		3	13	31	21	10			1	5	12	20	27	7
	18.4		3.5	12.0	28.7	46.7	76.9			1.9	5.9	13.5	24.4	57.4	53.8
AVERAGE	11.74	6.81	8.94	11.31	13.85	17.29	20.31			7.43	9.76	11.35	13.22	18.55	18.23

NATIONAL ANALYSTS
METAL FINISHING STUDY (557-1)
SURVEY PARTICIPANTS

QUESTION NO.III-2 ALTOGETHER HOW MANY
DAYS PER WEEK ARE SPENT IN WET PLATING
AND/OR WET FINISHING?

		---- NUMBER OF FULL-TIME PEOPLE ----								--- T O T A L S A L E S ---					
	TOTAL	1-4	5-9	10-19	20-49	50-99	100-249	250-499	500& MORE	UNDER $100M	$100M -249M	$250M -499M	$500M -999M	$1MIL -2.4	$2.5 MIL+
TOTAL	461	64	85	118	111	46	13			56	89	92	86	49	13
NO ANSWER	9	4	4	1						1	3	1			
NUMBER ANSWERING	452	60	81	117	111	46	13			53	86	91	86	49	13
	100.0	100.0	100.0	100.0	100.0	100.0	100.0			100.0	100.0	100.0	100.0	100.0	100.0
LESS THAN 1 DAY	4	4								3					
	.9	6.7								5.7					
1 TO 5 DAYS	408	52	74	107	99	42	11			48	80	82	76	43	12
	90.3	86.7	91.4	91.5	89.2	91.3	84.6			90.6	93.0	90.1	88.4	87.8	92.3
6 DAYS	35	2	6	10	10	4	2			2	6	7	9	6	1
	7.7	3.3	7.4	8.5	9.0	8.7	15.4			3.8	7.0	7.7	10.5	12.2	7.7
7 DAYS	5	2	1		2							2	1		
	1.1	3.3	1.2		1.8							2.2	1.2		
AVERAGE	4.94	4.50	4.99	5.03	5.03	5.09	5.08			4.42	4.98	5.05	5.05	5.10	5.08

NATIONAL ANALYSTS
METAL FINISHING STUDY (557-1)
SURVEY PARTICIPANTS

QUESTION III-3 WHAT IS THE DEGREE OF AUTOMATION IN YOUR PLANT OPERATION?

		---- NUMBER OF FULL-TIME PEOPLE ----								--- T O T A L S A L E S ---					
	TOTAL	1-4	5-9	10-19	20-49	50-99	100-249	250-499	500& MORE	UNDER $100M	$100M -249M	$250M -499M	$500M -999M	$1MIL -2.4	$2.5 MIL+
TOTAL	461	64	85	118	111	46	13			54	89	92	86	49	13
NO ANSWER	7	5		1	1					2		1	1		
NUMBER ANSWERING	454	59	85	117	110	46	13			52	89	91	85	49	13
	100.0	100.0	100.0	100.0	100.0	100.0	100.0			100.0	100.0	100.0	100.0	100.0	100.0
PROGRAMMED CONTROL	13		1	6	3	3					1	3	4	4	1
	2.9		1.2	5.1	2.7	6.5					1.1	3.3	4.7	8.2	7.7
FULLY AUTOMATED	34			9	11	9	5				1	6	5	12	3
	7.5			7.7	10.0	19.6	38.5				1.1	6.6	5.9	24.5	23.1
SEMIAUTOMATED	103	6	14	27	31	13	4			6	17	20	30	13	4
	22.7	10.2	16.5	23.1	28.2	28.3	30.8			11.5	19.1	22.0	35.3	26.5	30.8
MANUAL	304	53	70	75	65	21	4			46	70	62	46	20	5
	67.0	89.8	82.4	64.1	59.1	45.7	30.8			88.5	78.7	68.1	54.1	40.8	38.5

NATIONAL ANALYSTS
METAL FINISHING STUDY (557-1)
SURVEY PARTICIPANTS

QUESTION NO.III-4 TYPES OF FINISHING OPERATIONS NORMALLY DONE

		- - - - NUMBER OF FULL-TIME PEOPLE - - - -								- - - T O T A L S A L E S - - -					
	TOTAL	1-4	5-9	10-19	20-49	50-99	100-249	250-499	500& MORE	UNDER $100M	$100M-249M	$250M-499M	$500M-999M	$1MIL-2.4	$2.5 MIL+
TOTAL	461	64	85	118	111	46	13			54	89	92	86	49	13
NO ANSWER	2	1				1									
NUMBER ANSWERING	459	63	85	118	111	45	13			54	89	92	86	49	13
	100.0	100.0	100.0	100.0	100.0	100.0	100.0			100.0	100.0	100.0	100.0	100.0	100.0
ELECTROPLATING ONLY	76	14	15	22	12	5	4			12	14	12	12	8	2
	16.6	22.2	17.6	18.6	10.8	11.1	30.8			22.2	15.7	13.0	14.0	16.3	15.4
NON-ELECTROPLATING ONLY	88	11	14	26	18	12	3			8	17	17	19	9	3
	19.2	17.5	16.5	22.0	16.2	26.7	23.1			14.8	19.1	18.5	22.1	18.4	23.1
OTHERS	295	38	56	70	81	28	6			34	58	63	55	32	8
	64.3	60.3	65.9	59.3	73.0	62.2	46.2			63.0	65.2	68.5	64.0	65.3	61.5

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NATIONAL ANALYSTS
METAL FINISHING STUDY (557-1)
SURVEY PARTICIPANTS

QUESTION NO.III-5 HOW MANY CLEANING, PLATING, FINISHING AND RINSE TANKS DO YOU HAVE ON YOUR FLOOR(S)?

		---- NUMBER OF FULL-TIME PEOPLE ----								---TOTAL SALES---					
	TOTAL	1-4	5-9	10-19	20-49	50-99	100-249	250-499	500& MORE	UNDER $100M	$100M -249M	$250M -499M	$500M -999M	$1MIL -2.4	$2.5 MIL+
TOTAL	461	64	85	118	111	46	13			54	89	92	86	49	13
NO ANSWER	11	2	1	4	3		1			1	3	1	1	2	1
NUMBER ANSWERING	450	62	84	114	108	46	12			53	86	91	85	47	12
	100.0	100.0	100.0	100.0	100.0	100.0	100.0			100.0	100.0	100.0	100.0	100.0	100.0
10 OR LESS	92	27	22	24	7	4	1			21	16	16	8	2	2
	20.4	43.5	26.2	21.1	6.5	8.7	8.3			39.6	18.6	17.6	9.4	4.3	16.7
11-39	194	33	40	55	38	13	3			29	47	36	33	11	4
	43.1	53.2	47.6	48.2	35.2	28.3	25.0			54.7	54.7	39.6	38.8	23.4	33.3
40-99	129	2	21	35	45	17	4			2	23	39	31	19	1
	28.7	3.2	25.0	30.7	41.7	37.0	33.3			3.8	26.7	42.9	36.5	40.4	8.3
100 OR MORE	35		1		18	12	4			1			13	15	5
	7.8		1.2		16.7	26.1	33.3			1.9			15.3	31.9	41.7
AVERAGE	41	14	30	30	58	76	104			23	26	35	51	86	109

032

NATIONAL ANALYSTS
METAL FINISHING STUDY (557-1)
SURVEY PARTICIPANTS

QUESTION NO.III-6 HOW MANY SEPARATE PRODUCTION LINES DO YOU HAVE SET UP NORMALLY TO HANDLE YOUR METALFINISHING OPERATIONS?

		---- NUMBER OF FULL-TIME PEOPLE ----							--- TOTAL SALES ---					
	TOTAL	1-4	5-9	10-19	20-49	50-99	100-249	250-499	500& MORE	UNDER $100M	$100M -249M	$250M -499M	$500M -999M	$1MIL -2.4	$2.5 MIL+
TOTAL	461	64	85	118	111	46	13			54	89	92	86	49	13
NO ANSWER	19	6	3	5	4					4	3	3	1		
NUMBER ANSWERING	442	58	82	113	107	46	13			50	86	89	85	49	13
	100.0	100.0	100.0	100.0	100.0	100.0	100.0			100.0	100.0	100.0	100.0	100.0	100.0
NONE	24	10	8	4	1					8	6	5			
	5.4	17.2	9.8	3.5	.9					16.0	7.0	5.6			
1 TO 3	264	45	55	75	49	15	7			37	61	52	46	14	8
	59.7	77.6	67.1	66.4	45.8	32.6	53.8			74.0	70.9	58.4	54.1	28.6	61.5
4 TO 6	102	2	14	28	36	16	4			5	14	25	22	19	1
	23.1	3.4	17.1	24.8	33.6	34.8	30.8			10.0	16.3	28.1	25.9	38.8	7.7
7 OR MORE	52	1	5	6	21	15	2				5	7	17	16	4
	11.8	1.7	6.1	5.3	19.6	32.6	15.4				5.8	7.9	20.0	32.7	30.8
AVERAGE	3.12	1.53	2.56	2.77	4.10	4.89	3.77			1.58	2.63	3.07	3.78	5.12	4.23

033

NATIONAL ANALYSTS
METAL FINISHING STUDY (557-1)
SURVEY PARTICIPANTS

QUESTION NO.III-9 REQUEST FOR DATA ON
AREA PLATED, FINISHED OR REMOVED

		---- NUMBER OF FULL-TIME PEOPLE ----								--- T O T A L S A L E S ---					
	TOTAL	1-4	5-9	10-19	20-49	50-99	100-249	250-499	500& MORE	UNDER $100M	$100M -249M	$250M -499M	$500M -999M	$1MIL -2.4	$2.5 MIL+
TOTAL	461	64	85	118	111	46	13			54	89	92	86	49	13
NO ANSWER															
NUMBER ANSWERING	461	64	85	118	111	46	13			54	89	92	86	49	13
	100.0	100.0	100.0	100.0	100.0	100.0	100.0			100.0	100.0	100.0	100.0	100.0	100.0
YES, SOME DATA ARE ENTERED OR SUPPLIED	125	13	16	33	36	11	6			6	26	29	26	14	8
	27.1	20.3	18.8	28.0	32.4	23.9	46.2			11.1	29.2	31.5	30.2	28.6	61.5
NO, NO DATA PROVIDED	336	51	69	85	75	35	7			48	63	63	60	35	5
	72.9	79.7	81.2	72.0	67.6	76.1	53.8			88.9	70.8	68.5	69.8	71.4	38.5

034

METAL FINISHING STUDY (557-1)
SURVEY PARTICIPANTS

QUESTION NO.III-10 WHAT IS YOUR PLANT'S WATER USE FOR A TYPICAL DAY DURING 1975 FOR TOTAL PLANT?

		---- NUMBER OF FULL-TIME PEOPLE ----								--- T O T A L S A L E S ---					
	TOTAL	1-4	5-9	10-19	20-49	50-99	100-249	250-499	500& MORE	UNDER $100M	$100M -249M	$250M -499M	$500M -999M	$1MIL -2.4	$2.5 MIL+
TOTAL	461	64	85	118	111	46	13			54	89	92	86	49	13
NO ANSWER	75	13	15	27	9	4	1			10	14	13	8	3	1
NUMBER ANSWERING	386	51	70	91	102	42	12			44	75	79	78	46	12
	100.0	100.0	100.0	100.0	100.0	100.0	100.0			100.0	100.0	100.0	100.0	100.0	100.0
NONE	1	1								1					
	.3	2.0								2.3					
LESS THAN 5,000 GAL. PER DAY	119	42	38	19	10	3	1			35	29	21	9	2	1
	30.8	82.4	54.3	20.9	9.8	7.1	8.3			79.5	38.7	26.6	11.5	4.3	8.3
5,000 TO 19,999	94	6	26	27	23	4	2			8	31	23	18	5	3
	24.4	11.8	37.1	29.7	22.5	9.5	16.7			18.2	41.3	29.1	23.1	10.9	25.0
20,000 TO 49,999	75	1	3	27	36	5	1				13	22	24	4	2
	19.4	2.0	4.3	29.7	35.3	11.9	8.3				17.3	27.8	30.8	8.7	16.7
50,000 TO 99,999	49		1	11	22	9	2				2	10	17	15	1
	12.7		1.4	12.1	21.6	21.4	16.7				2.7	12.7	21.8	32.6	8.3
100,000 OR MORE	48	1	2	7	11	21	6					3	10	20	5
	12.4	2.0	2.9	7.7	10.8	50.0	50.0					3.8	12.8	43.5	41.7
AVERAGE (HUNDREDS)	525	54	330	445	445	1555	1787			30	125	386	447	1510	1518

035

NATIONAL ANALYSTS
METAL FINISHING STUDY (557-1)
SURVEY PARTICIPANTS

QUESTION NO.III-10 WHAT IS YOUR PLANT'S WATER USE FOR A TYPICAL DAY DURING 1975 FOR METALFINISHING PROCESSING WATER?

		---- NUMBER OF FULL-TIME PEOPLE ----								--- T O T A L S A L E S ---					
	TOTAL	1-4	5-9	10-19	20-49	50-99	100-249	250-499	500& MORE	UNDER $100M	$100M -249M	$250M -499M	$500M -999M	$1MIL -2.4	$2.5 MIL+
TOTAL	461	64	85	118	111	46	13			54	89	92	86	49	13
NO ANSWER	163	31	30	42	35	11	2			24	29	25	32	11	1
NUMBER ANSWERING	298	33	55	76	76	35	11			30	60	67	54	38	12
	100.0	100.0	100.0	100.0	100.0	100.0	100.0			100.0	100.0	100.0	100.0	100.0	100.0
NONE	3	2			1					1			1		
	1.0	6.1			1.3					3.3			1.9		
LESS THAN 5,000 GAL. PER DAY	105	28	33	22	11	5	1			24	29	20	11	4	2
	35.2	84.8	60.0	28.9	14.5	14.3	9.1			80.0	48.3	29.9	20.4	10.5	16.7
5,000 TO 19,999	68	2	20	21	16	3	2			5	20	21	9	3	3
	22.8	6.1	36.4	27.6	21.1	8.6	18.2			16.7	33.3	31.3	16.7	7.9	25.0
20,000 TO 49,999	57	1	1	20	27	5	1				10	18	18	4	2
	19.1	3.0	1.8	26.3	35.5	14.3	9.1				16.7	26.9	33.3	10.5	16.7
50,000 TO 99,999	32		1	8	15	5	2				1	5	10	11	
	10.7		1.8	10.5	19.7	14.3	18.2				1.7	7.5	18.5	28.9	
100,000 OR MORE	33			5	6	17	5					3	5	16	5
	11.1			6.6	7.9	48.6	45.5					4.5	9.3	42.1	41.7
AVERAGE (HUNDREDS)	456	21	74	433	399	1369	1667			32	99	395	369	1338	1348

036

NATIONAL ANALYSTS
METAL FINISHING STUDY (557-1)
SURVEY PARTICIPANTS

QUESTION NO.III-11A WHERE DOES YOUR DISCHARGE WATER GO?

		---- NUMBER OF FULL-TIME PEOPLE ----								--- T O T A L S A L E S ---					
	TOTAL	1-4	5-9	10-19	20-49	50-99	100-249	250-499	5006 MORE	UNDER $100M	$100M -249M	$250M -499M	$500M -999M	$1MIL -2.4	$2.5 MIL+
TOTAL	461	64	85	116	111	46	13			54	89	92	86	49	13
NO ANSWER	8	5	1		1					4					
NUMBER ANSWERING	453	59	84	118	110	46	13			50	89	92	86	49	13
	100.0	100.0	100.0	100.0	100.0	100.0	100.0			100.0	100.0	100.0	100.0	100.0	100.0
MUNICIPAL SEWER SYSTEM	392	49	72	108	95	36	12			45	80	85	71	37	13
	86.5	83.1	85.7	91.5	86.4	78.3	92.3			90.0	89.9	92.4	82.6	75.5	100.0
RIVER, LAKE, POND, OTHER	49	7	12	9	10	7	1			4	7	7	12	9	
	10.8	11.9	14.3	7.6	9.1	15.2	7.7			8.0	7.9	7.6	14.0	15.4	
BOTH	12	3		1	5	3				1	2		3	3	
	2.6	5.1		.8	4.5	6.5				2.0	2.2		3.5	6.1	

037

NATIONAL ANALYSTS
METAL FINISHING STUDY (557-1)
SURVEY PARTICIPANTS

QUESTION NO.III-11B DO YOU HAVE THE OPTION OF SWITCHING FROM YOUR PRESENT MEANS OF WATER DISCHARGE TO ANOTHER?

		---- NUMBER OF FULL-TIME PEOPLE ----								--- T O T A L S A L E S ---					
	TOTAL	1-4	5-9	10-19	20-49	50-99	100-249	250-499	500& MORE	UNDER $100M	$100M -249M	$250M -499M	$500M -999M	$1MIL -2.4	$2.5 MIL+
TOTAL	461	64	85	118	111	46	13			54	89	92	86	49	13
NO ANSWER	9	3	2	2	1					3	1	1			
NUMBER ANSWERING	452	61	83	116	110	46	13			51	88	91	86	49	13
	100.0	100.0	100.0	100.0	100.0	100.0	100.0			100.0	100.0	100.0	100.0	100.0	100.0
YES	13	1	1	3	5	2	1			2		2	6	1	1
	2.9	1.6	1.2	2.6	4.5	4.3	7.7			3.9		2.2	7.0	2.0	7.7
NO	439	60	82	113	105	44	12			49	88	89	80	48	12
	97.1	98.4	98.8	97.4	95.5	95.7	92.3			96.1	100.0	97.8	93.0	98.0	92.3

NATIONAL ANALYSTS
METAL FINISHING STUDY (557-1)
SURVEY PARTICIPANTS

QUESTION NO.III-11B1 (IF 'YES', Q.11B)
WHAT IS THE NATURE OF YOUR OPTION?

		---- NUMBER OF FULL-TIME PEOPLE ----								--- T O T A L S A L E S ---					
	TOTAL	1-4	5-9	10-19	20-49	50-99	100-249	250-499	500& MORE	UNDER $100M	$100M -249M	$250M -499M	$500M -999M	$1MIL -2.4	$2.5 MIL+
TOTAL	13	1	1	3	5	2	1			2		2	6	1	1
NO ANSWER															
NUMBER ANSWERING	13	1	1	3	5	2	1			2		2	6	1	1
	100.0	100.0	100.0	100.0	100.0	100.0	100.0			100.0		100.0	100.0	100.0	100.0
TO GROUND VIA FILTER BEDS															
TO RIVER, LAKE, STREAM, ETC.	5			1	3		1						3		1
	38.5			33.3	60.0		100.0						50.0		100.0
OTHER OPTIONS	8	1	1	2	2	2				2		2	3	1	
	61.5	100.0	100.0	66.7	40.0	100.0				100.0		100.0	50.0	100.0	

039

QUESTION NO.III-12 (IF DISCHARGE WATER GOES TO MUNICIPAL SEWER SYSTEM, Q.11A) WHAT WERE YOUR 1975 TOTAL SEWER COSTS?

		---- NUMBER OF FULL-TIME PEOPLE ----								--- TOTAL SALES ---					
	TOTAL	1-4	5-9	10-19	20-49	50-99	100-249	250-499	500& MORE	UNDER $100M	$100M -249M	$250M -499M	$500M -999M	$1MIL -2.4	$2.5 MIL+
TOTAL	404	52	72	109	100	39	12			46	82	85	74	40	13
NO ANSWER	122	14	26	34	29	12	1			13	21	22	22	8	5
NUMBER ANSWERING	282	38	46	75	71	27	11			33	61	63	52	32	8
	100.0	100.0	100.0	100.0	100.0	100.0	100.0			100.0	100.0	100.0	100.0	100.0	100.0
LESS THAN $500	102	30	26	27	14	1				25	29	17	12	2	
	36.2	78.9	56.5	36.0	19.7	3.7				75.8	47.5	27.0	23.1	6.3	
$500 TO $999	35	6	8	10	5	4				6	10	10	6	1	
	12.4	15.8	17.4	13.3	7.0	14.8				18.2	16.4	15.9	11.5	3.1	
$1,000 TO $2,999	69	2	7	24	25	4	2			2	14	25	16	4	
	24.5	5.3	15.2	32.0	35.2	14.8	18.2			6.1	23.0	39.7	30.8	12.5	
$3,000 TO $5,999	32		5	9	14	3	1				7	8	11	2	1
	11.3		10.9	12.0	19.7	11.1	9.1				11.5	12.7	21.2	6.3	12.5
$6,000 OR MORE	44			5	13	15	8				1	3	7	23	7
	15.6			6.7	18.3	55.6	72.7				1.6	4.8	13.5	71.9	87.5
AVERAGE	3437	283	831	1727	3608	11969	16017			345	1118	1738	3558	13236	15050

NATIONAL ANALYSTS
METAL FINISHING STUDY (557-1)
SURVEY PARTICIPANTS

QUESTION NO.III-13 HOW MANY POUNDS OF
SLUDGE DO YOU PRODUCE IN A MONTH?

		---- NUMBER OF FULL-TIME PEOPLE ----								--- T O T A L S A L E S ---					
	TOTAL	1-4	5-9	10-19	20-49	50-99	100-249	250-499	500& MORE	UNDER $100M	$100M -249M	$250M -499M	$500M -999M	$1MIL -2.4	$2.5 MIL+
TOTAL	461	64	85	118	111	46	13			54	89	92	86	49	13
NO ANSWER	179	19	30	49	48	15	8			17	30	39	30	21	7
NUMBER ANSWERING	282	45	55	69	63	31	5			37	59	53	56	28	6
	100.0	100.0	100.0	100.0	100.0	100.0	100.0			100.0	100.0	100.0	100.0	100.0	100.0
NONE	98	21	21	19	21	9	1			14	21	18	23	8	1
	34.8	46.7	38.2	27.5	33.3	29.0	20.0			37.8	35.6	34.0	41.1	28.6	16.7
1 TO 99	70	17	22	17	9	4				20	18	12	8	1	
	24.8	37.8	40.0	24.6	14.3	12.9				54.1	30.5	22.6	14.3	3.6	
100 TO 999	61	7	9	22	13	5	1			3	17	16	8	4	4
	21.6	15.6	16.4	31.9	20.6	16.1	20.0			8.1	28.8	30.2	14.3	14.3	66.7
1,000 TO 9,999	36		2	8	13	9	1				2	4	12	11	
	12.8		3.6	11.6	20.6	29.0	20.0				3.4	7.5	21.4	39.3	
10,000 OR MORE	17		1	3	7	4	2				1	3	5	4	1
	6.0		1.8	4.3	11.1	12.9	40.0				1.7	5.7	8.9	14.3	16.7
AVERAGE	2240	55	878	972	5607	4268	4440			27	446	2149	4560	5003	1867

041

NATIONAL ANALYSTS
METAL FINISHING STUDY (557-1)
SURVEY PARTICIPANTS

QUESTION NO.III-14 (IF SLUDGE PRODUCED, Q.13) HOW IS THE SLUDGE DISPOSED?

		---- NUMBER OF FULL-TIME PEOPLE ----								--- T O T A L S A L E S ---					
	TOTAL	1-4	5-9	10-19	20-49	50-99	100-249	250-499	500& MORE	UNDER $100M	$100M -249M	$250M -499M	$500M -999M	$1MIL -2.4	$2.5 MIL+
TOTAL	184	24	34	50	42	22	4			23	38	35	33	20	5
NO ANSWER															
NUMBER ANSWERING	184 100.0	24 100.0	34 100.0	50 100.0	42 100.0	22 100.0	4 100.0			23 100.0	38 100.0	35 100.0	33 100.0	20 100.0	5 100.0
LAND FILL	76 41.3	7 29.2	14 41.2	15 30.0	22 52.4	13 59.1	1 25.0			7 30.4	12 31.6	13 37.1	20 60.6	13 65.0	3 60.0
INTO WATER OR SEWER	27 14.7	3 12.5	6 17.6	5 10.0	9 21.4	3 13.6	1 25.0			4 17.4	9 23.7	4 11.4	5 15.2	2 10.0	
INCINERATOR	1 .5			1 2.0							1 2.6				
LAGOON	8 4.3	1 4.2		1 2.0	1 2.4	5 22.7				1 4.3	1 2.6		1 3.0	3 15.0	1 20.0
TRASH PICKUP	90 48.9	13 54.2	20 58.8	29 58.0	13 31.0	8 36.4	3 75.0			12 52.2	22 57.9	18 51.4	13 39.4	5 25.0	2 40.0
REFINERY	3 1.6	1 4.2	1 2.9				1 25.0			1 4.3	1 2.6				1 20.0
RECYCLED	6 3.3			2 4.0	1 2.4	1 4.5						3 8.6		1 5.0	
OTHER	2 1.1		1 2.9		1 2.4								1 3.0		
DON'T KNOW	1 .5				1 2.4								1 3.0		

042

NATIONAL ANALYSTS
METAL FINISHING STUDY (557-1)
SURVEY PARTICIPANTS

QUESTION NO.IV-1A WHO OWNS YOUR FIRM?

	TOTAL	1-4	5-9	10-19	20-49	50-99	100-249	250-499	500& MORE	UNDER $100M	$100M-249M	$250M-499M	$500M-999M	$1MIL-2.4	$2.5 MIL+
		- - - - NUMBER OF FULL-TIME PEOPLE - - -								- - - T O T A L S A L E S - - -					
TOTAL	461	64	85	118	111	46	13			54	89	92	86	49	13
NO ANSWER	41	8	6	11	11	3	1			4	7	5	6	2	1
NUMBER ANSWERING	420	56	79	107	100	43	12			50	82	87	80	47	12
	100.0	100.0	100.0	100.0	100.0	100.0	100.0			100.0	100.0	100.0	100.0	100.0	100.0
AN INDIVIDUAL	131	29	26	36	22	8	3			22	27	26	20	9	3
	31.2	51.8	32.9	33.6	22.0	18.6	25.0			44.0	32.9	29.9	25.0	19.1	25.0
A FAMILY	141	15	30	31	37	18				16	33	27	27	18	2
	33.6	26.8	38.0	29.0	37.0	41.9				32.0	40.2	31.0	33.8	38.3	16.7
A SMALL GROUP	129	11	21	36	38	12	5			11	19	33	30	13	5
	30.7	19.6	26.6	33.6	38.0	27.9	41.7			22.0	23.2	37.9	37.5	27.7	41.7
ANOTHER FIRM	16	1	1	3	2	5	4				2		3	7	2
	3.8	1.8	1.3	2.8	2.0	11.6	33.3				2.4		3.8	14.9	16.7
OTHER	3		1	1	1					1	1	1			
	.7		1.3	.9	1.0					2.0	1.2	1.1			

043

NATIONAL ANALYSTS
METAL FINISHING STUDY (557-1)
SURVEY PARTICIPANTS

QUESTION NO.IV-1B HOW MANY OWNERS ARE THERE?

		---- NUMBER OF FULL-TIME PEOPLE ----								--- T O T A L S A L E S ---					
	TOTAL	1-4	5-9	10-19	20-49	50-99	100-249	250-499	500& MORE	UNDER $100M	$100M -249M	$250M -499M	$500M -999M	$1MIL -2.4	$2.5 MIL+
TOTAL	461	64	85	118	111	46	13			54	89	92	86	49	13
NO ANSWER	46	4	4	14	10	9	4			1	4	6	5	9	2
NUMBER ANSWERING	415	60	81	104	101	37	9			53	85	86	81	40	11
	100.0	100.0	100.0	100.0	100.0	100.0	100.0			100.0	100.0	100.0	100.0	100.0	100.0
1-3	337	54	71	85	78	24	5			48	74	72	61	26	6
	81.2	90.0	87.7	81.7	77.2	64.9	55.6			90.6	87.1	83.7	75.3	65.0	54.5
4-7	65	5	9	15	20	10	3			4	10	13	16	10	3
	15.7	8.3	11.1	14.4	19.8	27.0	33.3			7.5	11.8	15.1	19.8	25.0	27.3
8 OR MORE	13	1	1	4	3	3	1			1	1	1	4	4	2
	3.1	1.7	1.2	3.8	3.0	8.1	11.1			1.9	1.2	1.2	4.9	10.0	18.2
AVERAGE	2.46	1.95	2.21	2.37	2.77	3.14	3.22			1.94	2.21	2.30	2.84	3.25	4.00

044

NATIONAL ANALYSTS
METAL FINISHING STUDY (557-1)
SURVEY PARTICIPANTS

QUESTION NO.IV-1C HOW MANY OF THESE OWNERS WORK FULL-TIME?

		---- NUMBER OF FULL-TIME PEOPLE ----								--- T O T A L S A L E S ---					
	TOTAL	1-4	5-9	10-19	20-49	50-99	100-249	250-499	500& MORE	UNDER $100M	$100M-249M	$250M-499M	$500M-999M	$1MIL-2.4	$2.5 MIL+
TOTAL	461	64	85	118	111	46	13			54	89	92	86	49	13
NO ANSWER	51	7	8	12	8	9	5			2	8	5	3	9	3
NUMBER ANSWERING	410	57	77	106	103	37	8			52	81	87	83	40	10
	100.0	100.0	100.0	100.0	100.0	100.0	100.0			100.0	100.0	100.0	100.0	100.0	100.0
NONE	22	8	4	5	4	1				4	8	1	2	2	
	5.4	14.0	5.2	4.7	3.9	2.7				7.7	9.9	1.1	2.4	5.0	
1-3	367	47	72	97	95	30	5			48	70	84	76	31	8
	89.5	82.5	93.5	91.5	92.2	81.1	62.5			92.3	86.4	96.6	91.6	77.5	80.0
4-7	19	2	1	4	4	5	2				3	2	5	6	1
	4.6	3.5	1.3	3.8	3.9	13.5	25.0				3.7	2.3	6.0	15.0	10.0
8 OR MORE	2					1	1							1	1
	.5					2.7	12.5							2.5	10.0
AVERAGE	1.66	1.19	1.45	1.57	1.83	2.30	3.25			1.27	1.37	1.67	1.86	2.28	3.10

045

NATIONAL ANALYSTS
METAL FINISHING STUDY (557-1)
SURVEY PARTICIPANTS

QUESTION NO.IV-1D HOW MANY OF THESE OWNERS WORK PART-TIME?

		---- NUMBER OF FULL-TIME PEOPLE ----								--- T O T A L S A L E S ---					
	TOTAL	1-4	5-9	10-19	20-49	50-99	100-249	250-499	500& MORE	UNDER $100M	$100M -249M	$250M -499M	$500M -999M	$1MIL -2.4	$2.5 MIL+
TOTAL	461	64	85	118	111	46	13			54	89	92	86	49	13
NO ANSWER	101	12	16	25	26	13	5			7	14	16	16	16	3
NUMBER ANSWERING	360	52	69	93	85	33	8			47	75	76	70	33	10
	100.0	100.0	100.0	100.0	100.0	100.0	100.0			100.0	100.0	100.0	100.0	100.0	100.0
NONE	270	40	50	70	62	24	8			36	53	57	52	25	9
	75.0	76.9	72.5	75.3	72.9	72.7	100.0			76.6	70.7	75.0	74.3	75.8	90.0
1-3	88	12	19	23	22	8				11	22	19	17	7	1
	24.4	23.1	27.5	24.7	25.9	24.2				23.4	29.3	25.0	24.3	21.2	10.0
4-7	2				1	1							1	1	
	.6				1.2	3.0							1.4	3.0	
8 OR MORE															
AVERAGE	.34	.29	.35	.31	.38	.48				.30	.41	.28	.39	.45	.10

046

259-718 O - 78 - 17

NATIONAL ANALYSTS
METAL FINISHING STUDY (557-1)
SURVEY PARTICIPANTS

QUESTION NO.IV-2 FROM 1972 TO 1975, HOW WOULD YOU DESCRIBE THE CHANGES IN YOUR ANNUAL SALES?

		---- NUMBER OF FULL-TIME PEOPLE ----								--- T O T A L S A L E S ---					
	TOTAL	1-4	5-9	10-19	20-49	50-99	100-249	250-499	500& MORE	UNDER $100M	$100M -249M	$250M -499M	$500M -999M	$1MIL -2.4	$2.5 MIL+
TOTAL	461	64	85	118	111	46	13			54	89	92	86	49	13
NO ANSWER	16	2	2	6	4	1					2	1	1		
NUMBER ANSWERING	445	62	83	112	107	45	13			54	87	91	85	49	13
	100.0	100.0	100.0	100.0	00.0	100.0	100.0			100.0	100.0	100.0	100.0	100.0	100.0
SALES WERE INCREASING STEADILY	152	21	25	40	34	18	4			17	26	38	28	17	8
	34.2	33.9	30.1	35.7	31.8	40.0	30.8			31.5	29.9	41.8	32.9	34.7	61.5
SALES WERE DECREASING STEADILY	38	8	8	7	11	1	2			9	6	4	10	3	1
	8.5	12.9	9.6	6.3	10.3	2.2	15.4			16.7	6.9	4.4	11.8	6.1	7.7
SALES MOVED IN CYCLES	164	14	28	41	47	21	6			12	35	30	36	23	4
	36.9	22.6	33.7	36.6	43.9	46.7	46.2			22.2	40.2	33.0	42.4	46.9	30.8
SALES WERE ABOUT THE SAME	84	16	18	24	15	5	1			13	18	19	11	6	
	18.9	25.8	21.7	21.4	14.0	11.1	7.7			24.1	20.7	20.9	12.9	12.2	
NOT IN BUSINESS ALL OR PART OF THIS TIME PERIOD	7	3	4							3	2				
	1.6	4.8	4.8							5.6	2.3				

NATIONAL ANALYSTS
METAL FINISHING STUDY (557-1)
SURVEY PARTICIPANTS

QUESTION NO.IV-3 WHAT IS YOUR 1975 YEAR-END VALUE FROM YOUR PROFIT AND LOSS STATEMENT FROM SALES?

		---- NUMBER OF FULL-TIME PEOPLE ----								---TOTAL SALES---					
	TOTAL	1-4	5-9	10-19	20-49	50-99	100-249	250-499	500& MORE	UNDER $100M	$100M -249M	$250M -499M	$500M -999M	$1MIL -2.4	$2.5 MIL+
TOTAL	461	64	85	118	111	46	13			54	89	92	86	49	13
NO ANSWER	78	19	18	18	14	4	1								
NUMBER ANSWERING	383	45	67	100	97	42	12			54	89	92	86	49	13
	100.0	100.0	100.0	100.0	100.0	100.0	100.0			100.0	100.0	100.0	100.0	100.0	100.0
UNDER $100,000	54	34	15	1						54					
	14.1	75.6	22.4	1.0						100.0					
$100,000 TO $249,999	89	10	41	32	1	1					89				
	23.2	22.2	61.2	32.0	1.0	2.4					100.0				
$250,000 TO $499,999	92		9	53	25							92			
	24.0		13.4	53.0	25.8							100.0			
$500,000 TO $999,999	86	1	2	12	59	8							86		
	22.5	2.2	3.0	12.0	60.8	19.0							100.0		
$1,000,000 TO $2,499,999	49			1	12	29	5							49	
	12.8			1.0	12.4	69.0	41.7							100.0	
$2,500,000 OR MORE	13			1		4	7								13
	3.4			1.0		9.5	58.3								100.0
AVERAGE (THOUSANDS)	676	89	170	441	691	1638	3776			64	174	346	692	1461	5932

NATIONAL ANALYSTS
METAL FINISHING STUDY (557-1)
SURVEY PARTICIPANTS

QUESTION NO.IV-3 WHAT IS YOUR 1975 YEAR-END VALUE FROM YOUR PROFIT AND LOSS STATEMENT FROM RENT OR LEASE PAYMENTS?

		- - - - NUMBER OF FULL-TIME PEOPLE - - - -								- - - T O T A L S A L E S - - -					
	TOTAL	1-4	5-9	10-19	20-49	50-99	100-249	250-499	500& MORE	UNDER $100M	$100M-249M	$250M-499M	$500M-999M	$1MIL-2.4	$2.5 MIL+
TOTAL	461	64	85	118	111	46	13			54	89	92	86	49	13
NO ANSWER	107	22	25	24	20	8	1			8	9	7	2	5	1
NUMBER ANSWERING	354	42	60	94	91	38	12			46	80	85	84	44	12
	100.0	100.0	100.0	100.0	100.0	100.0	100.0			100.0	100.0	100.0	100.0	100.0	100.0
LESS THAN $1,000	70	6	9	22	17	8	2			9	11	22	16	11	1
	19.8	14.3	15.0	23.4	18.7	21.1	16.7			19.6	13.8	25.9	19.0	25.0	8.3
$1,000 TO $4,999	57	18	16	12	6	1				24	20	7	5		
	16.1	42.9	26.7	12.8	6.6	2.6				52.2	25.0	8.2	6.0		
$5,000 TO $9,999	71	15	20	22	12					9	27	25	8		
	20.1	35.7	33.3	23.4	13.2					19.6	33.8	29.4	9.5		
$10,000 TO $35,999	118	3	15	34	45	12	4			4	22	28	46	14	4
	33.3	7.1	25.0	36.2	49.5	31.6	33.3			8.7	27.5	32.9	54.8	31.8	33.3
$36,000 OR MORE	38			4	11	17	6					3	9	19	7
	10.7			4.3	12.1	44.7	50.0					3.5	10.7	43.2	58.3
AVERAGE (THOUSANDS)	16	4	7	12	20	38	43			4	7	9	20	36	68

049

NATIONAL ANALYSTS
METAL FINISHING STUDY (557-1)
SURVEY PARTICIPANTS

QUESTION NO.IV-3 WHAT IS YOUR 1975 YEAR-END VALUE FROM YOUR PROFIT AND LOSS STATEMENT FROM OWNER'S/OFFICER'S COMPENSATION?

		---- NUMBER OF FULL-TIME PEOPLE ----								--- T O T A L S A L E S ---					
	TOTAL	1-4	5-9	10-19	20-49	50-99	100-249	250-499	500& MORE	UNDER $100M	$100M -249M	$250M -499M	$500M -999M	$1MIL -2.4	$2.5 MIL+
TOTAL	461	64	85	118	111	46	13			54	89	92	86	49	13
NO ANSWER	117	26	27	25	20	9	3			11	10	7	5	4	4
NUMBER ANSWERING	344	38	58	93	91	37	10			43	79	85	81	45	9
	100.0	100.0	100.0	100.0	100.0	100.0	100.0			100.0	100.0	100.0	100.0	100.0	100.0
LESS THAN $20,000	86	22	19	22	9	3	5			30	28	14	4	6	3
	25.0	57.9	32.8	23.7	9.9	8.1	50.0			69.8	35.4	16.5	4.9	13.3	33.3
$20,000 TO $39,999	113	10	27	36	27	6	1			11	34	32	29	6	
	32.8	26.3	46.6	38.7	29.7	16.2	10.0			25.6	43.0	37.6	35.8	13.3	
$40,000 TO $59,999	58	3	5	17	20	9	1			1	14	14	20	8	1
	16.9	7.9	8.6	18.3	22.0	24.3	10.0			2.3	17.7	16.5	24.7	17.8	11.1
$60,000 TO $79,999	44	2	5	10	16	10				1	2	18	10	12	1
	12.8	5.3	8.6	10.8	17.6	27.0				2.3	2.5	21.2	12.3	26.7	11.1
$80,000 OR MORE	43	1	2	8	19	9	3				1	7	18	13	4
	12.5	2.6	3.4	8.6	20.9	24.3	30.0				1.3	8.2	22.2	28.9	44.4
AVERAGE (THOUSANDS)	45	24	29	38	58	71	77			16	28	43	58	71	105

050

NATIONAL ANALYSTS
METAL FINISHING STUDY (557-1)
SURVEY PARTICIPANTS

QUESTION NO.IV-3 WHAT IS YOUR 1975 YEAR-END VALUE FROM YOUR PROFIT AND LOSS STATEMENT FROM DEPRECIATION?

		---- NUMBER OF FULL-TIME PEOPLE ----								--- T O T A L S A L E S ---					
	TOTAL	1-4	5-9	10-19	20-49	50-99	100-249	250-499	500& MORE	UNDER $100M	$100M -249M	$250M -499M	$500M -999M	$1MIL -2.4	$2.5 MIL+
TOTAL	461	64	85	118	111	46	13			54	89	92	86	49	13
NO ANSWER	140	33	32	34	20	11	3			14	21	12	8	5	3
NUMBER ANSWERING	321	31	53	84	91	35	10			40	68	80	78	44	10
	100.0	100.0	100.0	100.0	100.0	100.0	100.0			100.0	100.0	100.0	100.0	100.0	100.0
LESS THAN $1,000	13	5	4	2	1		1			7	2	2	1		1
	4.0	16.1	7.5	2.4	1.1		10.0			17.5	2.9	2.5	1.3		10.0
$1,000 TO $9,999	123	22	39	36	16	2				29	46	34	13	1	
	38.3	71.0	73.6	42.9	17.6	5.7				72.5	67.6	42.5	16.7	2.3	
$10,000 TO $29,999	107	3	9	33	51	5				2	16	39	43	6	
	33.3	9.7	17.0	39.3	56.0	14.3				5.0	23.5	48.8	55.1	13.6	
$30,000 TO $59,999	39			8	15	11	3			1	1	2	17	17	1
	12.1			9.5	16.5	31.4	30.0			2.5	1.5	2.5	21.8	38.6	10.0
$60,000 TO $99,999	21	1	1	1	4	12	2			1	1	1	2	13	3
	6.5	3.2	1.9	1.2	4.4	34.3	20.0			2.5	1.5	1.3	2.6	29.5	30.0
$100,000 OR MORE	18			4	4	5	4				2	2	2	7	5
	5.6			4.8	4.4	14.3	40.0				2.9	2.5	2.6	15.9	50.0
AVERAGE (THOUSANDS)	32	7	7	23	29	72	206			6	15	17	25	76	228

051

NATIONAL ANALYSTS
METAL FINISHING STUDY (557-1)
SURVEY PARTICIPANTS

QUESTION NO.IV-3 WHAT IS YOUR 1975 YEAR-END VALUE FROM YOUR PROFIT AND LOSS STATEMENT FROM PROFIT BEFORE TAX?

		---- NUMBER OF FULL-TIME PEOPLE ----							--- T O T A L S A L E S ---					
	TOTAL	1-4	5-9	10-19	20-49	50-99	100-249	250-499	500& MORE	UNDER $100M	$100M -249M	$250M -499M	$500M -999M	$1MIL -2.4	$2.5 MIL+
TOTAL	461	64	85	118	111	46	13			54	89	92	86	49	13
NO ANSWER	118	27	29	27	19	8	2			10	15	9	3	3	2
NUMBER ANSWERING	343	37	56	91	92	38	11			44	74	83	83	46	11
	100.0	100.0	100.0	100.0	100.0	100.0	100.0			100.0	100.0	100.0	100.0	100.0	100.0
LESS THAN $10,000	200	27	40	55	45	19	6			35	53	46	39	23	2
	58.3	73.0	71.4	60.4	48.9	50.0	54.5			79.5	71.6	55.4	47.0	50.0	18.2
$10,000 TO $24,999	56	4	10	20	14	6				6	12	18	15	5	
	16.3	10.8	17.9	22.0	15.2	15.8				13.6	16.2	21.7	18.1	10.9	
$25,000 TO $74,999	62	6	5	13	25	7	1			3	8	17	24	9	1
	18.1	16.2	8.9	14.3	27.2	18.4	9.1			6.8	10.8	20.5	28.9	19.6	9.1
$75,000 TO $149,999	13		1	1	5	4					1	1	4	7	
	3.8		1.8	1.1	5.4	10.5					1.4	1.2	4.8	15.2	
$150,000 OR MORE	12			2	3	2	4					1	1	2	8
	3.5			2.2	3.3	5.3	36.4					1.2	1.2	4.3	72.7
AVERAGE (THOUSANDS)	30	9	8	25	28	57	170			6	9	17	25	40	376

052

NATIONAL ANALYSTS
METAL FINISHING STUDY (557-1)
SURVEY PARTICIPANTS

QUESTION NO.IV-3 WHAT IS YOUR 1975 YEAR-END VALUE FROM YOUR PROFIT AND LOSS STATEMENT FROM PROFIT AFTER TAX?

		---- NUMBER OF FULL-TIME PEOPLE ----								--- T O T A L S A L E S ---					
	TOTAL	1-4	5-9	10-19	20-49	50-99	100-249	250-499	500& MORE	UNDER $100M	$100M -249M	$250M -499M	$500M -999M	$1MIL -2.4	$2.5 MIL+
TOTAL	461	64	85	118	111	46	13			54	89	92	86	49	13
NO ANSWER	122	26	25	28	25	8	4			9	10	14	8	2	4
NUMBER ANSWERING	339	38	60	90	86	38	9			45	79	78	78	47	9
	100.0	100.0	100.0	100.0	100.0	100.0	100.0			100.0	100.0	100.0	100.0	100.0	100.0
LESS THAN $10,000	232	31	50	66	49	23	6			37	66	55	43	26	2
	68.4	81.6	83.3	73.3	57.0	60.5	66.7			82.2	83.5	70.5	55.1	55.3	22.2
$10,000 TO $24,999	53	5	7	16	15	4	1			7	10	13	18	4	1
	15.6	13.2	11.7	17.8	17.4	10.5	11.1			15.6	12.7	16.7	23.1	8.5	11.1
$25,000 TO $74,999	43	2	3	6	20	8				1	3	10	15	14	
	12.7	5.3	5.0	6.7	23.3	21.1				2.2	3.8	12.8	19.2	29.8	
$75,000 TO $149,999	5				2	1	1						1	3	1
	1.5				2.3	2.6	11.1						1.3	6.4	11.1
$150,000 OR MORE	6			2		2	1						1		5
	1.8			2.2		5.3	11.1						1.3		55.6
AVERAGE (THOUSANDS)	16	7	5	15	16	31	37			5	5	9	16	24	171

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NATIONAL ANALYSTS
METAL FINISHING STUDY (557-1)
SURVEY PARTICIPANTS

QUESTION NO.IV-3 WHAT IS YOUR 1975 YEAR-END
VALUE FROM YOUR PROFIT AND LOSS STATEMENT
FROM LOSS BEFORE TAX?

		---- NUMBER OF FULL-TIME PEOPLE ----								--- TOTAL SALES ---					
	TOTAL	1-4	5-9	10-19	20-49	50-99	100-249	250-499	500& MORE	UNDER $100M	$100M -249M	$250M -499M	$500M -999M	$1MIL -2.4	$2.5 MIL+
TOTAL	461	64	85	118	111	46	13			54	89	92	86	49	13
NO ANSWER	165	29	35	42	30	18	4			13	25	21	13	13	4
NUMBER ANSWERING	296	35	50	76	81	28	9			41	64	71	73	36	9
	100.0	100.0	100.0	100.0	100.0	100.0	100.0			100.0	100.0	100.0	100.0	100.0	100.0
LESS THAN $10,000	275	35	50	73	71	22	7			41	63	69	62	30	8
	92.9	100.0	100.0	96.1	87.7	78.6	77.8			100.0	98.4	97.2	84.9	83.3	88.9
$10,000 TO $24,999	7			2	2	2	1				1	1	3	1	1
	2.4			2.6	2.5	7.1	11.1				1.6	1.4	4.1	2.8	11.1
$25,000 TO $74,999	10				7	3						1	8	1	
	3.4				8.6	10.7						1.4	11.0	2.8	
$75,000 TO $149,999	2			1		1								2	
	.7			1.3		3.6								5.6	
$150,000 OR MORE	2				1		1							2	
	.7				1.2		11.1							5.6	
AVERAGE (THOUSANDS)	4	1		2	6	11	35					1	5	22	2

054

NATIONAL ANALYSTS
METAL FINISHING STUDY (557-1)
SURVEY PARTICIPANTS

QUESTION NO. IV-3 WHAT IS YOUR 1975 YEAR-END VALUE FROM YOUR PROFIT AND LOSS STATEMENT FROM LOSS AFTER TAX?

	TOTAL	NUMBER OF FULL-TIME PEOPLE 1-4	5-9	10-19	20-49	50-99	100-249	250-499	500& MORE	TOTAL SALES UNDER $100M	$100M -249M	$250M -499M	$500M -999M	$1MIL -2.4	$2.5 MIL+
TOTAL	461	64	85	118	111	46	13			54	89	92	86	49	13
NO ANSWER	167	30	36	41	30	19	4			15	25	20	14	13	4
NUMBER ANSWERING	294	34	49	77	81	27	9			39	64	72	72	36	9
	100.0	100.0	100.0	100.0	100.0	100.0	100.0			100.0	100.0	100.0	100.0	100.0	100.0
LESS THAN $10,000	277	34	49	76	71	22	8			39	64	71	62	30	9
	94.2	100.0	100.0	98.7	87.7	81.5	88.9			100.0	100.0	98.6	86.1	83.3	100.0
$10,000 TO $24,999	7				4	3							5	2	
	2.4				4.9	11.1							6.9	5.6	
$25,000 TO $74,999	6				5	1						1	5		
	2.0				6.2	3.7						1.4	6.9		
$75,000 TO $149,999	4			1	1	1	1							4	
	1.4			1.3	1.2	3.7	11.1							11.1	
$150,000 OR MORE															
AVERAGE (THOUSANDS)	3	1		2	5	8	17					.1	5	15	1

NATIONAL ANALYSTS
METAL FINISHING STUDY (557-1)
SURVEY PARTICIPANTS

QUESTION NO.IV-4 WHAT IS THE 1975 YEAR
END VALUE FOR *(ITEM) FOUND IN YOUR
BALANCE SHEET?
*CURRET ASSETS

	TOTAL	1-4	5-9	10-19	20-49	50-99	100-249	250-499	500& MORE	UNDER $100M	$100M -249M	$250M -499M	$500M -999M	$1MIL -2.4	$2.5 MIL+
		- - - - NUMBER OF FULL-TIME PEOPLE - - - -								- - - T O T A L S A L E S - - -					
TOTAL	461	64	85	118	111	46	13			54	89	92	86	49	13
NO ANSWER	141	33	36	33	18	10	4			17	22	12	6	8	4
NUMBER ANSWERING	320	31	49	85	93	36	9			37	67	80	80	41	9
	100.0	100.0	100.0	100.0	100.0	100.0	100.0			100.0	100.0	100.0	100.0	100.0	100.0
LESS THAN $20,000	34	18	8	4						17	12	2	1		
	10.6	58.1	16.3	4.7						45.9	17.9	2.5	1.3		
$20,000 TO $99,999	136	12	39	52	26					19	49	47	18		
	42.5	38.7	79.6	61.2	28.0					51.4	73.1	58.8	22.5		
$100,000 TO $199,999	75	1	2	22	39	8				1	6	27	37	4	
	23.4	3.2	4.1	25.9	41.9	22.2				2.7	9.0	33.8	46.3	9.8	
$200,000 TO $499,999	55			6	25	19	3					4	23	27	
	17.2			7.1	26.9	52.8	33.3					5.0	28.8	65.9	
$500,000 OR MORE	20			1	3	9	6						1	10	9
	6.3			1.2	3.2	25.0	66.7						1.3	24.4	100.0
AVERAGE (THOUSANDS)	210	28	45	165	177	448	1740			30	50	97	168	444	2560

NATIONAL ANALYSTS
METAL FINISHING STUDY (1557-1)
SURVEY PARTICIPANTS

QUESTION NO.IV-4 WHAT IS THE 1975 YEAR
END VALUE FOR *(ITEM) FOUND IN YOUR
BALANCE SHEET?
*FIXED AND OTHER ASSETS

		- - - - NUMBER OF FULL-TIME PEOPLE - - - -								- - - T O T A L S A L E S - - -					
	TOTAL	1-4	5-9	10-19	20-49	50-99	100-249	250-499	500& MORE	UNDER $100M	$100M-249M	$250M-499M	$500M-999M	$1MIL-2.4	$2.5 MIL+
TOTAL	461	64	85	118	111	46	13			54	89	92	86	49	13
NO ANSWER	147	35	36	34	19	11	4			18	23	13	9	8	4
NUMBER ANSWERING	314	29	49	84	92	35	9			36	66	79	77	41	9
	100.0	100.0	100.0	100.0	100.0	100.0	100.0			100.0	100.0	100.0	100.0	100.0	100.0
LESS THAN $20,000	50	13	20	7	6					20	17	7	4		
	15.9	44.8	40.8	8.3	6.5					55.6	25.8	8.9	5.2		
$20,000 TO $99,999	119	14	23	48	25	2				15	38	42	23		
	37.9	48.3	46.9	57.1	27.2	5.7				41.7	57.6	53.2	29.9		
$100,000 TO $199,999	70	2	5	18	35	7	1			1	9	22	29	6	
	22.3	6.9	10.2	21.4	38.0	20.0	11.1			2.8	13.6	27.8	37.7	14.6	
$200,000 TO $499,999	30		1	10	21	13	3				2	7	16	24	1
	15.9		2.0	11.9	22.8	37.1	33.3				3.0	8.9	20.8	58.5	11.1
$500,000 OR MORE	25			1	5	13	5					1	5	11	8
	8.0			1.2	5.4	37.1	55.6					1.3	6.5	26.8	88.9
AVERAGE (THOUSANDS)	176	33	41	98	176	542	768			23	57	95	168	495	1038

NATIONAL ANALYSTS
METAL FINISHING STUDY (557-1)
SURVEY PARTICIPANTS

QUESTION NO.IV-4 WHAT IS THE 1975 YEAR
END VALUE FOR *(ITEM) FOUND IN YOUR
BALANCE SHEET?
*CURRENT LIABILITIES

		---- NUMBER OF FULL-TIME PEOPLE ----								--- T O T A L S A L E S ---					
	TOTAL	1-4	5-9	10-19	20-49	50-99	100-249	250-499	500& MORE	UNDER $100M	$100M -249M	$250M -499M	$500M -999M	$1MIL -2.4	$2.5 MIL+
TOTAL	461	64	85	118	111	46	13			54	89	92	86	49	13
NO ANSWER	142	32	35	31	20	12	4			16	21	12	8	9	4
NUMBER ANSWERING	319	32	50	87	91	34	9			38	68	80	78	40	9
	100.0	100.0	100.0	100.0	100.0	100.0	100.0			100.0	100.0	100.0	100.0	100.0	100.0
LESS THAN $20,000	106	23	30	36	11					30	41	26	7		
	33.2	71.9	60.0	41.4	12.1					78.9	60.3	32.5	9.0		
$20,000 TO $99,999	130	8	20	43	44	7	1			7	26	48	39	7	
	40.8	25.0	40.0	49.4	48.4	20.6	11.1			18.4	38.2	60.0	50.0	17.5	
$100,000 TO $199,999	40	1		4	24	8	1			1	1	6	19	13	
	12.5	3.1		4.6	26.4	23.5	11.1			2.6	1.5	7.5	24.4	32.5	
$200,000 TO $499,999	31			2	12	13	3						12	16	2
	9.7			2.3	13.2	38.2	33.3						15.4	40.0	22.2
$500,000 OR MORE	12			2		6	4						1	4	7
	3.8			2.3		17.6	44.4						1.3	10.0	77.8
AVERAGE (THOUSANDS)	115	15	21	85	102	351	612			13	22	40	117	295	1142

NATIONAL ANALYSTS
METAL FINISHING STUDY (597-1)
SURVEY PARTICIPANTS

QUESTION NO.IV-4 WHAT IS THE 1975 YEAR
END VALUE FOR *(ITEM) FOUND IN YOUR
BALANCE SHEET?
*LONG TERM DEBT

		- - - - NUMBER OF FULL-TIME PEOPLE - - - -								- - - T O T A L S A L E S - - -					
	TOTAL	1-4	5-9	10-19	20-49	50-99	100-249	250-499	500& MORE	UNDER $100M	$100M -249M	$250M -499M	$500M -999M	$1MIL -2.4	$2.5 MIL+
TOTAL	461	64	85	118	111	46	13			54	89	92	86	49	13
NO ANSWER	136	30	34	31	20	10	4			14	20	12	8	8	4
NUMBER ANSWERING	325	34	51	87	91	36	9			40	69	80	78	41	9
	100.0	100.0	100.0	100.0	100.0	100.0	100.0			100.0	100.0	100.0	100.0	100.0	100.0
LESS THAN $20,000	177	24	32	52	43	15	2			29	42	45	38	16	2
	54.5	70.6	62.7	59.8	47.3	41.7	22.2			72.5	60.9	56.3	48.7	39.0	22.2
$20,000 TO $99,999	94	10	19	25	32	4				11	20	30	26	5	
	28.9	29.4	37.3	28.7	35.2	11.1				27.5	29.0	37.5	33.3	12.2	
$100,000 TO $199,999	31			10	10	4	3				6	5	9	7	3
	9.5			11.5	11.0	11.1	33.3				8.7	6.3	11.5	17.1	33.3
$200,000 TO $499,999	14				4	8	2				1		4	7	2
	4.3				4.4	22.2	22.2				1.4		5.1	17.1	22.2
$500,000 OR MORE	9				2	5	2						1	6	2
	2.8				2.2	13.9	22.2						1.3	14.6	22.2
AVERAGE (THOUSANDS)	70	13	19	33	61	222	459			13	33	31	56	215	450

NATIONAL ANALYSTS
METAL FINISHING STUDY (557-1)
SURVEY PARTICIPANTS

QUESTION NO.IV-4 WHAT IS THE 1975 YEAR END VALUE FOR *(ITEM) FOUND IN YOUR BALANCE SHEET?
*COMPANY NET WORTH

		---- NUMBER OF FULL-TIME PEOPLE ----								--- TOTAL SALES ---					
	TOTAL	1-4	5-9	10-19	20-49	50-99	100-249	250-499	500& MORE	UNDER $100M	$100M -249M	$250M -499M	$500M -999M	$1MIL -2.4	$2.5 MIL+
TOTAL	461	64	85	118	111	46	13			54	89	92	86	49	13
NO ANSWER	150	31	38	31	24	14	5			19	19	13	13	11	4
NUMBER ANSWERING	311	33	47	87	87	32	8			35	70	79	73	38	9
	100.0	100.0	100.0	100.0	100.0	100.0	100.0			100.0	100.0	100.0	100.0	100.0	100.0
LESS THAN $20,000	47	15	9	10	5	6				15	14	8	6	3	
	15.1	45.5	19.1	11.5	5.7	18.8				42.9	20.0	10.1	8.2	7.9	
$20,000 TO $99,999	116	16	28	38	20	3	1			18	41	31	17	4	
	37.3	48.5	59.6	43.7	23.0	9.4	12.5			51.4	58.6	39.2	23.3	10.5	
$100,000 TO $199,999	64	2	8	24	23	5				1	13	25	20	5	
	20.6	6.1	17.0	27.6	26.4	15.6				2.9	18.6	31.6	27.4	13.2	
$200,000 TO $499,999	58		2	14	29	9	2			1	2	15	26	12	1
	18.6		4.3	16.1	33.3	28.1	25.0			2.9	2.9	19.0	35.6	31.6	11.1
$500,000 OR MORE	26			1	10	9	5						4	14	8
	8.4			1.1	11.5	28.1	62.5						5.5	36.8	88.9
AVERAGE (THOUSANDS)	212	40	61	148	244	368	1688			39	61	130	197	414	2148

NATIONAL ANALYSTS
METAL FINISHING STUDY (557-1)
SURVEY PARTICIPANTS

QUESTION NO.IV-4 WHAT IS THE 1975 YEAR END VALUE FOR *(ITEM) FOUND IN YOUR BALANCE SHEET?
*LOSS

		---- NUMBER OF FULL-TIME PEOPLE ----								--- TOTAL SALES ---					
	TOTAL	1-4	5-9	10-19	20-49	50-99	100-249	250-499	500& MORE	UNDER $100M	$100M -249M	$250M -499M	$500M -999M	$1MIL -2.4	$2.5 MIL+
TOTAL	461	64	85	118	111	46	13			54	89	92	86	49	13
NO ANSWER	5	1		1	1	2				1	2		1	1	
NUMBER ANSWERING	456	63	85	117	110	44	13			53	87	92	85	48	13
	100.0	100.0	100.0	100.0	100.0	100.0	100.0			100.0	100.0	100.0	100.0	100.0	100.0
LESS THAN $20,000	450	63	85	115	107	43	13			53	86	90	83	47	13
	98.7	100.0	100.0	98.3	97.3	97.7	100.0			100.0	98.9	97.8	97.6	97.9	100.0
$20,000 TO $99,999	4			1	2	1						2	1	1	
	.9			.9	1.8	2.3						2.2	1.2	2.1	
$100,000 TO $199,999	2			1	1						1		1		
	.4			.9	.9						1.1		1.2		
$200,000 TO $499,999															
$500,000 OR MORE															
AVERAGE (THOUSANDS)	1			2	2	2					1	1	3	2	

NATIONAL ANALYSTS
METAL FINISHING STUDY (557-1)
SURVEY PARTICIPANTS

QUESTION NO.IV-5 WHAT IS THE BOOK VALUE
OF YOUR BUILDING?

	TOTAL	---- NUMBER OF FULL-TIME PEOPLE ---- 1-4	5-9	10-19	20-49	50-99	100-249	250-499	500& MORE	--- TOTAL SALES --- UNDER $100M	$100M -249M	$250M -499M	$500M -999M	$1MIL -2.4	$2.5 MIL+
TOTAL	461	64	85	118	111	46	13			54	89	92	86	49	13
NO ANSWER	328	54	65	84	68	33	8			42	63	53	57	29	9
NUMBER ANSWERING	133	10	20	34	43	13	5			12	26	39	29	20	4
	100.0	100.0	100.0	100.0	100.0	100.0	100.0			100.0	100.0	100.0	100.0	100.0	100.0
LESS THAN $100,000	91	9	17	28	28	3	2			11	22	33	17	3	2
	68.4	90.0	85.0	82.4	65.1	23.1	40.0			91.7	84.6	84.6	58.6	15.0	50.0
$100,000 TO $499,999	39	1	3	6	15	7	3			1	4	6	12	14	2
	29.3	10.0	15.0	17.6	34.9	53.8	60.0			8.3	15.4	15.4	41.4	70.0	50.0
$500,000 OR MORE	3					3								3	
	2.3					23.1								15.0	
AVERAGE (THOUSANDS)	96	34	44	58	92	301	173			43	48	51	93	289	101

062

NATIONAL ANALYSTS
METAL FINISHING STUDY (557-1)
SURVEY PARTICIPANTS

QUESTION NO. IV-5 WHAT IS THE BOOK VALUE
OF YOUR PRODUCTION EQUIPMENT?

		NUMBER OF FULL-TIME PEOPLE								TOTAL SALES					
	TOTAL	1-4	5-9	10-19	20-49	50-99	100-249	250-499	500& MORE	UNDER $100M	$100M-249M	$250M-499M	$500M-999M	$1MIL-2.4	$2.5 MIL+
TOTAL	461	64	85	118	111	46	13			54	89	92	86	49	13
NO ANSWER	194	37	47	48	32	15	5			26	34	27	20	9	5
NUMBER ANSWERING	267	27	38	70	79	31	8			28	55	65	66	40	8
	100.0	100.0	100.0	100.0	100.0	100.0	100.0			100.0	100.0	100.0	100.0	100.0	100.0
LESS THAN $30,000	78	16	23	25	9	2				18	26	23	8	1	
	29.2	59.3	60.5	35.7	11.4	6.5				64.3	47.3	35.4	12.1	2.5	
$30,000 TO $49,999	39	7	5	11	14	1				6	11	12	10		
	14.6	25.9	13.2	15.7	17.7	3.2				21.4	20.0	18.5	15.2		
$50,000 TO $99,999	51	3	9	16	14	2	1			3	13	17	15	2	
	19.1	11.1	23.7	22.9	17.7	6.5	12.5			10.7	23.6	26.2	22.7	5.0	
$100,000 OR MORE	99	1	1	18	42	26	7			1	5	13	33	37	8
	37.1	3.7	2.6	25.7	53.2	83.9	87.5			3.6	9.1	20.0	50.0	92.5	100.0
AVERAGE (THOUSANDS)	134	28	35	72	145	394	481			28	42	59	132	392	505

063

NATIONAL ANALYSTS
METAL FINISHING STUDY (557-1)
SURVEY PARTICIPANTS

QUESTION NO.IV-5 WHAT IS THE REMAINING
LIFE OF YOUR BUILDING?

		---- NUMBER OF FULL-TIME PEOPLE ----								---TOTAL SALES---					
	TOTAL	1-4	5-9	10-19	20-49	50-99	100-249	250-499	500& MORE	UNDER $100M	$100M -249M	$250M -499M	$500M -999M	$1MIL -2.4	$2.5 MIL+
TOTAL	461	64	85	118	111	46	13			54	89	92	86	49	13
NO ANSWER	353	54	68	88	82	36	7			45	64	60	65	36	7
NUMBER ANSWERING	108	10	17	30	29	10	6			9	25	32	21	13	6
	100.0	100.0	100.0	100.0	100.0	100.0	100.0			100.0	100.0	100.0	100.0	100.0	100.0
10 YEARS OR LESS	43	4	10	11	11	3	2			4	11	16	8	2	2
	39.8	40.0	58.8	36.7	37.9	30.0	33.3			44.4	44.0	50.0	38.1	15.4	33.3
11 TO 19 YEARS	27	4	4	7	8	1	2			2	7	7	5	2	2
	25.0	40.0	23.5	23.3	27.6	10.0	33.3			22.2	28.0	21.9	23.8	15.4	33.3
20 TO 39 YEARS	34	2	3	11	9	4	2			3	7	7	8	8	1
	31.5	20.0	17.6	36.7	31.0	40.0	33.3			33.3	28.0	21.9	38.1	61.5	16.7
40 YEARS OR MORE	4			1	1	2						2		1	1
	3.7			3.3	3.4	20.0						6.3		7.7	16.7
AVERAGE	15.29	14.00	11.65	16.77	14.90	20.90	12.67			14.67	13.76	14.72	14.52	20.92	15.83

064

QUESTION NO.IV-5 WHAT IS THE REMAINING LIFE OF YOUR PRODUCTION EQUIPMENT?

		---- NUMBER OF FULL-TIME PEOPLE ----								--- T O T A L S A L E S ---					
	TOTAL	1-4	5-9	10-19	20-49	50-99	100-249	250-499	500& MORE	UNDER $100M	$100M-249M	$250M-499M	$500M-999M	$1MIL-2.4	$2.5 MIL+
TOTAL	461	64	85	118	111	46	13			54	89	92	86	49	13
NO ANSWER	242	41	55	56	51	21	6			31	38	38	37	17	6
NUMBER ANSWERING	219	23	30	62	60	25	7			23	51	54	49	32	7
	100.0	100.0	100.0	100.0	100.0	100.0	100.0			100.0	100.0	100.0	100.0	100.0	100.0
5 YEARS OR LESS	123	12	21	35	36	11	3			11	31	31	34	12	3
	56.2	52.2	70.0	56.5	60.0	44.0	42.9			47.8	60.8	57.4	69.4	37.5	42.9
6 TO 9 YEARS	48	5	4	10	14	9	2			5	7	15	7	12	2
	21.9	21.7	13.3	16.1	23.3	36.0	28.6			21.7	13.7	27.8	14.3	37.5	28.6
10 TO 19 YEARS	45	5	5	16	10	4	2			7	12	7	8	7	2
	20.5	21.7	16.7	25.8	16.7	16.0	28.6			30.4	23.5	13.0	16.3	21.9	28.6
20 YEARS OR MORE	3	1		1		1					1	1		1	
	1.4	4.3		1.6		4.0					2.0	1.9		3.1	
AVERAGE	6.33	6.65	5.67	6.27	6.15	7.40	5.86			6.61	6.47	5.78	5.86	7.59	6.14

065

NATIONAL ANALYSTS
METAL FINISHING STUDY (557-1)
SURVEY PARTICIPANTS

QUESTION NO.IV-5 WHAT IS THE EXPECTED INVESTMENT OVER THE NEXT FIVE YEARS FOR BUILDING?

		---- NUMBER OF FULL-TIME PEOPLE ----								--- T O T A L S A L E S ---					
	TOTAL	1-4	5-9	10-19	20-49	50-99	100-249	250-499	500& MORE	UNDER $100M	$100M -249M	$250M -499M	$500M -999M	$1MIL -2.4	$2.5 MIL+
TOTAL	461	64	85	118	111	46	13			54	89	92	86	49	13
NO ANSWER	334	54	63	87	73	34	7			42	59	62	60	29	10
NUMBER ANSWERING	127	10	22	31	38	12	6			12	30	30	26	20	3
	100.0	100.0	100.0	100.0	100.0	100.0	100.0			100.0	100.0	100.0	100.0	100.0	100.0
LESS THAN $15,000	78	10	17	20	19	6	2			11	19	22	15	6	2
	61.4	100.0	77.3	64.5	50.0	50.0	33.3			91.7	63.3	73.3	57.7	30.0	66.7
$15,000 TO $99,999	29		2	11	10	2	1			1	8	6	6	6	
	22.8		9.1	35.5	26.3	16.7	16.7			8.3	26.7	20.0	23.1	30.0	
$100,000 TO $499,999	19		3		9	3	3				3	2	5	8	1
	15.0		13.6		23.7	25.0	50.0				10.0	6.7	19.2	40.0	33.3
$500,000 OR MORE	1					1									
	.8					8.3									
(AVERAGE (THOUSANDS)	38		18	16	57	78	105			5	24	19	46	72	83

NATIONAL ANALYSTS
METAL FINISHING STUDY (557-1)
SURVEY PARTICIPANTS

QUESTION NO.IV-5 WHAT IS THE EXPECTED INVESTMENT OVER THE NEXT FIVE YEARS FOR PRODUCTION EQUIPMENT?

		- - - - NUMBER OF FULL-TIME PEOPLE - - - -								- - - T O T A L S A L E S - - -					
	TOTAL	1-4	5-9	10-19	20-49	50-99	100-249	250-499	500& MORE	UNDER $100M	$100M -249M	$250M -499M	$500M -999M	$1MIL -2.4	$2.5 MIL+
TOTAL	461	64	85	118	111	46	13			54	89	92	86	49	13
NO ANSWER	361	56	68	94	82	36	8			45	67	64	68	34	10
NUMBER ANSWERING	100	8	17	24	29	10	5			9	22	28	18	15	3
	100.0	100.0	100.0	100.0	100.0	100.0	100.0			100.0	100.0	100.0	100.0	100.0	100.0
LESS THAN $10,000	86	8	14	23	25	7	3			8	20	24	15	13	2
	86.0	100.0	82.4	95.8	86.2	70.0	60.0			88.9	90.9	85.7	83.3	86.7	66.7
$10,000 TO $29,999	5		1		1	1	1			1		2		1	1
	5.0		5.9		3.4	10.0	20.0			11.1		7.1		6.7	33.3
$30,000 TO $99,999	7		2	1	3		1				2	2	2	1	
	7.0		11.8	4.2	10.3		20.0				9.1	7.1	11.1	6.7	
$100,000 TO $499,999	1					1							1		
	1.0					10.0							5.6		
$500,000 OR MORE	1					1									
	1.0					10.0									
AVERAGE (THOUSANDS)	12		9	3	7	67	15			2	6	6	14	5	8

067

NATIONAL ANALYSTS
METAL FINISHING STUDY (557-1)
SURVEY PARTICIPANTS

QUESTION NO.V-1 WHICH OF THESE WASTEWATER TREATMENT FEATURES MAKE UP YOUR SYSTEM?

	TOTAL	NUMBER OF FULL-TIME PEOPLE 1-4	5-9	10-19	20-49	50-99	100-249	250-499	500& MORE	TOTAL SALES UNDER $100M	$100M -249M	$250M -499M	500M 999M	$1MIL -2.4	$2.5 MIL+
TOTAL	461	64	85	118	111	46	13			54	89	92	86	49	13
NO ANSWER															
NUMBER ANSWERING	461	64	85	118	111	46	13			54	89	92	86	49	13
	100.0	100.0	100.0	100.0	.00.0	100.0	100.0			100.0	100.0	100.0	00.0	100.0	100.0
A- PH ADJUSTMENT	146	8	17	34	50	23	7			3	23	27	35	28	7
	31.7	12.5	20.0	28.8	45.0	50.0	53.8			5.6	25.8	29.3	40.7	57.1	53.8
B- FLOW EQUALIZATION	52	2	7	7	23	7	2			2	6	10	18	9	2
	11.3	3.1	8.2	5.9	20.7	15.2	15.4			3.7	6.7	10.9	20.9	18.4	15.4
C- CHROMIUM REDUCTION	84	4	11	18	31	13	4			2	10	13	22	20	2
	18.2	6.3	12.9	15.3	27.9	28.3	30.8			3.7	11.2	14.1	25.6	40.8	15.4
D- CYANIDE DESTRUCTION	79	4	10	16	29	12	3			4	11	12	20	18	2
	17.1	6.3	11.8	13.6	26.1	26.1	23.1			7.4	12.4	13.0	23.3	36.7	15.4
E- PRECIPITATOR-CLARIFICATION	77	1	9	17	28	15	4			1	6	18	17	20	1
	16.7	1.6	10.6	14.4	25.2	32.6	30.8			1.9	6.7	19.6	19.8	40.8	7.7
F-LAGOON	30	2	3	3	9	9	2			2	2	3	8	12	2
	6.5	3.1	3.5	2.5	8.1	19.6	15.4			3.7	2.2	3.3	9.3	24.5	15.4
G- SEPARATE CYANIDE STREAM	36		5	9	12	6	3				7	6	9	9	2
	7.8		5.9	7.6	10.8	13.0	23.1				7.9	6.5	10.5	18.4	15.4
H- SEPARATE HEXAVALENT-CHROME STREAM	40	1	6	9	15	6	2				6	6	11	8	
	8.7	1.6	7.1	7.6	13.5	13.0	15.4				6.7	6.5	12.8	16.3	
I- COUNTERCURRENT RINSE	79	2	9	17	29	13	5			3	10	15	21	20	2
	17.1	3.1	10.6	14.4	26.1	28.3	38.5			5.6	11.2	16.3	24.4	40.8	15.4
J- REVERSE OSMOSIS, EVAPORATION, ION EXCHANGE, ETC.	29	1	1	4	13	8	2				2	2	9	12	1
	6.3	1.6	1.2	3.4	11.7	17.4	15.4				2.2	2.2	10.5	24.5	7.7
NONE	280	51	61	77	52	21	3			47	59	59	46	15	6
	60.7	79.7	71.8	65.3	46.8	45.7	23.1			87.0	66.3	64.1	53.5	30.6	46.2
A ONLY	17	2	2	5	6	1					7	3	3		1
	3.7	3.1	2.4	4.2	5.4	2.2					7.9	3.3	3.5		7.7
A, B, AND C ONLY	1	1													
	.2	1.6													

(CONTINUED)

(CONTINUED PAGE 2)

NATIONAL ANALYSTS
METAL FINISHING STUDY (557-1)
SURVEY PARTICIPANTS

QUESTION NO.V-1 WHICH OF THESE WASTEWATER
TREATMENT FEATURES MAKE UP YOUR SYSTEM?

		---- NUMBER OF FULL-TIME PEOPLE ----								--- T O T A L S A L E S ---					
	TOTAL	1-4	5-9	10-19	20-49	50-99	100-249	250-499	500& MORE	UNDER $100M	$100M -249M	$250M -499M	$500M -999M	$1MIL -2.4	$2.5 MIL+
A, B, C, D AND E ONLY	5 1.1				5 4.5								3 3.5	1 2.0	
A, B, C, D, E, G, AND H ONLY	1 .2		1 1.2												
I ONLY	4 .9	1 1.6	1 1.2	1 .8	1 .9					1 1.9		1 1.1			
J ONLY	4 .9				2 1.8	2 4.3							2 2.3	1 2.0	
ALL OTHER COMBINATIONS	145 31.5	8 12.5	18 21.2	35 29.7	45 40.5	22 47.8	10 76.9			5 9.3	22 24.7	29 31.5	32 37.2	32 65.3	6 46.2

068

NATIONAL ANALYSTS
METAL FINISHING STUDY (557-1)
SURVEY PARTICIPANTS

QUESTION NO.V-2A HOW MUCH DID YOUR WASTE-WATER SYSTEM COST TO PURCHASE AND INSTALL?

		---- NUMBER OF FULL-TIME PEOPLE ----							--- T O T A L S A L E S ---					
	TOTAL	1-4	5-9	10-19	20-49	50-99	100-249	250-499	500& MORE	UNDER $100M	$100M -249M	$250M -499M	$500M -999M	$1MIL -2.4	$2.5 MIL+
TOTAL	461	64	85	118	111	46	13			54	89	92	86	49	13
NO ANSWER	308	53	64	84	59	24	6			49	67	63	51	18	7
NUMBER ANSWERING	153	11	21	34	52	22	7			5	22	29	35	31	6
	100.0	100.0	100.0	100.0	100.0	100.0	100.0			100.0	100.0	100.0	100.0	100.0	100.0
LESS THAN $10,000	44	6	11	15	9	2				3	14	10	8	2	
	28.8	54.5	52.4	44.1	17.3	9.1				60.0	63.6	34.5	22.9	6.5	
$10,000 TO $24,999	38	4	4	11	13	3	1			2	3	9	12	5	1
	24.8	36.4	19.0	32.4	25.0	13.6	14.3			40.0	13.6	31.0	34.3	16.1	16.7
$25,000 TO $74,999	36	1	5	7	10	6	5				5	9	4	9	3
	23.5	9.1	23.8	20.6	19.2	27.3	71.4				22.7	31.0	11.4	29.0	50.0
$75,000 TO $149,999	19		1		12	6						1	6	8	1
	12.4		4.8		23.1	27.3						3.4	17.1	25.8	16.7
$150,000 OR MORE	16			1	8	5	1						5	7	1
	10.5			2.9	15.4	22.7	14.3						14.3	22.6	16.7
AVERAGE (THOUSANDS)	50	10	21	21	71	96	49			8	15	23	50	105	57

QUESTION NO.V-28 IN WHAT YEAR DID YOU MAKE THE LAST MAJOR ADDITION TO THE SYSTEM?

		---- NUMBER OF FULL-TIME PEOPLE ----								--- TOTAL SALES ---					
	TOTAL	1-4	5-9	10-19	20-49	50-99	100-249	250-499	500& MORE	UNDER $100M	$100M-249M	$250M-499M	$500M-999M	$1MIL-2.4	$2.5 MIL+
TOTAL	461	64	85	118	111	46	13			54	89	92	86	49	13
NO ANSWER	297	53	63	83	55	21	5			49	65	61	48	16	6
NUMBER ANSWERING	164	11	22	35	56	25	8			5	24	31	38	33	7
	100.0	100.0	100.0	100.0	100.0	100.0	100.0			100.0	100.0	100.0	100.0	100.0	100.0
1968 OR EARLIER	9		2	2	2	3					1	2	2	3	
	5.5		9.1	5.7	3.6	12.0					4.2	6.5	5.3	9.1	
1969	2	1		1						1		1			
	1.2	9.1		2.9						20.0		3.2			
1970	7		2	1	1	1	2				2	1	1	1	2
	4.3		9.1	2.9	1.8	4.0	25.0				8.3	3.2	2.6	3.0	28.6
1971	4	1	1		2						2	1	1		
	2.4	9.1	4.5		3.6						8.3	3.2	2.6		
1972	9	1	2	2	2	2				1	1	2	1	2	
	5.5	9.1	9.1	5.7	3.6	8.0				20.0	4.2	6.5	2.6	6.1	
1973	9		1	3	2	1	2				1	2	2	2	
	5.5		4.5	8.6	3.6	4.0	25.0				4.2	6.5	5.3	6.1	
1974	26	3	3	2	13	2	1				4	5	8	3	1
	15.9	27.3	13.6	5.7	23.2	8.0	12.5				16.7	16.1	21.1	9.1	14.3
1975	38	4	4	9	14	4	2			3	4	5	9	8	2
	23.2	36.4	18.2	25.7	25.0	16.0	25.0			60.0	16.7	16.1	23.7	24.2	28.6
1976	60	1	7	15	20	12	1				9	12	14	14	2
	36.6	9.1	31.8	42.9	35.7	48.0	12.5				37.5	38.7	36.8	42.4	28.6

NATIONAL ANALYSTS
METAL FINISHING STUDY (557-1)
SURVEY PARTICIPANTS

QUESTION NO.V-2D HOW MUCH DOES IT COST EACH YEAR TO OPERATE?

		---- NUMBER OF FULL-TIME PEOPLE ----								--- T O T A L S A L E S ---					
	TOTAL	1-4	5-9	10-19	20-49	50-99	100-249	250-499	500& MORE	UNDER $100M	$100M -249M	$250M -499M	$500M -999M	$1MIL -2.4	$2.5 MIL+
TOTAL	461	64	85	118	111	46	13			54	89	92	86	49	13
NO ANSWER	336	57	70	91	69	27	5			50	72	67	59	25	6
NUMBER ANSWERING	125	7	15	27	42	19	8			4	17	25	27	24	7
	100.0	100.0	100.0	100.0	100.0	100.0	100.0			100.0	100.0	100.0	100.0	100.0	100.0
LESS THAN $5,000	37	3	8	13	10	1				1	8	14	5	2	
	29.6	42.9	53.3	48.1	23.8	5.3				25.0	47.1	56.0	18.5	8.3	
$5,000 TO $14,999	30	3	5	10	8		1			2	7	8	7	1	1
	24.0	42.9	33.3	37.0	19.0		12.5			50.0	41.2	32.0	25.9	4.2	14.3
$15,000 TO $49,999	44	1	2	4	19	12	4			1	2	3	13	13	4
	35.2	14.3	13.3	14.8	45.2	63.2	50.0			25.0	11.8	12.0	48.1	54.2	57.1
$50,000 TO $99,999	9				5	2	2						2	4	1
	7.2				11.9	10.5	25.0						7.4	16.7	14.3
$100,000 OR MORE	5					4	1							4	1
	4.0					21.1	12.5							16.7	14.3
AVERAGE	21	6	5	7	23	51	41			8	6	6	21	45	41

071

NATIONAL ANALYSTS
METAL FINISHING STUDY (557-1)
SURVEY PARTICIPANTS

QUESTION NO.V-2F DID YOU CONTRACT FOR ANY PART OF THE DESIGN, CONSTRUCTION AND INSTALLATION OF THE SYSTEM OR DID YOU DO IT ALL YOURSELF?

		---- NUMBER OF FULL-TIME PEOPLE ----								---- TOTAL SALES ----					
	TOTAL	1-4	5-9	10-19	20-49	50-99	100-249	250-499	5006 MORE	UNDER $100M	$100M -249M	$250M -499M	$500M -999M	$1MIL -2.4	$2.5 MIL+
TOTAL	461	64	85	118	111	46	13			54	89	92	86	49	13
NO ANSWER	293	52	62	84	53	21	4			49	64	61	48	16	6
NUMBER ANSWERING	168	12	23	34	58	25	9			5	25	31	38	33	7
	100.0	100.0	100.0	100.0	100.0	100.0	100.0			100.0	100.0	100.0	100.0	100.0	100.0
CONTRACTED FOR SOME	125	8	15	26	43	20	8			3	17	26	26	28	5
	74.4	66.7	65.2	76.5	74.1	80.0	88.9			60.0	68.0	83.9	68.4	84.8	71.4
DID ALL MYSELF	43	4	8	8	15	5	1			2	8	5	12	5	2
	25.6	33.3	34.8	23.5	25.9	20.0	11.1			40.0	32.0	16.1	31.6	15.2	28.6

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NATIONAL ANALYSTS
METAL FINISHING STUDY (557-1)
SURVEY PARTICIPANTS

QUESTION NO.V-2G DID YOU REDUCE YOUR WATER USE TO PUT IN THE SYSTEM?

		- - - - NUMBER OF FULL-TIME PEOPLE - - - -								- - - T O T A L S A L E S - - -					
	TOTAL	1-4	5-9	10-19	20-49	50-99	100-249	250-499	500& MORE	UNDER $100M	$100M -249M	$250M -499M	$500M -999M	$1MIL -2.4	$2.5 MIL+
TOTAL	461	64	85	118	111	46	13			54	89	92	86	49	13
NO ANSWER	291	51	60	83	53	21	6			47	63	60	48	16	7
NUMBER ANSWERING	170	13	25	35	58	25	7			7	26	32	38	33	6
	100.0	100.0	100.0	100.0	100.0	100.0	100.0			100.0	100.0	100.0	100.0	100.0	100.0
YES	115	8	15	27	40	17	4			5	18	23	28	23	4
	67.6	61.5	60.0	77.1	69.0	68.0	57.1			71.4	69.2	71.9	73.7	69.7	66.7
NO	39	3	7	7	12	4	3			1	5	8	7	6	2
	22.9	23.1	28.0	20.0	20.7	16.0	42.9			14.3	19.2	25.0	18.4	18.2	33.3
DON'T KNOW	16	2	3	1	6	4				1	3	1	3	4	
	9.4	15.4	12.0	2.9	10.3	16.0				14.3	11.5	3.1	7.9	12.1	

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NATIONAL ANALYSTS
METAL FINISHING STUDY (557-1)
SURVEY PARTICIPANTS

QUESTION NO.VI-1 WHAT IS THE ESTIMATED AMOUNT FOR THE DESIGN, PURCHASE AND INSTALLATION OF A NEW WASTEWATER SYSTEM?

		---- NUMBER OF FULL-TIME PEOPLE ----								--- T O T A L S A L E S ---					
	TOTAL	1-4	5-9	10-19	20-49	50-99	100-249	250-499	500& MORE	UNDER $100M	$100M -249M	$250M -499M	$500M -999M	$1MIL -2.4	$2.5 MIL+
TOTAL	461	64	85	118	111	46	13			54	89	92	86	49	13
NO ANSWER	268	47	57	70	54	20	6			38	53	50	39	22	5
NUMBER ANSWERING	193	17	28	48	57	26	7			16	36	42	47	27	8
	100.0	100.0	100.0	100.0	100.0	100.0	100.0			100.0	100.0	100.0	100.0	100.0	100.0
LESS THAN $10,000	65	9	10	21	14	4	3			8	13	17	14	4	3
	33.7	52.9	35.7	43.8	24.6	15.4	42.9			50.0	36.1	40.5	29.8	14.8	37.5
$10,000 TO $19,999	20	3	4	6	4	1	1			2	6	4	5	1	1
	10.4	17.6	14.3	12.5	7.0	3.8	14.3			12.5	16.7	9.5	10.6	3.7	12.5
$20,000 TO $49,999	38	2	11	8	9	5				3	12	6	9	3	
	19.7	11.8	39.3	16.7	15.8	19.2				18.8	33.3	14.3	19.1	11.1	
$50,000 TO $99,999	34	2	3	5	17	5	1			3	2	10	10	6	1
	17.6	11.8	10.7	10.4	29.8	19.2	14.3			18.8	5.6	23.8	21.3	22.2	12.5
$100,000 OR MORE	36	1		8	13	11	2				3	5	9	13	3
	18.7	5.9		16.7	22.8	42.3	28.6				8.3	11.9	19.1	48.1	37.5
AVERAGE (THOUSANDS)	61	18	21	37	75	138	104			19	28	36	54	158	135

QUESTION NO.VI-2 WHAT ARE ALL THE SOURCES OF CAPITAL OPEN TO YOUR FIRM FOR THE PURCHASE OF A WASTEWATER SYSTEM?

		---- NUMBER OF FULL-TIME PEOPLE ----								--- T O T A L S A L E S ---					
	TOTAL	1-4	5-9	10-19	20-49	50-99	100-249	250-499	500& MORE	UNDER $100M	$100M -249M	$250M -499M	$500M -999M	$1MIL -2.4	$2.5 MIL+
TOTAL	461	64	85	118	111	46	13			54	89	92	86	49	13
NO ANSWER	117	19	26	30	25	10	1			9	26	20	17	10	1
NUMBER ANSWERING	344	45	59	88	86	36	12			45	63	72	69	39	12
	100.0	100.0	100.0	100.0	100.0	100.0	100.0			100.0	100.0	100.0	100.0	100.0	100.0
PROFITS FROM THE BUSINESS	201	19	34	50	61	20	9			19	34	43	48	21	9
	58.4	42.2	57.6	56.8	70.9	55.6	75.0			42.2	54.0	59.7	69.6	53.8	75.0
PERSONAL FUNDS	66	7	17	17	19	4	2			11	17	12	14	5	1
	19.2	15.6	28.8	19.3	22.1	11.1	16.7			24.4	27.0	16.7	20.3	12.8	8.3
LOAN FROM CUSTOMERS/SUPPLIERS	12	2	1	2	6					1	3	1	6	1	
	3.5	4.4	1.7	2.3	7.0					2.2	4.8	1.4	8.7	2.6	
SMALL BUSINESS ADMINISTRATION LOAN	118	8	26	26	38	14	2			13	23	26	31	16	1
	34.3	17.8	44.1	29.5	44.2	38.9	16.7			28.9	36.5	36.1	44.9	41.0	8.3
COMMERCIAL BANK LOAN	223	22	36	60	62	26	8			23	40	51	49	26	11
	64.8	48.9	61.0	68.2	72.1	72.2	66.7			51.1	63.5	70.8	71.0	66.7	91.7
WILL CLOSE BUSINESS	3		1	1						1					
	.9		1.7	1.1						2.2					
OTHER	13		1	3	4	4	1				1	2	4	3	2
	3.8		1.7	3.4	4.7	11.1	8.3				1.6	2.8	5.8	7.7	16.7
NO SOURCES OPEN	25	8	5	5	3		2			7	7	6	1	2	
	7.3	17.8	8.5	5.7	3.5		16.7			15.6	11.1	8.3	1.4	5.1	
PROFITS & PERSONAL FUNDS ONLY	10	2	3	2	3					2	3	1	3		
	2.9	4.4	5.1	2.3	3.5					4.4	4.8	1.4	4.3		
PROFITS, PERSONAL FUNDS, AND COMM. BANK LOAN ONLY	25	1	4	6	11	2	1			1	6	6	6	3	
	7.3	2.2	6.8	6.8	12.8	5.6	8.3			2.2	9.5	8.3	8.7	7.7	
PROFITS AND COMMERCIAL BANK LOAN ONLY	61	6	6	17	17	8	5			2	9	15	13	6	7
	17.7	13.3	10.2	19.3	19.8	22.2	41.7			4.4	14.3	20.8	18.8	15.4	58.3
ALL OTHERS	223	28	41	58	52	26	4			33	38	44	46	28	5
	64.8	62.2	69.5	65.9	60.5	72.2	33.3			73.3	60.3	61.1	66.7	71.8	41.7

NATIONAL ANALYSTS
METAL FINISHING STUDY (557-1)
SURVEY PARTICIPANTS

QUESTION NO.VI-3 WHAT ARE THE AVAILABLE SPACES FOR THE INSTALLATION OF A SYSTEM IF IT WERE PURCHASED?

		---- NUMBER OF FULL-TIME PEOPLE ----								---- TOTAL SALES ----					
	TOTAL	1-4	5-9	10-19	20-49	50-99	100-249	250-499	500& MORE	UNDER $100M	$100M -249M	$250M -499M	$500M -999M	$1MIL -2.4	$2.5 MIL+
TOTAL	461	64	85	118	111	46	13			54	89	92	86	49	13
NO ANSWER	19	4	4	6	2		1			3	3	4	2	1	1
NUMBER ANSWERING	442	60	81	112	109	46	12			51	86	88	84	48	12
	100.0	100.0	100.0	100.0	100.0	100.0	100.0			100.0	100.0	100.0	100.0	100.0	100.0
ON PRESENTLY AVAILABLE FLOOR SPACE	102	11	15	23	30	14	3			13	17	19	22	15	6
	23.1	18.3	18.5	20.5	27.5	30.4	25.0			25.5	19.8	21.6	26.2	31.3	50.0
ON SPACE PRESENTLY USED FOR PLATING/FINISHING OPERATIONS	82	9	17	18	27	7	2			15	14	14	20	8	2
	18.6	15.0	21.0	16.1	24.8	15.2	16.7			29.4	16.3	15.9	23.8	16.7	16.7
ON SPECIALLY CONSTRUCTED FACILITY IN THE PLANT	37	2	7	8	13	4	2			2	4	7	12	7	2
	8.4	3.3	8.6	7.1	11.9	8.7	16.7			3.9	4.7	8.0	14.3	14.6	16.7
OUTSIDE THE PLANT ON MY PROPERTY	127	12	19	32	35	18	6			12	27	21	28	19	6
	28.7	20.0	23.5	28.6	32.1	39.1	50.0			23.5	31.4	23.9	33.3	39.6	50.0
OUTSIDE THE PLANT ON LAND I WOULD HAVE TO BUY	26	3	4	9	4	4	1			2	3	9	3	4	1
	5.9	5.0	4.9	8.0	3.7	8.7	8.3			3.9	3.5	10.2	3.6	8.3	8.3
NO PLACE TO PUT IT	71	13	14	21	14	4	2			8	15	22	10	4	1
	16.1	21.7	17.3	18.8	12.8	8.7	16.7			15.7	17.4	25.0	11.9	8.3	8.3

NATIONAL ANALYSTS
METAL FINISHING STUDY (557-1)
SURVEY PARTICIPANTS

QUESTION NO.VI-4 IF YOU LACKED SPACE TO ADD TO, OR TO INSTALL A WASTEWATER SYSTEM, WHAT IS THE LIKELIHOOD THAT YOU MIGHT TAKE OUT A PRODUCTION LINE TO FREE UP FLOOR SPACE?

		---- NUMBER OF FULL-TIME PEOPLE ----								--- TOTAL SALES ---					
	TOTAL	1-4	5-9	10-19	20-49	50-99	100-249	250-499	500& MORE	UNDER $100M	$100M -249M	$250M -499M	$500M -999M	$1MIL -2.4	$2.5 MIL+
TOTAL	461	64	85	118	111	46	13			54	89	92	86	49	13
NO ANSWER	222	34	41	54	51	23	6			21	46	33	38	24	5
NUMBER ANSWERING	239	30	44	64	60	23	7			33	43	59	48	25	8
	100.0	100.0	100.0	100.0	100.0	100.0	100.0			100.0	100.0	100.0	100.0	100.0	100.0
1-VERY UNLIKELY	127	14	29	34	29	11	2			19	25	28	23	10	5
	53.1	46.7	65.9	53.1	48.3	47.8	28.6			57.6	58.1	47.5	47.9	40.0	62.5
2-UNLIKELY	32	6	2	7	9	4	3			3	4	9	6	6	2
	13.4	20.0	4.5	10.9	15.0	17.4	42.9			9.1	9.3	15.3	12.5	24.0	25.0
3-MAYBE	30	5	2	6	11	3	2			4	4	8	7	4	1
	12.6	16.7	4.5	9.4	18.3	13.0	28.6			12.1	9.3	13.6	14.6	16.0	12.5
4-LIKELY	24	2	7	9	5	1				4	7	6	4	2	
	10.0	6.7	15.9	14.1	8.3	4.3				12.1	16.3	10.2	8.3	8.0	
5-VERY LIKELY	26	3	4	8	6	4				3	3	8	8	3	
	10.9	10.0	9.1	12.5	10.0	17.4				9.1	7.0	13.6	16.7	12.0	
MEAN	2.12	2.13	1.98	2.22	2.17	2.26	2.00			2.06	2.05	2.27	2.33	2.28	1.50

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NATIONAL ANALYSTS
METAL FINISHING STUDY (557-1)
SURVEY PARTICIPANTS

QUESTION NO.VI-4 IF YOU LACKED SPACE TO ADD TO, OR TO INSTALL A WASTEWATER SYSTEM, WHAT IS THE LIKELIHOOD THAT YOU MIGHT PAY TO ALTER THE FACILITY, FOR EXAMPLE, BY KNOCKING OUT WALLS OR BUILDING A BALCONY?

		---- NUMBER OF FULL-TIME PEOPLE ----								--- TOTAL SALES ---					
	TOTAL	1-4	5-9	10-19	20-49	50-99	100-249	250-499	5006 MORE	UNDER $100M	$100M -249M	$250M -499M	$500M -999M	$1MIL -2.4	$2.5 MIL+
TOTAL	461	64	85	118	111	46	13			54	89	92	86	49	13
NO ANSWER	217	34	39	55	50	21	6			22	46	33	40	21	5
NUMBER ANSWERING	244	30	46	63	61	25	7			32	43	59	46	28	8
	100.0	100.0	100.0	100.0	100.0	100.0	100.0			100.0	100.0	100.0	100.0	100.0	100.0
1-VERY UNLIKELY	92	15	19	28	16	8	2			16	16	26	14	6	2
	37.7	50.0	41.3	44.4	26.2	32.0	28.6			50.0	37.2	44.1	30.4	21.4	25.0
2-UNLIKELY	16	3	1	3	8					2	3	8	1	1	
	6.6	10.0	2.2	4.8	13.1					6.3	7.0	13.6	2.2	3.6	
3-MAYBE	57	3	12	14	19	5	2			8	8	10	16	7	2
	23.4	10.0	26.1	22.2	31.1	20.0	28.6			25.0	18.6	16.9	34.8	25.0	25.0
4-LIKELY	34	3	7	9	8	3	2			4	8	7	7	3	2
	13.9	10.0	15.2	14.3	13.1	12.0	28.6			12.5	18.6	11.9	15.2	10.7	25.0
5-VERY LIKELY	45	6	7	9	10	9	1			2	8	8	8	11	2
	18.4	20.0	15.2	14.3	16.4	36.0	14.3			6.3	18.6	13.6	17.4	39.3	25.0
MEAN	2.69	2.40	2.61	2.49	2.80	3.20	3.00			2.19	2.74	2.37	2.87	3.43	3.25

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NATIONAL ANALYSTS
METAL FINISHING STUDY (557-1)
SURVEY PARTICIPANTS

QUESTION NO.VI-4 IF YOU LACKED SPACE TO ADD TO, OR TO INSTALL A WASTEWATER SYSTEM, WHAT IS THE LIKELIHOOD THAT YOU MIGHT PAY TO RELOCATE TO A BIGGER FACILITY WITH MORE FLOOR SPACE?

		---- NUMBER OF FULL-TIME PEOPLE ----								--- TOTAL SALES ---					
	TOTAL	1-4	5-9	10-19	20-49	50-99	100-249	250-499	500& MORE	UNDER $100M	$100M -249M	$250M -499M	$500M -999M	$1MIL -2.4	$2.5 MIL+
TOTAL	461	64	85	118	111	46	13			54	89	92	86	49	13
NO ANSWER	233	37	41	58	55	23	6			23	48	36	40	25	5
NUMBER ANSWERING	228	27	44	60	56	23	7			31	41	56	46	24	8
	100.0	100.0	100.0	100.0	100.0	100.0	100.0			100.0	100.0	100.0	100.0	100.0	100.0
1-VERY UNLIKELY	142	14	28	38	38	14	4			20	25	35	31	14	6
	62.3	51.9	63.6	63.3	67.9	60.9	57.1			64.5	61.0	62.5	67.4	58.3	75.0
2-UNLIKELY	22	3	2	4	8	1	2			3	1	6	4	5	
	9.6	11.1	4.5	6.7	14.3	4.3	28.6			9.7	2.4	10.7	8.7	20.8	
3-MAYBE	30	3	8	8	4	6				4	7	7	6	4	
	13.2	11.1	18.2	13.3	7.1	26.1				12.9	17.1	12.5	13.0	16.7	
4-LIKELY	15	3	3	5	3	1				2	4	4	2		1
	6.6	11.1	6.8	8.3	5.4	4.3				6.5	9.8	7.1	4.3		12.5
5-VERY LIKELY	19	4	3	5	3	1	1			2	4	4	3	1	1
	8.3	14.8	6.8	8.3	5.4	4.3	14.3			6.5	9.8	7.1	6.5	4.2	12.5
MEAN	1.89	2.26	1.89	1.92	1.66	1.87	1.86			1.81	2.05	1.86	1.74	1.71	1.88

NATIONAL ANALYSTS
METAL FINISHING STUDY (557-1)
SURVEY PARTICIPANTS

QUESTION NO.VI-5 IF YOU HAD THE ROOM TO PUT IN A WASTEWATER SYSTEM, BUT COULDN'T RAISE THE CAPITAL, WHAT IS THE LIKELIHOOD THAT YOU MIGHT ADD TO WORKING CAPITAL BY SELLING OFF SOME OF THE ASSETS OF THE BUSINESS?

		- - - - NUMBER OF FULL-TIME PEOPLE - - - -								- - - T O T A L S A L E S - - -					
	TOTAL	1-4	5-9	10-19	20-49	50-99	100-249	250-499	500& MORE	UNDER $100M	$100M -249M	$250M -499M	$500M -999M	$1MIL -2.4	$2.5 MIL+
TOTAL	461	64	85	118	111	46	13			54	89	92	86	49	13
NO ANSWER	177	32	35	45	37	14	4			17	38	24	28	17	4
NUMBER ANSWERING	284 100.0	32 100.0	50 100.0	73 100.0	74 100.0	32 100.0	9 100.0			37 100.0	51 100.0	68 100.0	58 100.0	32 100.0	9 100.0
1-VERY UNLIKELY	220 77.5	24 75.0	42 84.0	53 72.6	59 79.7	22 68.8	7 77.8			30 81.1	38 74.5	51 75.0	46 79.3	22 68.8	8 88.9
2-UNLIKELY	39 13.7	5 15.6	6 12.0	16 21.9	8 10.8	2 6.3	2 22.2			4 10.8	7 13.7	16 23.5	5 8.6	4 12.5	
3-MAYBE	18 6.3	3 9.4	1 2.0	3 4.1	6 8.1	5 15.6				2 5.4	3 5.9		5 8.6	6 18.8	1 11.1
4-LIKELY	4 1.4		1 2.0	1 1.4		1 3.1				1 2.7	2 3.9		1 1.7		
5-VERY LIKELY	3 1.1				1 1.4	2 6.3					1 2.0	1 1.5	1 1.7		
MEAN	1.35	1.34	1.22	1.34	1.32	1.72	1.22			1.30	1.45	1.29	1.38	1.50	1.22

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NATIONAL ANALYSTS
METAL FINISHING STUDY (557-1)
SURVEY PARTICIPANTS

QUESTION NO.VI-5 IF YOU HAD THE ROOM TO PUT IN A WASTEWATER SYSTEM, BUT COULDN'T RAISE THE CAPITAL, WHAT IS THE LIKELIHOOD THAT YOU MIGHT REDUCE THE OWNER'S COMPENSATION TO HELP SECURE A BANK LOAN?

		---- NUMBER OF FULL-TIME PEOPLE ----								--- TOTAL SALES ---					
	TOTAL	1-4	5-9	10-19	20-49	50-99	100-249	250-499	500& MORE	UNDER $100M	$100M -249M	$250M -499M	$500M -999M	$1MIL -2.4	$2.5 MIL+
TOTAL	461	64	85	118	111	46	13			54	89	92	86	49	13
NO ANSWER	175	33	33	45	37	13	4			18	35	25	27	17	4
NUMBER ANSWERING	286	31	52	73	74	33	9			36	54	67	59	32	9
	100.0	100.0	100.0	100.0	100.0	100.0	100.0			100.0	100.0	100.0	100.0	100.0	100.0
1-VERY UNLIKELY	134	18	21	32	33	17	5			20	23	28	26	13	7
	46.9	58.1	40.4	43.8	44.6	51.5	55.6			55.6	42.6	41.8	44.1	40.6	77.8
2-UNLIKELY	49	2	9	16	13	6	2			5	12	11	12	4	2
	17.1	6.5	17.3	21.9	17.6	18.2	22.2			13.9	22.2	16.4	20.3	12.5	22.2
3-MAYBE	57	5	13	14	16	6	1			4	9	17	14	7	
	19.9	16.1	25.0	19.2	21.6	18.2	11.1			11.1	16.7	25.4	23.7	21.9	
4-LIKELY	27	2	3	9	10	1				5	5	8	4	4	
	9.4	6.5	5.8	12.3	13.5	3.0				13.9	9.3	11.9	6.8	12.5	
5-VERY LIKELY	19	4	6	2	2	3	1			2	5	3	3	4	
	6.6	12.9	11.5	2.7	2.7	9.1	11.1			5.6	9.3	4.5	5.1	12.5	
MEAN	2.12	2.10	2.31	2.08	2.12	2.00	1.89			2.00	2.20	2.21	2.08	2.44	1.22

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NATIONAL ANALYSTS
METAL FINISHING STUDY (557-1)
SURVEY PARTICIPANTS

QUESTION NO.VI-5 IF YOU HAD THE ROOM TO PUT IN A WASTEWATER SYSTEM, BUT COULDN'T RAISE THE CAPITAL, WHAT IS THE LIKELIHOOD THAT YOU MIGHT CLOSE DOWN THE BUSINESS, RETIRE OR DO SOMETHING ELSE?

		---- NUMBER OF FULL-TIME PEOPLE ----								--- T O T A L S A L E S ---					
	TOTAL	1-4	5-9	10-19	20-49	50-99	100-249	250-499	500& MORE	UNDER $100M	$100M -249M	$250M -499M	$500M -999M	$1MIL -2.4	$2.5 MIL+
TOTAL	461	64	85	118	111	46	13			54	89	92	86	49	13
NO ANSWER	153	24	26	38	37	15	4			13	27	19	29	19	4
NUMBER ANSWERING	308	40	59	80	74	31	9			41	62	73	57	30	9
	100.0	100.0	100.0	100.0	100.0	100.0	100.0			100.0	100.0	100.0	100.0	100.0	100.0
1-VERY UNLIKELY	51	4	9	11	16	6	4			3	10	7	13	6	5
	16.6	10.0	15.3	13.8	21.6	19.4	44.4			7.3	16.1	9.6	22.8	20.0	55.6
2-UNLIKELY	26	4	2	6	11	3				2	2	9	7	3	
	8.4	10.0	3.4	7.5	14.9	9.7				4.9	3.2	12.3	12.3	10.0	
3-MAYBE	87	10	11	28	20	12	2			10	14	26	14	11	3
	28.2	25.0	18.6	35.0	27.0	38.7	22.2			24.4	22.6	35.6	24.6	36.7	33.3
4-LIKELY	55	6	11	16	9	6	2			8	11	14	11	6	1
	17.9	15.0	18.6	20.0	12.2	19.4	22.2			19.5	17.7	19.2	19.3	20.0	11.1
5-VERY LIKELY	89	16	26	19	18	4	1			18	25	17	12	4	
	28.9	40.0	44.1	23.8	24.3	12.9	11.1			43.9	40.3	23.3	21.1	13.3	
MEAN	3.34	3.65	3.73	3.33	3.03	2.97	2.56			3.88	3.63	3.34	3.04	2.97	2.00

NATIONAL ANALYSTS
METAL FINISHING STUDY (557-1)
SURVEY PARTICIPANTS

QUESTION NO.VI-5 IF YOU HAD THE ROOM TO PUT IN A WASTEWATER SYSTEM, BUT COULDN'T RAISE THE CAPITAL, WHAT IS THE LIKELIHOOD THAT YOU MIGHT TRY TO FIND A BUYER FOR THE BUSINESS, OR SET UP A MERGER?

		---- NUMBER OF FULL-TIME PEOPLE ----								--- T O T A L S A L E S ---					
	TOTAL	1-4	5-9	10-19	20-49	50-99	100-249	250-499	500& MORE	UNDER $100M	$100M -249M	$250M -499M	$500M -999M	$1MIL -2.4	$2.5 MIL+
TOTAL	461	64	85	118	111	46	13			54	89	92	86	49	13
NO ANSWER	159	28	32	37	36	14	4			17	31	23	26	17	4
NUMBER ANSWERING	302	36	53	81	75	32	9			37	58	69	60	32	9
	100.0	100.0	100.0	100.0	100.0	100.0	100.0			100.0	100.0	100.0	100.0	100.0	100.0
1-VERY UNLIKELY	50	5	10	11	14	4	2			4	11	10	13	4	3
	16.6	13.9	18.9	13.6	18.7	12.5	22.2			10.8	19.0	14.5	21.7	12.5	33.3
2-UNLIKELY	28	3	4	8	7	4	2			3	3	5	6	5	1
	9.3	8.3	7.5	9.9	9.3	12.5	22.2			8.1	5.2	7.2	10.0	15.6	11.1
3-MAYBE	81	12	12	21	28	5	2			9	11	24	20	9	
	26.8	33.3	22.6	25.9	37.3	15.6	22.2			24.3	19.0	34.8	33.3	28.1	
4-LIKELY	71	4	10	26	11	12	2			7	14	21	12	8	3
	23.5	11.1	18.9	32.1	14.7	37.5	22.2			18.9	24.1	30.4	20.0	25.0	33.3
5-VERY LIKELY	72	12	17	15	15	7	1			14	19	9	9	6	2
	23.8	33.3	32.1	18.5	20.0	21.9	11.1			37.8	32.8	13.0	15.0	18.8	22.2
MEAN	3.29	3.42	3.38	3.32	3.08	3.44	2.78			3.65	3.47	3.20	2.97	3.22	3.00

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APPENDIX B

THE PRINTED CIRCUIT BOARD INDUSTRY SURVEY

This appendix presents the methodology and results of our survey of manufacturers of Printed Circuit Boards. Part 1 of this appendix describes how we defined the sample and secured the data. All of the second part is devoted to the findings. The last part of this appendix presents the survey instrument used in the gathering of data.

THE METHODOLOGY OF THE SURVEY

The starting point of any survey is to define a universe and sample from it. In preparing the survey of Printed Board manufacturers, the concern was that no definitive listing of eligible firms appeared readily available.

Printed Board manufacturers do not appear as a homogeneous SIC listing with the Department of Commerce. Firms belonging to the Institute of Printed Circuits tend to be the larger producers, and are not exclusively independent producers.

A solution was provided when the EPA furnished a listing of some 600 manufacturers of Printed Boards that had submitted their products to Underwriters Laboratories (UL) for approval. We asked Dun and Bradstreet to run a computer match of this UL listing against their industrial file. There were 508 "matches." DMI yielded a listing of 357 independent, domestic Printed Board producers. Given the lack of any alternate, readily available list of firms, we are prepared to treat the DMI list as an approximator of the universe of independent Printed Board manufacturers.

1. A SELECT SAMPLE OF PRINTED BOARD FIRMS WAS IDENTIFIED FOR CONTACT

Through the earlier work on the metalfinishing industry, we were heavily aware of the importance of good financial data to complement the analytic data base of our closure model. Equally keen was our awareness that gathering financial data in survey work is difficult because of the sensitivity and confidentiality of the information. We needed the financial data but did not have time for a full mail survey. A decision was made to order the latest financial reports on approximately half the identified population. This yielded a randomly generated group of 190 firms all possessing financial records. Perusal of these records showed slightly more than 100 provided values for enough account categories to develop complete and consistent balance sheets as well as sales and profit data.

All firms for which sufficient financial records existed were defined as the segment of the universe to be contacted. This pre-screening of the sample assumed two risks. One, there is a certain probability of under-representing smaller firms since they seem to be less likely to volunteer their statements to D&B. A second is the possibility that those firms offering data are overstating their condition since no validation or certification of the records is offered by D&B. While these biases could be self-canceling, the fact remains that the sample is neither fully stratified nor randomly drawn. All subsequent results will have to be interpreted accordingly.

2. DIRECT PHONE INTERVIEWS WERE CONDUCTED

The attached telephone interview guide was developed by Booz, Allen & Hamilton and the client. In addition, the Technical Contractor was consulted for guidance on the production and process items. Brevity guided the effort. Each interview took fewer than 20 minutes to complete.

A team of special Booz, Allen & Hamilton consultants, working for a week, made all the calls. Each call went directly to the individual shown on the D&B listing as the owner, president or chief officer.

Calls from the list of 190 continued until 100 interviews were completed. Reviewing all financial and technical data for accuracy yielded a sub-sample of 40 plants that will be used for estimating compliance burdens for the population.

RESULTS OF THE PRINTED CIRCUIT BOARD INDUSTRY SURVEY

This section of the report presents the results of our telephone survey of independent Printed Circuit Board manufacturers (PB's). For purposes of comparability, as many of the dimensions used to describe the metalfinishing job shops will be used for the PB's as well. The dimensions are:

- Size of the industry
- Mix of processes
- Role of metalfinishing
- Pricing practices
- Capital structure
- Attitudes toward investment

Each is now developed in sequence.

1. ALL RESPONDENTS ARE COVERED BY THE GUIDELINES AS WILL ALL 400 FIRMS ESTIMATED IN THE POPULATION

All survey results for PB manufacturers will be extrapolated to a population of 400 independent firms. Wherever possible, our industry characterization will be compared with other source estimates to illustrate convergence of findings. Although there is the possibility that two independent sets of estimates can both be wrong, agreement of findings is one test for validity. In the absence of objective complete information, it is the best that can be done.

(1) <u>On Average, the PB Industry Is a Larger Sales, Smaller Water-Using Industry Than the Job Shops</u>

Whereas 42% of the job shops were structured with up to 10 full-time people, for PB's only 11% of the sample has 1-9 employees. Fully 70% of PB firms are in the (20-49) and (50-99) man intervals, while for job shops, 33% of the population fell in the same intervals.

The total employment of the PB industry is taken by multiplying mean employment within categories by the number of firms in that category and then summing across categories. Table B-1 below presents these estimates.

Table B-1
Total Estimated Full Time Employment in the PB Industry

	No. in Sample	No. in Pop.	Mean Employ.	Total Est. Employ.
1-4	1	4	3.0	12
5-9	10	40	7.2	288
10-19	8	32	11.8	378
20-49	45	180	30.9	5,562
50-99	25	100	64.3	6,430
100-249	6	24	135.0	3,240
250+	5	20	414.4	8,288
Total	100	400		24,198

The industry-wide mean employment is 60.5 (SD=90.6) persons. The total employment is 24,200.

The next table displays the estimate of total metal-finishing/printed board employment for the industry.

We note that, on the average, if a typical PB firm has 61 full-time people, it also has 35 people working directly in the production of PB's.

Table B-2
Total Estimated Production Employment in the PB Industry

	No. in Sample	No. in Pop.	Mean Employ.	Total Est. Employ.
1-4	4	16	3.5	56
5-9	15	60	6.6	396
10-19	20	80	15.1	1,208
20-49	43	172	29.9	5,143
50-99	14	56	64.8	3,629
100-249	3	12	179.7	2,159
250+	1	4	310.0	1,240
Total	100	400		13,831

Production employment is estimated to be on the order of 13,800 with the mean employment per firm at 35 men (SD=43.8).

It is on sales that we have the first source of convergent information. From our sample results, the estimated total sales for the PB industry are $610 million, with a per firm sales figure of $1.5 million.

Table B-3
Industry Total Sales

Sales Up To	No. in Sample	Mean Sales	Total Industry Sales (millions)
$ 250,000	18	$ 131,300	11.2
499,999	11	338,000	17.7
999,999	19	676,200	61.1
1,000,000	36	3,037,000	520.4
Total	84	$1,530,000	$610.4M.

A report prepared for the Institute of Printed Circuits estimates the total market (1975) at greater than $1 billion with independent producers projected at a 40% share. This yields their industry estimate at $400 million compared with our calculation of $610 million.

The final two industry sizing measures that we have been using are total plant water use and metalfinishing process water use. In our survey, 72 respondents gave data on plant water use. For the sample as a whole, the mean total plant water use is 21,900 gallons per day. This is approximately one-half the water use found in the metalfinishing job shop survey. Metalfinishing process water is reported to be 86% of the total plant figure or 18,800 gallons per day per firm. Again this process water use ratio approximates that found in the metalfinishing industry, although in absolute terms, it is one-half the job shop value.

In terms of total usage, we can group the plant water use by several sizing categories and extrapolate across. These water use data appear below.

Table B-4
Industry Total Water Use

Gallons Per Day	No. in Sample	Mean Use	Total Use (000's)
Under 1,000	12	174	11.5
1,000-4,999	20	2,442	269.6
5,000-19,999	19	11,880	1,245.9
20,000-49,999	12	30,290	2,006.4
Above 50,000	9	103,800	5,156.7
Total	72	21,900	8,690.1

Our extrapolation suggests that the PB industry demands 8.69 million gallons of water per day (one-twentieth the job shops) of which 86% or 7.47 million gallons per day is for metalfinishing process water.

Only 4% of the sample discharged directly to navigable waters; 81% discharged to POTW's, 13% to leaching ponds and 2% did not say.

(2) Basically, One Production Process Predominates

Several questions were asked during the telephone survey about the production processes used by the firm. In addition, the type of board and quantity produced were also explored. We found that:

> Two percent did just multilayer boards, 12% did single-sided and 33% did double-sided. Fully 53% do a combination of boards.
>
> Eighty-six percent said the boards are through hole plated, and the subtractive process is employed eight times as prevalently as the additive or semi-additive process (76% to 9%).
>
> Fifty percent of the sample produce 500 or fewer boards a day. Another 25% do as many as 1,000 per day. Only 10% of the sample produces 3,000 or more finished boards in a day.
>
> The average size of a board is less than one square foot.

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(3) Virtually Every Firm Contacted Falls Into the Electroplating Guidelines

We askdd each respondent to list the characteristic metals and materials consumed in the course of producing his finished boards. Below is a list of trace materials and the proportion of the total sample answering "yes," the metal/substance is present.

Copper	98%
Nickel	88%
Solder	86%
Tin	72%
Chrome	13%
Cyanide	18%
Gold	95%
Silver	11%
Fluorides	40%
Phosphorous	13%
Chelates	26%

2. MANY FIRMS SHOULD BE ABLE TO PASS ON THE INCREMENTAL COSTS OF POLLUTION CONTROL

There are two considerations we investigated as part of an analysis of the cost pass through characteristics of the industry. One was a description of how dependent the firm was on its metalfinishing work. The other was a request for information on perceived pricing freedoms open to the firm to recover the cost of putting in a pollution control system.

(1) Metalfinishing Is Integral to the Success of Printed Board Manufacturers

Prior results from the job shop survey suggested that some independent producers are market dependent job shops, whereas others are independent producers who manufacture for resale and own their inventories. We asked two questions on this point:

Whether 100% of all company sales came from the manufacture of PB's (if not, what was the percent)

Whether the firm could divest itself of its metalfinishing work and still be economically viable

The answers were as follows:

Two-thirds of the sample (69%) derives 100% of its sales from PB's.

Only 12% of the sample derives 50% or less of its total sales from PB's. Whereas 85% of the sample enjoys at least three-quarters of all its revenue from the sale of PB's.

There is little doubt that the vast majority of the sample are direct manufacturers of boards. Confirming this position is the fact that 80% of the sample said "No, we cannot remain productive without metalfinishing."

(2) The Sample Reports a 10% Price Increase Possibility

Price increase was self-reported and targeted specifically to raising prices to cover pollution control investment costs. We found that 39% of the sample indicated a zero price increase, with another 21% indicating a 1%-9% price rise. Fully 40% of the sample said at least 10% with the sample mean at 11.2% and an S.D. of 17.6%. On the average, this predicted future price use is on the same order of magnitude as that reported by the job shop survey.

3. PB MANUFACTURERS APPEAR TO BE FINANCIALLY STRONGER THAN JOB SHOPS

A key point in appreciating the capital structure of the PB industry is to have a reference for comparison; in this case the survey data from the job shops can serve. Before arraying the sets of data, however, an important qualifier must be introduced. The PB firms may be biased in favor of the better capitalized ones because they are the ones most likely to provide financial data to Dun and Bradstreet. Although income statement items were not taken from the D&B but requested orally, we want to introduce the awareness of potential bias in the reader.

Table B-5, following this page, arrays income and balance sheet items for the two samples.

In every line item the PB sample is not only larger, but by analysis, it is stronger. The sales to fixed assets ratio is higher for PB's (6.8 vs. 3.8) as is the profit to

Table B-5

Selected Financial Items

Income Items	Job Shops (n=344) ($000's)	PB Firms (n=100) ($000's)	
Sales	$676.0	$1,520.0	
Profit BT	30.1	64.6	
Profit AT	15.6	25.1	
Balance Sheet Items			
Current Assets	$210	$ 400.2	
Fixed Assets	176	222.9	
Current Liabilities	115	279.7	N = 40
Long Term Debt	70	101.5	
Net Worth	212	283.1	

total assets (10% vs. 8%). In terms of leverage, i.e., debt to equity, the groups are rather similar (36% vs. 33%) although the total debt percent of the PB's is higher (57% vs. 47%). It would seem that the cash flow situation of PB's is superior to that of the job shops and they may have more options toward absorbing new investments; either through profits or debt.

4. PB ESTABLISHMENTS MAY BE BETTER PREPARED FOR MEETING PRETREATMENT REQUIREMENTS THAN THE JOB SHOPS

In addition to the financial condition of PB establishments relative to their future investments in pollution control, two other factors pertinent to the issue assume importance.

Amount of pollution control equipment currently in place

Owner attitudes toward the investment

Data were gathered on each issue and will be developed here.

(1) Various Water Conservation and Control Systems Are Currently in Place

We asked two different types of questions on water control systems. One had to do with conservation, the other, with pollution control. On the first issue, we found the following:

49% used water control series rinse, 74% indicated spray rinse and 54% said they had still rinse.

Of advanced systems, 21% had ion exchange systems in place, 12% had reverse osmosis, 7% practiced evaporative recovery.

Of the total sample, 54% indicated the presence of some end-of-pipe control. The components listed by this 54% of the sample are as follows:

- Neutralization--42%
- Clarification--28%
- Chemical reduction--23%
- Chemical precipitation--17%
- Oxidation--6%
- Flotation--7%
- Sedimentation--0%
- Filtration--29%

Approximately 62% of all equipment in place is 3 years old or newer. The mean investment in pollution control equipment is $44,476, with an S.D. of $74,490.

As was done with job shops, when pretreatment systems are costed and applied to the PB industry, credit will be given to the components already in place.

(2) <u>The Investment in Equipment Is Viewed as a Necessary Business Loan</u>

Of interest was the question of where an owner would obtain the investment capital for a pollution control system. Not surprisingly, 60% of the sample anticipate a commercial bank loan. Only 4% would plan to use owner's funds, whereas 10% see the funds coming from profits or the cash flow generated by the business. There were 14 respondents who said they did not believe they could obtain any funds.

5. A CLOSURE ANALYSIS OF PB FIRMS IS ALMOST IDENTICAL TO THAT OF JOB SHOPS

The same financial closure model run for job shops was applied to PB firms. There was one exception. No data were obtained in the interviews on number of owners or on owner's compensation because of its sensitive nature. As a consequence, the issue of equity infusion as part of the closure analysis will have to be based on a modeling assumption rather than on survey data. In all other respects, the analysis proceeded in the same manner. Because many PB firms in the survey report equipment in place, and appear to be well capitalized, compliance impacts on the Printed Board industry are less than those estimated for the metalfinishing job shop sector.

* * * *

This section has presented an industry characterization of Printed Board manufacturers. In the next section, the survey instrument used for gathering the data is presented.

SURVEY INSTRUMENT

PRINTED CIRCUIT BOARD
TELEPHONE SURVEY

Date:
Interviewer:

Plant I. D. Number:

Company Name:

Address:

Phone Number:

Principal Name:

SIC's:

Status:

____ Completed

____ Incomplete

Terminated ____

Call back ____

Day, Time, Individual:

____

PRINTED BOARD PROTOCOL

Instructions

Call directly and ask for the individual identified on the cover sheet.

If the identified individual is not available, establish whether he or she will be available today or tomorrow.

If he will be available in a day, mark it a "call back" and go on to your next call.

If the individual is out of the office for several days, then request the name of another person in the firm able to comment on the size and operations of the firm.

Enter the name of this individual on the cover sheet and continue with the introductory remarks.

I. **SCALE OF OPERATIONS**

1. What is the total employment at your plant?

   # of plant employees__________

2. At any typical time, how many production employees work directly in the manufacture of printed boards?

   # of printed board employees_______

3. How many hours of the 24-hour day are spent on printed boards?

   # of hours __________

5. How many plating/finishing lines are set up for your printed board production?

   # of lines__________

6. Are 100% of your company sales from printed boards?

   (__) Yes (go to 9) (__) No (go to 7)

7. What % of all your sales come from Printed Board work? ____%

8. Could you list the other production activities at your plant that generate revenues? How many employees in each?

Activity	Employees
________	________
________	________

II. TYPE OF OPERATION

1. What type of boards do you make?

Single sided	1
Double sided	2
Multilayer	3

2. Are the boards through hole plated?

Yes	1
No	2
Varies	3

3. Which production process do you use most frequently?

Additive	1
Subtractive	2
Semi-additive	3
Varies	4

4. For a typical order, what quantity of boards do you produce in a day?

_____________ boards per day

5. What is the total immersed area of a board?

______ square inches or
______ square meters

6. How much water does your plant use in a day?

______ Gallons/day
or
______ Cubic feet/day

7. How much of the plant's water is from the printed board production lines?

_____% of plant total
or
_____ Gallons per day

8. From the list of metals and chemicals found in printed board operations, please identify the ones found in your plant.

Copper	_____	Chrome	_____	Fluorides	_____
Nickel	_____	Cyanide	_____	Phosphorous	_____
Solder	_____	Gold	_____	Chilating Agents	_____
Tin	_____	Silver	_____		

III. WATER TREATMENT

1. Where does your plant's discharge water go?

River or lake _________
Municipal sewer _________
Leaching Pond _________

2. Many plants practice water control. Do you use any of the following?

	Yes	No
Countercurrent rinse	_____	_____
Series rinse	_____	_____
Running rinse	_____	_____
Spray rinse	_____	_____
Still rinse	_____	_____

3. Some plants have recovery systems in place. Do you have:

	Yes	No
Ion exchange	_____	_____
Reverse osmosis	_____	_____
Evaporation	_____	_____

4. Some plants are now treating their end-of-pipe discharge water. Do you have any treatments in place?

( ) Yes (go to 5) ( ) No (go to Section IV)

5. Would you list the components of the system?

Neutralization _____
Clarification _____
Chemical Reduction _____
Chemical Precipitation_____
Oxidation _____
Flotation _____
Sedimentation
Filtration _____

6. How old is the system, and how much did it cost installed?

_____ Age in years
_____ Installed cost

IV. FINANCIAL ISSUES

"Now I would like to ask you a few questions about your company's financial position. The EPA is quite concerned with the ability of the Printed Board industry to manage the investment in pollution control equipment. For us to make that determination, we need to know the financial condition of affected firms.

"May I ask you about your firm's financial condition? Is there any other person in your firm able to comment on your finances?"

(After an appropriate respondent is on, we ask)

1. There are five items from your income statement that are important. From your latest fiscal year-end statement, what were your company's:

Sales	$________	
Depreciation	________	
Interest	________	
Profit (Loss) before Tax	________	Enter Loss in parenthesis)
Profit (Loss) after Tax	________	Enter Loss in parenthesis)

2. There are also six items from your balance sheet for the same period. We would like to know:

Current Assets	$________
Fixed Assets	________
Other Assets	________
Current Liabilities	$________
Long Term Debt	________
Company Net Worth (Owners Equity)	________

B. OPTIONS

1. If you and all your competitors were to install pollution control equipment, what is the maximum you could raise prices before your business volume might fall off significantly?

% maximum price increase ________

2. Where would the capital come from to purchase the pollution control equipment?

_____ Bank loan
_____ Owner's funds
_____ Cash flow/profits
_____ Other:
_____ Can't get it

3. If the cost of pollution control equipment were a serious problem, could your firm remain productive doing no metal plating at all?

( ) Yes ( ) No

APPENDIX C

THE CAPTIVE METALFINISHING INDUSTRY SURVEY

This appendix presents the method, instrument, and findings of the captive metalfinishing operations survey. Detailed data on the financial condition of these operations were not gathered because a financial closure analysis was not planned for this sector. Rather, the issue for captives is one of resource allocation and management decision-making rules. A closure decision for captives depends on process operations, alternatives to in-house work, and marginal increases in operating costs; more than on capital availability and owner sacrifice.

The key points of this appendix are:

- Study method
- Data gathering instrument
- Findings

1. ALL IDENTIFIED ESTABLISHMENTS LIKELY TO USE METALFINISHING WERE MAILED A QUESTIONNAIRE

As in the study of the Printed Circuit Board industry, the key starting point in the survey of captive operations was to define the universe. Essential to any sample design is knowing the totality of all cases defining the population from which a sample can be drawn.

There appears to be no definitive list of manufacturing establishments known to house their own internal (captive) metalfinishing operation. Industry experts said that Products Finishing magazine was widely read in the metal-finishing industry; that its subscription list probably includes a majority of businesses concerned with finishing, and some prior survey data from the readership indicated the finishing processes used by each subscriber. Inasmuch as this readership list also served as the source data for the National Commission on Water Quality's estimate of 60,000-80,000 captives, the list seemed appropriate as the population of firms for our survey.

The editor of Products Finishing magazine provided full cooperation with our effort under the following two conditions:

> Names and addresses of firms were not to be seen by the Agency, or by BA&H. Mailing labels would be provided only if we agreed not to see, record, or identify respondents in any fashion. This we agreed to.
>
> Mailing was to occur at a single point, with no means for second mailings, follow-ups or subsequent contact. We agreed to this as well.

From the magazine's subscription list, approximately 8,800 firms (out of 22,000) were identified as currently involved in finishing or plating operations defined under the Electroplating Point Source category. In early March, we sent a questionnaire to all 8,800 rather than to a selected sample. By Friday, April 8, we closed down the effort with returns from approximately 3,400 firms. Almost 40% of the population returned a questionnaire. Of this total group of returns, slightly fewer than half (47%) acknowledged doing a regulated process. We have data on 1,610 captive operations.

The closure method and the planned analyses are presented in the next section.

2. A MODIFIED CLOSURE ANALYSIS WAS DEVELOPED FOR CAPTIVE METALFINISHING ESTABLISHMENTS

To aid response rates and also because of the presumed fiscal complexity of these firms, we did not solicit information on income or balance sheet information. The closure analysis cannot be a financially calculated routine. Such financial data would have been of limited use because the decision for captives is not whether the owner (or banker) of a small firm considers the investment worthwhile, but rather if a large firm, with presumed capital access would find the investment worthwhile based on an analysis of alternatives: modifying the products or using jobbers.

Closures are estimated by inference. Of particular importance to this qualitative closure analysis are the following issues:

Age and size of the finishing operation

Criticality of the operation with respect to production activities

Operating budget for finishing as a proportion of total sales

Percent value added of finishing with respect to the value of all finished goods sold

Amount of metalfinishing equipment in place

In sum, the closure test is whether a firm is "free" to divest its captive operations. The analysis focuses on the likelihood that a firm could economically as well as operationally divest itself of its finishing given its present commitment to the process. Firms likely to divest rather than make the investment in requisite treatment systems are those which among other things:

Have the freedom to send out finishing work or produce goods with an alternate finish

Produce relatively few metalfinished goods, and for which the added value of finishing is minor

The full closure methodology for captives is presented in Section 4 of this appendix.

3. SURVEY DATA YIELD A DETAILED PROFILE OF ESTABLISHMENTS WITH CAPTIVE METALFINISHING OPERATIONS

There are four sequential steps to be taken in order to characterize the captive sector of the metalfinishing industry. They are the following:

Arraying the respondents across the information elements of the survey to appreciate frequency patterns

Calculating mean scores for all continuous variables in order to test for differences in patterns

Applying alternative treatment scenarios to the captives to appreciate marginal changes in costs

Incorporating sets of decision rules to identify clusters of firms more or less burdened by the investment.

Each of these steps has been followed and the results for the 1,600+ respondents appear below.

(1) <u>Captives Are Large Establishments in Which the Captive Operation Appears Minor</u>

In almost one-half (49.7%) of the cases, the plant with the finishing operation sells at least $5 million. The most heavily represented sales sector is $10M - $50M with 35% of all respondents.

In terms of employment, facilities with captives are far larger than job shops. One-sixth of all respondents (16.7%) report having at least 1,000 total employees, with 57% having between 100 and 999 men. When the employment data are tabulated by wetfinishing employees, the picture is far different. Less than 10% of the sample (8.4%) has more than 50 people in finishing.

More than half (53%) report between 5 and 49 men with fully 38% of the sample reporting 1-4 men in wetfinishing.

An additional means of appreciating the impact of the in-plant value of metalfinishing is computing its incremental cost as a percent of the total cost of the finished good. On this variable, the pattern of responses suggests that metalfinishing is particularly costly for one-quarter of the respondents; 24% report that metalfinishing is at least 10% of the cost of the final product. For 40% of the sample, the cost is 3% and less. As will be shown in the closure methodology section, it is within this low cost sector that the possibility for divesture exists most strongly. Interestingly, when this variable is cross-tabulated against employment, 22% of all respondents (376 cases) have 1-4 finishing employees and a 3% or under cost factor. As employment increases along with finishing cost, divestiture may be less likely. But for 376 cases eliminating a low employment, low cost function seems an easier management decision.

(2) The Continuous Data Items Provide an Appreciation of the Economic and Environmental Significance of Captives

Sales and total employment at the plant move in the expected linear fashion. While the sample overall mean employment is 661 people, for firms selling below $1,000,000 mean total employment is 177 people; at plants selling in excess of $50,000,000, plant level employment increases to 2,445.

Wetfinishing employment shows a similar linear trend with sales but at a much reduced scale. For the smallest sales interval, the mean wetmetalfinishing employment is 5 people. At $50,000,000 in sales, wetmetalfinishing rises to 54 people. Sample wide, wetmetalfinishing employment accounts for 20 people per firm.

On some other production indices, captive operations do not differ significantly from job shop operations.

> On average, captives run 4.9 days a week, with only firms at the largest sales interval averaging more than 5 days a week.
>
> There is no significant difference within the sample on years in finishing. The sample as a whole has done finishing for 23.6 years. Small sales plants have had captives for 21.5 years and large sales plants for 25.6 years.

With respect to hours per day of captive operations, jobbers and captives are quite comparable. Smaller firms run 8.3 hours a day and large ones run 16.5. Overall, the sample reports 12.8 hours which is comparable to the mean work time of job shop operations.

On key issues pertinent to the pollution abatement issue, there are striking differences between the jobbers and captives samples.

On average, captive operations have made a $740,000 capital investment in their metalfinishing production equipment. By sales intervals, this ranges from $170K for the smallest group to at least $1 million for the largest.

On average, captive operations operate on an annual budget that closely parallels their prior capitalization. Specifically, for the entire sample the annual budget is $736,000 with the small plants operating on $127K with the largest exceeding $1 million.

On metalfinishing process water use, the size of captive operations is most vivid. Each day on average, the captives use 371,000 gallons of process water. Smaller firms are at 34,900 with the largest at 555,000.

Captives reported their future capital investments for pollution controls over the next 2 and 5 years. Overall, the sample reported $140,000 in the next 2 years and $340,000 in the next 5. Small firms report short-term capital investments on the order of $26K with the largest firms reporting $400K.

Interestingly, the projected pollution control costs for the sample under the full BPPT scenario represents no conflict with the self reported investment plans with one exception. That exception rests with the smallest plants.

> For the total sample, the projected pollution control capital is $194,000, not far removed from the sample data of $140,000. The largest plants will need approximately $300,000 which falls within their estimation of $340,000.
>
> Small plants, those selling below $1,000,000, are projected to need $55,000 for a system and that is twice their reported planned investment.

Clearly, the captives as a sector are quite large. But the evidence suggests the smaller operations may experience problems not dissimilar to those of some job shops.

4. A CAPTIVES CLOSURE ANALYSIS USES AN INFERENTIAL MODEL THAT IDENTIFIES FIRMS LEAST COMMITTED AND CONSTRAINED TO KEEP THEIR FINISHING FUNCTION

Several new analytic variables were created from the core questions of the captive's survey instrument. These new variables are items that could not be asked outright because they are not readily answered by respondents; or they were created outside the instrument because they are interactive; i.e., they build on the results of prior answers. As examples, it is important to know the economic value of the finishing operation with respect to the revenues generated by the final finished good. The question was asked: what percent of the total value added of all goods produced at the plant is due to the value of the metalfinishing? We were not optimistic that respondents could give accurate estimates. Additional questions were built into the instrument so that the same item could be computed from those answers. Seven of these items are particularly key to the closure analysis. They are the following:

Plant value added by metalfinishing: computed as the product of the respondent's answers to three items:

- Annual sales at the plant
- Percent of goods receiving metalfinishing
- Cost of metalfinishing as percent of the total cost

Corporate value added by metalfinishing: computed as the product of answers to the following:

- Annual sales of corporation
- Percent of goods receiving metalfinishing
- Cost of metalfinishing as a percent of the total cost

Estimated pollution control annualized cost: computed from flow rates, metals present, production processes and value of equipment in place.

Estimated annual increase in the metalfinishing budget: computed as the ratio:

$$\frac{\text{Estimated pollution control cost}}{\text{Metalfinishing annual budget}}$$

Estimated increase in metalfinishing value added due to the cost of the pollution control equipment computed as the ratio:

$$\frac{\text{Estimated pollution control cost}}{\text{Plant value added by metalfinishing}}$$

Estimated increase in sales price of goods receiving metalfinishing due to the cost of the pollution control equipment: computed as the term:

$$\frac{\text{Pollution control cost}}{\text{Sales at plant}} \times \text{percent of all goods receiving metalfinishing}$$

Estimated risk factor, which is the incremental increase in the metalfinishing equipment base represented by the investment in pollution controls: computed as the ratio:

$$\frac{\text{Pollution control capital cost}}{\text{Replacement value of metalfinishing equipment}}$$

In the following sections, the means for applying these variables in a captives closure analysis will be presented.

(1) <u>All Captives Can Be Described by Five Key Variables</u>

Given that no financial data are available for an investment closure analysis, the method for estimating closures tends to be qualitative.

From the analysis of the independent sector several variables serve well as descriptive or sizing dimensions. Two of these variables are common to both captives and jobbers; total plant sales and total metalfinishing employment. Three of the sizing variables are unique to this sector; they are value added by metalfinishing, plant value added and the computed risk factor. Combining and cross tabulating all firms within the matrices created by these variables enables the closure analysis to proceed.

(2) <u>Potential Closures Can Be Identified by Cell Frequencies Within Matrices</u>

Using these five sizing dimensions enables all respondents to be scored and assigned to a specific cell in a matrix. Not all possible combinations of the variables are relevant and for purposes of this analysis, 5 matrices have been generated. They are:

- Plant sales x value added
- Plant sales x WMF employment
- Value added x WMF employment
- Plant value added x plant sales
- Value added x risk factor

As suggested previously, there will be a certain number of plants which on their position in a matrix could be candidates to divest their in-house finishing capacity. As an example, there will be a certain number of firms that are characterized in the following terms; they have:

- Few wetmetalfinishing employees
- Finish few of their products
- Low value added by finishing
- High capital costs (risk factor)
- Operational freedom to send out work

Were this the pattern for a firm, the prima facie case could be made that it would chose to divest. These are less economic predictions than estimates of cases that satisfy a succession of cut-off criteria.

Once this core group of candidates for divestiture has been identified, the economic significance of such divestitures can be computed. These calculations involve projecting the total number of production employees affected, volume of finishing water curtailed, shifts in total value added by finishing across production sectors and incremental effects on pricing in the job shop sector.

Estimates of captive operations that might choose to divest are presented in the next major section.

5. FEW SURVEY RESPONDENTS APPEAR TO SATISFY THE COST AND PRICE CRITERIA TO ALLOW DIVESTITURE OF THE CAPTIVE OPERATION

Two treatment scenarios were costed for the captive operations. They are the same ones utilized in both the jobbers and Printed Board sectors:

- Full BPPT for all; cyanide oxidation, hexavalent chromium reduction, clarification or filtration for metals removal
- Full BPPT for firms using at least 10,000 GPD of process water with oxidation of amenable cyanide and chromium reduction with no metals removal for all firms below 10,000 GPD

For each cost scenario, the 5 matrices were generated, and cases arrayed. These matrices were used to identify clusters of vulnerable operations.

259-718 O - 78 - 22

(1) Under Full BPPT 1% - 3% of All Cases Could Choose To Divest

If investing in pollution controls adds significantly to the total capitalization of the finishing function, but the value added by finishing is quite small, then a plant may judge the investment to be unwarranted. Such a firm is then a candidate to divest.

In the sample, 84 out of 1,467 cases would at least double their total capitalization in finishing by the investment (risk factor $\geq$ 1.00) but also report a value added by finishing that is less than 1% the value of all finished goods. This group is 5.7% of all respondents. By broadening the categories to include all cases for which the risk factor is at least .75 and for whom the value added is up to 3%, there are 206 cases or 14% of the sample. These cases define the potential divestiture group.

Because the divestiture group is derived from meeting a series of linked criteria, before closure estimates can be finalized the behavior of these cases on other key items must also be examined.

For the group of plants in which the value added by finishing is less than 3% of the finished good, data also exist on the requisite price increase of the finished goods needed to pass on the annualized investment burden. If a plant might divest because its risk factor is high and its value added low; it may choose not to (divest) if the requisite price increase of finished goods is low.

Fully 75% of all firms with a metalfinishing value added of up to 3% also face price increases on their finished goods of not more than 1%. Should 75% of the 206 cases with high risk and low value added feel free to pass on a 1% price increase, then the maximum number of estimated divestitures falls to 51 or 3% of the sample. Under the more stringent case of a value added of $>$ 1%, fully 72% need a price increase of $>$ 1%. This yields a closure estimate of 24 firms or 1.6% of the total.

Presuming very modest price increases on the order of 1% or less has the effect of almost precluding captive closures.

(2) <u>Under a Modified Abatement Scenario Closures Are Essentially Unchanged</u>

Introducing a modified abatement scenario aimed at firms using not more than 10,000 GPD of process water has relatively little impact on captives. There were 1,125 respondents providing process water use data and

386 (34%) fall below 10,000 GPD. There still remain so many large water users receiving full BPPT systems that average capital costs here are 95% of what they are for the full-up case ($105K vs. $110K).

There are now 13% of all cases (200 of 1,461) that fall in the cross-product of high risk (.75+) and low value added (up to 3%). For this group, 77% can pass on their pollution control costs by raising the price of their metalfinished products not more than 1%. Should this prove to be the case, then total estimated closures are fewer than 50 or 3% of the sample. When the focus is restricted to just those firms facing a risk factor (<1.) and value added of under 1%, closures are limited to 1% of the sample.

* * * *

This completes the presentation of findings. The instrument and data follow.

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

March 2, 1977

Dear Sir:

The U. S. Environmental Protection Agency is studying the effects its regulations could have on the metal finishing industry. As part of this effort we are sending the enclosed questionnaire to some 10,000 firms who are thought to do metal finishing. Your answers to the enclosed questions will help us to better understand the economics of the industry.

You and other people in the industry have the best information on the needs and capabilities of firms affected by EPA regulations. It is vital for you and all firms surveyed to provide as much information as possible so that potential economic problems can be more carefully considered by the Agency.

You are not being asked to sign the questionnaire or in any way to identify yourself or your firm. Your answers are anonymous and there will be no way to connect the answers you give with you or your firm. Only summary information such as "average sales of firms employing ten to twenty people" will be used in reports.

Your cooperation in this survey is important to us, to the industry, and most of all to you. With your help, we are confident that final regulations will best balance the needs of all concerned.

Please answer all questions. If you are not certain about a question perhaps one of your colleagues knows the answer. Please return the completed questionnaire to National Analysts, the company conducting the survey for us, by Friday, March 25. A postage paid return envelope is provided. If you have any questions, feel free to place a collect call to Mr. Nat Greenfield in Washington. He can be reached at (202) 293-7933.

Thank you for your help.

Sincerely,

Roy N. Gamse

Roy N. Gamse, Director
Economic Analysis Division

Enclosure

When filling in this questionnaire, please think of the word "plant" as meaning the building or group of buildings in which your metal finishing can be found.

1. Please circle a code number for each of the types of electroplating activities done at this plant.

(CIRCLE AS MANY AS APPLY)

Copper	1
Nickel	2
Chromium	3
Cadmium	4
Zinc	5
Solder	6
Lead	7
Tin	8
Gold	9
Silver	10
Platinum metals group	1
Iron	2
Brass	3
Bronze	4

2. Please circle a code number for each of the types of finishing activities done at this plant.

(CIRCLE AS MANY AS APPLY)

Anodizing	1
Phosphating	2
Chromating	3
Chemical Milling/Etching	4
Printed Circuits	5
Electrochemical Milling	6

NOTE: IF YOUR PLANT DOES NONE OF THE ABOVE METAL FINISHING PROCESSES, THEN PLACE A "CHECK" IN THE BOX, ANSWER NO FURTHER QUESTIONS, AND PLEASE MAIL BACK THE QUESTIONNAIRE IN THE SELF-ADDRESSED ENVELOPE. ☐

SCALE OF OPERATION

We wish to know in this section how extensive your in-house metal finishing operation is.

Remember when we use the word "plant" in this questionnaire we mean the building or group of buildings all at the same mailing address in which your metal finishing can be found.

3. What is the total employment at your plant?

\# OF PLANT EMPLOYEES: ______________

4. At any typical time, how many production employees work in plating or finishing activities?

\# OF METAL FINISHING EMPLOYEES:__________

5. Typically, how many hours of the 24-hour day are spent doing metal finishing at the plant?

\# OF HOURS OF METAL FINISHING:__________

6. Typically, how many days of each week are spent doing metal finishing?

\# OF DAYS PER WEEK:__________

7. How many years has this plant done metal finishing?

\# OF YEARS OF METAL FINISHING:__________

8. If today you were to replace all of the metal finishing production equipment at your plant, how much would it cost? (Do not include costs of pollution control equipment.) Please estimate to the best of your ability.

REPLACEMENT VALUE: $______________

TYPE OF OPERATION

This section is concerned with your use of metal finishing, your customers, capacity and the like.

9. There are many reasons why a firm does in-house metal finishing. Which of the reasons listed in the table below are factors in your decision to do metal finishing in-house? Please circle a code number for each reason which is a factor.

10. Now choose the two most important reasons for doing metal finishing in-house. Please put a "1" in the column for the most important reason and a "2" in the column for the second most important reason.

	Reasons for In-House	Two Most Important Reasons
No job shops in the area to send work to	1	
Job shops are not responsive to our needs	2	
Less expensive to do it in-house	3	
Our work flow does not allow for the interruption caused by sending work out	4	
Always have done our metal finishing in-house	5	

11. Thinking about all of the metal finishing you do in-house, what percent of that work is done with parts produced at your plant? What percent is done with parts sent in from other units of the firm? What percent is done with parts from outside customers?

	% of Total In-House Volume
Parts produced here at our plant	%
Parts sent to us from other units of the firm	%
Parts from outside customers	%
	100%

Think of the last three years when answering Questions 12-15.

12. Please estimate the average annual sales of all goods produced at this plant. Your estimate should include the total value of the goods made at this plant and the total value of the metal finishing done with parts from outside this plant.

	(CIRCLE CODE)
Under $1,000,000	1
$1,000,000 to $4,999,999	2
$5,000,000 to $9,999,999	3
$10,000,000 to $50,000,000	4
More than $50,000,000	5

13. What are the average annual sales of the whole corporation of which you are a part?

	(CIRCLE CODE)
Under $1,000,000	1
$1,000,000 to $4,999,999	2
$5,000,000 to $9,999,999	3
$10,000,000 to $50,000,000	4
More than $50,000,000	5

14. What percent of all goods produced at this plant receive some metal finishing?

% RECEIVE METAL FINISHING___________

15. On the average, for the products made at your plant, how much of the total cost to manufacture a product is due to the cost of metal finishing?

(CIRCLE CODE)

Less than 1%	1
1% to 3%	2
4% to 6%	3
7% to 9%	4
10% or more	5
Don't know	V

16. Do you compile or receive on a regular basis a cost breakdown for the metal finishing operation?

(CIRCLE CODE)

Yes, for just this plant	1
Yes, but includes this plant plus other locations	2
No, costs handled elsewhere	3
No, costs not recorded	4

17. If records are kept for the metal finishing operation, please circle the code numbers for all the items accounted for on a regular basis.

(CIRCLE AS MANY AS APPLY)

Total water	1
Process water	2
Area plated	3
Jobs processed	4
Amp hours	5
Chemical use	6
Factory overhead	7
Direct labor	8
Person hours	9
Revenues generated	10

CIRCLE CODE IF NONE OF THE ABOVE ITEMS IS ACCOUNTED FOR | V

18. In 1976, what was your total operating budget for doing metal finishing at your plant?

METAL FINISHING BUDGET: $______________

19. Please break down your 1976 metal finishing budget, showing the dollar values of the following items:

	Dollar Value
Direct labor	$
Chemical	$
Water	$
Energy and utilities	$
Other	$

POLLUTION ABATEMENT

The questions in this section all deal with your plant's water use, metal finishing, waste and pollution control measures.

20. Please fill in the table below showing your plant's water use for a typical day during 1976. Use gallons per day (GPD) if available. If your information is in cubic feet or some other measurement, please note it in the table.

Water Use	GPD
Total plant	
Metal finishing process water	
Other production process water	

21. Now please indicate where your metal finishing discharge water goes. (CIRCLE THE CODE WHICH BEST DESCRIBES YOUR ANSWER)

Municipal sewer system	1
River, lake, pond, other surface water	2
Both of the above	3
Holding tanks	4

22. Do you treat the effluent from your metal finishing operations at this plant?

CONTINUE	Yes	1
GO TO NEXT SECTION	No	2

23. How much have you spent to buy all of your water pollution control equipment at the plant? (Use actual costs, not book or replacement value.)

	(CIRCLE CODE)
Under $100,000	1
$100,000 to $249,999	2
$250,000 to $499,999	3
$500,000 to $1,000,000	4
More than $1,000,000	5

24. How much of this total capital investment represents the cost of treating metal finishing wastes?

	(CIRCLE CODE)
100% - All of it	1
75% - Most of it	2
50% - About half	3
25% - Little	4
0% - None	5

ABATEMENT DECISIONS

This section is to be filled in by all respondents whether or not your plant has a water pollution control system. The concern here is how your plant did approach, or might approach, its investment decision.

25. Many issues, both of cost and production, may be part of a decision to invest in pollution control. From the issues listed below; please identify the <u>three</u> issues your plant judged most important.

	3 MOST IMPORTANT ISSUES
Size of required investment	1
Potential cost impacts of the investment	2
Feasibility of changing finishing processes	3
Feasibility of sending out metal finishing	4
Deciding on what system to install	5
Deciding how and when to install the system	6
Relocating metal finishing operations	7
Changing from or to a municipal sewer system	8

26. If you have not participated in planning meetings for pollution control and/or your plant does not have water pollution controls, please review the list of reasons below and circle all items that apply.

	(CIRCLE CODES)
Other people are responsible for it	1
It is not considered a problem	2
Pollution control planning is low priority	3
Other (WRITE IN: ______________________ ______________________)	0

27. Based on your best estimate, how much will your plant spend on pollution control equipment during the next 2 years? During the next 5 years?

2 YEARS $ ________

5 YEARS $ ________

THIS COMPLETES THE QUESTIONNAIRE. THANK YOU. PLEASE MAIL IT BACK IN THE ENCLOSED ENVELOPE.

QUESTION NO.1 WHICH TYPES OF ELECTRO-PLATING ACTIVITIES ARE DONE AT THIS PLANT?

		--- PERCENTAGE VALUE ADDED ---					- T O T A L P L A N T S A L E S -				
	TOTAL	LESS THAN 1 PCT	1-3 PCT	4-6 PCT	7-9 PCT	10 OR MORE	UNDER $1 MIL	$1 MIL-4.9 MIL	$5 MIL-9.9 MIL	$10-50 MILLION	MORE THAN $50 MIL
TOTAL	1614	254	400	270	155	394	175	367	233	565	237
NO ANSWER	480	108	121	76	52	90	57	125	79	143	68
NUMBER ANSWERING	1134 100.0	146 100.0	279 100.0	194 100.0	103 100.0	304 100.0	118 100.0	242 100.0	154 100.0	422 100.0	169 100.0
COPPER	579 51.1	67 45.9	127 45.5	77 39.7	47 45.6	198 65.1	65 55.1	123 50.8	76 49.4	188 44.5	111 65.7
NICKEL	709 62.5	61 41.8	148 53.0	120 61.9	67 65.0	240 78.9	80 67.8	172 71.1	93 60.4	230 54.5	115 68.0
CHROMIUM	459 40.5	49 33.6	89 31.9	79 40.7	44 42.7	143 47.0	40 33.9	78 32.2	69 44.8	163 38.6	97 57.4
CADMIUM	282 24.9	34 23.3	77 27.6	48 24.7	32 31.1	50 16.4	24 20.3	47 19.4	32 20.8	107 25.4	65 38.5
ZINC	400 35.3	40 27.4	110 39.4	70 36.1	51 49.5	88 28.9	25 21.2	68 28.1	60 39.0	168 39.8	70 41.4
SOLDER	152 13.4	18 12.3	37 13.3	21 10.8	16 15.5	46 15.1	19 16.1	30 12.4	22 14.3	40 9.5	37 21.9
LEAD	54 4.8	5 3.4	10 3.6	10 5.2	4 3.9	18 5.9	4 3.4	10 4.1	5 3.2	19 4.5	15 8.9
TIN	228 20.1	36 24.7	64 22.9	23 11.9	28 27.2	54 17.8	20 16.9	35 14.5	21 13.6	90 21.3	58 34.3
GOLD	272 24.0	28 19.2	55 19.7	38 19.6	23 22.3	94 30.9	40 33.9	67 27.7	33 21.4	66 15.6	54 32.0
SILVER	209 18.4	25 17.1	49 17.6	34 17.5	21 20.4	48 15.8	20 16.9	43 17.8	25 16.2	70 16.6	45 26.6
PLATINUM METALS GROUP	71 6.3	9 6.2	12 4.3	8 4.1	8 7.8	26 8.6	10 8.5	21 8.7	7 4.5	13 3.1	18 10.7
IRON	31 2.7	2 1.4	13 4.7	4 2.1	4 3.9	7 2.3	3 2.5	7 2.9	2 1.3	13 3.1	6 3.6
BRASS	143 12.6	5 3.4	25 9.0	14 7.2	21 20.4	62 20.4	12 10.2	44 18.2	20 13.0	51 12.1	12 7.1

(CONTINUED)

(CONTINUED PAGE 2)

NATIONAL ANALYSTS
METAL FINISHING STUDY (815-2)

QUESTION NO.1 WHICH TYPES OF ELECTRO-PLATING ACTIVITIES ARE DONE AT THIS PLANT?

		- - - PERCENTAGE VALUE ADDED - - -					- T O T A L P L A N T S A L E S -				
	TOTAL	LESS THAN 1 PCT	1-3 PCT	4-6 PCT	7-9 PCT	10 OR MORE	UNDER $1 MIL	$1 MIL-4.9 MIL	$5 MIL-9.9 MIL	$10-50 MILLION	MORE THAN $50 MIL
BRONZE	43	2	8	4	6	20	4	8	5	18	7
	3.8	1.4	2.9	2.1	5.8	6.4	3.4	3.3	3.2	4.3	4.1
HOT DIP GALVANIZE											

001

QUESTION NO.2 WHICH TYPES OF FINISHING ACTIVITIES ARE DONE AT THIS PLANT?

		- - - PERCENTAGE VALUE ADDED - - -					- T O T A L P L A N T S A L E S -				
	TOTAL	LESS THAN 1 PCT	1-3 PCT	4-6 PCT	7-9 PCT	10 OR MORE	UNDER $1 MIL	$1 MIL- 4.9 MIL	$5 MIL- 9.9 MIL	$10-50 MILLION	MORE THAN $50 MIL
TOTAL	1614	254	400	270	155	394	175	367	233	565	237
NO ANSWER	329	58	75	46	27	97	58	97	44	100	18
NUMBER ANSWERING	1285	196	325	224	128	297	117	270	189	465	219
	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
ANODIZING	310	29	69	58	29	79	25	66	43	105	67
	24.1	14.8	21.2	25.9	22.7	26.6	21.4	24.4	22.8	22.6	30.6
PHOSPHATING	718	118	200	119	81	135	46	123	93	295	147
	55.9	60.2	61.5	53.1	63.3	45.5	39.3	45.6	49.2	63.4	67.1
CHROMATING	634	77	177	113	73	127	47	125	88	239	123
	49.3	39.3	54.5	50.4	57.0	42.8	40.2	46.3	46.6	51.4	56.2
CHEMICAL MILLING/ETCHING	279	45	56	45	24	76	25	50	38	82	78
	21.7	23.0	17.2	20.1	18.8	25.6	21.4	18.5	20.1	17.6	35.6
PRINTED CIRCUITS	191	26	57	28	12	48	29	39	19	45	54
	14.9	13.3	17.5	12.5	9.4	16.2	24.8	14.4	10.1	9.7	24.7
ELECTROCHEMICAL MILLING	59	13	17	9	6	8	5	2	3	23	24
	4.6	6.6	5.2	4.0	4.7	2.7	4.3	.7	1.6	4.9	11.0

NATIONAL ANALYSTS
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QUESTION NO.3 WHAT IS THE TOTAL
EMPLOYMENT AT YOUR PLANT?

	TOTAL	- - - PERCENTAGE VALUE ADDED - - - LESS THAN 1 PCT	1-3 PCT	4-6 PCT	7-9 PCT	10 OR MORE	- T O T A L P L A N T S A L E S - UNDER $1 MIL	$1 MIL-4.9 MIL	$5 MIL-9.9 MIL	$10-50 MILLION	MORE THAN $50 MIL
TOTAL	1614	254	400	270	155	394	175	367	233	565	237
NO ANSWER	45	9	13	10	2	5	6	6	6	19	5
NUMBER ANSWERING	1569	245	387	260	153	389	169	361	227	546	232
	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
1 TO 49 EMPLOYEES	222	28	52	33	17	70	121	76	9	7	3
	14.1	11.4	13.4	12.7	11.1	18.0	71.6	21.1	4.0	1.3	1.3
50 TO 99 EMPLOYEES	178	16	35	27	26	63	19	128	19	5	4
	11.3	6.5	9.0	10.4	17.0	16.2	11.2	35.5	8.4	.9	1.7
100 TO 199 EMPLOYEES	266	37	62	45	31	69	11	120	93	34	2
	17.0	15.1	16.0	17.3	20.3	17.7	6.5	33.2	41.0	6.2	.9
200 TO 499 EMPLOYEES	379	61	90	74	40	99	6	25	86	246	12
	24.2	24.9	23.3	28.5	26.1	25.4	3.6	6.9	37.9	45.1	5.2
500 TO 999 EMPLOYEES	262	46	78	45	20	42	7	8	12	195	34
	16.7	18.8	20.2	17.3	13.1	0.8	4.1	2.2	5.3	35.7	14.7
1,000 TO 1,999 EMPLOYEES	133	23	41	20	10	22	2	3	2	55	66
	8.5	9.4	0.6	7.7	6.5	5.7	1.2	.8	.9	10.1	28.4
2,000 OR MORE EMPLOYEES	129	34	29	16	9	24	3	1	6	4	111
	8.2	13.9	7.5	6.2	5.9	6.2	1.8	.3	2.6	.7	47.8
AVERAGE	661.19	993.80	663.40	584.92	530.41	457.93	177.15	126.96	322.96	544.03	2445.63

QUESTION NO.4 AT ANY TYPICAL TIME, HOW MANY PRODUCTION EMPLOYEES WORK IN PLATING OR FINISHING ACTIVITIES?

		--- PERCENTAGE VALUE ADDED ---					- T O T A L P L A N T S A L E S -				
	TOTAL	LESS THAN 1 PCT	1-3 PCT	4-6 PCT	7-9 PCT	10 OR MORE	UNDER $1 MIL	$1 MIL- 4.9 MIL	$5 MIL- 9.9 MIL	$10-50 MILLION	MORE THAN $50 MIL
TOTAL	1614	254	400	270	155	394	175	367	233	565	237
NO ANSWER	15	2	3	1	3	5	1	3		8	3
NUMBER ANSWERING	1599	252	397	269	152	389	174	364	233	557	234
	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
1 TO 4 EMPLOYEES	609	176	200	97	30	67	115	191	88	159	42
	38.1	69.8	50.4	36.1	19.7	17.2	66.1	52.5	37.8	28.5	17.9
5 TO 9 EMPLOYEES	293	35	84	59	28	67	32	79	48	103	26
	18.3	13.9	21.2	21.9	18.4	17.2	18.4	21.7	20.6	18.5	11.1
10 TO 19 EMPLOYEES	293	24	47	58	35	92	18	58	50	120	39
	18.3	9.5	11.8	21.6	23.0	23.7	10.3	15.9	21.5	21.5	16.7
20 TO 49 EMPLOYEES	267	13	48	34	46	98	7	31	32	125	65
	16.7	5.2	12.1	12.6	30.3	25.2	4.0	8.5	13.7	22.4	27.8
50 TO 99 EMPLOYEES	75	3	13	14	6	29	2	4	10	31	28
	4.7	1.2	3.3	5.2	3.9	7.5	1.1	1.1	4.3	5.6	12.0
100 TO 249 EMPLOYEES	45		5	5	6	24		1	4	16	23
	2.8		1.3	1.9	3.9	6.2		.3	1.7	2.9	9.8
250 TO 499 EMPLOYEES	9			1		8			1	2	5
	.6			.4		2.1			.4	.4	2.1
500 OR MORE EMPLOYEES	6			1	1	3				1	5
	.4			.4	.7	.8				.2	2.1
AUTOMATED SYSTEM	2	1				1					1
	.1	.4				.3					.4
AVERAGE	20.18	5.50	11.17	17.13	23.96	37.80	5.25	7.70	14.59	21.18	53.79

NATIONAL ANALYSTS
METAL FINISHING STUDY (815-2)

QUESTION NO.3.4 PERCENTAGE OF WORKERS IN METAL FINISHING

		--- PERCENTAGE VALUE ADDED ---					- T O T A L P L A N T S A L E S -				
	TOTAL	LESS THAN 1 PCT	1-3 PCT	4-6 PCT	7-9 PCT	10 OR MORE	UNDER $1 MIL	$1 MIL- 4.9 MIL	$5 MIL- 9.9 MIL	$10-50 MILLION	MORE THAN $50 MIL
TOTAL	1614	254	400	270	155	394	175	367	233	565	237
NO ANSWER	58	11	15	10	5	10	7	10	6	25	7
NUMBER ANSWERING	1556	243	385	260	150	384	168	357	227	540	230
	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
LESS THAN 25 PERCENT	1421	240	368	252	138	309	126	317	206	521	223
	91.3	98.8	95.6	96.9	92.0	80.5	75.0	88.8	90.7	96.5	97.0
25 TO 49 PERCENT	63	1	4	2	8	42	17	20	14	7	3
	4.0	.4	1.0	.8	5.3	10.9	10.1	5.6	6.2	1.3	1.3
50 TO 74 PERCENT	31		6	2	1	18	8	11	3	6	2
	2.0		1.6	.8	.7	4.7	4.8	3.1	1.3	1.1	.9
75 PERCENT OR MORE	41	2	7	4	3	15	17	9	4	6	2
	2.6	.8	1.8	1.5	2.0	3.9	10.1	2.5	1.8	1.1	.9
AVERAGE	9.17	2.58	5.76	6.46	9.90	16.82	21.36	11.33	9.26	5.75	4.20

NATIONAL ANALYSTS
METAL FINISHING STUDY (615-2)

QUESTION NO.5 HOW MANY HOURS OF THE 24-HOUR DAY ARE SPENT DOING METAL FINISHING AT THE PLANT?

		--- PERCENTAGE VALUE ADDED ---					- T O T A L P L A N T S A L E S -				
	TOTAL	LESS THAN 1 PCT	1-3 PCT	4-6 PCT	7-9 PCT	10 OR MORE	UNDER $1 MIL	$1 MIL- 4.9 MIL	$5 MIL- 9.9 MIL	$10-50 MILLION	MORE THAN $50 MIL
TOTAL	1614	254	400	270	155	394	175	367	233	565	237
NO ANSWER	15	1	3	5	2	1	3	3	2	6	1
NUMBER ANSWERING	1599	253	397	265	153	393	172	364	231	559	236
	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
LESS THAN 1 HOUR	5	4	1				2	1		2	
	.3	1.6	.3				1.2	.3		.4	
1 TO 8 HOURS	709	147	191	119	57	142	121	221	111	191	46
	44.3	58.1	48.1	44.9	37.3	36.1	70.3	60.7	48.1	34.2	19.5
9 TO 16 HOURS	563	73	136	89	69	134	43	103	81	216	107
	35.2	28.9	34.3	33.6	45.1	34.1	25.0	28.3	35.1	38.6	45.3
17 TO 24 HOURS	322	29	69	57	27	117	6	39	39	150	83
	20.1	11.5	17.4	21.5	17.6	29.8	3.5	10.7	16.9	26.8	35.2
AVERAGE	12.82	10.51	12.32	13.17	13.32	14.18	8.33	10.43	12.42	14.42	16.59

NATIONAL ANALYSTS
METAL FINISHING STUDY (815-2)

QUESTION NO.6 HOW MANY DAYS OF EACH WEEK
ARE SPENT DOING METAL FINISHING?

	TOTAL	--- PERCENTAGE VALUE ADDED --- LESS THAN 1 PCT	1-3 PCT	4-6 PCT	7-9 PCT	10 OR MORE	- T O T A L P L A N T S A L E S - UNDER $1 MIL	$1 MIL- 4.9 MIL	$5 MIL- 9.9 MIL	$10-50 MILLION	MORE THAN $50 MIL
TOTAL	1614	254	400	270	155	394	175	367	233	565	237
NO ANSWER	10	5	1	1	1	2		4	1	2	2
NUMBER ANSWERING	1604	249	399	269	154	392	175	363	232	563	235
	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
LESS THAN 1 DAY	5	3	1		1		2	2		1	
	.3	1.2	.3		.6		1.1	.6		.2	
1-5 DAYS	1452	230	371	251	138	336	168	334	219	512	185
	90.5	92.4	93.0	93.3	89.6	85.7	96.0	92.0	94.4	90.9	78.7
6 DAYS	126	14	27	17	11	44	2	23	12	44	43
	7.9	5.6	6.8	6.3	7.1	11.2	1.1	6.3	5.2	7.8	18.3
7 DAYS	21	2		1	4	12	3	4	1	6	7
	1.3	.8		.4	2.6	3.1	1.7	1.1	.4	1.1	3.0
AVERAGE	4.88	4.57	4.85	4.87	4.94	5.06	4.31	4.76	4.94	5.00	5.18

NATIONAL ANALYSTS
METAL FINISHING STUDY (815-2)

QUESTION NO.7 HOW MANY YEARS HAS THIS PLANT DONE METAL FINISHING?

		- - - PERCENTAGE VALUE ADDED - - -					- T O T A L P L A N T S A L E S -				
	TOTAL	LESS THAN 1 PCT	1-3 PCT	4-6 PCT	7-9 PCT	10 OR MORE	UNDER $1 MIL	$1 MIL- 4.9 MIL	$5 MIL- 9.9 MIL	$10-50 MILLION	MORE THAN $50 MIL
TOTAL	1614	254	400	270	155	394	175	367	233	565	237
NO ANSWER	27	7	4	5	2	6	2	7	4	6	4
NUMBER ANSWERING	1587	247	396	265	153	388	173	360	229	559	233
	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
LESS THAN 10 YEARS	265	41	80	46	18	64	40	79	38	76	24
	16.7	16.6	20.2	17.4	11.8	16.5	23.1	21.9	16.6	13.6	10.3
10 TO 19	446	72	109	72	40	112	47	113	80	149	49
	28.1	29.1	27.5	27.2	26.1	28.9	27.2	31.4	34.9	26.7	21.0
20 TO 29	410	77	102	57	44	91	44	69	50	159	78
	25.8	31.2	25.8	21.5	28.8	23.5	25.4	19.2	21.8	28.4	33.5
30 TO 39	202	24	41	42	23	52	18	35	26	73	44
	12.7	9.7	10.4	15.8	15.0	13.4	10.4	9.7	11.4	13.1	18.9
40 TO 49	97	14	26	17	11	22	8	24	7	42	15
	6.1	5.7	6.6	6.4	7.2	5.7	4.6	6.7	3.1	7.5	6.4
50 YEARS OR MORE	167	19	38	31	17	47	16	40	28	60	23
	10.5	7.7	9.6	11.7	11.1	12.1	9.2	11.1	12.2	10.7	9.9
AVERAGE	23.90	21.97	22.63	24.30	25.35	25.45	21.67	23.26	23.10	24.81	25.91

NATIONAL ANALYSTS
METAL FINISHING STUDY (815-2)

QUESTION NO.8 IF TODAY YOU WERE TO REPLACE ALL OF THE METAL FINISHING PRODUCTION EQUIPMENT AT YOUR PLANT, HOW MUCH WOULD IT COST?

		- - - PERCENTAGE VALUE ADDED - - -					- T O T A L P L A N T S A L E S -				
	TOTAL	LESS THAN 1 PCT	1-3 PCT	4-6 PCT	7-9 PCT	10 OR MORE	UNDER $1 MIL	$1 MIL-4.9 MIL	$5 MIL-9.9 MIL	$10-50 MILLION	MORE THAN $50 MIL
TOTAL	1614	254	400	270	155	394	175	367	233	565	237
NO ANSWER	52	10	10	6	5	13	14	12	8	10	7
NUMBER ANSWERING	1562	244	390	264	150	381	161	355	225	555	230
	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
LESS THAN $10,000	93	45	24	12	1	7	28	35	4	20	3
	6.0	18.4	6.2	4.5	.7	1.8	17.4	9.9	1.8	3.6	1.3
$10,000 TO $49,999	222	66	70	32	12	32	54	68	38	44	11
	14.2	27.0	17.9	12.1	8.0	8.4	33.5	19.2	16.9	7.9	4.8
$50,000 TO $99,999	165	40	47	32	10	27	24	56	24	49	12
	10.6	16.4	12.1	12.1	6.7	7.1	14.9	15.8	10.7	8.8	5.2
$100,000 TO $499,999	591	68	157	107	63	139	46	156	96	221	56
	37.8	27.9	40.3	40.5	42.0	36.5	28.6	43.9	42.7	39.8	24.3
$500,000 TO $999,999	188	7	42	37	26	56	5	27	33	88	29
	12.0	2.9	10.8	14.0	17.3	14.7	3.1	7.6	14.7	15.9	12.6
$1,000,000 TO $4,999,999	246	15	44	39	29	93	3	12	27	116	84
	15.7	6.1	11.3	14.8	19.3	24.4	1.9	3.4	12.0	20.9	36.5
$5,000,000 OR MORE	57	3	6	5	9	27	1	1	3	17	35
	3.6	1.2	1.5	1.9	6.0	7.1	.6	.3	1.3	3.1	15.2
AVERAGE (THOUSANDS)	56	280	495	593	1135	1188	169	217	505	891	2102

QUESTION NO.9 WHAT ARE THE REASONS WHICH ARE FACTORS IN YOUR DECISION TO DO METAL FINISHING IN-HOUSE?

		--- PERCENTAGE VALUE ADDED ---					- T O T A L P L A N T S A L E S -				
	TOTAL	LESS THAN 1 PCT	1-3 PCT	4-6 PCT	7-9 PCT	10 OR MORE	UNDER $1 MIL	$1 MIL- 4.9 MIL	$5 MIL- 9.9 MIL	$10-50 MILLION	MORE THAN $50 MIL
TOTAL	1614	254	400	270	155	394	175	367	233	565	237
NO ANSWER	29	2	2	2		14	13	6	3	2	2
NUMBER ANSWERING	1585 100.0	252 100.0	398 100.0	268 100.0	155 100.0	380 100.0	162 100.0	361 100.0	230 100.0	563 100.0	235 100.0
NO JOB SHOPS IN THE AREA TO SEND WORK TO	350 22.1	52 20.6	90 22.6	62 23.1	37 23.9	81 21.3	37 22.8	76 21.1	53 23.0	127 22.6	50 21.3
JOB SHOPS ARE NOT RESPONSIVE TO OUR NEEDS	654 41.3	93 36.9	163 41.0	102 38.1	61 39.4	180 47.4	66 40.7	153 42.4	85 37.0	232 41.2	99 42.1
LESS EXPENSIVE TO DO IT IN-HOUSE	1207 76.2	183 72.6	315 79.1	217 81.0	124 80.0	274 72.1	99 61.1	262 72.6	182 79.1	457 81.2	180 76.6
WORK FLOW DOESN'T ALLOW INTERRUPTION OF WORK SENT OUT	1332 84.0	212 84.1	332 83.4	220 82.1	137 88.4	317 83.4	118 72.8	293 81.2	186 80.9	494 87.7	217 92.3
ALWAYS HAVE DONE OUR METAL FINISHING IN-HOUSE	683 43.1	87 34.5	140 35.2	115 42.9	78 50.3	196 51.6	66 40.7	152 42.1	105 45.7	236 41.9	115 48.9
OTHER REASONS	8 .5	2 .8		2 .7	1 .6	1 .3	1 .6	4 1.1		2 .4	1 .4

QUESTION NO.10 WHICH OF THESE IS THE MOST IMPORTANT REASON FOR DOING METAL FINISHING IN-HOUSE?

		- - - PERCENTAGE VALUE ADDED - - -					- T O T A L P L A N T S A L E S -				
	TOTAL	LESS THAN 1 PCT	1-3 PCT	4-6 PCT	7-9 PCT	10 OR MORE	UNDER $1 MIL	$1 MIL- 4.9 MIL	$5 MIL- 9.9 MIL	$10-50 MILLION	MORE THAN $50 MIL
TOTAL	1614	254	400	270	155	394	175	367	233	565	237
NO ANSWER	191	26	38	30	13	59	45	46	23	52	15
NUMBER ANSWERING	1423 100.0	228 100.0	362 100.0	240 100.0	142 100.0	335 100.0	130 100.0	321 100.0	210 100.0	513 100.0	222 100.0
NO JOB SHOPS IN THE AREA TO SEND WORK TO	51 3.6	10 4.4	19 5.2	6 2.5	5 3.5	9 2.7	14 10.8	14 4.4	7 3.3	12 2.3	2 .9
JOB SHOPS ARE NOT RESPONSIVE TO OUR NEEDS	133 9.3	18 7.9	38 10.5	21 8.8	10 7.0	32 9.6	13 10.0	35 10.9	17 8.1	40 7.8	22 9.9
LESS EXPENSIVE TO DO IT IN-HOUSE	480 33.7	60 26.3	124 34.3	96 40.0	48 33.8	122 36.4	31 23.8	101 31.5	80 38.1	198 38.6	60 27.0
WORK FLOW DOESN'T ALLOW INTER-RUPTION OF WORK SENT OUT	685 48.1	135 59.2	170 47.0	112 46.7	68 47.9	140 41.8	58 44.6	153 47.7	90 42.9	248 48.3	127 57.2
ALWAYS HAVE DONE OUR METAL FINISHING IN-HOUSE	70 4.9	4 1.8	11 3.0	4 1.7	10 7.0	32 9.6	14 10.8	16 5.0	16 7.6	14 2.7	10 4.5
OTHER REASONS	4 .3	1 .4		1 .4	1 .7			2 .6		1 .2	1 .5

QUESTION NO.10 WHICH OF THESE IS THE SECOND MOST IMPORTANT REASON FOR DOING METAL FINISHING IN-HOUSE?

		--- PERCENTAGE VALUE ADDED ---					- TOTAL PLANT SALES -				
	TOTAL	LESS THAN 1 PCT	1-3 PCT	4-6 PCT	7-9 PCT	10 OR MORE	UNDER $1 MIL	$1 MIL- 4.9 MIL	$5 MIL- 9.9 MIL	$10-50 MILLION	MORE THAN $50 MIL
TOTAL	1614	254	400	270	155	394	175	367	233	565	237
NO ANSWER	246	35	52	35	18	78	56	62	28	65	23
NUMBER ANSWERING	1368 100.0	219 100.0	348 100.0	235 100.0	137 100.0	316 100.0	119 100.0	305 100.0	205 100.0	500 100.0	214 100.0
NO JOB SHOPS IN THE AREA TO SEND WORK TO	84 6.1	15 6.8	26 7.5	18 7.7	6 4.4	13 4.1	9 7.6	19 6.2	13 6.3	28 5.6	15 7.0
JOB SHOPS ARE NOT RESPONSIVE TO OUR NEEDS	235 17.2	48 21.9	59 17.0	31 13.2	17 12.4	61 19.3	26 21.8	61 20.0	28 13.7	81 16.2	33 15.4
LESS EXPENSIVE TO DO IT IN-HOUSE	460 33.6	83 37.9	122 35.1	76 32.3	54 39.4	89 28.2	35 29.4	102 33.4	68 33.2	163 32.6	85 39.7
WORK FLOW DOESN'T ALLOW INTER-RUPTION OF WORK SENT OUT	419 30.6	43 19.6	108 31.0	72 30.6	46 33.5	117 37.0	33 27.7	85 27.9	66 32.2	170 34.0	55 25.7
ALWAYS HAVE DONE OUR METAL FINISHING IN-HOUSE	168 12.3	30 13.7	33 9.5	37 15.7	14 10.2	35 11.1	15 12.6	38 12.5	30 14.6	57 11.4	26 12.1
OTHER REASONS	2 .1			1 .4		1 .3	1 .8			1 .2	

NATIONAL ANALYSTS
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QUESTION NO.11 THINKING ABOUT ALL OF THE METAL FINISHING YOU DO IN-HOUSE, WHAT PERCENT OF THAT WORK IS DONE WITH PARTS PRODUCED HERE AT OUR PLANT?

		--- PERCENTAGE VALUE ADDED ---					- TOTAL PLANT SALES -				
	TOTAL	LESS THAN 1 PCT	1-3 PCT	4-6 PCT	7-9 PCT	10 OR MORE	UNDER $1 MIL	$1 MIL-4.9 MIL	$5 MIL-9.9 MIL	$10-50 MILLION	MORE THAN $50 MIL
TOTAL	1614	254	400	270	155	394	175	367	233	555	237
NO ANSWER	37	8	9	4	1	8	3	9	7	5	6
NUMBER ANSWERING	1577 100.0	246 100.0	391 100.0	266 100.0	154 100.0	386 100.0	172 100.0	358 100.0	226 100.0	560 100.0	231 100.0
LESS THAN 25 PERCENT	85 5.4	16 6.5	14 3.6	12 4.5	3 1.9	30 7.8	32 18.6	14 3.9	7 3.1	21 3.8	9 3.9
25 TO 49 PERCENT	32 2.0	5 2.0	7 1.8	5 1.9	2 1.3	10 2.6	9 5.2	9 2.5	3 1.3	6 1.1	5 2.2
50 TO 74 PERCENT	92 5.8	11 4.5	19 4.9	13 4.9	14 9.1	27 7.0	9 5.2	20 5.6	14 6.2	31 5.5	15 6.5
75 PERCENT OR MORE	1368 86.7	214 87.0	351 89.8	236 88.7	135 87.7	319 82.6	122 70.9	315 88.0	202 89.4	502 89.6	202 87.4
AVERAGE	75.88	70.26	78.71	79.02	82.27	71.97	51.95	75.68	80.06	80.10	80.13

QUESTION NO.11 THINKING ABOUT ALL OF THE METAL FINISHING YOU DO IN-HOUSE, WHAT PERCENT OF THAT WORK IS DONE WITH PARTS SENT TO US FROM OTHER UNITS OF THE FIRM?

		- - - PERCENTAGE VALUE ADDED - - -					- T O T A L P L A N T S A L E S -				
	TOTAL	LESS THAN 1 PCT	1-3 PCT	4-6 PCT	7-9 PCT	10 OR MORE	UNDER $1 MIL	$1 MIL-4.9 MIL	$5 MIL-9.9 MIL	$10-50 MILLION	MORE THAN $50 MIL
TOTAL	1614	254	400	270	155	394	175	367	233	565	237
NO ANSWER	45	12	10	5	1	11	5	11	10	6	6
NUMBER ANSWERING	1569	242	390	265	154	383	170	356	223	559	231
	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
LESS THAN 25 PERCENT	1476	229	365	255	142	355	161	339	210	525	214
	94.1	94.6	93.6	96.2	92.2	92.7	94.7	95.2	94.2	93.9	92.6
25 TO 49 PERCENT	46	5	9	6	10	13	3	7	11	19	5
	2.9	2.1	2.3	2.3	6.5	3.4	1.8	2.0	4.9	3.4	2.2
50 TO 74 PERCENT	20	2	10	1		6	2	5	1	7	5
	1.3	.8	2.6	.4		1.6	1.2	1.4	.4	1.3	2.2
75 PERCENT OR MORE	27	6	6	3	2	9	4	5	1	8	7
	1.7	2.5	1.5	1.1	1.3	2.3	2.4	1.4	.4	1.4	3.0
AVERAGE	4.09	3.13	4.00	3.03	4.37	5.34	3.81	3.27	3.16	4.23	5.76

NATIONAL ANALYSTS
METAL FINISHING STUDY (815-2)

QUESTION NO.11 THINKING ABOUT ALL OF THE METAL FINISHING YOU DO IN-HOUSE, WHAT PERCENT OF THAT WORK IS DONE WITH PARTS FROM OUTSIDE CUSTOMERS/VENDERS?

		--- PERCENTAGE VALUE ADDED ---					- TOTAL PLANT SALES -				
	TOTAL	LESS THAN 1 PCT	1-3 PCT	4-6 PCT	7-9 PCT	10 OR MORE	UNDER $1 MIL	$1 MIL- 4.9 MIL	$5 MIL- 9.9 MIL	$10-50 MILLION	MORE THAN $50 MIL
TOTAL	1614	254	400	270	155	394	175	367	233	565	237
NO ANSWER	46	12	10	5	1	11	5	11	10	6	7
NUMBER ANSWERING	1568	242	390	265	154	383	170	356	223	559	230
	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
LESS THAN 25 PERCENT	1425	219	368	240	145	337	127	324	208	521	216
	90.9	90.5	94.4	90.6	94.2	88.0	74.7	91.0	93.3	93.2	93.9
25 TO 49 PERCENT	44	7	5	7	6	15	7	11	5	16	5
	2.8	2.9	1.3	2.6	3.9	3.9	4.1	3.1	2.2	2.9	2.2
50 TO 74 PERCENT	51	10	10	10	2	14	10	13	5	14	8
	3.3	4.1	2.6	3.8	1.3	3.7	5.9	3.7	2.2	2.5	3.5
75 PERCENT OR MORE	48	6	7	8	1	17	26	8	5	8	1
	3.1	2.5	1.8	3.0	.6	4.4	15.3	2.2	2.2	1.4	.4
AVERAGE	6.14	5.45	4.63	7.30	5.03	7.48	12.96	5.89	5.43	5.02	5.42

NATIONAL ANALYSTS
METAL FINISHING STUDY (815-2)

QUESTION NO.12 IN THE LAST THREE YEARS, WHAT WAS THE AVERAGE ANNUAL SALES OF ALL GOODS PRODUCED AT THIS PLANT?

		- - - PERCENTAGE VALUE ADDED - - -					- T O T A L P L A N T S A L E S -				
	TOTAL	LESS THAN 1 PCT	1-3 PCT	4-6 PCT	7-9 PCT	10 OR MORE	UNDER $1 MIL	$1 MIL- 4.9 MIL	$5 MIL- 9.9 MIL	$10-50 MILLION	MORE THAN $50 MIL
TOTAL	1614	254	400	270	155	394	175	367	233	565	237
NO ANSWER	37	8	9		1	7					
NUMBER ANSWERING	1577	246	391	270	154	387	175	367	233	565	237
	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
UNDER $1,000,000	175	27	39	27	11	53	175				
	11.1	11.0	10.0	10.0	7.1	13.7	100.0				
$1,000,000-4,999,999	367	36	96	61	40	109		367			
	23.3	14.6	24.6	22.6	26.0	28.2		100.0			
$5,000,000-9,999,999	233	32	43	54	29	61			233		
	14.8	13.0	11.0	20.0	18.8	15.8			100.0		
$10,000,000-50,000,000	565	101	152	98	53	121				565	
	35.8	41.1	38.9	36.3	34.4	31.3				100.0	
MORE THAN $50,000,000	237	50	61	30	21	43					237
	15.0	20.3	15.6	11.1	13.6	11.1					100.0

NATIONAL ANALYSTS
METAL FINISHING STUDY (815-2)

QUESTION NO.13 WHAT ARE THE AVERAGE ANNUAL SALES OF THE WHOLE CORPORATION OF WHICH YOU ARE A PART?

		--- PERCENTAGE VALUE ADDED ---					- TOTAL PLANT SALES -				
	TOTAL	LESS THAN 1 PCT	1-3 PCT	4-6 PCT	7-9 PCT	10 OR MORE	UNDER $1 MIL	$1 MIL-4.9 MIL	$5 MIL-9.9 MIL	$10-50 MILLION	MORE THAN $50 MIL
TOTAL	1614	254	400	270	155	394	175	367	233	565	237
NO ANSWER	41	4	6	3	3	10	3	7	3	4	2
NUMBER ANSWERING	1573	250	394	267	152	384	172	360	230	561	235
	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
UNDER $1,000,000	106	15	20	17	7	38	102	3			
	6.7	6.0	5.1	6.4	4.6	9.9	59.3	.8			
$1,000,000-4,999,999	227	23	51	35	22	82	26	193	4	1	1
	14.4	9.2	12.9	13.1	14.5	21.4	15.1	53.6	1.7	.2	.4
$5,000,000-9,999,999	126	19	26	22	15	34	9	37	74	5	
	8.0	7.6	6.6	8.2	9.9	8.9	5.2	10.3	32.2	.9	
$10,000,000-50,000,000	271	34	78	44	34	63	14	55	51	144	4
	17.2	13.6	19.8	16.5	22.4	16.4	8.1	15.3	22.2	25.7	1.7
MORE THAN $50,000,000	843	159	219	149	74	167	21	72	101	411	230
	53.6	63.6	55.6	55.8	48.7	43.5	12.2	20.0	43.9	73.3	97.9

QUESTION NO.14 WHAT PERCENT OF ALL GOODS PRODUCED AT THIS PLANT RECEIVES SOME METAL FINISHING?

		--- PERCENTAGE VALUE ADDED ---					- TOTAL PLANT SALES -				
	TOTAL	LESS THAN 1 PCT	1-3 PCT	4-6 PCT	7-9 PCT	10 OR MORE	UNDER $1 MIL	$1 MIL- 4.9 MIL	$5 MIL- 9.9 MIL	$10-50 MILLION	MORE THAN $50 MIL
TOTAL	1614	254	400	270	155	394	175	367	233	565	237
NO ANSWER	42	10	8	2	2	4	6	8	2	10	7
NUMBER ANSWERING	1572	244	392	268	153	390	169	359	231	555	230
	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
LESS THAN 25 PERCENT	292	124	79	41	16	14	50	53	41	90	53
	18.6	50.8	20.2	15.3	10.5	3.6	29.6	14.8	17.7	16.2	23.0
25 TO 49 PERCENT	188	28	57	38	17	37	13	51	25	65	30
	12.0	11.5	14.5	14.2	11.1	9.5	7.7	14.2	10.8	11.7	13.0
50 TO 74 PERCENT	219	21	56	42	25	59	20	56	29	84	27
	13.9	8.6	14.3	15.7	16.3	15.1	11.8	15.6	12.6	15.1	11.7
75 PERCENT OR MORE	873	71	200	147	95	280	86	199	136	316	120
	55.5	29.1	51.0	54.9	62.1	71.8	50.9	55.4	58.9	56.9	52.2
AVERAGE	54.17	27.15	51.22	56.83	65.67	69.37	43.53	57.73	56.59	56.53	48.07

NATIONAL ANALYSTS
METAL FINISHING STUDY (815-2)

QUESTION NO.15 ON THE AVERAGE, FOR THE PRODUCTS MADE AT YOUR PLANT HOW MUCH OF THE TOTAL COST TO MANUFACTURE A PRODUCT IS DUE TO THE COST OF METAL FINISHING?

		--- PERCENTAGE VALUE ADDED ---					- T O T A L P L A N T S A L E S -				
	TOTAL	LESS THAN 1 PCT	1-3 PCT	4-6 PCT	7-9 PCT	10 OR MORE	UNDER $1 MIL	$1 MIL- 4.9 MIL	$5 MIL- 9.9 MIL	$10-50 MILLION	MORE THAN $50 MIL
TOTAL	1614	254	400	270	155	394	175	367	233	565	237
NO ANSWER	23						6	3	2	4	3
NUMBER ANSWERING	1591	254	400	270	155	394	169	364	231	561	234
	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
LESS THAN 1 PERCENT	254	254					27	36	32	101	50
	16.0	100.0					16.0	9.9	13.9	18.0	21.4
1 PERCENT TO 3 PERCENT	400		400				39	96	43	152	61
	25.1		100.0				23.1	26.4	18.6	27.1	26.1
4 PERCENT TO 6 PERCENT	270			270			27	61	54	98	30
	17.0			100.0			16.0	16.8	23.4	17.5	12.8
7 PERCENT TO 9 PERCENT	155				155		11	40	29	53	21
	9.7				100.0		6.5	11.0	12.6	9.4	9.0
10 PERCENT OR MORE	394					394	53	109	61	121	43
	24.8					100.0	31.4	29.9	26.4	21.6	18.4
DON'T KNOW	118						12	22	12	36	29
	7.4						7.1	6.0	5.2	6.4	12.4

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NATIONAL ANALYSTS
METAL FINISHING STUDY (815-2)

QUESTION NO.12,14,15 PLANT VALUE ADDED

		- - - PERCENTAGE VALUE ADDED - - -					- T O T A L P L A N T S A L E S -				
	TOTAL	LESS THAN 1 PCT	1-3 PCT	4-6 PCT	7-9 PCT	10 OR MORE	UNDER $1 MIL	$1 MIL-4.9 MIL	$5 MIL-9.9 MIL	$10-50 MILLION	MORE THAN $50 MIL
TOTAL	1614	254	400	270	155	394	175	367	233	565	237
NO ANSWER	189	16	16	2	3	11	20	31	16	49	36
NUMBER ANSWERING	1425 100.0	238 100.0	384 100.0	268 100.0	152 100.0	383 100.0	155 100.0	336 100.0	217 100.0	516 100.0	201 100.0
LESS THAN $50,000	386 27.1	167 70.2	144 37.5	48 17.9	16 10.5	11 2.9	110 71.0	133 39.6	50 23.0	58 13.2	25 12.4
$50,000 TO $99,999	154 10.8	20 8.4	38 9.9	32 11.9	11 7.2	53 13.8	45 29.0	58 17.3	14 6.5	30 5.8	7 3.5
$100,000 TO $499,999	363 25.5	42 17.6	95 24.7	83 31.0	39 25.7	104 27.2		145 43.2	82 37.8	114 22.1	22 10.9
$500,000 TO $999,999	134 9.4	9 3.8	68 17.7	18 6.7	20 13.2	19 5.0			34 15.7	74 14.3	26 12.9
$1,000,000 TO $4,999,999	329 23.1		39 10.2	78 29.1	53 34.9	159 41.5			37 17.1	230 44.6	62 30.8
$5,000,000 OR MORE	59 4.1			9 3.4	13 8.6	37 9.7					59 29.4
AVERAGE (THOUSANDS)	348	65	365	802	1478	2545	27	133	398	1356	3658

NATIONAL ANALYSTS
METAL FINISHING STUDY (815-2)

QUESTION NO.13,14,15 CORPORATE VALUE ADDED

		- - - PERCENTAGE VALUE ADDED - - -					- T O T A L P L A N T S A L E S -				
	TOTAL	LESS THAN 1 PCT	1-3 PCT	4-6 PCT	7-9 PCT	10 OR MORE	UNDER $1 MIL	$1 MIL- 4.9 MIL	$5 MIL- 9.9 MIL	$10-50 MILLION	MORE THAN $50 MIL
TOTAL	1614	254	400	270	155	394	175	367	233	565	237
NO ANSWER	190	13	13	5	5	13	21	37	19	51	38
NUMBER ANSWERING	1424	241	387	265	150	381	154	330	214	514	199
	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
LESS THAN $50,000	255	130	81	26	10	8	79	76	30	42	25
	17.9	53.9	20.9	9.8	6.7	2.1	51.3	23.0	14.0	8.2	12.6
$50,000 TO $99,999	113	20	26	23	3	41	40	45	8	12	6
	7.9	8.3	6.7	8.7	2.0	10.8	26.0	13.6	3.7	2.3	3.0
$100,000 TO $499,999	288	64	76	43	26	79	15	120	43	86	22
	20.2	26.6	19.6	16.2	17.3	20.7	9.7	36.4	20.1	16.7	11.1
$500,000 TO $999,999	131	27	54	22	13	15	4	22	26	50	26
	9.2	11.2	14.0	8.3	8.7	3.9	2.6	6.7	12.1	9.7	13.1
$1,000,000 TO $4,999,999	402		150	115	51	86	13	48	73	204	62
	28.2		38.8	43.4	34.0	22.6	8.4	14.5	34.1	39.7	31.2
$5,000,000 OR MORE	235			36	47	152	3	19	34	120	58
	16.5			13.6	31.3	39.9	1.9	5.8	15.9	23.3	29.1
AVERAGE (THOUSANDS)	2541	132	800	2046	3199	5919	455	1224	2649	3570	3654

NATIONAL ANALYSTS
METAL FINISHING STUDY (815-2)

QUESTION NO.16 DO YOU COMPILE OR RECEIVE ON A REGULAR BASIS A COST BREAKDOWN FOR THE METAL FINISHING OPERATION?

		--- PERCENTAGE VALUE ADDED ---					- T O T A L P L A N T S A L E S -				
	TOTAL	LESS THAN 1 PCT	1-3 PCT	4-6 PCT	7-9 PCT	10 OR MORE	UNDER $1 MIL	$1 MIL- 4.9 MIL	$5 MIL- 9.9 MIL	$10-50 MILLION	MORE THAN $50 MIL
TOTAL	1614	254	400	270	155	394	175	367	233	565	237
NO ANSWER	17	1	1	2	1	3	2	4	1	4	2
NUMBER ANSWERING	1597	253	399	268	154	391	173	363	232	561	235
	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
YES, FOR JUST THIS PLANT	913	98	209	170	105	276	86	206	146	333	126
	57.2	38.7	52.4	63.4	68.2	70.6	49.7	56.7	62.9	59.4	53.6
YES, BUT INCLUDES THIS PLANT PLUS OTHER LOCATIONS	63	7	14	8	10	21	5	13	5	24	14
	3.9	2.8	3.5	3.0	6.5	5.4	2.9	3.6	2.2	4.3	6.0
NO, COSTS HANDLED ELSEWHERE	213	33	63	38	14	30	14	31	30	83	50
	13.3	13.0	15.8	14.2	9.1	7.7	8.1	8.5	12.9	14.8	21.3
NO, COSTS NOT RECORDED	408	115	113	52	25	64	68	113	51	121	45
	25.5	45.5	28.3	19.4	16.2	16.4	39.3	31.1	22.0	21.6	19.1

QUESTION NO.17 IF RECORDS ARE KEPT FOR THE METAL FINISHING OPERATION, WHAT ITEMS ARE ACCOUNTED FOR ON A REGULAR BASIS?

	TOTAL	--- PERCENTAGE VALUE ADDED --- LESS THAN 1 PCT	1-3 PCT	4-6 PCT	7-9 PCT	10 OR MORE	- TOTAL PLANT SALES - UNDER $1 MIL	$1 MIL-4.9 MIL	$5 MIL-9.9 MIL	$10-50 MILLION	MORE THAN $50 MIL
TOTAL	1614	254	400	270	155	394	175	367	233	565	237
NO ANSWER	121	31	32	17	7	19	21	36	10	30	17
NUMBER ANSWERING	1493	223	368	253	148	375	154	331	223	535	220
	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
TOTAL WATER	635	45	131	113	81	217	45	119	107	257	96
	42.5	20.2	35.6	44.7	54.7	57.9	29.2	36.0	48.0	48.0	43.6
PROCESS WATER	401	34	83	68	48	136	22	63	65	170	75
	26.9	15.2	22.6	26.9	32.4	36.3	14.3	19.0	29.1	31.8	34.1
AREA PLATED	274	19	61	43	28	103	19	61	44	100	43
	18.4	8.5	16.6	17.0	18.9	27.5	12.3	18.4	19.7	18.7	19.5
JOBS PROCESSED	817	91	184	144	96	234	64	166	132	301	137
	54.7	40.8	50.0	56.9	64.9	62.4	41.6	50.2	59.2	56.3	62.3
AMP HOURS	193	9	28	36	23	83	18	45	22	73	30
	12.9	4.0	7.6	14.2	15.5	22.1	11.7	13.6	9.9	13.6	13.6
CHEMICAL USE	1056	122	254	187	117	290	81	204	161	412	177
	70.7	54.7	69.0	73.9	79.1	77.3	52.6	61.6	72.2	77.0	80.5
FACTORY OVERHEAD	915	97	213	163	109	261	72	192	151	340	144
	61.3	43.5	57.9	64.4	73.6	69.6	46.8	58.0	67.7	63.6	65.5
DIRECT LABOR	1197	146	278	222	132	320	103	247	183	451	192
	80.2	65.5	75.5	87.7	89.2	85.3	66.9	74.6	82.1	84.3	87.3
PERSON HOURS	836	96	195	147	95	238	76	169	117	321	137
	56.0	43.0	53.0	58.1	64.2	63.5	49.4	51.1	52.5	60.0	62.3
REVENUES GENERATED	283	15	43	36	35	134	43	85	41	71	40
	19.0	6.7	11.7	14.2	23.6	35.7	27.9	25.7	18.4	13.3	18.2
NONE OF THE ABOVE ITEMS IS ACCOUNTED FOR	202	58	63	22	11	30	42	58	24	54	19
	13.5	26.0	17.1	8.7	7.4	8.0	27.3	17.5	10.8	10.1	8.6

NATIONAL ANALYSTS
METAL FINISHING STUDY (815-2)

QUESTION NO.18 IN 1976, WHAT WAS YOUR TOTAL OPERATING BUDGET FOR DOING METAL FINISHING AT YOUR PLANT?

		- - - PERCENTAGE VALUE ADDED - - -					- T O T A L P L A N T S A L E S -				
	TOTAL	LESS THAN 1 PCT	1-3 PCT	4-6 PCT	7-9 PCT	10 OR MORE	UNDER $1 MIL	$1 MIL- 4.9 MIL	$5 MIL- 9.9 MIL	$10-50 MILLION	MORE THAN $50 MIL
TOTAL	1614	254	400	270	155	394	175	367	233	565	237
NO ANSWER	562	104	127	88	42	119	61	129	88	172	86
NUMBER ANSWERING	1052	150	273	182	113	275	114	238	145	393	151
	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
LESS THAN $100,000	391	101	121	69	28	51	76	140	50	96	24
	37.2	67.3	44.3	37.9	24.8	18.5	66.7	58.8	34.5	24.4	15.9
$100,000 TO $499,999	383	40	101	74	49	99	31	74	62	174	38
	36.4	26.7	37.0	40.7	43.4	36.0	27.2	31.1	42.8	44.3	25.2
$500,000 TO $999,999	125	5	28	21	21	45	6	17	22	52	27
	11.9	3.3	10.3	11.5	18.6	16.4	5.3	7.1	15.2	13.2	17.9
$1,000,000 TO $4,999,999	121	3	20	16	12	58	1	7	10	61	41
	11.5	2.0	7.3	8.8	10.6	21.1	.9	2.9	6.9	15.5	27.2
$5,000,000 OR MORE	32	1	3	2	3	22			1	10	21
	3.0	.7	1.1	1.1	2.7	8.0			.7	2.5	13.9
AVERAGE (THOUSANDS)	637	198	379	419	663	1265	111	194	381	686	1875

NATIONAL ANALYSTS
METAL FINISHING STUDY (815-2)

QUESTION NO.19 WHAT IS YOUR 1976 BUDGET FOR DIRECT LABOR?

	TOTAL	--- PERCENTAGE VALUE ADDED --- LESS THAN 1 PCT	1-3 PCT	4-6 PCT	7-9 PCT	10 OR MORE	- TOTAL PLANT SALES - UNDER $1 MIL	$1 MIL-4.9 MIL	$5 MIL-9.9 MIL	$10-50 MILLION	MORE THAN $50 MIL
TOTAL	1614	254	400	270	155	394	175	367	233	565	237
NO ANSWER	675	125	156	118	49	139	81	176	112	186	93
NUMBER ANSWERING	939	129	244	152	106	255	94	191	121	379	144
	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
LESS THAN $20,000	140	43	56	20	4	9	31	46	14	42	6
	14.9	33.3	23.0	13.2	3.8	3.5	33.0	24.1	11.6	11.1	4.2
$20,000 TO $49,999	189	39	63	33	16	31	25	62	31	55	12
	20.1	30.2	25.8	21.7	15.1	12.2	26.6	32.5	25.6	14.5	8.3
$50,000 TO $99,999	172	21	36	30	23	51	17	35	29	78	12
	18.3	16.3	14.8	19.7	21.7	20.0	18.1	18.3	24.0	20.6	8.3
$100,000 TO $499,999	337	21	75	55	53	111	20	45	44	160	65
	35.9	16.3	30.7	36.2	50.0	43.5	21.3	23.6	36.4	42.2	45.1
$500,000 TO $999,999	52	4	7	9	5	23	1	2	1	27	20
	5.5	3.1	2.9	5.9	4.7	9.0	1.1	1.0	.8	7.1	13.9
$1,000,000 OR MORE	49	1	7	5	5	30		1	2	17	29
	5.2	.8	2.9	3.3	4.7	11.8		.5	1.7	4.5	20.1
AVERAGE (THOUSANDS)	269	90	161	224	309	487	65	82	151	248	809

QUESTION NO.19 WHAT IS YOUR 1976 BUDGET FOR
CHEMICAL?

		--- PERCENTAGE VALUE ADDED ---					- T O T A L P L A N T S A L E S -				
	TOTAL	LESS THAN 1 PCT	1-3 PCT	4-6 PCT	7-9 PCT	10 OR MORE	UNDER $1 MIL	$1 MIL- 4.9 MIL	$5 MIL- 9.9 MIL	$10-50 MILLION	MORE THAN $50 MIL
TOTAL	1614	254	400	270	155	394	175	367	233	565	237
NO ANSWER	719	133	163	130	50	147	89	181	114	206	100
NUMBER ANSWERING	895	121	237	140	105	247	86	186	119	359	137
	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
LESS THAN $20,000	281	79	86	38	30	35	57	91	34	76	22
	31.4	65.3	36.3	27.1	28.6	14.2	66.3	48.9	28.6	21.2	16.1
$20,000 TO $49,999	173	21	55	34	20	34	17	38	31	67	18
	19.3	17.4	23.2	24.3	19.0	13.8	19.8	20.4	26.1	18.7	13.1
$50,000 TO $99,999	133	6	36	24	15	43	9	23	16	65	19
	14.9	5.0	15.2	17.1	14.3	17.4	10.5	12.4	13.4	18.1	13.9
$100,000 TO $499,999	248	14	54	39	34	94	3	31	36	121	53
	27.7	11.6	22.8	27.9	32.4	38.1	3.5	16.7	30.3	33.7	38.7
$500,000 TO $999,999	39		3	4	4	27		3	1	23	12
	4.4		1.3	2.9	3.8	10.9		1.6	.8	6.4	8.8
$1,000,000 OR MORE	21	1	3	1	2	14			1	7	13
	2.3	.8	1.3	.7	1.9	5.7			.8	1.9	9.5
AVERAGE (THOUSANDS)	170	117	97	120	152	317	21	60	96	176	463

NATIONAL ANALYSTS
METAL FINISHING STUDY (815-2)

QUESTION NO.19 WHAT IS YOUR 1976 BUDGET FOR WATER?

		--- PERCENTAGE VALUE ADDED ---					- TOTAL PLANT SALES -				
	TOTAL	LESS THAN 1 PCT	1-3 PCT	4-6 PCT	7-9 PCT	10 OR MORE	UNDER $1 MIL	$1 MIL- 4.9 MIL	$5 MIL- 9.9 MIL	$10-50 MILLION	MORE THAN $50 MIL
TOTAL	1614.	254	400	270	155	394	175	367	233	565	237
NO ANSWER	922	180	216	161	67	192	112	221	144	281	130
NUMBER ANSWERING	692 100.0	74 100.0	184 100.0	109 100.0	88 100.0	202 100.0	63 100.0	146 100.0	89 100.0	284 100.0	107 100.0
LESS THAN $20,000	528 76.3	67 90.5	148 80.4	88 80.7	68 77.3	130 64.4	63 100.0	131 89.7	77 86.5	199 70.1	56 52.3
$20,000 TO $49,999	102 14.7	5 6.8	25 13.6	14 12.8	13 14.8	40 19.8		13 8.9	8 9.0	56 19.7	24 22.4
$50,000 TO $99,999	39 5.6	2 2.7	6 3.3	4 3.7	6 6.8	19 9.4		2 1.4	2 2.2	22 7.7	13 12.1
$100,000 TO $499,999	17 2.5		2 1.1	3 2.8		11 5.4			1 1.1	7 2.5	9 8.4
$500,000 TO $999,999	4 .6		2 1.1		1 1.1	1 .5			1 1.1		3 2.8
$1,000,000 OR MORE	2 .3		1 .5			1 .5					2 1.9
AVERAGE (THOUSANDS)	32	7	49	17	22	43	3	8	16	19	132

QUESTION NO.19 WHAT IS YOUR 1976 BUDGET FOR ENERGY AND UTILITIES?

		--- PERCENTAGE VALUE ADDED ---					- TOTAL PLANT SALES -				
	TOTAL	LESS THAN 1 PCT	1-3 PCT	4-6 PCT	7-9 PCT	10 OR MORE	UNDER $1 MIL	$1 MIL- 4.9 MIL	$5 MIL- 9.9 MIL	$10-50 MILLION	MORE THAN $50 MIL
TOTAL	1614	254	400	270	155	394	175	367	233	565	237
NO ANSWER	862	171	209	151	59	170	97	205	132	270	125
NUMBER ANSWERING	752 100.0	83 100.0	191 100.0	119 100.0	96 100.0	224 100.0	78 100.0	162 100.0	101 100.0	295 100.0	112 100.0
LESS THAN $20,000	360 47.9	56 67.5	114 59.7	56 47.1	35 36.5	82 36.6	63 80.8	109 67.3	43 42.6	116 39.3	27 24.1
$20,000 TO $49,999	153 20.3	16 19.3	30 15.7	29 24.4	28 29.2	39 17.4	13 16.7	27 16.7	33 32.7	56 19.7	21 18.8
$50,000 TO $99,999	102 13.6	6 7.2	27 14.1	15 12.6	13 13.5	36 16.1		19 11.7	16 15.8	56 19.0	11 9.8
$100,000 TO $499,999	112 14.9	5 6.0	18 9.4	18 15.1	16 16.7	50 22.3	2 2.6	7 4.3	8 7.9	54 18.3	40 35.7
$500,000 TO $999,999	14 1.9		2 1.0	1 .8		10 4.5			1 1.0	8 2.7	5 4.5
$1,000,000 OR MORE	11 1.5				4 4.2	7 3.1				3 1.0	8 7.1
AVERAGE (THOUSANDS)	90	24	41	54	117	171	12	24	41	88	295

NATIONAL ANALYSTS
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QUESTION NO.19 WHAT IS YOUR 1976 BUDGET FOR OTHER ITEMS?

		--- PERCENTAGE VALUE ADDED ---					- T O T A L P L A N T S A L E S -				
	TOTAL	LESS THAN 1 PCT	1-3 PCT	4-6 PCT	7-9 PCT	10 OR MORE	UNDER $1 MIL	$1 MIL-4.9 MIL	$5 MIL-9.9 MIL	$10-50 MILLION	MORE THAN $50 MIL
TOTAL	1614	254	400	270	155	394	175	367	233	565	237
NO ANSWER	1070	197	256	176	95	235	127	267	167	335	142
NUMBER ANSWERING	544	57	144	94	60	159	48	100	66	230	95
	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
LESS THAN $20,000	169	23	55	30	17	33	26	49	18	57	17
	31.1	40.4	38.2	31.9	28.3	20.8	54.2	49.0	27.3	24.8	17.9
$20,000 TO $49,999	98	16	27	16	9	24	9	17	11	47	14
	18.0	28.1	18.8	17.0	15.0	15.1	18.8	17.0	16.7	20.4	14.7
$50,000 TO $99,999	64	7	21	13	6	15	6	10	8	33	7
	11.8	12.3	14.6	13.8	10.0	9.4	12.5	10.0	12.1	14.3	7.4
$100,000 TO $499,999	141	9	30	27	19	49	7	19	22	61	29
	25.9	15.8	20.8	28.7	31.7	30.8	14.6	19.0	33.3	26.5	30.5
$500,000 TO $999,999	40	1	6	6	4	20		4	4	18	14
	7.4	1.8	4.2	6.4	6.7	12.6		4.0	6.1	7.8	14.7
$1,000,000 OR MORE	32	1	5	2	5	18		1	3	14	14
	5.9	1.8	3.5	2.1	8.3	11.3		1.0	4.5	6.1	14.7
AVERAGE (THOUSANDS)	272	77	174	161	312	497	54	90	192	290	591

QUESTION NO.20 ON A TYPICAL DAY IN 1976
HOW MUCH WATER DID YOUR TOTAL PLANT USE?

		--- PERCENTAGE VALUE ADDED ---					- TOTAL PLANT SALES -				
	TOTAL	LESS THAN 1 PCT	1-3 PCT	4-6 PCT	7-9 PCT	10 OR MORE	UNDER $1 MIL	$1 MIL- 4.9 MIL	$5 MIL- 9.9 MIL	$10-50 MILLION	MORE THAN $50 MIL
TOTAL	1614	254	400	270	155	394	175	367	233	565	237
NO ANSWER	441	67	107	82	41	90	76	148	71	101	26
NUMBER ANSWERING	1173	187	293	188	114	304	99	219	162	464	211
	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
LESS THAN 2,000 GALLONS	82	17	19	13	7	21	31	27	10	10	2
	7.0	9.1	6.5	6.9	6.1	6.9	31.3	12.3	6.2	2.2	.9
2,000 TO 9,999	124	21	33	25	7	33	25	65	9	20	3
	10.6	11.2	11.3	13.3	6.1	10.9	25.3	29.7	5.6	4.3	1.4
10,000 TO 49,999	254	38	58	39	25	74	23	81	53	82	13
	21.7	20.3	19.8	20.7	21.9	24.3	23.2	37.0	32.7	17.7	6.2
50,000 TO 99,999	152	27	42	27	23	24	6	22	27	79	16
	13.0	14.4	14.3	14.4	20.2	7.9	6.1	10.0	16.7	17.0	7.6
100,000 TO 499,999	357	49	89	56	34	105	12	18	53	206	61
	30.4	26.2	30.4	29.8	29.8	34.5	12.1	8.2	32.7	44.4	28.9
500,000 GALLONS OR MORE	204	35	52	28	18	47	2	6	10	67	116
	17.4	18.7	17.7	14.9	15.8	15.5	2.0	2.7	6.2	14.4	55.0
AVERAGE (THOUSANDS)	808	787	691	288	1500	917	241	205	494	823	1950

QUESTION NO.20 ON A TYPICAL DAY IN 1976
HOW MUCH WATER DID YOUR METAL FINISHING
PROCESS USE?

		--- PERCENTAGE VALUE ADDED ---					- TOTAL PLANT SALES -				
	TOTAL	LESS THAN 1 PCT	1-3 PCT	4-6 PCT	7-9 PCT	10 OR MORE	UNDER $1 MIL	$1 MIL- 4.9 MIL	$5 MIL- 9.9 MIL	$10-50 MILLION	MORE THAN $50 MIL
TOTAL	1614	254	400	270	155	394	175	367	233	565	237
NO ANSWER	489	95	121	82	37	97	81	150	75	116	48
NUMBER ANSWERING	1125	159	279	188	118	297	94	217	158	449	189
	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
LESS THAN 2,000 GALLONS	188	55	49	32	14	30	41	59	23	50	11
	16.7	34.6	17.6	17.0	11.9	10.1	43.6	27.2	14.6	11.1	5.8
2,000 TO 9,999	198	33	54	31	19	47	22	67	32	59	17
	17.6	20.8	19.4	16.5	16.1	15.8	23.4	30.9	20.3	13.1	9.0
10,000 TO 49,999	305	37	90	54	30	67	24	55	49	137	36
	27.1	23.3	32.3	28.7	25.4	22.6	25.5	25.3	31.0	30.5	19.0
50,000 TO 99,999	138	18	27	20	19	44	3	23	26	62	20
	12.3	11.3	9.7	10.6	16.1	14.8	3.2	10.6	16.5	13.8	10.6
100,000 TO 499,999	239	13	48	45	25	87	3	7	27	122	76
	21.2	8.2	17.2	23.9	21.2	29.3	3.2	3.2	17.1	27.2	40.2
500,000 GALLONS OR MORE	57	3	11	6	11	22	1	6	1	19	29
	5.1	1.9	3.9	3.2	9.3	7.4	1.1	2.8	.6	4.2	15.3
AVERAGE (THOUSANDS)	277	50	162	78	423	621	30	118	339	358	356

NATIONAL ANALYSTS
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QUESTION NO.20 ON A TYPICAL DAY IN 1976
HOW MUCH WATER DID YOUR OTHER PRODUCTION
PROCESS USE?

		--- PERCENTAGE VALUE ADDED ---					- T O T A L P L A N T S A L E S -				
	TOTAL	LESS THAN 1 PCT	1-3 PCT	4-6 PCT	7-9 PCT	10 OR MORE	UNDER $1 MIL	$1 MIL- 4.9 MIL	$5 MIL- 9.9 MIL	$10-50 MILLION	MORE THAN $50 MIL
TOTAL	1614	254	400	270	155	394	175	367	233	565	237
NO ANSWER	572	100	143	98	45	120	86	176	88	147	52
NUMBER ANSWERING	1042	154	257	172	110	274	89	191	145	418	185
	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
LESS THAN 2,000 GALLONS	368	56	86	63	39	98	67	99	52	112	29
	35.3	36.4	33.5	36.6	35.5	35.8	75.3	51.8	35.9	26.8	15.7
2,000 TO 9,999	127	16	34	23	13	34	10	55	21	36	5
	12.2	10.4	13.2	13.4	11.8	12.4	11.2	28.8	14.5	8.6	2.7
10,000 TO 49,999	211	34	45	34	20	65	7	23	41	108	31
	20.2	22.1	17.5	19.8	18.2	23.7	7.9	12.0	28.3	25.8	16.8
50,000 TO 99,999	96	14	29	17	9	18	3	8	14	57	14
	9.2	9.1	11.3	9.9	8.2	6.6	3.4	4.2	9.7	13.6	7.6
100,000 TO 499,999	181	23	45	25	20	51	2	4	16	88	69
	17.4	14.9	17.5	14.5	18.2	18.6	2.2	2.1	11.0	21.1	37.3
500,000 GALLONS OR MORE	59	11	18	10	9	8		2	1	17	37
	5.7	7.1	7.0	5.8	8.2	2.9		1.0	.7	4.1	20.0
AVERAGE (THOUSANDS)	384	446	486	124	1214	147	9	99	67	363	1174

QUESTION NO.21 WHERE DOES YOUR METAL FINISHING DISCHARGE WATER GO?

		--- PERCENTAGE VALUE ADDED ---					- T O T A L P L A N T S A L E S -				
	TOTAL	LESS THAN 1 PCT	1-3 PCT	4-6 PCT	7-9 PCT	10 OR MORE	UNDER $1 MIL	$1 MIL-4.9 MIL	$5 MIL-9.9 MIL	$10-50 MILLION	MORE THAN $50 MIL
TOTAL	1614	254	400	270	155	394	175	367	233	565	237
NO ANSWER	32	12	5	3	4	4	1	8	7	9	3
NUMBER ANSWERING	1582	242	395	267	151	390	174	359	226	556	234
	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
MUNICIPAL SEWER SYSTEM	955	156	230	169	90	225	115	223	136	339	123
	60.4	64.5	58.2	63.3	59.6	57.7	66.1	62.1	60.2	61.0	52.6
RIVER, LAKE, POND, OTHER SURFACE WATER	250	40	62	34	21	64	22	40	37	93	54
	15.8	16.5	15.7	12.7	13.9	16.4	12.6	11.1	16.4	16.7	23.1
BOTH OF THE ABOVE	78	6	21	10	11	24	3	16	10	30	16
	4.9	2.5	5.3	3.7	7.3	6.2	1.7	4.5	4.4	5.4	6.8
HOLDING TANKS	174	24	42	36	18	47	26	43	22	54	25
	11.0	9.9	10.6	13.5	11.9	12.1	14.9	12.0	9.7	9.7	10.7
MUNICIPAL SEWER SYSTEM AND HOLDING TANK	98	15	30	12	8	24	5	27	17	31	15
	6.2	6.2	7.6	4.5	5.3	6.2	2.9	7.5	7.5	5.6	6.4
NATURAL SURFACE WATER AND HOLDING TANK	23		7	6	3	6	3	10	3	7	
	1.5		1.8	2.2	2.0	1.5	1.7	2.8	1.3	1.3	
CHEMICAL TREATMENT PLANT	1		1						1		
	.1		.3						.4		
COMBINED MUNICIPAL, NATURAL, AND HOLDING	3	1	2							2	1
	.2	.4	.5							.4	.4

QUESTION NO.22 DO YOU TREAT THE EFFLUENT FROM YOUR METAL FINISHING OPERATIONS AT THIS PLANT?

		--- PERCENTAGE VALUE ADDED ---					- TOTAL PLANT SALES -				
	TOTAL	LESS THAN 1 PCT	1-3 PCT	4-6 PCT	7-9 PCT	10 OR MORE	UNDER $1 MIL	$1 MIL- 4.9 MIL	$5 MIL- 9.9 MIL	$10-50 MILLION	MORE THAN $50 MIL
TOTAL	1614	254	400	270	155	394	175	367	233	565	237
NO ANSWER	33	10	7	5	2	4	6	11	4	5	3
NUMBER ANSWERING	1581 100.0	244 100.0	393 100.0	265 100.0	153 100.0	390 100.0	169 100.0	356 100.0	229 100.0	560 100.0	234 100.0
YES	941 59.5	116 47.5	216 55.0	149 56.2	101 66.0	261 66.9	70 41.4	189 53.1	130 56.8	355 63.4	172 73.5
NO	640 40.5	128 52.5	177 45.0	116 43.8	52 34.0	129 33.1	99 58.6	167 46.9	99 43.2	205 36.6	62 26.5

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QUESTION NO.23 (IF EFFLUENT IS TREATED, Q.22) HOW MUCH HAVE YOU SPENT TO BUY ALL OF YOUR WATER POLLUTION CONTROL EQUIPMENT AT THIS PLANT?

		--- PERCENTAGE VALUE ADDED ---					- T O T A L P L A N T S A L E S -				
	TOTAL	LESS THAN 1 PCT	1-3 PCT	4-6 PCT	7-9 PCT	10 OR MORE	UNDER $1 MIL	$1 MIL-4.9 MIL	$5 MIL-9.9 MIL	$10-50 MILLION	MORE THAN $50 MIL
TOTAL	941	116	216	149	101	261	70	189	130	355	172
NO ANSWER	7	2		1		3	1	1	2		2
NUMBER ANSWERING	934	114	216	148	101	258	69	188	128	355	170
	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
UNDER $100,000	463	66	109	79	47	114	59	135	73	151	34
	49.6	57.9	50.5	53.4	46.5	44.2	85.5	71.8	57.0	42.5	20.0
$100,000-$249,999	214	18	57	32	21	67	5	43	30	95	33
	22.9	15.8	26.4	21.6	20.8	26.0	7.2	22.9	23.4	26.8	19.4
$250,000-$499,999	122	9	23	24	16	38	4	9	18	63	25
	13.1	7.9	10.6	16.2	15.8	14.7	5.8	4.8	14.1	17.7	14.7
$500,00-$1,000,000	71	8	14	8	12	21			5	41	25
	7.6	7.0	6.5	5.4	11.9	8.1			3.9	11.5	14.7
MORE THAN $1,000,000	64	13	13	5	5	18	1	1	2	5	53
	6.9	11.4	6.0	3.4	5.0	7.0	1.4	.5	1.6	1.4	31.2

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QUESTION NO.24 HOW MUCH OF THIS TOTAL CAPITAL INVESTMENT REPRESENTS THE COST OF TREATING METAL FINISHING WASTES?

		- - - PERCENTAGE VALUE ADDED - - -					- T O T A L P L A N T S A L E S -				
	TOTAL	LESS THAN 1 PCT	1-3 PCT	4-6 PCT	7-9 PCT	10 OR MORE	UNDER $1 MIL	$1 MIL-4.9 MIL	$5 MIL-9.9 MIL	$10-50 MILLION	MORE THAN $50 MIL
TOTAL	941	116	216	149	101	261	70	189	130	355	172
NO ANSWER	22	6	3	2	2	5	5	5	4	2	5
NUMBER ANSWERING	919	110	213	147	99	256	65	184	126	353	167
	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
100 PERCENT-ALL OF IT	486	29	99	89	57	164	32	106	83	190	61
	52.9	26.4	46.5	60.5	57.6	64.1	49.2	57.6	65.9	53.8	36.5
75 PERCENT-MOST OF IT	155	12	40	25	23	37	7	14	10	74	47
	16.9	10.9	18.8	17.0	23.2	14.5	10.8	7.6	7.9	21.0	28.1
50 PERCENT-ABOUT HALF	75	8	24	9	7	15	7	15	8	20	22
	8.2	7.3	11.3	6.1	7.1	5.9	10.8	8.2	6.3	5.7	13.2
25 PERCENT-LITTLE	178	50	46	20	11	38	16	43	22	62	32
	19.4	45.5	21.6	13.6	11.1	14.8	24.6	23.4	17.5	17.6	19.2
0 PERCENT-NONE	25	11	4	4	1	2	3	6	3	7	5
	2.7	10.0	1.9	2.7	1.0	.8	4.6	3.3	2.4	2.0	3.0

NATIONAL ANALYSTS
METAL FINISHING STUDY (815-2)

QUESTION NO.25 WHICH OF THESE ISSUES OF COST AND PRODUCTION WOULD BE THE THREE MOST IMPORTANT IN INFLUENCING YOUR PLANT'S DECISION TO INVEST IN A WATER POLLUTION CONTROL SYSTEM?

		--- PERCENTAGE VALUE ADDED ---					- T O T A L P L A N T S A L E S -				
	TOTAL	LESS THAN 1 PCT	1-3 PCT	4-6 PCT	7-9 PCT	10 OR MORE	UNDER $1 MIL	$1 MIL- 4.9 MIL	$5 MIL- 9.9 MIL	$10-50 MILLION	MORE THAN $50 MIL
TOTAL	1614	254	400	270	155	394	175	367	233	565	237
NO ANSWER	80	20	21	12	1	15	15	25	13	15	5
NUMBER ANSWERING	1534	234	379	258	154	379	160	342	220	550	232
	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
SIZE OF REQUIRED INVESTMENT	1161	178	277	190	121	297	127	263	176	417	155
	75.7	76.1	73.1	73.6	78.6	78.4	79.4	76.9	80.0	75.8	66.8
POTENTIAL COST IMPACT OF THE INVESTMENT	921	126	227	166	89	245	98	223	132	329	127
	60.0	53.8	59.9	64.3	57.8	64.6	61.3	65.2	60.0	59.8	54.7
FEASIBILITY OF CHANGING FINISHING PROCESSES	469	82	124	81	50	92	44	96	57	182	80
	30.6	35.0	32.7	31.4	32.5	24.3	27.5	28.1	25.9	33.1	34.5
FEASIBILITY OF SENDING OUT METAL FINISHING	420	92	124	66	40	68	50	104	68	142	49
	27.4	39.3	32.7	25.6	26.0	17.9	31.3	30.4	30.9	25.8	21.1
DECIDING ON WHAT SYSTEM TO INSTALL	758	94	184	134	75	203	62	154	107	291	126
	49.4	40.2	48.5	51.9	48.7	53.6	38.8	45.0	48.6	52.9	54.3
DECIDING HOW AND WHEN TO INSTALL THE SYSTEM	436	57	98	74	39	124	42	78	55	148	103
	28.4	24.4	25.9	28.7	25.3	32.7	26.3	22.8	25.0	26.9	44.4
RELOCATING METAL FINISHING OPERATIONS	119	20	27	18	16	26	18	26	22	38	12
	7.8	8.5	7.1	7.0	10.4	6.9	11.3	7.6	10.0	6.9	5.2
CHANGING FROM OR TO A MUNICIPAL SEWER SYSTEM	229	42	65	32	22	55	27	45	30	84	39
	14.9	17.9	17.2	12.4	14.3	14.5	16.9	13.2	13.6	15.3	16.8
OTHER ISSUES	11	1	2	1		6	1	3	3	1	3
	.7	.4	.5	.4		1.6	.6	.9	1.4	.2	1.3

QUESTION NO.26 IF YOU HAVE NOT PARTICIPATED IN PLANNING MEETINGS FOR POLLUTION CONTROL AND/OR YOUR PLANT DOES NOT HAVE WATER POLLUTION CONTROLS, WHAT REASONS WOULD ACCOUNT FOR THIS?

		- - - PERCENTAGE VALUE ADDED - - -					- T O T A L P L A N T S A L E S -				
	TOTAL	LESS THAN 1 PCT	1-3 PCT	4-6 PCT	7-9 PCT	10 OR MORE	UNDER $1 MIL	$1 MIL- 4.9 MIL	$5 MIL- 9.9 MIL	$10-50 MILLION	MORE THAN $50 MIL
TOTAL	1614	254	400	270	155	394	175	367	233	565	237
NO ANSWER	921	116	216	161	91	247	62	174	122	361	177
NUMBER ANSWERING	693	138	184	109	64	147	113	193	111	204	60
	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
OTHER PEOPLE ARE RESPONSIBLE FOR IT	80	15	22	12	7	15	13	19	16	17	12
	11.5	10.9	12.0	11.0	10.9	10.2	11.5	9.8	14.4	8.3	20.0
IT IS NOT CONSIDERED A PROBLEM	416	103	122	65	35	65	83	128	61	114	23
	60.0	74.6	66.3	59.6	54.7	44.2	73.5	66.3	55.0	55.9	38.3
POLLUTION CONTROL PLANNING IS LOW PRIORITY	71	13	17	12	7	17	8	22	13	20	6
	10.2	9.4	9.2	11.0	10.9	11.6	7.1	11.4	11.7	9.8	10.0
PRESENT PLANNING OF PROCEDURES HAVE COMPLIED, HAVE FACILITIES	121	15	22	23	16	36	9	17	27	50	15
	17.5	10.9	12.0	21.1	25.0	24.5	8.0	8.8	24.3	24.5	25.0
WAITING FOR PENDING GOVERNMENTAL REGULATIONS	32	2	10	3	3	13	1	10	3	11	7
	4.6	1.4	5.4	2.8	4.7	8.8	.9	5.2	2.7	5.4	11.7
OTHER REASONS	19	2	3	1	3	8	4	8	1	6	
	2.7	1.4	1.6	.9	4.7	5.4	3.5	4.1	.9	2.9	

NATIONAL ANALYSTS
METAL FINISHING STUDY (815-2)

QUESTION NO.27 HOW MUCH WILL YOUR PLANT SPEND ON POLLUTION CONTROL EQUIPMENT DURING THE NEXT 2 YEARS?

		--- PERCENTAGE VALUE ADDED ---					- T O T A L P L A N T S A L E S -				
	TOTAL	LESS THAN 1 PCT	1-3 PCT	4-6 PCT	7-9 PCT	10 OR MORE	UNDER $1 MIL	$1 MIL- 4.9 MIL	$5 MIL- 9.9 MIL	$10-50 MILLION	MORE THAN $50 MIL
TOTAL	1614	254	400	270	155	394	175	367	233	565	237
NO ANSWER	334	52	91	41	30	85	59	104	42	39	24
NUMBER ANSWERING	1280	202	309	229	125	309	116	263	191	476	213
	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
LESS THAN $10,000	397	84	116	63	32	70	70	130	61	110	25
	31.0	41.6	37.5	27.5	25.6	22.7	60.3	49.4	31.9	23.1	11.7
$10,000 TO $49,999	377	55	85	77	36	99	32	82	61	160	35
	29.5	27.2	27.5	33.6	28.8	32.0	27.6	31.2	31.9	33.6	16.4
$50,000 TO $99,999	187	22	37	40	22	50	7	28	26	89	35
	14.6	10.9	12.0	17.5	17.6	16.2	6.0	10.6	13.6	18.7	16.4
$100,000 TO $499,999	250	31	56	38	29	74	5	21	39	98	77
	19.5	15.3	18.1	16.6	23.2	23.9	4.3	8.0	20.4	20.6	36.2
$500,000 OR MORE	69	10	15	11	6	16	2	2	4	19	41
	5.4	5.0	4.9	4.8	4.8	5.2	1.7	.8	2.1	4.0	19.2
AVERAGE (THOUSANDS)	138	187	116	125	169	108	37	30	107	105	427

NATIONAL ANALYSTS
METAL FINISHING STUDY (815-2)

QUESTION NO.27 HOW MUCH WILL YOUR PLANT SPEND ON POLLUTION CONTROL EQUIPMENT DURING THE NEXT 5 YEARS?

	TOTAL	--- PERCENTAGE VALUE ADDED --- LESS THAN 1 PCT	1-3 PCT	4-6 PCT	7-9 PCT	10 OR MORE	- T O T A L P L A N T S A L E S - UNDER $1 MIL	$1 MIL-4.9 MIL	$5 MIL-9.9 MIL	$10-50 MILLION	MORE THAN $50 MIL
TOTAL	1614	254	400	270	155	394	175	367	233	565	237
NO ANSWER	455	72	113	65	42	114	74	138	76	106	38
NUMBER ANSWERING	1159 100.0	182 100.0	287 100.0	205 100.0	113 100.0	280 100.0	101 100.0	229 100.0	157 100.0	459 100.0	199 100.0
LESS THAN $10,000	244 21.1	60 33.0	69 24.0	40 19.5	18 15.9	33 11.8	47 46.5	77 33.6	37 23.6	68 14.8	15 7.5
$10,000 TO $49,999	220 19.0	40 22.0	60 20.9	51 24.9	16 14.2	42 15.0	27 26.7	63 27.5	27 17.2	89 19.4	13 6.5
$50,000 TO $99,999	183 15.8	23 12.6	43 15.0	30 14.6	23 20.4	51 18.2	13 12.9	36 15.7	32 20.4	79 17.2	22 11.1
$100,000 TO $499,999	355 30.6	40 22.0	79 27.5	61 29.8	36 31.9	110 39.3	10 9.9	49 21.4	51 32.5	162 35.3	76 38.2
$500,000 OR MORE	157 13.5	19 10.4	36 12.5	23 11.2	20 17.7	44 15.7	4 4.0	4 1.7	10 6.4	61 13.3	73 36.7
AVERAGE (THOUSANDS)	293	336	273	271	332	264	82	66	209	204	923

APPENDIX D

SAMPLE DESIGN AND SURVEY ISSUES

INTRODUCTION

Executing a successful mail survey of the job shop sector of the metalfinishing sector required careful preplanning. No matter how well conceived, in practice every survey must confront and satisfy several critical questions in order to accept the results as valid. The questions are these:

- Is the basic sampling frame sound, e.g., free from systematic sample selection bias?
- Was a sound procedure employed to account for non-respondents in order to assess the general representativeness of the findings?
- Do the response rates and data patterns permit extrapolation of sample results to the population?

The purpose of this appendix is to present all the analytic steps taken to satisfy these key questions.

1. A FIXED INTERVAL, RANDOM SELECTION DESIGN WAS USED TO IDENTIFY THE SAMPLE: TWO MAILINGS PLUS FOLLOW-UP PHONE CALLS WERE MADE

The approach taken in this survey was a mail questionnaire followed by a follow-up telephone interview to a sample of establishments not responding to the mail phase. A mail, rather than a telephone or personal survey, was planned because of the nature of the data elements sought in the inquiry. We needed detailed and comprehensive information regarding production line configurations, water usage, employment statistics, and financial data. Such figures are not normally readily accessible in an interview situation and often require review and consultation with others. The mail approach affords respondents an opportunity to search out and to consider thoughtfully their written replies. Previous studies among members of this industry have shown the respondents can and do answer even the most detailed and searching questions in a mail survey. The telephone follow-up with non-respondents was included as an essential second step to determine whether or not these establishments differed along key parameters from those responding to the mail survey. If the non-respondents could be shown to be no different from respondents, then it would be reasonable to generalize the survey data to all independent metalfinishing establishments. If systematic differences were found between first and second mail-backs, or between all mail respondents and telephone respondents, then a means of weighting mail results to reflect population parameters is needed.

(1) <u>The Dun's Market Identifiers File Defined the Metalfinishing Universe to be Sampled</u>

Firms providing electroplating and metalfinishing services are listed in SIC (Standard Industrial Classifications of the Department of Commerce) 3471 and 3479. Therefore, the universe under investigation in the study was defined as all firms listed in the two SIC's that currently perform those manufacturing processes covered by the regulations.

The most recent and complete listing of such firms available to us at the start of the study was the Dun's Market Identifiers File (DMI) purchased by the U.S. EPA from Dun and Bradstreet. Contained in the DMI were 5,551 names of organizations whose primary SIC is either 3471 or 3479.

This listing of 5,551 was ordered first by the size of the company (using number of employees) and then alphabetically by state within size category.

A survey design was employed that systematically sampled from the universe using a fixed interval and a random starting point. By employing a 2.5 interval and going through the list, a sample universe of 2,221 establishments was derived. An additional 70 firm names were provided us by the Agency for inclusion in the sample. They were included because they provided data previously and effects over time could prove interesting.

(2) Great Care Went Into the Development of the Data Gathering Instrument

Prior analyses, client discussions, and coordination with the metalfinishing industry reinforced our understanding of how much information was needed for systematic economic impact analysis. The data would have to be gathered via the mail. The instrument had to be a convenient self-administered questionnaire. To this end, we did the following:

Solicited descriptors of technical and production variables from the technical contractor. In this way, data would be gathered from which pollution control costs could be developed.

Provided drafts of the instrument to the industry's association, the NAMF (National Association of Metal Finishers). Their comments contributed directly to the form, content, and length of the final instrument.

Reviewed the early drafts with our sampling survey division, National Analysts. Their contribution went far beyond the duties of administering, coding, and scoring the returns. On early drafts, they reviewed critically the language, format, and lucidity of all items.

Prior to the first mailing subsample, the instrument was tested on a subsample of 12 firms located in New Jersey. This effort was conducted to ensure that directions were self-explanatory, items clear, and data obtainable. Valuable information was gathered by sitting with a respondent and "walking him through" all items. Several changes in the instrument's form and length were made as a result of this pre-test.

By this point, the instrument had gone through six drafts. It represented the most extensive, clear, detailed, and balanced questionnaire we were able (at the time) to create.

(3) Two Separate Mailings Were Made

At the end of this development phase the final instrument was 14 pages long (see Appendix A) and covered the topics of:

- Production activities
- Market conditions
- Technical operations
- Financial conditions
- Treatment requirements
- Investment options

In October, all 2,221 establishments plus 40 of the 70 EPA firms were mailed a questionnaire with cover letters from both the NAMF and the Agency. A postage paid return envelope was enclosed. Replies were monitored as received by National Analysts and when the response levels diminished to fewer than two to three a day, a second mailing went out to the non-respondents. Again, a cover letter and a return envelope accompanied each questionniare.

(4) Telephone Interviews Were Conducted With a Sub-Set of Mail Non-Respondents

By the end of the mail phase, more than 1,400 firms identified for the sample had not responded. To identify as much as possible about these non-respondents, it was decided to telephone and interview some of them directly.

First, a shorter version of the mail instrument was devised for use as a telephone protocol. Not only was some language changed to make the questions more conversational, but many production and financial items were omitted for the sake of a limited (10-15 minute) interview.

At the time, the subsample of non-respondents was to be selected, 150 sample firms were known to be inactive (e.g., mail returned as undeliverable, notes written on questionnaires stating firm no longer in business, and the like). In addition, not all active organizations were subject to regulation and, therefore, not eligible to complete a questionnaire. Of those returning a questionnaire, only 68% were engaged in work involving regulated processes. Moreover, this eligibility rate varied by size of company.

Because of this differential eligibility, it was decided that the subsample for follow-up should be selected in such a way as to yield a specified number of <u>eligible</u> firms within each size category.

Operationally, the following seven steps were executed:

Eight strata of company size were established (7 groupings based on known employment and 1 in which the number of employees was unknown) and the number of mailouts in the original sample determined.

The number of firms in each stratum was adjusted proportionately by the 150 known to be out of business. This reduced the total sample universe of 2,221 to an eligible universe of 2,071.

The percentage of eligible returns within each stratum was calculated on the base of active firms only.

The projected size of each stratum was derived by multiplying the number of eligible firms within each stratum by the eligibility rate for the stratum. This stratum size estimate was then divided by the sum of all strata (1,345) to yield the relative size of a stratum (as a %).

The total number of eligible firms to be contacted in a sample of 600 was computed using the computed relative size of each stratum. This yielded a proportionate eligible sample of follow-ups based on patterns of mail respondents.

The difference between the total eligible firms (613) to be contacted and the number of eligible returns from the mail phase (419) was determined for each stratum. This figure was then multiplied by the eligibility rate for the stratum to identify the total number of non-respondents to be drawn for telephone follow-up.

A systematic sample with random start was taken for each stratum to select the non-respondents.

These steps are summarized in Tables D-1 and D-2, on the following pages. The number of telephone contacts was targeted at 326; when the sample was drawn, 332 firms were included due to rounding in the selection process.

3. RESULTS OF THE TELEPHONE FOLLOW-UP SURVEY PRECIPITATED EXTENSIVE REVIEW OF SURVEY RESPONSES

Expecting that the smaller establishments were of primary importance to the economic impact study, they were oversampled in the telephone follow-up survey. Results of the follow-ups, particularly eligibility levels were combined with eligibility levels from the mail effort to yield total size strata levels for the population.

Table D-3, following Exhibit D-3, presents a distribution of results from both the phone and mail surveys.

Since all phone follow-ups were based on expected eligibility rates, the proportions of usable returns between the surveys should be the same. For the phone effort, 44% of the sample is regulated and cooperated but for the main survey 24% are regulated and cooperated. Combining telephone and mail responses to yield a population estimate of regulated firms required matching the samples to known population parameters.

Once eligibility rates were computed for both mail and telephone respondents, the task became one of weighting respondents and extrapolating out to the population. All data were

TABLE D-1

Determining the Size of the Eligible Population by Correcting for Eligibility Rates

Size Strata	Total Mailouts	Out of Business	Total Returns	Usable Returns	Eligibility Rate	Total Eligibles*
1 - 4	563	51	108	51	.47	241
5 - 9	478	36	139	88	.63	280
10 - 19	435	13	143	103	.72	304
20 - 49	373	7	146	117	.80	293
50 - 99	111	3	35	30	.86	93
100 - 249	43	2	13	13	1.00	41
250+	7	0	1	1	1.00	7
Unknown	211	38	32	16	.50	86
	2,221	150	617	419		1,345

* [Eligibility rate x Eligibles in business]

TABLE D-2

Determining the Size of the Telephone Sample by Strata Eligibility Levels

Size Strata	Total Eligible (Mail)	Relative Size (Mail)	Total Eligible (Population)	Less Prior Mail Returns	Total to be Telephoned**
1 - 4	241	.18	110	59	125
5 - 9	280	.21	128	40	63
10 - 19	304	.23	139	36	50
20 - 49	293	.22	134	17	21
50 - 99	93	.07	42	12	14
100 - 249	41	.03	18	5	5
250+	7	.01	3	2	2
Unknown	86	.06	39	23	46
	1,345	1.01	613*	195	326

* 613 = perfectly proportionate population for follow-up

** Computed for each strata from the eligibility rate of that strata and the relative size of the strata

TABLE D-3

Total Distribution of Types of Respondents to the Phone and Mail Surveys

	Mail Survey	Phone Survey	
Usable	444	143	
Self-selected Out	243	112	
Unlocated*	143	37	
Refusal	-	28	
Not contacted	1,059	-	
Unclassifiable		12	
Totals	1,889	332	= 2,221

* Mergers, firms known to be out of business and firms that could not be reached

by sizing intervals. All eligible main respondents were given a factor weight of (1). The eligible telephone respondents were given a weight ranging from (3.1) to (11.5) depending on size strata. By summing over the weighted respondents (444 mail, 144 telephone), the eligibility total of the original sample frame (2,221) was found. This figure was then multiplied by the original sample section interval (2.5) to yield the population of eligible firms (2,941).

APPENDIX E

AUTOMATED FINANCIAL CLOSURE METHODOLOGY

A. DEVELOPMENTAL ISSUES

An automated financial closure routine was developed for predicting firms least able to support an investment in a pollution control system. The routine described below was developed principally for the job shops and applied, with minor revision to the printed board manufacturers. The automated closure routine was not applied to the data base of captive establishments.

Special features of this routine deserve special mention here. Any combination of interest rates, payback periods and abatement systems can be specified, costed and closures predicted. The model uses a two-stage decision rule; screening candidates for closure both by capital availability through commercial sources, and then by equity infusion by private (owner) sources. In addition, by altering the assumptions on pay back period, sales and coverage ratio, a cash-flow approach to the investment can be simulated.

During the development period of the closure model the point was borne in mind that the outputs of the program will receive intense scrutiny. Therefore, great care went into defining the model's data elements; its decision logic and criteria, and its capacity to withstand shifts in objective functions and still yield discriminating results. In the following sections the capabilities, requirements and products of the model are presented.

1. NINE SEQUENTIAL STEPS OCCUR IN THE MODEL

Exhibit E-I, on the following page, presents the eight sequential steps of the program. The program begins with costs, applies costs to all appropriate cases, assigns models to various categories of fiscal strength, and yields the number of cases that fail the financial tests. In sequence, a brief description of each step appears below:

> Analysis of Pollution Control Costs--The technical descriptors and the pollution control capital and operating costs developed for the 82 model plants by the EPA's technical contractor were analyzed using correlation techniques. A regression formula was developed that predicts pollution control capital costs based on finishing production water use.
>
> Selection of Survey Respondents Having Complete and Consistent Financial Data--Because the financial model requires detailed financial data, only those respondents that answered all the financial questions and had a balance sheet that balanced (within a 5% range of error) were analyzed within the financial closure methodology.
>
> Assignment of Pollution Control Costs to the 244 Selected Respondents--Pollution control costs were established as follows:
>
>> Capital costs were set to the value predicted by the regression formula (discussed in step one) for those pieces of equipment needed by the respondent

EXHIBIT E-I

U.S. Environmental Protection Agency

FINANCIAL CLOSURE METHODOLOGY

1. Analysis of pollution control costs of the model plants
2. Selection of survey respondents having complete and consistent financial data
3. Assignment of pollution control costs to the selected respondents
4. Initial selection of appropriate interest rates and allowable price increases
5. Operation of automated financial model
6. Classifications of firms based on projected profitability and capital access
7. Further investigation of marginal firms
8. Prediction of candidates for closure among the selected firms

Operating costs were calculated as a percentage of capital costs, using the average ratio calculated for the 82 model plants, i.e., 12% of total capital

Initial Selection of Appropriate Interest Rates and Allowable Price Increases--A number of possible pricing and interest rate scenarios were developed and analyzed in order to yield three cases: best, worst and mid-range. The cases are described in the next section.

Operation of the Automated Financial Model--The financial model was used to calculate the current financial performance and to estimate the projected financial performance of each firm for the three different cases. The automated financial model is described in detail in the next section.

Classification of Firms Based on Projected Profitability and Capital Access--Based on the calculated financial measures, firms were grouped into four categories for further analysis:

Good capital access and good profitability
Good capital access but poor profitability
Poor capital access but good profitability
Poor capital access and poor profitability

Further Investigation of Marginal Firms--Firms that could not be classified clearly as candidates for closures or nonclosures based on the preceding analysis were analyzed further. Several analytic techniques involving profitability and owners compensation were used to determine:

Which firms with good capital access but poor profitability might elect to close

Which firms with poor capital access but good profitability might remain open if a reasonable amount of additional equity were invested by the owners.

Which firms considered candidates for closure might have been expected to close regardless of the pollution control investment decision (Vulnerable Firms on a pre-investment basis).

Prediction of Candidates for Closure Among the Selected Firms--The results of the preceding analyses were combined to estimate which of the 244 selected firms are likely candidates for closure.

2. FINANCIAL CLOSURES ARE THOSE THAT FAIL ON PROFITABILITY AND CAPITAL ACCESS CRITERIA

The automated financial model was designed to project cash flows under different assumptions and then prepare pro forma financial statements. The inputs, variables and outputs contained in the model are listed in Exhibit E-II, following this page. The basic operation of the model for a survey respondent includes these steps:

Calculation of current financial measures using the respondent provided balance sheet and income statement data, with an assumed repayment schedule for reported long term debt

Calculation of a modified, i.e., projected, income statement using an:

- Adjustment to sales due to a postulated price increase to recover some portion of expected pollution control costs
- Increase in operating costs equal to pollution control operating costs, depreciation of pollution control equipment (over five year period) and interest on a loan to purchase the pollution control equipment

1. **RESPONDENT PROVIDED DATA**

Balance Sheet Data

Current Assets
Fixed and Other Assets

Current Liabilities
Long Term Debt
Net Worth

Income Statement Data

Sales Depreciation
Owners Compensation
Profit (Loss) Before Taxes
Profit (Loss) After Taxes

Other Information

Ownership
Forecast Maximum Allowable
Price Increase
Number Of Owners Who Work Full Time

2. **ADDITIONAL INPUT/VARIABLE DATA**

Inputs

Pollution Control Capital Cost
Pollution Control Operating Costs

Variables

Interest on Outstanding Debt
Interest on Pollution Control Loan
Allowable Price Increase
Possible Equity Infusion

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
- Dollars per owner who works full time

Financial ratios such as:

- Debt percent
- Current ratio

Increase in profit after tax due to the above changes and the investment tax credit received for purchase of pollution control equipment

Formulation of a projected balance sheet reflecting the purchase and operation of pollution control equipment

Calculation of financial measures using the updated balance sheet, income statement and cash flow calculations

Determination of the amount of additional equity capital that a profitable firm with capital access problems would have to invest to qualify for a loan for the remainder of the pollution control capital cost

The resultant financial measures predicted by the model are used to identify the firms with potential capital access or profitability problems. The three most important predictive measures are:

(Profit after tax)/(net worth), which is the basic return on equity measure used in analyzing business investment decisions

(Profit after tax) plus (owner's compensation/number of working owners), which is the total salary and return that a working owner received from running his firm

(Cash Flow)/(Fixed Obligation), the coverage ratio which is a standard banking measure of the projected ability of the borrowers to repay a loan

These and three other output measures are illustrated in Exhibit E-III, following this page. This form is generated by the model for each respondent.

EXHIBIT E-III

U.S. Environmental Protection Agency

STANDARD DATA ELEMENTS FOR FINANCIAL ANALYSIS
OF MODEL PLANTS

Model Identification:

Projected:

Assets		Liabilities	
Current		Current	
Fixed + Other		LTD	
		Net Worth	
Totals			
Difference (%)			

Present:

Assets		Liabilities	
Current		Current	
Fixed + Other		LTD	
		Net Worth	
Totals			
Difference (%)			

Projected:

Sales
Depreciation
Profit Before Taxes
Profit After Taxes
Cash Flow
Coverage Ratio
Operating Ratios:
Fixed Asset Turnover:
Cash Flow/Sales:
Cash Flow/Total Assets:
Profitability:
Profit After Taxes/Sales:
PAT/Total Assets:
PAT/Net Worth:
PAT+Owners Comp/Net Worth
Cash Flow/Capitalization:
Liquidity:
Current Ratio:
Leverage:
Debt Percent:
Debt to Equity:

Pollution Control Costs:
Least Cost Option:
Capital Cost:
O&M Cost:
Energy Cost:

Equity Infusion:
Percent of PCC Borrowed:
Cost Pass-Through:
Return to Working Owner:
Closure Category:

Present:

Sales
Depreciation
Profit Before Taxes
Profit After Taxes
Cash Flow
Coverage Ratio
Operating Ratios:
Fixed Asset Turnover:
Cash Flow/Sales:
Cash Flow/Total Assets:
Profitability:
Profit After Taxes/Sales:
PAT/Total Assets:
PAT/Net Worth:
PAT+Owners Comp/Net Worth
Cash Flow/Capitalization:
Liquidity:
Current Ratio:
Leverage:
Debt Percent:
Debt to Equity:

Profitability Changes
Profit After Taxes/Sales:
PAT/Total Assets:
PAT/Net Worth:
PAT+Owners Comp/Net Worth

B. VERIFICATIONS

From all of the preceding it should be clear that the outputs of the financial closure model are a set of solutions to specific independent (or input) variables. The identified vulnerable firms are those which failed to meet a set of empirical criteria and objective functions. In order to accept the program's outcomes as valid estimates of economic consequences for firms in the industry, objective reviews of the findings are required. There are two compelling reasons for this verification step:

> A financial investment closure model is one specification of economic behavior. Any model is limited by the set of variables it includes for prediction and by the values it assigns to those variables. Because changes to these variables might change the outcomes, it is critical to establish the predictive power of the model, e.g., its capacity to make predictions that agree with other, non-model data.
>
> Assessing the fiscal strength of a particular firm by using self-reported financial data also requires confirmation. Financial data can be interpreted differently by different analysts, and not all parties would necessarily agree on precisely what constitutes an economically non-viable firm.

To deal with these issues we conducted a series of special follow-up analyses on the data. Collectively these steps constitute a verification of the automated closure model, and covered the following:

> A core group of predicted closures was analyzed by inspecting all the available information on

the returns. This review incorporated items such as planned capital investments for productive assets, computation of financial ratios other than the ones of the model, and an assessment of whether the plant might be a baseline closure independent of the incremental investment in pollution controls.

Closures were predicted in plants that sell in excess of a million dollars annually. This finding seemed counter-intuitive because such firms were presumed to enjoy scalar economies as well as a stronger capital base. For these cases complete financial reports were purchased from Dun & Bradstreet (D&B) and detailed financial (closure) analyses were run using those data.

Concerns existed that our base year (1975) was atypical and that it represented a poor sales year for basing industry financial closures. In addition, there was the point that bank lending rules differed from those of the model. Third, the concern was expressed that the raw data of the survey may vary from that given other sources (D&B) and conclusions drawn from the model might be in error. Special follow-up surveys coupled with the most recent D&B data dealt with this group of potential problems.

Each potential problem coupled to its verification step is presented below.

1. <u>FROM THE FIRST GROUP OF CLOSURES 90% WERE FOUND TO BE TRULY NON-VIABLE ECONOMIC ENTITIES</u>

To test whether the closure model made accurate selections of financially vulnerable firms, a special cost-closure scenario was run for all models. This specification was one of the least expensive options possible, i.e., oxidation of amenable cyanide only. With a mean capital requirement of under $20,000, 19 cases were predicted to close. These 19 were reviewed in detail to pinpoint precisely what constituted their vulnerabilities. The following was found:

> Most of the 19 reported either a loss before or after tax. On the basis of cash flows none of the firms generated sufficient profits to support a loan.
>
> Almost all cases (17) fell considerably below the projected coverage ratio of 1.5. Two cases were calculated at 1.40-1.49. These two cases were judged "swing" cases in the sense that minor reductions in their investment (= \$2,500) would result in computed coverage ratios of at least 1.5.

2. SPECIAL ANALYSIS OF LARGER FIRMS CONFIRMED THAT SOME MIGHT NOT SUCCESSFULLY SUPPORT ADDED CAPITAL BURDENS

From the survey returns there were 13 firms with employment of at least 100 men and sales of at least \$1 million. Based on the completeness of those returns, seven cases qualified as models. In a full BPT investment case there were three closures for a closure rate of 23% for the group.

Several questions arose:

> Are the 13 respondents truly representative of most large firms?
>
> Are the seven models a good cross-sectional representation of such firms?
>
> Are the three identified closures unique or representative?

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The only means of answering these questions was to test the model's predictions against an alternate data base and determine whether the observed closures are aberrant cases or not. To this end the following was done:

> From the Dun & Bradstreet file on the industry 70 large firms were identified and their financial records requested. This yielded 42 usable reports.
>
> Of the 42 reports, 19 clearly were not job shops. Of the remaining 23 cases, 16 lacked all the necessary information for comparable analysis. This left seven cases for comparison with the seven models.
>
> These 7 D&B cases were compared with the 13 survey respondents as a whole, and then with the 7 models and 6 non-models. Specifically noted were agreement on mean sales, sales per man, debt levels, and a series of financial ratios. No significant disagreements were noted. The conclusion here is that the 13 survey respondents are a good representation of the financial characteristics of large job shops.
>
> On these seven D&B cases, a modified closure analysis was run using financial ratios reflecting the firm's relative capacity ot take on debt:
>
> - Long-Term Debt/Net Worth
> - Net Worth/Employee
> - Total Assets/Net Worth
>
> In the group of seven D&B firms, there were two and perhaps a third firm that had extraordinary debt levels that precluded assuming more for pollution controls.

This comparison of seven new D&B cases to seven study models is more a support than a proof of the model's findings. Were better financial data available for all 42 cases, there would be greater confidence in the projected closure rate of 23% for the group. At best, we have established that our 13 respondents are not fundamentally different from other cases in the group and that identifying 2 of 7 firms as financially vulnerable can be replicated with a second group.

3. A SERIES OF SPECIAL SURVEYS LENT SUPPORT TO BOTH THE ASSUMPTIONS AND UTILITY OF THE FINANCIAL CLOSURE MODEL

Several additional concerns were raised during the course of the study that required a response. These concerns come down to three generic issues:

> 1975 may not be a typical year for the industry and conclusions based on data for 1975 could misrepresent the industry's capabilities.
>
> Bankers may or may not use a 1.5 coverage ratio. To the extent banks use unique criteria for assessing loan recipients, the predictions of the model may be in error.
>
> Base data received via the survey may be different from that given other sources. Potentially the raw data of the study could be biased and of questionable use in an economic impact study.

During the life of the study each issue was addressed in a manner that both satisfies methodological rigor and lays the potential criticism to rest.

(1) 1975 Was a "Typical" Year for the Industry

Shortly after the raw data were in hand and preliminary analyses run it was apparent that a means to assess the "goodness" of 1975 would be desirable. Financial data over-time were omitted from the survey in hopes of boosting response rates. There was no built-in mechanism for interpreting each firm's relative performance in 1975 against prior years. A first step in addressing this issue was to pull a sampling of 100 job shop respondents for follow-up contact. A short phone protocol was developed in which the key question was:

> Looking back to your plant's financial performance in 1975, would you judge that year to be: (1) above average, (2) about average, or (3) below average?

Responses split evenly across the item. There were as many people (33) who judged 1975 to be above average as those (34) who judged it to be below. On the basis of this follow-up survey, 1975 serves as well as any year in which to project the economic consequences of compliance on the industry.

The second step in judging the suitability of using 1975 survey data was to match updated D&B financial reports to the survey data. More than 300 financial reports were purchased for our core group of 461 respondents. Of the firms not contacted by phone, we assembled a cluster of 150 firms that provided both financial data to use in 1975 and to D&B in either 1976 or early 1977.

We noted that more than half the cases (80) gave the same data to use as they did to D&B in 1975 or early 1976. Fully one-quarter of the cases reported 1976 data that were within ± 10% of the 1975 data. Of the remaining 50 cases there were not more than 10 that reported a 1976 or 1977 line item from the balance sheet that was more than 50% greater than in 1975.

Not only is the agreement between survey information and D&B information quite strong, but the operating changes are slow to be reflected within the company balance sheet. This helps support two conclusions:

> Respondents provide consistent financial information to us and to D&B. There was no systematic distortion in the survey.
>
> Closure rates computed for 1975, all things being equal, should reflect industry viability as well as any other year.

(2) Bankers Supported the Use of Coverage Ratio Calculations

A major component of the automated closure routine is the incorporation of commercial lending rules. Here there are two potential errors; either a coverage ratio calculation is irrelevant to the loan process, and/or our threshold value of 1.5 is inappropriate. We found neither to be the case.

Prior attempts to contact banks familiar with the financial needs of metalfinishers had proven of limited value. Without knowing the specific banks in specific cities in which finishers conduct their business, a survey of commercial bankers becomes a stab in the dark.

From the same D&B financial reports utilized in comparing 1975 to recent financial conditions we noted the name of the company's banker, and selected a distribution of 25 cases for contact. This is an admittedly small sample, but it is drawn with the knowledge that each bank is actually serving a firm in the industry.

No question that identified a particular respondent to the survey was posed. The focus was specifically the bank's lending rules for the industry, the prevalence of requests for pollution control investments, and the applicability of a 1.5 criterion for a coverage ratio calculation. Not surprisingly, each commercial lending officer maintained that loan applications are treated as unique cases and universal lending rules are not applied. Each did acknowledge, however, that a calculated coverage ratio is one important predictor of a firm's condition and the higher the value the better. Our use of 1.5 to split probable loan rejections from loan approvals was generally confirmed in our conversations with commercial lending officers.

APPENDIX F

THE POLLUTION ABATEMENT COST GENERATING PROGRAM

INTRODUCTION

This appendix describes the methodology employed by the technical contractor (Hamilton Standard) for estimating wastewater treatment costs for 82 electroplating job shops. These model plants were selected by the economics contractor and supplied to the technical contractor. Technical and production data on these plants were used as input data to the contractor's cost estimating program.

Hamilton Standard has revised and updated this program during the past several years. At this time it may be the most sophisticated tool of its type. It is capable of generating equipment specifications and costs for direct and indirect dischargers, reflecting cases with partial equipment-in-place as well as alternative treatment scenarios.

1. AN AUTOMATED POLLUTION CONTROL COST ESTIMATING PROGRAM IS INDISPENSABLE FOR MANAGING COMPLEX TECHNICAL INFORMATION

As the U.S. Environmental Protection Agency commissions technical development documents in support of guidelines limitations and standards for industrial point source dischargers, an immediate problem is the management of complex technical data. Not only are large quantities of data generated for plant flows, concentrations and contaminants, but also systematic cost estimates must be derived for all abatement components designed to meet established or recommended limitations.

Calculations are made for both the effluent dimensions and for the pollution control systems. Designing, developing, and applying automated cost generating programs for these data are critical to the expeditious discharge of the regulation setting mission of the Agency.

To this end, Hamilton Standard has developed two computer routines to facilitate such calculations. The routines have been used successfully in two separate EPA studies over the past few years and have been updated to reflect critical comments and new base line data.

2. THE COST PROGRAMS INCORPORATE SYSTEMATICALLY ALL RELEVANT TECHNICAL DATA

The first step in computerized analysis of the collected data for an EPA project is the formation of a plant tape data file. Information on the data tape for each plant typically consists of raw and effluent stream flows and pollutant concentrations, production processes performed, production rates for each production subcategory or factors from which production rates can be determined (such as hours per day of operation, floor area in production, water discharge from production subcategories, etc.), and waste treatment equipment employed. A separate tape file is typically generated for each industry due to variations in the type of data collected. Exhibit F-I, following this page, shows a typical plant data file for a plant performing painting or similar surface treatment.

The next step in computerization is the generation of the analysis programs. The analysis programs calculate the actual plant effluent as either grams per day or in terms of a production-related parameter such as mg/square meter of surface processed. The first analysis program brought into play is the statistical analysis program. This program calculates the actual discharge from each sub-category through the use of flow data and concentrations or by using an apportioning formula. A set of pass/fail criteria is established in the program. These pass/fail criteria may be the average of all data, current regulations for the industry under study or some value established on the basis of water use per unit of production times an acceptable concentration. The pass/fail gate allows the computer to display the distribution of data points relative to the gate. Those data points not passing the gates are listed along with the company identification number (ID). These "flagged" data points are examined to ensure that the input data to the computer are correct, that the laboratory analysis is correct and consistent and that the raw waste and treated effluent are reasonable. If no apparent errors

HAMILTON STANDARD DIVISION OF UNITED TECHNOLOGIES

DATA COLLECTION SURVEY FOR THE SURFACE TREATMENT AND CHEMICAL COATING SEGMENT
OF THE MACHINERY AND MECHANICAL PRODUCTS POINT SOURCE CATEGORY
MANUFACTURING EFFLUENT LIMITATIONS GUIDELINES DEVELOPMENT PROGRAM

1.0 MANUFACTURING ESTABLISHMENT DATA
ID NUMBER 6-679-12-0
NAME
ADDRESS
TELEPHONE

PLANT PERSONNEL CONTACTED:

SHOP TYPE: CAPTIVE DISCHARGE: MUNICIPAL
NO. SURFACE TRTMT WORKERS 210
TOTAL NUMBER OF EMPLOYEES 4200
STANDARD INDUSTRIAL CLASSIFICATION 3429
PRINCIPLE PRODUCTS SURFACE TREATED BUILDING HARDWARE

PRINCIPLE RAW MATERIALS CONSUMED

SULFURIC ACID	750.0	LB / DAY
TOT ORGANIC CARBON	108.0	LB / DAY
PHOSPHATING CHEMICAL	24.0	LB / DAY
ENAMELS	55.0	GAL / DAY

PRINCIPLE WASTE TREATMENT CHEMICALS CONSUMED

NONE LISTED

2.0 WATER SUPPLY AND USE

2.1 WATER SUPPLY SOURCE

TYPE	QUANTITY GPH
MUNICIPAL	71000
WELL	43125

2.2 WATER USAGE DOES PLANT PRODUCTION LEVEL AFFECT WATER USAGE? YES

TYPE	QUANTITY GPH	PERCENT RECYCLE
TOTAL PROCESS	132500	0
SANITARY	4687	0
COOLING	28750	17
TOTAL NONPROCESS	33438	0

3.0 WASTE CHARACTERISTICS

3.1 CURRENT REQUIREMENTS OR REGULATIONS: MUNICIPAL ORDINANCE FOR DISCHARGE

3.2 COMPOSITION OF STREAMS ID NUMBER 6-679-12-0

PARAMETERS MEASURED AS TOTAL (********** INDICATES NO ENTRY)

CONSTITUENTS	SPRAY COATNG RAW WASTE> 0 8HR COMPSITE JUN 25,1976	SPRAY COATNG FINL EFFL>22 GRAB SAMPLE JUN 25,1976	SPRAY COATNG RAW WASTE> 0 GRAB SAMPLE JUN 25,1976	SPRAY COATNG FINL EFFL>22 GRAB SAMPLE JUN 25,1976	SPRAY COATNG RAW WASTE> 0 GRAB SAMPLE JUN 25,1976	SPRAY COATNG INTFRMEDT> 0 8HR COMPSITE JUN 25,1976	SPRAY COATNG FINL EFFL>22 8HR COMPSITE JUN 25,1976	SPRAY COATNG FINL EFFL>22 8HR COMPSITE JUN 25,1976
ALUMINUM	2.19	29.50	30.50	1.37	5.28	0.74	0.19	0.79
AMMONIA	0.850	**********	0.275	**********	**********	0.120	0.210	0.290
BARIUM	**********	**********	**********	**********	**********	**********	**********	**********
B. O. D.	**********	**********	**********	**********	**********	**********	**********	**********
BORON	**********	**********	**********	**********	**********	**********	**********	**********
CADMIUM	0.001	0.004	0.003	0.001	0.001	0.008	0.001	0.009
CHLORINATED HYDROCAR	**********	**********	**********	**********	**********	**********	**********	**********
CHROMIUM,HEXAVALENT	0.028	1.890	2.000	0.005	0.005	0.005	0.005	0.005
CHROMIUM,TOTAL	0.097	1.890	2.000	0.089	0.737	0.375	0.019	0.005
C. O. D.	19136.	15438.	16702.	9560.	74.	581.	98.	32.
CONDUCTANCE UMHO/CM	**********	**********	**********	**********	**********	**********	**********	**********
COPPER	0.237	2.470	2.530	0.100	18.800	0.150	0.476	0.039
CYANIDE AMN.TO CHLOR	**********	**********	**********	**********	**********	**********	**********	**********
CYANIDE,TOTAL	**********	**********	**********	**********	**********	**********	**********	**********
DISSOLVED OXYGEN	**********	**********	**********	**********	**********	**********	**********	**********
FLOW (GPH)	3.	30.	19.	30.	3.	30.	30.	30.
FLUORIDES	3.80	2.90	3.20	2.90	2.90	0.22	1.30	0.90
GOLD	**********	**********	**********	**********	**********	**********	**********	**********
IRON	2.310	1.000	1.080	1.250	23.200	3750.000	1.200	0.667
LEAD	0.291	0.177	0.263	0.050	2.500	0.050	0.138	0.010
MAGNESIUM	**********	**********	**********	**********	**********	**********	**********	**********
MERCURY	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001
MOLYBDENUM	**********	**********	**********	**********	**********	**********	**********	**********
NICKEL	0.028	0.043	0.028	0.017	0.128	0.067	0.012	0.031
NITRATES	**********	**********	**********	**********	**********	**********	**********	**********
OIL, GREASE	1609.	360.	218.	1.	692.	30.	9.	1.
PALLADIUM	**********	**********	**********	**********	**********	**********	**********	**********
PH, ACIDIC	**********	**********	**********	**********	**********	**********	**********	**********
PH, ALKALINE	**********	**********	**********	**********	**********	**********	**********	**********
PHENOLS	0.447	**********	0.409	**********	0.288	0.127	0.163	0.110
PHOSPHORUS	2.20	5.50	3.80	0.50	0.50	3.80	15.30	8.40
PLATINUM	**********	**********	**********	**********	**********	**********	**********	**********
POTASSIUM	**********	**********	**********	**********	**********	**********	**********	**********
RHODIUM	**********	**********	**********	**********	**********	**********	**********	**********
SILICA	**********	**********	**********	**********	**********	**********	**********	**********
SILVER	**********	**********	**********	**********	**********	**********	**********	**********
SETTLEABLE SOLIDS	**********	**********	**********	**********	**********	**********	**********	**********
TOTAL SOLIDS	**********	**********	**********	**********	**********	**********	**********	**********
TOT. DISSOLVD SOLIDS	822.00	7764.00	8196.00	744.00	575.00	9511.00	368.00	166.00
TOT. SUSPENDED SDS.	7729.00	360.00	592.00	782.00	3818.00	264.00	23.00	19.00
TOT. VOLATILE SOLIDS	**********	**********	**********	**********	**********	**********	**********	**********
SULFATES	**********	**********	**********	**********	**********	**********	**********	**********
SULFIDES	**********	**********	**********	**********	**********	**********	**********	**********
SURFACTANTS	**********	**********	**********	**********	**********	**********	**********	**********
TEMPERATURE DEG F	**********	**********	**********	**********	**********	**********	**********	**********
TIN	0.06	0.09	0.08	0.06	0.06	0.06	0.06	0.06
TITANIUM	**********	**********	**********	**********	**********	**********	**********	**********
ZINC	1.380	0.762	0.952	0.200	9.760	0.462	0.692	0.714
TOT ORGANIC CARBON	6125.	42.	4740.	3000.	1050.	46.	37.	23.
KJELDAHL NITROGEN	3.63	**********	0.56	**********	6.82	**********	0.49	0.56

3.3 WASTE TREATMENT COST INFORMATION

TREATMENT SYSTEM IDENTIFICATION	DATE INSTALLED	CAPITAL COSTS ($)	OPERATING COSTS ($/YR)	RAW WASTE STREAMS TREATED	WASTE REDUCTION (%)	ENERGY REQUIREMENT (KW*HR)/YR
CONVENTIONAL						
BAKER BROS. CHROME UNIT	1973	50000	1248	CHROME RINSE	0	0
CONVENTIONAL						
OIL SEPERATION	1975	22000	0	NON-SOLUBLE OILS	100	0
CONVENTIONAL						
NEW PLATING TREATMENT	1977	1250000	0	PLATING ACIDS AND RINSE	0	0
RECYCLE						
WASTESAVER DISTILLATION	1975	60000	0	CYANIDE PLATING WASTE	50	0
RECYCLE						
ECO-TEC	1976	45000	0	CHROME WAST	[illegible]	0

4.0 WASTE TREATMENT SYSTEM DESCRIPTION

METHOD	I.D.NO.	TECHNIQUE
1	24	CHEMICAL REDUCTION
1	25	PH ADJUST (FINAL)
1	95	MIXER NODE 1
1	2	CONTINUOUS
1	12	EVAPORATION
1	91	BRANCH NODE 2
1	75	PROCESSING FOR REUSE
1	91	BRANCH NODE 2
1	95	MIXER NODE 1
1	2	CONTINUOUS
1	24	CHEMICAL REDUCTION
1	11	ION EXCHANGE
1	25	PH ADJUST (FINAL)
1	92	BRANCH NODE 3
1	75	PROCESSING FOR REUSE
1	92	BRANCH NODE 3
1	95	MIXER NODE 1
1	1	BATCH
1	24	CHEMICAL REDUCTION
1	23	CHEMICAL OXIDATION
1	25	PH ADJUST (FINAL)
1	93	BRANCH NODE 4
1	70	SANITARY SEWER
2	21	EMULSION BREAKING
2	90	BRANCH NODE 1
2	.2	CONTRACT REMOVAL-OIL
2	90	BRANCH NODE 1
2	96	MIXER NODE 2
2	75	PROCESSING FOR REUSE

6.0 SURFACE TREATMENT PROCESSES

DESCRIPTION	HR/DAY	LB/HR	CPLX	BASE MATERIAL
PAINT LINE NO. 1	16.0	250.0	0	IRON

are found, further checks are made. Historical data, when available, is compared to the "flagged" data. Often the company is called and asked if this data point is consistent with past samples of the same parameter. Whenever possible, an explanation is developed for each "flagged" data point.

A second analytical program is used in many industry studies. This second program calculates the actual plant discharge in grams per day, the allowable discharge based on the established or tentative regulations, and compares the two numbers for each pollutant. This program also allows the combination of multiple regulations to provide a pass/fail test of a multiple use plant.

A log diagram is shown in Exhibit F-II, following this page, which depicts the basic steps used in the programs.

The first set of analytical programs developed used all available concentration values for all parameters. Since then, many refinements have been incorporated. The first unique feature of the programs is that they do not use values for pollutants which do not exist in the plant. A search is made of the plant description and raw material file to determine if a particular pollutant material is used in the plant. If no use of the pollutant is found, the values are not normally used in calculating the minimum and mean values for all plants. The exception to this rule is used when the concentration value is abnormally high or

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EXHIBIT F-I (4)

	OPERATION			FT2/HR	GAL/HR	FT2
43	ELECTROSATIC SPRAY	SOLVENT BASE ENAMELS		63.80	3.40	140.
[illegible]5	DRYING			63.80	0.0	650.

DESCRIPTION	HR/DAY	LB/HR	CPLX	BASE MATERIAL
PAINT LINE NO. 2	16.0	625.0	0	IRON

	OPERATION			FT2/HR	GAL/HR	FT2
5	PHOSPHATING	WATER BASE	PHOSPHATING CHEMICAL	159.50	0.0	760.
11	1 STAGE RINSE		FIXED ORIFICE	15[illegible].50	30.00	760.
11	1 STAGE RINSE		FIXED ORIFICE	159.50	30.00	760.
43	ELECTROSATIC SPRAY	SOLVENT BASE ENAMELS		159.50	0.0	760.
99	OTHER POSTTREATMENT			159.50	0.0	530.

DESCRIPTION	HR/DAY	LB/HR	CPLX	BASE MATERIAL
PICKLE LINE	16.0	44000.0	0	IRON

	OPERATION			FT2/HR	GAL/HR	FT2
61	ACID PICKLE/DESCALE	WATER BASE	SULFURIC ACID	3375.00	480.00	370.
61	ACID PICKLE/DESCALE	WATER BASE	SULFURIC ACID	3375.00	480.00	370.
61	ACID PICKLE/DESCALE	WATER BASE	SULFURIC ACID	3375.00	480.00	370.
11	1 STAGE RINSE		FIXED ORIFICE	3[illegible]7[illegible].00	480.00	370.
11	1 STAGE RINSE		FIXED ORIFICE	3375.00	0.0	370.
85	DRYING			3375.00	0.0	370.

the production related value exceeds the gate. Another unique feature of the programs is the ability to use multiple gates (usually an existing regulation and a set of proposed changes). This feature allows comparison of the allowable discharges from various plants to quickly ascertain the impact of the changes. Comparisons have been run with all parameters as well as just a selected list of the critical ones.

The analytical programs currently in use can analyze treatment effluent as reported (usually monthly) or as an average for all reported values of a parameter. Raw waste analysis can also be done on the same basis. Finally, individual selected types of streams can be analyzed for particular features. A comparison feature has also been included to provide the percent removal accomplished for each pollutant parameter.

These analytical programs can handle up to 77 pollutant parameters and 8 months of sample data. Table F-1, following this page, shows 67 parameters currently programmed and there are 10 open boxes for other pollutants. Also, since data is received from many sources, such as self sampling, compliance data from regulatory agencies, and sampling programs conducted by the EPA, the source of the data is coded to show who supplied the information.

EXHIBIT F-II

U.S. Environmental Protection Agency

SIMPLIFIED LOGIC DIAGRAM POLLUTANT
ANALYSIS PROGRAM

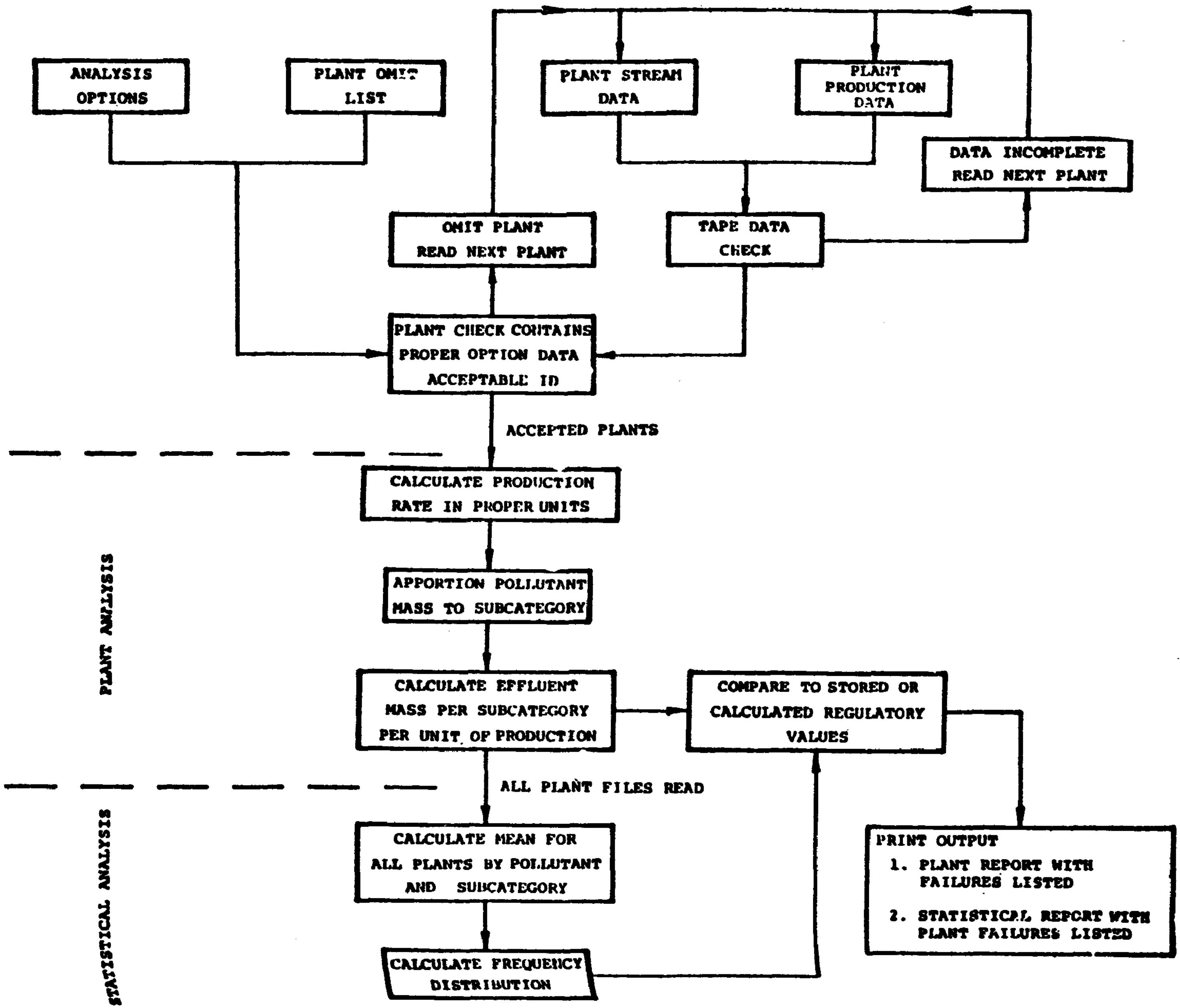


TABLE F-1 (1)

Pollutant Parameters

Parameter	Units
pH	pH units
Turbidity	Jackson units
Temperature	Degrees C
Dissolved Oxygen	mg/liter
Residual Chlorine	mg/liter
Acidity	mg/liter $CaCO_3$
Alkalinity	mg/liter $CaCO_3$
Ammonia	mg/liter
Biochemical Oxygen Demand (BOD5)	mg/liter
Color	chloroplatinate units
Sulfide	mg/liter
Cyanides	mg/liter
Kjeldahl Nitrogen	mg/liter
Phenols	mg/liter
Conductance	micromhos/cm
Total Solids	mg/liter
Total Suspendable Solids	mg/liter
Settleable Solids	mg/liter
Aluminum	mg/liter
Barium	mg/liter
Cadmium	mg/liter
Calcium	mg/liter
Chloride	mg/liter
Chromium	mg/liter
Copper	mg/liter
Fluoride	mg/liter
Iron, Total	mg/liter
Lead	mg/liter
Magnesium	mg/liter
Manganese	mg/liter
Molybdenum	mg/liter
Oil, Grease	mg/liter
Hardness	mg/liter $CaCO_3$
Chemical Oxygen Demand (COD)	mg/liter
Algicides	mg/liter
Total Phosphate	mg/liter
Polychlorobiphenyls	mg/liter
Pottassium	mg/liter
Silica	mg/liter
Sodium	mg/liter
Sulfate	mg/liter
Sulfite	mg/liter
Titanium	mg/liter
Zinc	mg/liter

TABLE F-1 (2)

Parameter	Units
Arsenic	mg/liter
Boron	mg/liter
Iron, Dissolved	mg/liter
Mercury	mg/liter
Nickel	mg/liter
Nitrate	mg/liter
Nitrite	mg/liter
Selenium	mg/liter
Silver	mg/liter
Strontium	mg/liter
Beryllium	mg/liter
Chlorinated Hydrocarbons	mg/liter
Total Volatile Solids	mg/liter
Surfactants	mg/liter
Plasticizers	mg/liter
Antimony	mg/liter
Bromide	mg/liter
Cobalt	mg/liter
Thallium	mg/liter
Tin	mg/liter

When using these programs, several options are available. These include the selection of:

> Discharge Destination--All surface dischargers, all municipal dischargers, or all dischargers may be selected and used. With sewer dischargers, pretreatment standards are used. When all dischargers are combined, the programs use the surface discharge regulations.
>
> Type of Analysis--Raw waste, treated waste or special.
>
> Analysis of Individual Stream or Plant Average--On a stream basis, actual mass dischargers from each appropriate stream are used as individual data points. When analyzed by plant, the actual mass dischargers for all of the appropriate streams are averaged to provide a single data point for the plant.
>
> Type of Output--Either the statistical format showing minimum, maximum and mean values by subcategory, or the plant performance format showing individual plant allowable and actual discharge.

The calculation of actual discharge is quite straightforward. Effluent flow times the concentration provides the actual mass discharged. Calculation of the allowable discharge is more complex and depends on the industry and the regulations involved. The simplest of the allowable calculations is for Machinery and Mechanical Products. Here a fixed factor (mg/m^2 of floor area) for each subcategory is multipled by the existing floor area devoted to the operations in the subcategory. The procedure is repeated for each subcategory and summed to show the total allowable discharge for the plant.

3. A SEPARATE PROGRAM (THE SYSTEM COST ANALYSIS PROGRAM) GENERATES COST ESTIMATES FOR EQUIPMENT

A second major problem facing the U.S. EPA is consistent estimates of cost of treatment. Each new effluent limitation requires an estimate of the cost of the Best Practicable Technology (BPT) and Best Available Technology (BAT) wastewater treatment systems necessary to meet the standards.

A mathematical model or set of correlations was developed for each individual wastewater treatment technology commonly found in industry. A list of the programmed process is contained in Table F-2, on the following page. In general, these correlations relate equipment size to influent flow rate and pollutant concentrations and, in turn, relate cost to equipment size.

(1) All Data Comes From Authoritative Sources

The basic cost data came from a number of primary sources. Some of the data were obtained during on-site surveys. Other data were obtained through discussions with waste treatment equipment manufacturers. Another block of data was derived from previous EPA projects which utilized data from engineering firms experienced in the installation of waste treatment systems. These data for wastewater flow rates, corresponding equipment size and cost, were related by means of a separate computer program. This program was developed to correlate the data by regression analysis, utilizing

TABLE F-2

Programmed Processes

Spray/Fog Rinse
Countercurrent Rinse
Vacuum Filtration
Gravity Thickening
Sludge Drying Beds
Raw Wastewater Pumping
Holding Tanks (lined or unlined)
Centrifugation
Equalization (concrete or earth)
Contractor Removal (wet or dry)
Reverse Osmosis
Landfill
Chemical Reduction of Chromium
Chemical Oxidation of Cyanide
Neutralization
Clarification (settling tank or tube settler)
API Oil Skimming
Emulsion Breaking
Membrane Filtration
Filtration (with or without alum. precoat)
Ion Exchange-In-Plant Regeneration
Ion Exchange-Service Regeneration
Flash Evaporation
Climbing Film Evaporation
Atmospheric Evaporation
Sanitary Sewer Discharge Fee
Cyclic Ion Exchange
Ultrafiltration
Submerged Tube Evaporation
Flotation/Separation
Wiped Film Evaporation
Preliminary Treatment
Preliminary Sedimentation
Aerator - Final Settler
Tricking Filter - Final Settler
Chlorination
Flotation Thickening
Multiple Hearth Incineration
Aerobic Digestion
Post Aeration
Sludge Pumping
Activated Carbon Adsorption
Copper Cementation

first order arithmetic equations, first order logarithmic equations, and multiple order equations as appropriate.

Subsequent to the initial programming, reviews have been conducted by the EPA and at least two Economic Analysis Contractors. These reviews questioned some assumptions and provided some valuable suggestions for further updating. The capability for the computer to select the least cost approach has been incorporated. Large flows use a full treatment system, but, as the flow decreases, batch treatment and finally contractor wet haul of all wastes becomes the most economical. Also for large flows, a concrete tank (clarifier, etc.) is cheapest but as flow decreases, steel tanks become the more economical. This type of variation plus constant review of the cost equations provides an accurate method of estimating impact of treatment on an industry as well as providing the EPA with a consistent result from industry to industry.

The System Cost Analysis program was generated to perform both the system cost estimate and performance calculations. The needed cost estimates include the system required investment and total annual cost break-down. Wastewater treatment system performance must also be modeled to determine if the treatment system being costed satisfies the proposed effluent limitations. To provide the broadest modeling tool possible, the following techniques were incorporated into the program logic:

- Generalized, "black-box," wastewater treatment process definition to allow flexibility in the variety of wastewater treatment systems that can be described

- "Decision" fields for each individual treatment process so that process design parameters such as hydraulic loadings, retention times, or operating mode decisions can be varied

- Multiple raw waste stream allocations so that stream segregation treatment techniques can be described

- Generalized wastewater stream pollutant parameter definition to model various wastes and to perform intermediate system performance calculations

- Generalized costing factors so that material or localized cost estimates can be made for any desired dollar base period

(2) <u>Five Data Elements Have to be Specified</u>

To execute the System Cost Analysis program, a definition must be provided for the following five items:

- The treatment processses to be used and their interconnection

- The "decision" parameters for each process used

- The raw waste steam flow and pollutants for each influent stream

The costing factors for the treatment system

The tolerance bands for any recycle loops in the system

Up to 24 individual wastewater treatment processes can be modeled into a single system. A simplified logic diagram is shown in Exhibit F-III, on the following page, depicting the basic steps taken by the program. Table F-2 on page 10, presented a list of the currently programmed treatment processes. The connecting stream locations and the "decision" parameters for each of the wastewater treatment processes being incorporated into the system model must also be specified.

The raw waste streams entering the treatment system must be specified either manually or from the raw waste analysis program previously described. Anywhere from 1 to 10 influent streams can be defined. A typical treatment system with six raw waste streams is shown in Exhibit F-IV, following Exhibit F-III. Flow and up to 67 pollutant parameter values are specified for each raw waste stream. Table F-1 in the Effluent Analysis Program section presented a list of those pollutant parameters which can be entered as raw waste and for which performance calculations are made.

Data are also required for each wastewater treatment system to define costing factors at a desired

EXHIBIT F-III

U.S. Environmental Protection Agency

SIMPLIFIED LOGIC DIAGRAM--SYSTEM COST ANALYSIS PROGRAM

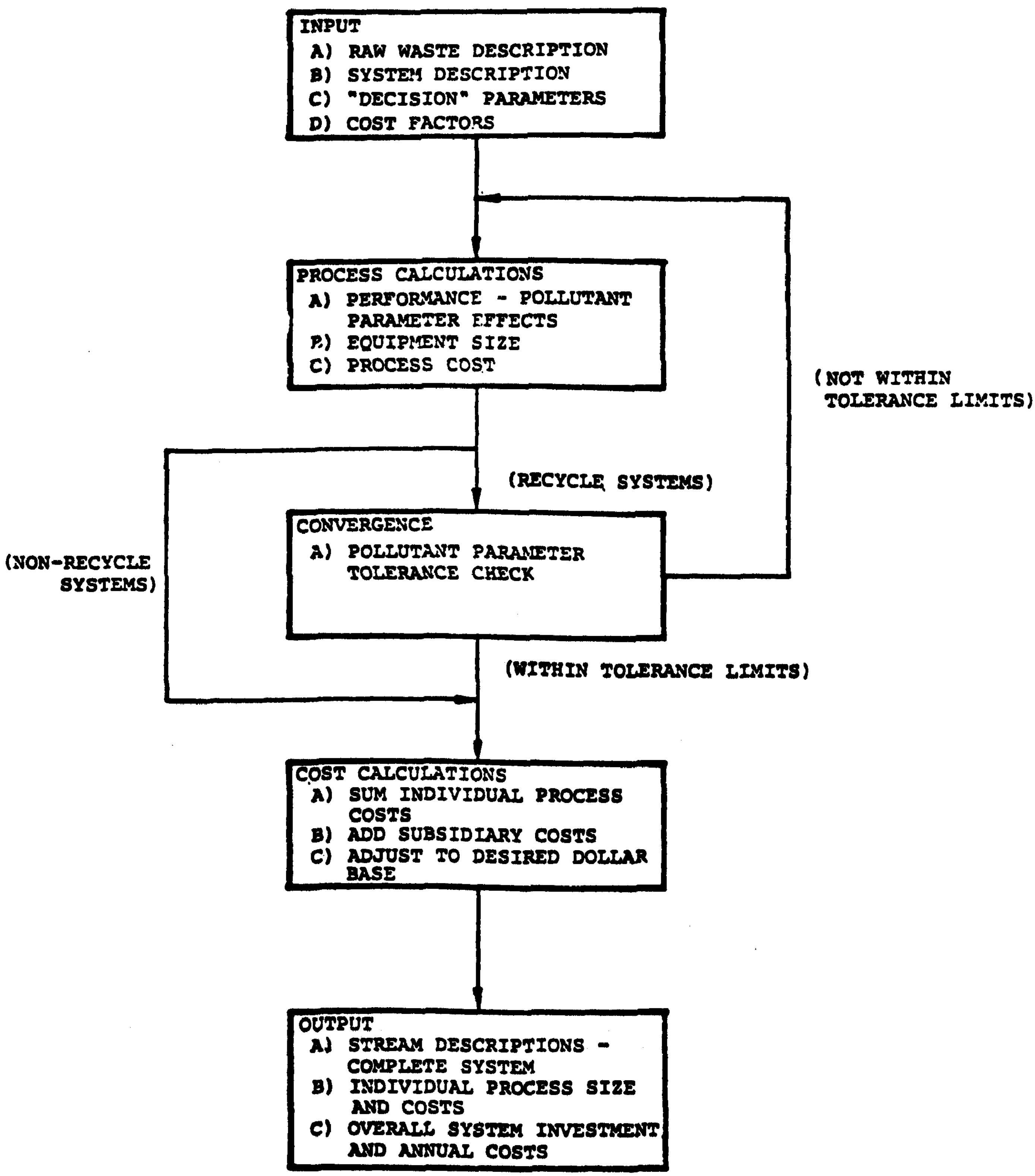
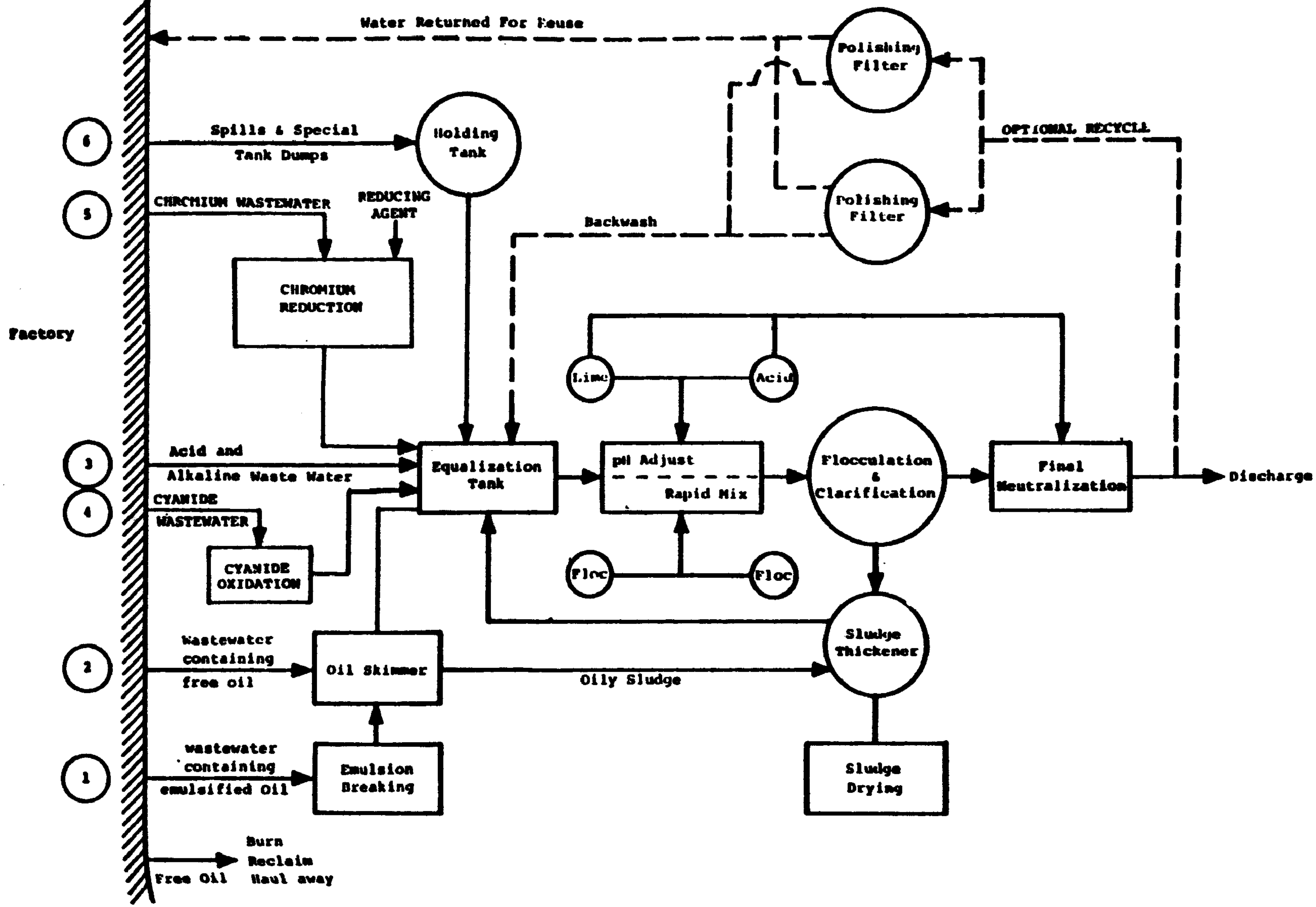


EXHIBIT F-IV

U.S. Environmental Protection Agency

TYPICAL SYSTEM WITH SIX PAIR WASTE SYSTEMS



reference time. Such items as Construction Cost Index, Wholesale Price Index, depreciation period, rate of interest, cost of land, cost of labor, and cost of electrical energy all must be specified. The option exists to use any dollar base desired. The reference time used for programming the various process costs was January 1971.

The computer program main routine accepts the control specifications and accesses all other routines. Each wastewater treatment process is described by a separate sub-routine which computes the performance and cost of the individual process step (clarification, oil skimming, etc.). The main routine iterates the raw waste load data to a system component until the last iteration is within the tolerance of the next to last iteration. For example, the clarifier has a sludge output to sludge dewatering. The water removed from the sludge is put back to the clarifier, changing the input concentration. This cycling is repeated until the tolerances are met. When the system iteration is complete, the main routine accesses a cost summation routine.

The cost summation routine sums all the process costs and calculates the least cost treatment option. They may be omitted if only process costs are desired.

This routine also adjusts all costs to the specified year dollar base. Capital costs are adjusted by the Sewage Treatment Plant Construction Cost Index. Operation and maintenance costs are related to the proper dollar base by use of the Wholesale Price Index for "Industrial Commodities" and by use of the hourly labor rate for non-supervisory workers in water, stream and sanitary systems.

When the cost summation routine is complete, the output routine is accessed. Output consists of a process connection listing, a complete presentation of the input and calculated stream pollutant parameter values at the various stream locations, a summarization of all costs and performance by process, and an overall system cost and effluent concentration table.

The output cost table shown in Exhibit F-V, on the following page, includes: investment cost, depreciation, cost of capital, operating and maintenance cost (less energy and power) and energy and power costs as a function of effluent flow. The effluent concentration table presents the selected parameters with their respective wastewater treatment system influent and effluent concentration expressed in units of milligrams per liter.

EXHIBIT F-V

U.S. Environmental Protection Agency

TYPICAL OUTPUT COST TABLE FOR WATER EFFLUENT TREATMENT COSTS-BPT

COST

Flow Rate (Liters/Hr)	7,885	15,771	39,427	157,708
Investment	$344,936	$398,924	$527,006	$1,063,173
Annual Costs:				
Capital Costs	16,912	19,559	25,839	52,127
Depreciation	34,494	39,892	52,701	106,317
Operation & Maintenance Costs (Excluding Energy & Power Costs)	34,207	38,451	49,965	103,675
Energy & Power Costs	10,064	20,139	50,383	201,531
Total Annual Cost	$ 95,676	$118,041	$178,887	$ 463,650

PERFORMANCE

Effluent Pollutant Parameters	Typical Waste Load	Typical Effluent Discharge Level
pH	9.2	8.5
Total Suspended Solids	1220 mg/l	15.0 mg/l
Cadmium	2.4 mg/l	0.12 mg/l
Chromium, Total	18.9 mg/l	0.4 mg/l
Copper	4.5 mg/l	0.2 mg/l
Fluoride	8.5 mg/l	2.0 mg/l
Iron	9.0 mg/l	0.5 mg/l
Lead	2.0 mg/l	0.1 mg/l
Nickel	3.4 mg/l	0.2 mg/l
Oil & Grease	668 mg/l	5.8 mg/l
Chemical Oxygen Demand	3087 mg/l	92.6 mg/l
Phosphates	10.0 mg/l	2.6 mg/l
Zinc	7.1 mg/l	0.5 mg/l

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4. TWO TYPES OF COST ASSUMPTIONS ARE INTEGRAL TO THE PROGRAM'S OUTPUTS

This section presents the two types of cost assumptions underlying the cost estimating routines described in the prior section. There are process cost assumptions which specify and size the abatement components, and there are system cost assumptions which also affect the magnitude of costs.

(1) Process Costs

The following process cost elements are built into the modeling capability of the program:

Cyanide Oxidation

The cyanide oxidation tank is sized as an above-ground cylindrical tank with a retention time of four hours based on the process flow. Since cyanide oxidation is considered to be of the batch type for the cost estimation program, two identical tanks are used and priced by the program.

Cyanide removal is accomplished by the addition of sodium hypochlorite as needed to maintain the proper pH level. A 60 day supply of sodium hypochlorite is stored in an in-ground covered concrete tank, 1 foot (.305 meters) thick. A 90 day supply of sodium hydroxide is also stored in an in-ground covered concrete tank, 1 foot (.305 meters) thick.

When using a continuous system for batch cyanide treatment, the system includes:

- 2 immersion pH probes and transmitters
- 2 immersion ORP probes and transmitters

- 2 pH and ORP monitors
- 2 2-pen recorders
- 2 slow process controllers
- 2 proportional sodium hypochlorite pumps
- 2 proportional sodium hydroxide pumps
- 2 mixers
- 3 transfer pumps
- 1 maintenance kit
- 2 liquid level controllers and alarms, and miscellaneous electrical equipment and piping

A complete manual control system is costed for the batch treatment alternative. This system includes:

- 2 pH probes and monitors
- 1 mixer
- 1 liquid level controller and horn
- 1 proportional sodium hypochlorite pump
- 1 on-off sodium hydroxide pump and PVC piping from the chemical storage tanks

Manpower estimates for operation and maintenance reflect the varying schemes for continuous and batch operation.

Mixer power requirements for both continuous and batch treatment are based on 2 horsepower for every 3,000 gallons of tank volume.

The mixer is assumed to be operational 25 percent of the time that the treatment system is operating.

<u>Chromium Reduction</u>

For both continuous and batch treatment, sulfuric acid is added for pH control. A 90 day supply is stored in the 25 percent aqueous form in an above-ground, covered, concrete tank 1 foot (.305 meters) thick. A constant power requirement of 2 horsepower is assumed to mix the chemicals.

For batch chromium reduction, the dual chromium reduction tanks are sized as above-ground cylindrical concrete tanks, 1 foot (.305 meters) thick, with a 4 hour retention time, and an excess capacity factor of 1.2. Sodium bisulfite is added to reduce the hexavalent chromium.

For continuous chromium reduction, the single chromium reduction tank is sized as an above-ground cylindrical concrete tank with a 1 foot (.305 meters) wall thickness, a 45 minute retention time, and an excess capacity factor of 1.2. Sulfur dioxide is added to convert the influent hexavalent chromium to the trivalent form.

The control system for continuous chromium reduction consists of:

1 immersion pH probe and transmitter

1 immersion ORP probe and transmitter

1 pH and ORP monitor

2 slow process controllers

1 sulfonator and associated pressure regulator

1 sulfuric acid pump

1 transfer pump for sulfur dioxide ejector

2 maintenance kits foı electrodes, and miscellaneous electrical equipment and piping

A completely manual system is provided for batch operation. Subsidiary equipment includes:

1 sodium bisulfite mixing and feed tank
1 metal stand and agitator collector
1 sodium bisulfite mixer with disconnects

- 1 sulfuric acid mixer with disconnects
- 1 sulfuric acid pump
- 2 immersion pH probes
- 1 pH monitor and miscellaneous piping

Manpower estimates for operation and maintenance reflect the varying schemes for continuous and batch operations.

Clarification

Clarification is employed for solids removal where land is available outside the plant for a treatment system. Clarification may be either continuous or batch treatment. Lime and sodium sulfide are added for metal and solids removal and pH adjustment.

For continuous clarification with an influent flow rate greater than or equal to 2600 gallons per hour (9,857 liters per hour), costs include a concrete flocculator and its excavation, and two centrifugal sludge pumps. The flocculator size is based on a 45 minute retention time, a length to width ratio of 5, a depth of 8 feet (244 meters), a thickness of 1 foot (.305 meters), and an excess capacity factor of 1.2. A mixer is included in the flocculator. The settling tank is sized by a design hydraulic loading of 33.3 gallons per hour per square foot (1356.7 liters per hour per square meter), a 4 hour retention time, and an excess capacity factor of 1.2.

For continuous clarification with an influent flow rate less than 2,600 gallons per hour (9,857 liter per hour), the flocculator and settling tank are each replaced with an aboveground conical, unlined carbon steel tank with a 4 hour retention time. The dual centrifugal sludge pumps are retained.

The sludge pumps are assumed operational 1 hour for each 12 hours of production operation and have 20% excess pumping capacity. Costs include motors, starters, alternators, and necessary piping.

For batch clarification, the dual centrifugal sludge pumps and the chemical demands are identical to continuous clarification. The flocculator and settling tank, however, are replaced with dual above-ground cylindrical carbon steel tanks, each tank with an 8 hour retention time, an excess capacity factor of 1.2, and a mixer that operates 1 hour for each 8 hours that the tank is being used. All power requirements are based on data from major manufacturers.

Diatomaceous Earth Filtration

Diatomaceous earth filtration is used in place of clarification for those plant models which have no land available outside the plant for a treatment system. Unit cost is based on one filter station comprised of one filter, one mix tank, two pumps, and associated valving. The unit is shut down one hour each day of operation for cleaning and filter pre-coating. Diatomaceous earth addition rates, power requirements, and manpower requirements are based on manufacturer's data.

pH Adjustment

pH adjustment is used for treatment at plants that discharge to a municipal treatment system. When used, the pH adjustment tank is an in-ground concrete tank with a 5 minute retention time. The tank has a width ratio of 5, a depth of 8 feet (2.44 meters), a thickness of 1 foot (.305 meters), and an excess capacity factor of 1.2. A mixer and tank excavation are included in the costs.

Lime is added to obtain the desired effluent pH. Mixer power is based on a representative installation with 1 turnover per minute.

Sludge Drying Beds

Sludge drying beds are sized by a drainage rate of 0.0078 gallons per hour per square foot (0.318 liters per hour per square meter) with a bed excavated to a depth of 4 feet (1.2 meters) and an excess capacity factor of 1.5. Costs include berms, underdrain piping, and all required gravel and sand. The unit is not sized for any influent flow rate less than 50 gallons per day (189 liters per day) as the bed area becomes too small to warrant construction.

Contractor Hauling

A flat rate of $42 per pick-up with a 15 cubic yard (11.5 cubic meters) capacity truck is charged for a January 1976 dollar base. This charge assumes that an appropriate landfill is available at no charge and no further treatment of the wastes is required.

Hauling costs are applied to the solids exiting from the solids removal devices in continuous and batch treatment systems and are applied to the total wastewater discharge flow when analyzing "haul" as a least cost system option.

(2) System Cost Assumptions

Section (1) presented the individual process cost elements. Subsidiary costs, however, must be included for any wastewater treatment system to be complete. This section presents all system subsidiary cost assumptions incorporated in the routines. Each cost assumption can be modified in use to satisfy any alternative set of conditions or assumptions.

Dollar Base

A dollar base of January 1976 is used for all costs. Investment costs are adjusted to this dollar base by use of the Sewage Treatment Plant Construction Cost Index from Reference 4. The national average of the Construction Cost Index for January 1976 is 256.7.

Supply costs, such as chemicals, are related to the dollar base by the "Industrial Commodities" Wholesale Price Index presented in Reference 5. For January 1976, this index is 177.3.

To relate operating and maintenance labor costs, the hourly wage rate for non-supervisory workers in water, stream, and sanitary systems is used from Reference 6. This wage rate is $5.19 per hour in January 1976. This wage rate is then applied to estimates of operational and maintenance man-hours required by each process to obtain process direct labor charges. To account for indirect labor charges, 15% of the direct labor costs is added to the direct labor charge to yield estimated total labor costs. Such items as Social Security, employer contributions to pension or retirement funds, and employer-paid premiums to various forms of insurance programs are considered indirect labor costs.

Energy and Power

Energy and power requirements are calculated directly within each process. Estimated costs are then determined by applying a rate of approximately 2.7 cents per kilowatt hour.

The electrical charge for January 1976 was corroborated through consultation with the Energy Consulting Service Department of the Connecticut Light and Power Company. This electrical charge was determined by assuming that any electrical needs of a waste treatment facility would be satisfied by an existing electrical distribution system; i.e., no new meter would be required.

Capital Recovery

Capital recovery costs are divided into depreciation and cost of capital. Depreciation is programmed for a straight line 5 year depreciation period consistent with the faster write-off (financial life) allowed by the IRS for these facilities, even though the equipment life is in the range of 20 to 25 years. Cost of capital is calculated by use of the capital recovery factor at a 10% annual interest rate applied for a period of 5 years.

The capital recovery factor (CFR) is normally used in industry to help allocate the initial investment and the interest to the total operating cost of the facility. The (CFR) is equal to the interest rate plus the interest rate divided by A-1. A is equal to the quantity 1 plus the interest rate raised to the n^{th} power, where n is the number of years the interest is applied. The annual capital recovery (ANR) is obtained by multiplying the initial investment by the CFR. The annual depreciation (D) of the capital investment is calculated by dividing the initial investment by the depreciation period N, which is assumed to be five years. The annual cost of capital is then equal to the annual capital recovery (ANR) minus the depreciation (D).

Line Segregation

These costs account for plant modifications to segregate waste if the wastes are present in the wastewater discharge. The maximum number of streams to be segregated is 1 less than the total number of waste streams entering the treatment system. This assumes that one general wastewater discharge point already exists at the plant. For example, if a plant has cyanide bearing wastes, chromium bearing wastes, and general wastewater, 2 lines would be the maximum number of streams to be segregated. If the plant model, however, indicates that either cyanide oxidation or chromium reduction is already in place, line segregation costs for this process (es) already in place are ignored.

The investment costs of line segregation include placing a trench in the existing plant floor and installing the lines in this trench. The same ditch is used for all pipe and a gravity feed to the treatment system is assumed. The piping is assumed to run from the center of the floor to a corner. Plant floor area is related to discharge flow by the results of an analysis of 300 plants visited for which flow and floor area are available. This data indicated that .05 gallons per hour of wastewater is discharged per square foot of floor area (2.04 liters per hour per square meter).

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Administrative and Laboratory Facilities

This item is the cost of constructing space for administration, laboratory, and service functions for the wastewater treatment system. All the plant models executed for electroplating economic impact analysis already had an existing building and space for administration, laboratory, and service functions. Therefore, there is no investment cost for this item.

Garage and Shop Facilities

For the industrial waste treatment facilities being costed, the garage and shop investment cost is assumed to be part of the normal plant costs and was not allocated to the wastewater treatment system.

Laboratory Operations

An analytical fee of $80 (January 1976 dollars) is charged for each wastewater sample, regardless of whether the laboratory work was done on or off site. This analytical fee is typical of the charges experienced by Hamilton Standard during the past several years of sampling programs.

The frequency of wastewater sampling is a function of wastewater discharge flow and is presented in Table F-3, on the following page. This frequency was suggested by the Water Compliance Division of the USEPA.

Yardwork

The yardwork investment cost item includes the costs of general site clearing, intercomponent piping, valves, overhead and underground electrical wiring, cable, lighting, control structures, manholes, tunnels, conduits, and general site items outside the structural confines of particular individual plant components. This cost is typically 9-18 percent of the installed component investment costs. For these cost estimates, an average of 14 percent is utilized. Yardwork operation and maintenance costs are considered a part of normal plant maintenance and are not included in these cost estimates.

Table F-3

Wastewater Sampling Frequency

Wastewater Discharge Flow (gallons per day)	Sampling Frequency
0 - 10,000	once per month
10,000 - 50,000	twice per month
50,000 - 100,000	once per week
100,000 - 250,000	twice per week
250,000 +	thrice per week

Land

The wastewater treatment system land requirements are calculated allowing a 10-foot (3-meter) perimeter around each treatment system component and a 5-foot (1.5-meter) perimeter around each chemical storage tank. Land is then bought in 5,000 square foot (464.5 square meter) segments to satisfy the land requirements. If a plant already has land available for its wastewater treatment system, this land cost is set to $0.

The locale of the plant also affects land costs. The following local relationships, as shown in Table F-4 below, are assumed to determine land costs.

Table F-4

Locale - Land Cost Relationships

Locale	$/acre (January 1976 dollars)
Urban	75,000
Suburban	10,000
Rural	2,000

Engineering

Engineering costs include both basic and special services. Basic services include preliminary design reports, detailed design, and certain office and field engineering services during construction of projects. Special services include improvement studies, resident engineering, soils investigations, land surveys, operation and maintenance manuals, and other miscellaneous services.

Engineering cost is a function of process installed and yardwork costs as presented in Reference 7. This charge has also been substantiated by data supplied by the Connecticut Engineers in Private Practice.

Legal, Fiscal, and Administrative

These costs relate to planning and construction of wastewater treatment facilities and include such items as preparation of legal documents, preparation of construction contracts, acquisition of land, etc. These costs are a function of processes installed yardwork, engineering, and land costs.

Interest During Construction

The dollar value calculated for this item consists of the interest cost accrued on funds from the time payment is made to the contractor to the end of the construction period. The total of all other project costs: (processes installed, yardwork, land, engineering, legal, fiscal and administrative) and the applied interest affect this cost.

An interest rate of 10% is used to determine the interest cost for these estimates.

5. THERE ARE SEVERAL SPECIAL CONDITIONS, IF NOT LIMITATIONS, TO THE ROUTINE'S APPLICABILITY

The results of the cost program generally agree with known costs to within ± 20 percent. Comparisons of the program estimates to actual plant data (for comparable wastewater treatment equipment) have been conducted for the Agency within the last year. Consistently, the sets of costs show high levels of agreement.

In addition, the sensitivity of the cost estimates to several variables is demonstrated in the program output. The variables reviewed include plant size (as modeled by wastewater discharge), treatment-in-place, and applied effluent discharge standards (as modeled by the various estimation modes).

There are, however, certain limitations associated with extrapolating the model plant cost estimates to the universe of job shop electroplaters. These limitations are discussed in detail below.

> The cost program calculates a nationwide, general cost of wastewater treatment system installation and operation applicable for average situations. Costs of unusual construction requirements, such as foundation piling, rock excavation, or dewatering, have not been included in the general cost estimates. Any one plant could experience installation costs far different from those estimated by the program.
>
> Plant alteration costs have only been estimated in part. Line segregation costs have been estimated per the procedure discussed in Section 2, above, and are dependent on the floor area, floor plan, and distance to the wastewater treatment facilities.
>
> Special plant alteration costs, such as the building of a mezzanine, the removal of a wall, or the strengthening of a floor were not estimated due to the special, unique nature of this type of alteration for each plant. Again, high cost variability on this item would be expected.
>
> The haul costs calculated by the program include transport costs only. It was assumed that a suitable landfill was available at no cost and that no further treatment of the wastes was required. The transport cost was corroborated by a local Connecticut hauler. To the extent that there is an added cost for treatment, then the program will understate the full costs of that treatment mode.

* * * *

This appendix has presented the logic, methodology and limitations of the computerized cost estimating routine developed by Hamilton Standard. Use of this program has enabled the present economic impact study to incorporate highly reliable estimates of pollution abatement system costs.

APPENDIX G

EXHIBIT G-I

U. S. Environmental Protection Agency

PLANTS WITH CLARIFIER ONLY

Plant #	Electroplating Operation	Finishing Operation	Treatment Equipment Previously Installed
409		Anodizing	
50		Chemical milling and chemical etching	
367	Ni, Cr, Gold	Bright dip, stripping	pH adjustment, Cr, separate hex Cr stream
169	Cadmium	Chromating	CN, countercurrent rinse
377		Anodizing, coloring, phosphating, chromating, non-aqueous plating, bright dip, chemical etching, stripping	pH adjustment, flow equalization, Cr, separate hex Cr stream, countercurrent rinse
52		Chemical milling, chemical etching, stripping	pH adjustment, lagoon
115		Phosphating	pH adjustment, flow equalization, Cr, lagoon
334		Chemical etching	pH adjustment, clarifier, lagoon
152		Phosphating, stripping	
353		Phosphating, chemical etching	
347		Anodizing, coloring	pH adjustment, clarifier, countercurrent rinse
355	Cu, Ni, Solder, Tin, Gold, Silver, Cobalt	Electroless on metals and plastics, bright dip, chemical etching, stripping	pH adjustment, CN, separate Cl stream, advanced treatment
302	Cu, Ni, Cadmium, Zn, Tin	Anodizing, coloring, phosphating, chromating, electroless on metals, bright dip, chemical etching, stripping	pH adjustment, Cr, CN

Source: Booz, Allen & Hamilton Inc.

VALIDATION OF THE POLLUTION ABATEMENT COST ESTIMATES

This appendix presents the methodologies employed by Booz, Allen for interpolating technical contractor's cost estimates for the initial 74 model plants. As stated in the methodology chapter, several analytic steps were required to derive generalized predictor equations from these 74 model plants for use on all models of the impact analysis. Specifically, the following was done:

- Operations were grouped by common processes to find basic treatment equipment requirements
- Flow allocation rules were derived on a per treatment component basis
- Cost equations were developed on a water flow sizing measure
- Costs derived by the equations were tested against the routine and outside sources

The next four sections provide the data and analyses of each activity.

1. TREATMENT EQUIPMENT REQUIREMENT

The four exhibits which follow, G I-IV, contain the raw data from which treatment equipment requirements rules

EXHIBIT G-II
U. S. Environmental Protection Agency
PLANTS WITH CHROME REDUCTION
AND CLARIFIER

Plant #	Electroplating Operation	Finishing Operation	Treatment Equipment Previously Installed
364		Anodizing, coloring, phosphating, chromating, bright dip, chemical etching, stripping	pH adjustment
142		Anodizing, coloring, bright dip, chemical etching, stripping	Lagoon
423	Cu/Ni,/Cr	Stripping	
308	Ni/Cr		
271		Anodizing, coloring, chromating, bright dip, chemical etching, stripping	pH adjustment, Cr, clarifier
34		Chromating, chemical etching	
111	Ni/Cr		
66		Anodizing, coloring, chemical etching, stripping	
123	Ni, Cr, Zn	Chromating	pH adjustment, Cr, clarifier, countercurrent rinse
162		Anodizing, coloring, phosphating, chromating, chemical etching	pH adjustment, flow equalization Cr, lagoon, separate hex Cr stre.
94		Anodizing, coloring, chromating, bright dip, chemical etching, stripping	pH adjustment, flow equalization, lagoon

Plant #	Electroplating Operation	Finishing Operation	Treatment Equipment Previously Installed
231	Cu, Ni, Cr	Stripping	
14	Cr	Stripping	
47		Phosphating, chromating	
15		Phosphating, chromating, chemical milling, bright dip, chemical etching, stripping	
303		Anodizing, coloring, bright dip, chemical etching	
414		Phosphating, chromating	
331		Anodizing	
281	Cr, Zn		pH adjustment, flow equalization, CN
391	Cu, Ni, Cr		countercurrent rinse, advanced treatment
128		Anodizing, coloring, chromating	
159	Cu, Ni, Cr	Electroless on plastics	pH adjustment, lagoon
316	Cu, Ni, Cadmium, Zn, Tin	Anodizing, coloring, phosphating, chromating	pH adjustment, flow equalization lagoon, separate CN stream, countercurrent rinse
187		Anodizing, coloring, bright dip	pH, Cr, lagoon, separate hex Cr stream, countercurrent rinse

Plant #	Electroplating Operation	Finishing Operation	Treatment Equipment Previously Installed
215		Anodizing, bright dip	
348	Ni, Cr, Cadmium, Zn		pH adjustment, CN, clarifier, countercurrent rinse
212	Cu, Ni, Cr	Anodizing, chromating, stripping	
149		Anodizing	

Source: Booz, Allen & Hamilton Inc.

EXHIBIT G-III
U. S. Environmental Protection Agency
PLANTS WITH CYANIDE DESTRUCTION
AND CLARIFIERS

Plant #	Electroplating Operation	Finishing Operation	Treatment Equipment Previously Installed
79	Cu, Ni, Gold, Silver	Stripping	
30	Platinum		
59	Cu, Ni, Tin, Gold, Silver, Brass	Electroless on metals, bright dip, stripping	Clarifier, countercurrent rinse, advanced treatment
332	Cu, Ni, Tin, Gold, Silver, Platinum	Electroless on metals	
44	Cu, Ni, Cr, Gold, Silver, Brass	Electroless on plastics	Cr, separate hex Cr stream, countercurrent rinse, advanced treatment
45	Cu, Ni, Cadmium, Zn		
39	Cadmium, Zn	Anodizing, coloring phosphating, bright dip	pH adjustment, Cr

Source: Booz, Allen & Hamilton, Inc.

EXHIBIT G-IV (1)
U. S. Environmental Protection Agency
PLANTS WITH FULL BPT SYSTEMS

Plant #	Electroplating Operation	Finishing Operation	Treatment Equipment Previously Installed
289	Cu, Ni, Cr, Tin, Silver, Brass and Bronze	Bright dip, stripping	
80	Cu, Ni, Cadmium, Zn, Tin, Brass and Bronze	Phosphating, chromating, bright dip, stripping	pH adjustment, flow equalizatio Cr, CN, clarifier, countercurre advanced treatment
151	Cu, Ni, Cr, Cadmium, Bronze	Chromating, electroless on metals, stripping	
25	Cu, Ni, Cr, Gold		
46	Cu, Zn	Chromating, bright dip, stripping	
287	Cu, Ni, Cr, Gold, Silver, Brass	Stripping	
392	Cu, Ni, Cr, Zn, Gold, Brass		
305	Cu, Ni, Cr, Cadmium, Zn, Tin	Chromating, bright dip	
184	Cu, Ni, Cr, Cadmium, Zn, Tin, Gold, Silver, Brass, Bronze	Anodizing, coloring, phosphating, chromating, bright dip, chemical etching, stripping	
373	Ni, Cr, Cadmium, Lead, Tin, Silver	Electroless on metals	Clarifier, countercurrent rinse
345	Cu, Ni, Cr, Cadmium, Zn, Tin, Gold, Silver, Platinum	Coloring, phosphating, chromating, electroless on metals, bright dip, chemical etching, stripping	
188	Ni, Cr, Zn	Chromating, stripping	Advanced treatment

Plant #	Electroplating Operation	Finishing Operation	Treatment Equipment Previously Installed
386	Cu, Ni, Cr, Cadmium, Zn, Solder, Tin	Anodizing, coloring, chromating, phosphating, electroless on metals, chemical etching, stripping	
110	Ni, Cr, Zn	Chromating	
26	Cu, Ni, Cr		
235	Cu, Ni, Cadmium, Solder, Tin, Gold, Silver, Platinum	Anodizing, coloring, chromating, electroless on metals, bright dip, stripping	
129	Cadmium, Zn	Chromating	
358	Cu, Ni, Cr, Brass	Stripping	
344	All electroplating	Chromating, electroless on plastics and metals, bright dip, milling, stripping	pH adjustment
76	Zn	Anodizing, coloring, phosphating, chromating, bright dip, chemical etching, stripping	pH adjustment, flow equalization, clarifier
55	Cu, Ni, Cr, Cadmium, Zn, Gold, Silver, Platinum, brass	Anodizing, coloring, chromating, electroless on metals, bright dip, stripping	pH adjustment, clarifier
143	Cadmium, Zn, Lead, Brass	Phosphating, chromating, bright dip	pH adjustment, flow equalization, Cr, CN, clarifier, separate CN stream, separate hexa-stream
346	Cadmium, Zn	Anodizing, coloring, chromating, bright dip, chemical etching, stripping	pH adjustment, clarifier

Plant #	Electroplating Operation	Finishing Operation	Treatment Equipment Previously Installed
340	Ni, Cr, Zn, Brass	Chromating, stripping	
82	Cr, Zn	Phosphating, chromating	pH adjustment, Cr, CN, lagoon, separate stream, countercurrent rinse
136	Cu, Ni, Cr, Zn, Cadmium	Phosphating, chromating, electroless on metals, chemical milling, stripping	Have everything

Source: Booz, Allen & Hamilton Inc.

were derived. Inspection of these exhibits provided the basis for developing the following decision rules:

> Plants involved only in sulfuric acid anodizing, and/or nonelectroplating metalfinishing operations (except chromating and bright dipping) were likely to require pH adjustment only to meet BPT requirements.
>
> Plants involved only in copper, tin, cadmium, zinc, precious metal plating or bright dipping or a combination thereof were likely to require cyanide destruction and pH adjustment equipment.
>
> Plants involved only in chromium plating, chromic acid anodizing, chromating or a combination thereof were likely to require hexavalent chromium reduction and pH adjustment equipment.
>
> Other plants doing combinations of these operations were likely to require all three major systems: cyanide destruction, hexavalent chromium reduction, and pH adjustment.
>
> Line segregation was assumed to be required when two or more pieces of equipment were required. In cases where only two pieces of equipment were required or because of previously installed equipment, one-half of the total estimated line segregation costs was likely.

The exhibits also show the treatment equipment which the survey respondents indicated had been installed at their shops. Again inspection of the exhibits shows that the decision rules for predicting equipment appear to be reasonably consistent with practice in the field.

2. FLOW ALLOCATION RULES

Exhibits G V-VIII on the following pages show the flow of process water through the pollution abatement units.

EXHIBIT G-V

U.S. Environmental Protection Agency

PERCENTAGE OF FLOW TO CYANIDE DESTRUCTION UNIT FOR PLANTS INSTALLING CYANIDE DESTRUCTION AND pH ADJUSTMENT EQUIPMENT

Plant No.	Percenc of Metal Finishing Water to Cyanide Unit	Operations
79	69.5	Copper, Nickel, Gold, Silver
59	62.1	Copper, Nickel, Tin, Gold, Silver Brass, electroless on metals, bright dip
332	62.9	Copper, Nickel, Tin, Gold, Silver, Platinum, electroless on metals
44	20.1	Copper, Nickel, Chromium, Gold, Silver Brass, electroless on plastics, (Chrome Reduction Unit already installed)
45	78.0	Copper, Nickel, Cadmium, Zinc
91	15.6	Brass, Bronze, flemish oxidizing bright dipping, chromating
18	67.4	Copper, Nickel, Cadmium, Zinc, chromating, bright dipping, chemical etching
39	73.8	Cadmium, Zinc, anodizing, phosphating, bright dip (Chrome reduction unit previously installed)

Average percentage to Cyanide Destruction Unit = 56.2%

Standard Deviation = 24.3%

Source: Booz, Allen & Hamilton Inc.

EXHIBIT G-VI (1)

U.S. Environmental Protection Agency

PERCENTAGE OF FLOW TO CHROME REDUCTION UNIT FOR PLANTS INSTALLING HEXAVALENT CHROMIUM REDUCTION AND PH ADJUSTMENT EQUIPMENT

Plant No.	Percentage of Metalfinishing Water To Hexavalent Chromium Reduction Unit (%)	Operations
364	33.4	Anodize, color, phosphating, chromating, bright dip chemical etch
142	43.8	Anodize, color, bright dip, chemical etch
308	9.9	Nickel, Chromium
271	24.1	Anodize, color, chromating, bright dip, chemical etch
34	19.9	Chromating, chemical etch
111	9.9	Nickel, Chromium
66	37.2	Anodize, color, chemical etch, strip
162	20.2	Anodize, color, phosphating, chromating chemical etch
94	37.2	Anodize, color, chromating, bright dip, chemical etch, strip
14	6.3	Chromium, strip
47	26.0	Phosphating, chromating
15	2.9	Phosphate, chromating, chemical mill, bright dip, chemical etch, strip

303	23.7	Anodize, color, bright dip, chemical etch
414	8.9	Phosphating, chromating.
331	58.9	Anodize
281	4.5	Chromium, Zinc (CN destruct in place)
391	6.3	Copper, Nickel, Chromium (Advanced treatment replace)
128	46.7	Anodize, Color, Chromating
159	6.7	Copper, Nickel, Chromium, electroless on plastics
316	6.6	Copper, Nickel, Cadmium Zinc, Tin, anodize, color phosphating, chromating (CN destruct in place)
187	56.7	Anodize, color, bright dip
348	1.7	Nickel, Chromium, Cadmium, Zinc (CN destruct in place)
149	37.3	Anodize

Average Percentage of Flow to Hexavalent Chromium Reduction Unit = 23.0%

Standard Deviation = 17.8%

Source: Booz, Allen & Hamilton Inc.

EXHIBIT G-VII (1)

U.S. Environmental Protection Agency

PERCENTAGES OF FLOW TO CYANIDE DESTRUCTION
AND CHROME REDUCTION UNITS FOR FULL BPPT SYSTEMS
-- COMPLEX PLANTS

Plant No.	Percentage of Metal Cyanide Destruction (%)	Finishing Water to Chrome Reduction (%)	Operation
289	19.0	2.9	Copper, Tin, Nickel, Chromium, Silver, Brass, Bronze, bright dip, strip
80	61.0	-	Copper, Nickel Cadmium, Zinc, Tin, Brass, Bronze, phosphating, chromating, bright dip, strip (Chrome reduction previously installed)
151	64.7	3.9	Copper, Nickel, Chromium, Cadmium, Bronze, Chromating, electroless on metals, strip
392	66.3	0.7	Copper, Nickel, Chromium, Zinc, Gold, Brass
305	61.0	2.9	Copper, Nickel, Chromium, Cadmium, Zinc, Tin, Chromating, bright dip
373	79.9	0.2	Nickel, Chromium, Cadmium, Lead, Tin, Silver, electroless on metals
345	56.2	3.5	Copper, Nickel, Chromium, Cadmium, Zinc, Tin, Gold, Silver, Platinum, coloring, phosphating, chromating, electroless on metals, bright dip, chemical etching, strip

386	64.2	7.7	Copper, Nickel, Chromium, Cadmium, Tin, Silver, Zinc, anodizing, coloring, chromating, phosphating, electroless on metals, chemical etching, strip
235	71.1	6.4	Copper, Nickel, Cadmium Solder, Tin, Gold, Silver, Platinum, anodizing, coloring, chromating, electroless on metals, bright dip, strip
344	64.7	0.2	All electroplating and metal finishing operation
55	76.0	5.4	Copper, Nickel, Chromium, Cadmium, Zinc, Gold, Silver, Platinum, Brass, anodizing coloring, chromating, electroless on metals, bright dip, strip
346	57.1	11.4	Cadmium, Zinc, anodizing, coloring, bright dip, chromating, chemical etching, strip

Average Percentage of Flow to Cyanide Destruction Unit = 61.8%

Standard Deviation = 15.2%

Average Percentage of Flow to Hexavalent Chromium Reduction Unit = 4.1%

Standard Deviation = 3.4%

Source: Booz, Allen & Hamilton Inc.

EXHIBIT G-VIII

U.S. Environmental Protection Agency

PERCENTAGE OF FLOW TO CYANIDE DESTRUCTION AND CHROME REDUCTION UNITS FOR FULL BPPT SYSTEMS--SIMPLE PLANT CONFIGURATION

Plant No.	Percentage of Metal Cyanide Destruction (%)	Finishing Water to Chrome Reduction (%)	Operation
287	9.8	4.6	Copper, Nickel, Chrome, Gold, Silver,
188	3.4	12.6	Nickel, Chrome, Zinc, chromating, strip
110	9.9	17.9	Nickel, Chrome, Zinc, chromating
26	5.9	9.6	Copper, Nickel, Chrome
340	9.2	3.2	Nickel, Chrome, Zinc, Brass, chromating
82	10.2	10.9	Chrome, Zinc, phosphating, chromating

Average Percentage of Flow to Cyanide Destruction Unit = 8.1%

Standard Deviation = 2.8%

Average Percentage of Flow to Hexavalent Chromium Reduction Unit = 9.8%

Standard Deviation = 5.4%

Source: Booz, Allen, Hamilton Inc.

Inspection of the flow volumes provided the basis for the following allocation rules:

> Plants requiring installation of cyanide destruction and pH equipment tend to have about 56% of their metalfinishing water flowing to the cyanide destruction unit.
>
> Plants requiring installation of hexavalent chromium reduction and pH adjustment equipment tend to have about 23% of their metalfinishing water flowing to the chrome reduction unit.
>
> Plants requiring installation of full BPPT systems fall into two categories:
>
> > Plants which perform more than six operations tend to have about 62% of their metalfinishing water flow in the cyanide destruction unit and about 4% of their metalfinishing water flowing to the hexavalent chromium reduction unit.
> >
> > Plants with six or fewer operations tend to have about 8% of their metalfinishing water flow to the cyanide destruction unit and about 10% flowing to the hexavalent chromium reduction unit.
>
> In all cases all the metalfinishing water flows through the pH adjustment unit.

3. COST EQUATIONS

Computer cost estimates were regressed against flow volume in gallons per hour. This process was repeated for each individual component. In this manner each component had its own cost predictor equation. The regression lines and the formulae appear in Chapter II. Only the basic cost equations are repeated here in Exhibit G IX, on the next page.

EXHIBIT G-IX

U.S. Environmental Protection Agency

EQUATIONS RELATING ESTIMATES OF INVESTMENT FOR WATER TREATMENT WITH GALLONS PER HOUR OF WATER TREATED

Subsystem	Equation*	Correlation Statistic
Hexavalent Chromium Reduction (2)	Investment ($) = 8,400 GPH 0.17	0.8
Cyanide Destruction	Investment ($) = 19,000 + 15.2 GPH	0.9
pH Adjustment	Investment ($) = 14,700 + 1.0 GPH	--
Line Segregation	Investment ($) 210 GPH 0.5	0.9
Clarifier	Investment ($) = $16,000 GPH 0.15	
Diatomaceous Earth Filter	Investment ($) = $4,065 GPH 0.33	

*Notes on Equations

1. Investment value in 1977 dollars.
2. GPH is the metalfinishing water to specific unit.
3. GPH is the total metalfinishing water of the plant.

Source: Booz, Allen & Hamilton Inc.

4. TESTING OF DERIVED COST ESTIMATES

Given that the regression equations are best fit relationships to the costs reported by the technical contractor, they tend to agree closely with those estimates. The utility of the cost equations rests not with how well they predict back to the data base, but rather with how well they predict to external sources.

Exhibit G X on the next page shows a comparison of supplier generated quotations and regression equation costs on a per component basis. This limited survey of equipment suppliers yields the following:

> At worst, the budgetary quotation from small capacity hexavalent chromium reduction units exceeds the model estimated cost by 33%.
>
> For hexavalent chromium reduction units, the average percentage difference between model estimates and budget quotes was 13%.
>
> For cyanide oxidation units, the average percentage difference between model estimates and quotes was about 7%.
>
> For clarifiers, the average percentage difference between model estimates and budget quotes was about 13%.

Given that the Technical Contractor's original component costs come from suppliers, and the regression equations agree closely with the computer generated costs, there is every reason to believe that the study can accurately predict a firm's pollution abatement costs.

* * *

EXHIBIT G-X

U.S. Environmental Protection Agency

COMPARISON OF SELECTED ESTIMATED
COST FOR POLLUTION CONTROL EQUIPMENT
AND BUDGETARY QUOTES BY SUPPLIERS

Equipment Item	Capacity (GPH)	Model Estimated Cost (Thousand)	Budgetary Quotes by Supplier (Thousand)
Chromium Reduction	300	20	30
	1,400	28	30
	2,000	32	35
	3,000	35	32
	5,000	40	38
Cyanide Oxidation	300	24	29
	500	17	30
	1,000	33	33
	1,500	36	35-41
	3,000	94	94
Clarifier	1,000	46	60
	10,000	66-105	82

(1) Two suppliers provided quotes in chromium reduction equipment. Three suppliers provided quotes on cyanide oxidation equipment. One supplier provided quotes on clarifiers.

Source: Booz, Allen & Hamilton