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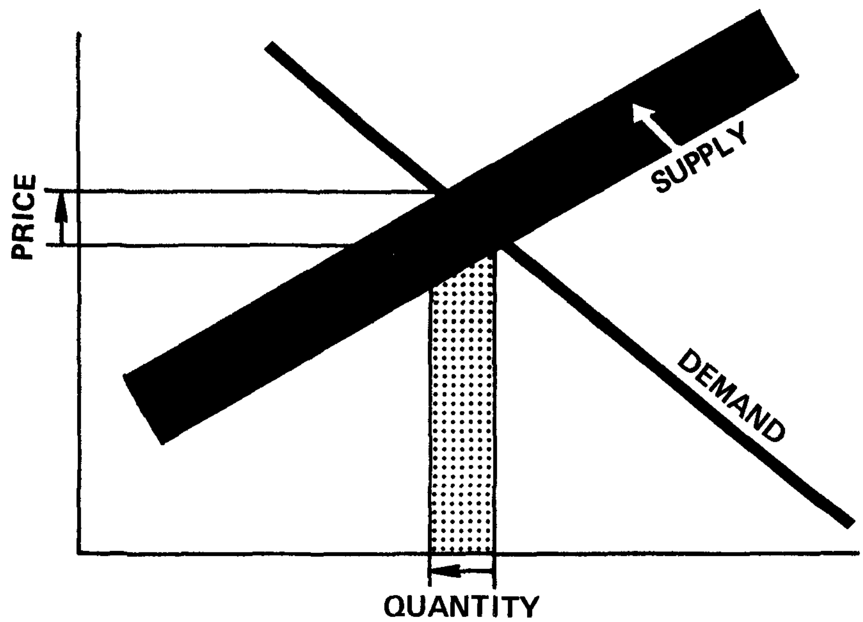
Economic Impact Analysis of Proposed Effluent Limitations and Standards for the Copper Forming Industry



ECONOMIC IMPACT ANALYSIS
OF PROPOSED EFFLUENT
LIMITATIONS AND STANDARDS
FOR THE
COPPER FORMING INDUSTRY

November 5, 1982

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PREFACE

This document is a contractor's study prepared for the Office of Water Regulations and Standards of the Environmental Protection Agency (EPA). The purpose of the study is to analyze the economic impact which could result from the application of effluent standards and limitations issued under Sections 301, 304, 306, and 307 of the Clean Water Act to the Copper Forming industry.

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

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1. INTRODUCTION AND SUMMARY OF FINDINGS

1.1 PURPOSE

The purpose of this study is to analyze the economic impacts which are likely to result from the promulgation of EPA's effluent regulations on the copper forming industry. The effluent standards and limitations which are issued under authority of Sections 301, 304, 306, 307, 308 and 501 of the Federal Water Pollution Control Act of 1972, as amended by the Clean Water Act of 1977 (P.L. 95-217), require the Administrator (EPA) to establish the following:

- Effluent limitations based on the Best Available Technology Economically Achievable (BAT) to be met by industrial dischargers by 1984;
- New Source Performance Standards (NSPS) to be met by new source industrial dischargers;
- Pretreatment Standards for Existing Sources (PSES) for existing dischargers to publicly-owned treatment works (POTW's);
- Pretreatment Standards for New Sources (PSNS) for new dischargers to publicly-owned treatment works (POTW's).

In order to establish these limitations, this study explicitly assesses the effects of pollution control regulatory options upon the costs (fixed and variable) of production, capacity expansion and replacement, profitability, and the potential for plant closures in the U.S. copper forming industry. In addition, the impacts on employment, communities, foreign trade, and small business, and the social costs of the regulation are considered.

1.2 SCOPE

1.2.1 Industry Coverage

For purposes of this study, the copper forming industry includes 176 plants that form refined copper and scrap copper into intermediate and finished copper and copper alloy products. The industry is classified under the following Standard Industrial Classification (SIC) groups:[1/]

- SIC 3351 - Copper Rolling and Drawing
- SIC 3357 - Copper and Copper-Base Alloy Wire, and other copper wire product segments of the nonferrous wire drawing and insulating industry group.

This SIC grouping is further disaggregated into the following major products manufactured by copper forming plants:

- Brass Mill Products
  - Sheet, Strip, and Plate,
  - Rod, Bar, and Mechanical Wire,
  - Commercial and Plumbing Tube and Pipe;
- Wire Mill Products.

1.2.2 Regulatory Options Considered

EPA considered three treatment and control options for the BPT, BAT, NSPS, PSES, and PSNS regulations. These are:

- Option 1: End-of-pipe treatment consisting of lime precipitation and settling, and, where necessary, preliminary treatment
- Option 2: Option 1 plus flow reduction for three waste streams

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1/ Included in this analysis of the copper forming industry is all of SIC 3351 and some, but not all, of SIC 3357.

- Option 3: Option 2 plus filtration for further reduction of toxic metals and TSS.

A more comprehensive description of these technologies and associated compliance costs is contained in Chapter 5.

1.3 METHODOLOGY, DATA, AND ASSUMPTIONS

This section summarizes the methodology, assumptions, and data used to analyze the economic impacts of the proposed effluent regulations on the copper forming industry. It describes the ways in which information on industry characteristics (from the 308 Economic Survey and from published sources) are used together with estimated compliance costs (from a separate study) to identify plants that may not be in a position to afford the installation of pollution control equipment. This section also summarizes the approaches used to identify potential plant closures, employment, price, and other impacts on plants in the industry. More detailed descriptions of the analytical techniques, data, and assumptions used appear, where appropriate, throughout the remainder of the report.

1.3.1 Overview of Approach

In general, effluent regulations impose added costs on plants in the industry. These costs include capital expenditures on pollution control equipment (fixed costs), and operating and maintenance expenses (variable costs), both of which cause the average production costs of a plant to increase. Under such conditions plant owners have the following options:

A. Raise the price of their products and pass through some or all of the increased costs to purchasers;

B. Absorb the increase in costs;

C. Shut down the operation and go out of business.

The approach to this study begins with a determination of which of these option(s) producers in the industry are most likely to follow, and what the resulting price and output levels are likely to be. Then, capital budgeting techniques are used to evaluate the financial status of copper forming plants under conditions of the estimated post-compliance price and output levels. Other impacts such as employment, community and foreign trade effects are evaluated based on the industry impacts.

1.3.2 Description of Industry Characteristics

The first step in the analysis is to describe the basic industry characteristics that will be related to the impacts of the regulation. These characteristics include the determinants of demand, market structure, financial performance, and the degree of intra-industry competition. These basic characteristics are described in Chapters 2 through 4 of the report.

The sources for this information are many. They include government reports, text books, trade association data, the trade press, discussions with individuals associated with the industry, and, of particular importance, a plant and firm level survey conducted by EPA under authority of Section 308 of the Clean Water Act (the 308 Economic Survey).

The survey questionnaire was mailed to every known plant in the copper forming industry. A total of 103 plants (i.e., approximately 59 percent of all copper forming plants) responded to the 308 Economic Survey, and the information obtained from these responses is included in the analysis.

The survey was designed to provide accurate and current information on the economic and financial characteristics of the industry's plants and firms. Data collected included information on market structure, profitability, investment in new capital, and value added. These data, together with estimates of the costs of alternate pollution control options, served as the basis of the economic impact analysis of the proposed regulation on this industry.

All questionnaires were returned directly to EPA by the respondents, and procedures were employed to protect the confidentiality of the data. These procedures included EPA removing the identification section from each questionnaire and assigning a code number to each questionnaire before it was forwarded to the contractor for processing.

1.3.3 Base Case Analysis

The economic impact analyses presented in this report are based on a series of projections made for each product group and compared against a set of baseline projections. The baseline projections represent an estimate of the economic characteristics of the industry over the impact period in the absence of the proposed regulations. When the impact projections are compared against the baseline, the difference represents the estimated impact over the base case. In general, small changes in the baseline projection will have little effect on the incremental impacts.

1.3.4 Compliance Cost Estimates

The water treatment control systems, costs, and effluent limitation and pretreatment standards recommended for the copper forming industry were derived in a separate analysis by EPA. A comprehensive description of the methodology and the recommended technologies and costs are provided in the EPA's proposed Development Document for Effluent Limitations Guidelines and Standards for the Copper Forming Point Source Category. EPA considered treatment and control options based on BPT, BAT, NSPS, PSES, and PSNS for facilities within the copper forming category.

- Option 1: Option 1 is end-of-pipe treatment consisting of lime precipitation and settling, and, where necessary, preliminary treatment consists of chemical emulsion breaking and chromium reduction. This combination of technology reduces toxic metals, conventional pollutants, and also toxic organics through oil skimming.

- Option 2: Option 2 is equal to Option 1 plus flow reduction for three waste streams: annealing water, solution heat treatment, and pickling rinse. Flow reduction of the annealing water and solution heat treatment streams is based on recycle, and flow reduction of the pickling rinse stream is based on spray rinsing and recirculation. The Option 1 flows for these streams are reduced by approximately 60 percent, and this reduction will result in a similar decrease of toxic metals and conventional pollutants.

- Option 3: Option 3 is equal to Option 2 plus filtration for further reduction of toxic metals and TSS.

The costs associated with these pollution control options were determined in a separate analysis and provided to the economic analysis study team for use in the analysis.

1.3.5 Price Impact Analysis

The extent to which the proposed pollution control costs can be passed through to the customers is very important and is analyzed separately. The increase in price which is likely to occur if pollution controls are required is determined by a microeconomic demand/supply analysis of the product markets in the copper forming industry. Compliance with effluent limitations will increase the production costs of the firms. This cost increase can be translated as an upward movement in the supply curve of the firms in the industry. The impact of an increase in costs on price in a single product market depends on the elasticities of supply and demand in that market. Furthermore, the percent price (p) increase resulting from a one percent increase in pollution control costs at the margin (MC) can be expressed precisely in the algebraic form:

$$\frac{dp/p}{dMC/MC} = \frac{\eta}{\eta - e} \qquad (1.1)$$

where η and e are the supply and demand elasticities, respectively. Consequently, if we know η and e, we can estimate the likely changes in the price of copper forming products which would result from changes in costs. Demand and supply curves are constructed to provide these elasticity estimates. Based on these estimates, the potential for the price of the copper forming products to rise due to the costs of pollution control required by the proposed regulation can be calculated. The percent price pass throughs estimated with equation (1.1) are used in conjunction with the additional per unit pollution control costs for the selected technologies to calculate the likely price increases for each product sector market.

1.3.6 Capital Availability Analysis

The capital availability analysis examines the ability of participants in the industry to finance investments in new capacity, both with and without pollution control. The approach focuses on the ability of participants to finance capital investments from their current cash flow, without relying on outside sources of capital. An implicit assumption in this approach is that if a plant can invest in pollution control and still remain profitable, then given the current cost of capital, the capital market would also be willing to provide the money for the pollution control investment. A capital budgeting approach that considers the profitability of the plant assuming that it decides to install the pollution control equipment is used. If the plant has a positive cash flow after the investment, it can afford to purchase the equipment. If not, it could not install the pollution control equipment and remain profitable.

1.3.7 Plant Closure Analysis

In general, the proposed pollution control requirement will force a rational plant manager to decide (a) whether to make an additional investment and incur additional fixed and operating costs, or (b) to sell the plant. His alternatives are:

(1) Sell the plant--either as an operating entity or as scrap.

(2) Make the investment and realize the value of the cash flows expected from remaining open.

Because a plant will remain open for several years if the manager invests to meet the pollution control limitations, the analysis takes into account the expected returns over the life of the plant plus the salvage value of the plant at the end of the last period. The future returns are discounted back to the present year, using a discount rate equal to the firm's cost of capital. The plant will be kept open if the expected discounted cash returns less investment costs exceed the expected salvage value of the plant. If the discounted cash flow less investment cost is less than the salvage value, a rational owner will sell the plant because he would receive a larger return from liquidating than from operating the plant.

1.3.8 Other Impacts

The proposed regulation may have both direct and indirect impacts on employment, balance of trade, industry structure, and earnings in the community. Direct employment and earnings impacts would result from plant closures, and indirect impacts would result from price increases and the subsequent production decreases. Given the changes that may result from the regulation these additional impacts can be estimated.

1.3.9 Social Costs

The total social costs that are associated with the proposed effluent regulations are determined. These costs provide a measure of the value of goods and services lost by society because of regulatory actions. They may include the use of resources to implement and enforce a regulation, the value of the output that is foregone because of a regulation and the added costs of the products to consumer because of a regulation.

For this analysis only the real resource costs are considered. This provides a reasonable estimate of social costs, since in this case other costs to society are insignificant, (e.g., the price effects are zero). Social costs for this analysis are calculated by adding the discounted stream of the estimated total annual operating and maintenance costs to the initial capital investment. The results suggest that the social costs of the regulatory options range from $25 million for Option 1 to $50 million for Option 3.

1.3.10 Small Entity Analysis

The Regulatory Flexibility Act (RFA) requires Federal regulatory agencies to consider small entities throughout the regulatory process. A small entity analysis of the copper forming industry is performed to determine if small entity will be significantly impacted by the proposed regulation and to ascertain if a Regulatory Flexibility Analysis is needed for this industry. The definition of small entity is not precise or universal and several criteria (e.g., plant production, employment, wastewater flows, etc.) were examined for establishing small plants in the copper forming industry.

Based on our analysis the impact on small entities does not appear to be more significant or different than for plants of larger sizes. Since there are no plant closure impacts in any size category, a formal regulatory flexibility analysis for copper forming industry is not required.

1.4 SUMMARY OF ECONOMIC IMPACT ESTIMATES

Of the 176 plants in the copper forming industry, 94 plants were excluded from the analysis because they were identified as having no wastewater discharges and, therefore, would incur no additional treatment costs as a result of the proposed regulations. Of the remaining 82 plants that have wastewater discharges, 45 are indirect dischargers and 37 are direct dischargers. Tables 1-1 and 1-2 summarize the results of the economic impact assessment for the alternative pollution control options for direct and indirect dischargers, respectively.

The industry-wide compliance costs in 1982 dollars for each of the pollution control treatment options are provided in these tables. They show the

TABLE 1-1. SUMMARY OF ESTIMATED ECONOMIC IMPACTS
DIRECT DISCHARGERS

IMPACT VARIABLE	OPTION 1	OPTION 2	OPTION 3
Number of Plants Incurring Costs Out of Total of 37	11	30	30
Total Industry Pollution[1] Control Investment Costs ($000)	2,429	6,191	9,252
Total Industry Pollution[1] Operating & Maintenance Costs ($000)	465	634	859
Price Changes (Percent)	0	0	0
Output Changes (Percent)	0	0	0
Predicted Capital Impacts	0	0	0
Predicted Plant Closures	0	0	0
Employment Impacts	0	0	0
Foreign Trade Impacts	0	0	0

[1] 1982 dollars

SOURCE: Compiled by JRB Associates.

TABLE 1-2. SUMMARY OF ESTIMATED ECONOMIC IMPACTS INDIRECT DISCHARGERS

INDUSTRY SEGMENT	OPTION 1	OPTION 2	OPTION 3
Number of Plants Incurring Costs Out of Total of 45	30	38	38
Total Industry Pollution[1] Control Investment Costs ($000)	4,153	7,088	11,177
Total Industry Pollution[1] Operating & Maintenance Costs ($000)	2,227	3,562	3,830
Price Changes (Percent)	0	0	0
Output Changes (Percent)	0	0	0
Predicted Capital Impacts	0	0	0
Predicted Plant Closures	0	0	0
Employment Impacts	0	0	0
Foreign Trade Impacts	0	0	0

[1] 1982 dollars

SOURCE: Compiled by JRB Associates.

total capital outlays and the annual operating and maintenance costs that are associated with the various pollution control options. The greatest costs are for option 3. The total copper forming industry would have to spend approximately $20.4 million to install, and $4.7 million annually to operate and maintain the pollution control treatment systems at the option 3 level.

The tables also summarize the estimated economic impacts. Although the added cost of pollution control systems will impact the profitability of the plants, the profit reductions are not significant enough to cause any plant closures or job losses. Our analysis also indicates that the copper forming plants should be able to afford to install, operate, and maintain the pollution control systems. The impacts of the added pollution control costs on prices of copper forming products and the balance of trade are expected to be negligible. Our results also indicate that small plants would not be adversely affected by the proposed effluent regulation.

2. MARKET DESCRIPTION

This chapter provides an overview of the copper forming industry. It describes the main characteristics of the industry and the factors that may affect the growth of the industry's markets. Particular attention is given to end-use markets for copper products, substitution, foreign competition, and price trends, because these factors determine the future outlook and competitiveness of the industry, and producers' ability to afford additional capital outlays for pollution control equipment.

2.1 INDUSTRY OVERVIEW

2.1.1 Industry Segmentation

The copper forming industry consists of approximately 176 plants that transform refined copper and copper scrap into intermediate and finished articles. This industry consists of two major groups--brass mills and wire mills. In 1980 these two groups consumed approximately 2.5 million tons of copper, about 86 percent of the copper consumed in that year.[1/] Wire mills which produce wire and cable products consumed approximately 49 percent of refined copper and scrap. Brass mills which are involved in the fabrication of shapes such as sheet, strip, and plate, tube, pipe and mechanical wire, consumed approximately 37 percent of refined copper and scrap. Other industries consuming copper include ingot makers and foundries that use mainly scrap to manufacture their products account for approximately 6 and 4 percent of the total copper consumed, respectively.[2/] The remaining 5 percent of

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1/ Copper Development Association, Annual Data 1981.

2/ For purposes of this economic analysis, the copper forming industry includes only wire and brass mills. Other industries consuming copper are covered by other regulations, e.g., the regulation on foundries.

U.S. copper consumption is accounted for by power mills and a variety of other industries. U.S. consumption of copper by the major copper using industries is shown in Table 2-1.

2.1.2 Production Processes

The copper forming industry is comprised of plants engaged in forming basic shapes (plate, sheet, strip, rod, tube, and wire) from cast forms, such as slabs, billets, and cakes. These plants employ a number of basic processes to form the copper or copper alloy, alter its mechanical properties, and change the condition of its surface. The basic operations are hot rolling, cold rolling, extrusion, drawing, and forging.

The wire mill segment is involved in drawing bare wire and the production of manufactured copper wire. Refined copper is heated, broken down by rolling or extrusion, and rolled into rods. The rods are then put through dies to make wire and cable of various sizes, ranging from thick electric power cables to hairlike wires for electronics equipment. Other wire mill products include high voltage overhead electricity transmission cables which are usually bare, and manufactured copper wire products which are generally insulated with a variety of materials.

The brass mills segment of the copper forming industry generally consumes large amounts of copper scrap and refined copper. Brass mill products, which are made of both alloyed and unalloyed copper, can be grouped into three basic shapes: sheet, rods, and tubes. The primary alloyed items, brass and bronze, are formed by melting scrap copper with primary copper and one of several possible alloying metals, such as zinc for brass and tin for bronze. Depending on the thickness to which they are rolled , brass sheets are classified as either plates or strips. Brass rods are produced by drawing and those that are subjected to additional drawing become mechanical wire (which is different than electrical wire). Brass tubes are produced by extruding copper in a variety of diameters, wall thicknesses, and configurations, including square and rectangular.

TABLE 2-1. CONSUMPTION OF COPPER IN THE UNITED STATES 1980[a]

MARKET SEGMENT	COPPER CONTENT, THOUSANDS OF SHORT TONS			% TOTAL
	REFINED COPPER	SCRAP	TOTAL	
Copper Formers				
Brass Mills	564.0	531.9	1,095.9	36.9
Wire Mills	1,442.8	-0-	1,442.8	48.6
Subtotal	2,006.8	531.9	2,538.7	85.5
Other Consumers				
Foundries	18.5	97.8	116.3	3.9
Powder Plants	10.0	17.0	27.0	0.9
Ingot Makers	2.7	171.0	173.7	5.9
Other Industries[b]	19.0	94.0	113.0	3.8
TOTAL	2,057.0	911.7	2,968.7	100.0

a/ Preliminary.

b/ Include chemical, steel, and aluminum industries.

SOURCE: Compiled by JRB Associates from the Copper Development Association, Annual Data 1981 Report.

2.1.3 Production Trends

Table 2-2 provides information on various copper forming products and gives annual production levels for the industry in 1970, 1975, and 1980. The industry's overall production dropped from 4,936 million pounds in 1970 to 4,142 million pounds in 1975, and then recovered to 5,386 million pounds in 1980. The cyclical movement in the overall economy over this period was a major factor affecting the downswing and upswing in the production of this industry. During the recession period of 1974-1975 the industry had to reduce its output as demand for copper products slackened. After the 1974-1975 recession period, as the economy improved, copper formers were able to increase their production levels. The growth of the industry's output has not been uniform over all of the various products. Major increases in output have been achieved by wire mills, which grew 18 percent over the 1970-1980 period. On the other hand, the output from brass mills has remained relatively constant.

2.2 END-USE MARKETS

The demand for copper forming products is a derived demand. Copper forming products are generally used in the production of final products and are not the final products themselves. For example, the housing, automobile, and electrical appliance industries use copper fabricated products to produce a variety of items such as radiators, heaters, and utensils. As a result, the demand for specific copper forming products depends on, and is influenced by, the behavior of key industrial sectors or end-use markets in the economy.

There are five major end-use markets for copper forming products. In order of importance, the major market segments are as follows:

- Building and construction;
- Electrical and electronic products;
- Industrial machinery and equipment;
- Consumer and general products; and
- Transportation equipment.

TABLE 2-2. PRODUCTION LEVELS FOR THE DOMESTIC COPPER FORMING INDUSTRY OVER SELECTED YEARS (MILLIONS OF POUNDS, METAL WEIGHT)

Copper Forming Products	1970	1975	1980
Brass Mill Products			
Sheet, Strip and Plate	883	853	908
Rod, Bar and Mechanical Wire	804	651	860
Plumbing Tube and Pipe	378	310	414
Commercial Tube and Pipe	448	265	334
Total Brass Mill Products	2,513	2,079	2,516
Wire Mill Products			
Bare Wire	226	167	204
Communication Wire and Cable	735	584	897
Other Wire Products	1,462	1,312	1,733
Total Wire Mill Products	2,423	2,063	2,870
TOTAL INDUSTRY	4,936	4,142	5,386

SOURCE: Copper Development Association, Annual Data 1981.

Table 2-3 shows copper consumption by major end-use markets in the United States over 1976 to 1980. A description of each of these end-use markets is given below.

2.2.1 Building and Construction

The building and construction industry was the leading end-user of copper products in 1980. This segment consumed approximately 30 percent of the products manufactured by the copper forming industry. Most of the products used by this market are in the form of wire mill products. Copper has also been widely used for plumbing, roofing, and decorative items in public buildings and homes, largely because of its corrosion resistant properties.

2.2.2 Electrical and Electronic Products

The electrical and electronic products market segment was the second largest end-user of copper forming products in 1980, representing about 28 percent of domestic copper products consumption. Copper is a preferred material for applications such as electrical lighting, wiring, and cable because of its superior electrical conductivity and energy efficiency. Other specific applications include telecommunications equipment, electric motors, generators, and numerous miscellaneous electrical parts.

2.2.3 Industrial Machinery and Equipment

The industrial machinery and equipment end-use segment accounted for approximately 18 percent of the 1980 U.S. copper consumption. This market segment uses brass and wire mill products in fittings, valves, bearings, screws, and pumps. Many of these parts are machined from extruded rod. Copper tubings in this market segment are used for heat exchangers in refrigerators, air conditioners, freezers, and water coolers.

TABLE 2-3. CONSTRUCTION OF COPPER PRODUCTS BY MAJOR END USE MARKETS[a]

DOMESTIC MARKETS	MILLIONS OF POUNDS BY METAL WEIGHT					% 1980
	1976	1977	1978	1979	1980	
Building Construction	1,707	1,942	2,095	2,107	1,792	30.4
Electrical and Electronic Products	1,449	1,639	1,711	1,820	1,632	27.7
Industrial Machinery and Equipment	1,501	1,137	1,215	1,229	1,056	17.9
Consumer and General Products	798	820	930	994	823	13.9
Transportation Equipment	835	909	882	846	599	10.1
Total	5,840	6,447	6,833	6,996	5,902	100.0

a/ Products from wire mills and brass mills account for most of these totals, but products from foundries, etc., are also included.

SOURCE: Copper Development Association, Inc., Annual Data 1981.

2.2.4 Consumer and General Products

Consumer and general products accounted for approximately 14 percent of domestic copper use in 1980. This market segment consumes copper to manufacture durables such as washing machines, radios, televisions, phonographs, tape recorders, cutlery, watches, clocks, microscopes, projectors, and many types of gages. Solid copper, brass, and bronze are also popular materials in utensils, furnishings, jewelry, and other decorative items.

Miscellaneous uses of copper forming products include shell castings, projectile fuses, and rotating bands for ordnance. Copper also has important applications in coinage in the United States.

2.2.5 Transportation

In 1980 the transportation equipment sector accounted for 10 percent of U.S. copper consumption. This industry segment uses copper in automobile, airplane, railroad, and marine components. For example, the automobile industry alone uses approximately 25 pounds of copper per vehicle. Most of this goes into radiators, air conditioners, power windows, seats, and brakes. Copper is also used in producing heaters, defrosters, bushings, carburetors, oil lines, and wiring in cars and other vehicles. Large quantities of copper are used in diesel locomotives, railroad passenger cars, and switching and signal devices.

2.3 TECHNOLOGICAL CHANGE AND SUBSTITUTION

There are three types of activities other than price that affect the demand for copper forming products. These factors are:

- Direct substitution of one material for another,
- Technical change in end-use markets,
- More efficient use of copper.

Each of these activities affect the demand for copper and is considered here to establish factors other than the proposed regulation which may affect the industry over the regulatory impact period.

2.3.1 Direct Material Substitution

Direct substitution of copper forming products from materials such as aluminum, plastic, steel, and others is widespread. Aluminum has made great inroads into traditional copper markets because of its similar properties, its lighter weight, and lower cost. The greatest replacement of copper by aluminum has been in the transmission of electricity at high voltages. Some 40 percent of the insulated power cable, and over 90 percent of bare conductor applications, are now provided by aluminum.2/ Because of its weight advantage over copper, aluminum-conductor, steel reinforced cable has been used for for most long-distance power transmission lines for more than a decade. Aluminum alloys are also being used as conductors on overhead transmission lines.

In the building industry, substitution of aluminum for copper has also been increasing. The amount of substitution is directly related to the size of the wire, i.e., the larger the wire size, the greater the percentage of aluminum building wire used. Substitution of aluminum for copper in small building wire sizes has been hampered because of safety problems in residential applications. At current prices copper still remains the first choice for automotive wiring. In areas where space in an existing design is not a problem, the use of the larger sizes of aluminum wire will increase. Examples of such applications are battery cables, air conditioners, clutch coils, alternators, anti-skid devices, horn coils, and some accessory motors.3/ Plastic has also replaced copper in many plumbing applications.

2/ Bureau of Mines, Mineral Commodity Profiles, Copper, September 1979.

3/ Raymond F. Mikesell, The World Copper Industry, Baltimore, Johns Hopkins University Press, 1979, pp. 160-163.

In addition, copper and aluminum are mutually interchangeable in some heat exchanger applications. Copper has been used predominately in this area because of its heat transfer properties, corrosion resistance, ease of fabrication, and ease of joining the various components by conventional soldering techniques. The largest use of copper in this area, automobile radiators, is vulnerable to aluminum. However, the inability to repair aluminum radiators is inhibiting widespread application. Copper tubing is still the predominant primary surface in heat exchangers for commercial refrigerators and freezers, and for room, central residential, and commercial air conditioners. Aluminum tubing is used in less than 10 percent of these products. Aluminum alloy tubing in air conditioners may have twice the wall thickness of copper, but still maintain a weight and cost advantage. However, extensive manufacturing development is necessary before aluminum could completely replace copper in these applications.

2.3.2 Technological Change in End-Use Markets

Technological substitution has also significantly impacted the demand for copper. The most obvious development is that of microwave technology and communication satellites, which have substantially reduced the demand for undersea and long distance copper cables. Current developments in fiber optic transmission technology for intracity communication transmission lines may reduce or eliminate much of the market for copper wire products over the long run.

2.3.3 More Efficient Uses of Copper

The demand for copper forming products has also been affected by the more efficient uses of copper. For example, improved copper alloys have made it possible to make thinner walled copper tubing, with the result that it requires substantially less copper to produce a foot of copper tubing of the same inside diameter today than it did ten years ago. Automobile radiator walls today are made thinner, thus reducing the amount of copper used in radiators.

2.4 IMPORTS AND EXPORTS

Copper forming products are traded worldwide. Additionally, foreign competition from overseas copper forming plants has increased. As a result, domestic producers must take into account the actions of foreign suppliers in their pricing policies or they could lose a portion of their markets to foreign producers.

2.4.1 The Trade Balance

The balance of trade in copper products has historically been unfavorable to the United States. Until recently, domestic producers had little incentive to develop an export market for their fabricated products primarily because of a widespread belief that they could not compete effectively in international markets because of subsidized production, tariff and nontariff barriers, and low input costs in foreign countries.[4/] Therefore, they concentrated their marketing efforts on domestic and traditional customers.

Recently, however, the competitive position of U.S. domestic suppliers in the world has changed to the point where the trade balance has improved substantially. As shown in Table 2-4, imports of copper mill products have dropped by 44 percent over the 1978-1980 period, from 492.6 million pounds in 1978 to 294.0 million pounds of copper mill products in 1980. Meanwhile, exports have increased by approximately 50 percent, from 209.4 to 312 million pounds over the same period. Thus, the trade deficits of 283.2 and 187 million pounds in 1978 and 1979, have changed to a trade surplus of 18 million pounds of copper in 1980. In general, brass mill products accounted for the largest

4/ U.S. Department of Commerce, The Export Potential of Copper Mill Products, July 1979.

TABLE 2-4. IMPORTS AND EXPORTS OF COPPER FORMING PRODUCTS 1970-1980
(Millions of Pounds)

YEAR	IMPORTS	EXPORTS	TRADE-BALANCE[a/]
1970	202.4	69.9	-132.5
1971	249.2	77.9	-171.3
1972	297.7	84.3	-213.4
1973	308.7	127.8	-180.9
1974	257.6	161.4	-96.2
1975	195.3	137.1	-58.2
1976	353.5	130.1	-223.4
1977	359.4	165.5	-193.9
1978	492.6	209.4	-283.2
1979	436.0	249.0	-187.0
1980	294.0	312.0	18.0

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a/ Calculated by JRB Associates, from import and export data in the Copper Development Association, Inc., Annual Data 1981.

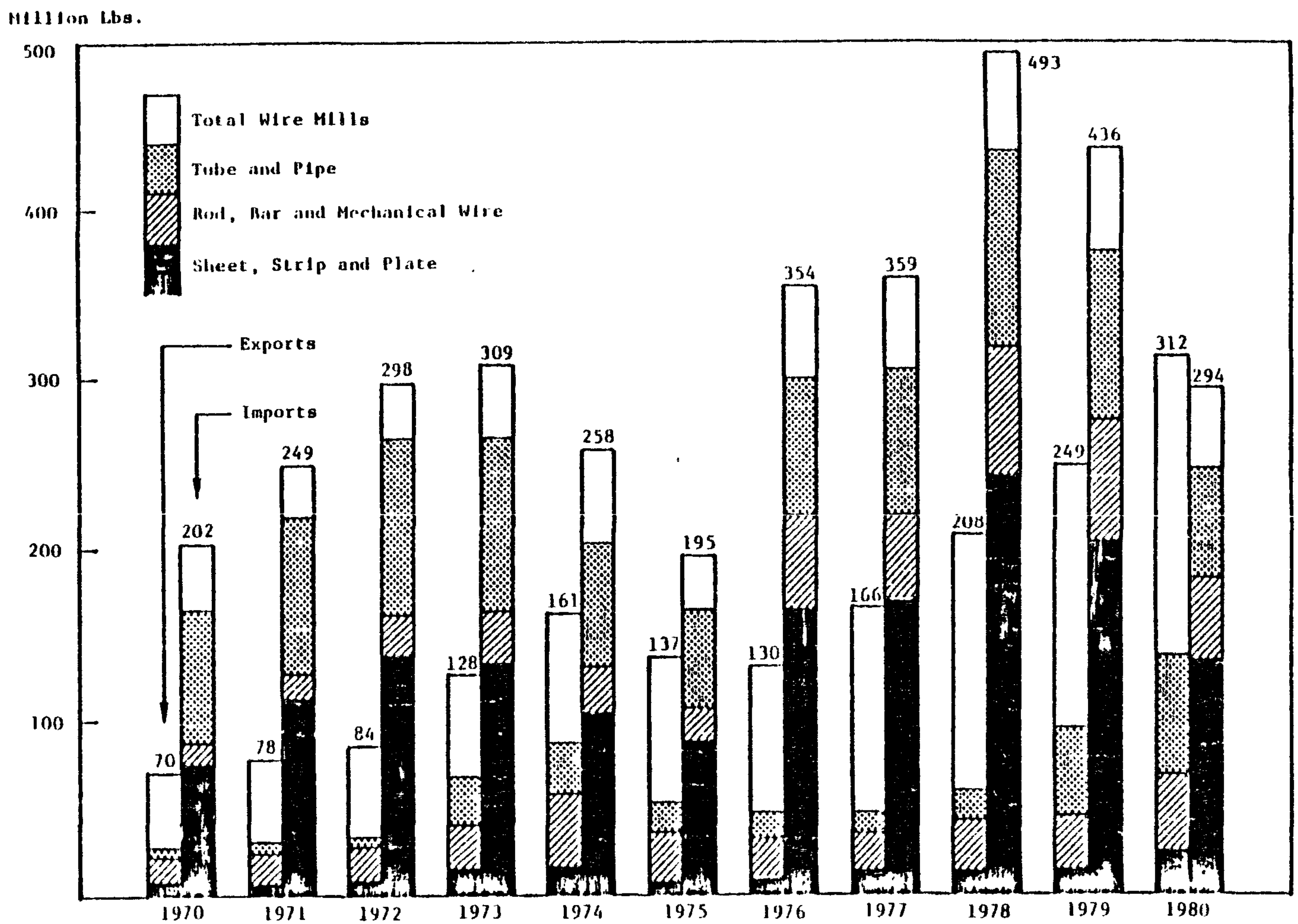
relative share of imports and lowest relative share of exports (see Figure 2-1). On the average, imports of brass mill products have been three times as great as exports. On the other hand, exports of wire mill copper products were four times as large as imports in 1980.

2.4.2 Factors Affecting the Trade Balance

There are many factors that account for the favorable change in the balance of trade for copper forming products in 1980. As stated earlier, the U.S. copper forming industry has not had a strong export performance. A study by the Department of Commerce Industry and Trade Administration Office suggests that the recent surge in U.S. exports and corresponding decline in imports for copper forming mill products is a result of the following major factors:[6/]

- The dramatic change in the pricing policies of U.S. producers which has made U.S. copper fabricated products more competitive, domestically and abroad. Before 1978, producers of copper mill products generally based their prices on the producer's list price. In mid-1978 domestic copper producers switched their pricing policies and began basing their prices on quotations directly or closely related to the New York Commodity Exchange (COMEX) prices. This move improved the competitiveness of U.S. products domestically and abroad, especially during periods of slack demand, when producer prices were generally higher than imported mill products.
- The decline in the U.S. dollar over the 1978-1980 period served to make U.S. mill products cheaper and thus more attractive to foreign purchasers.
- Increasing foreign input costs, especially energy related costs, have narrowed the competitive advantage foreign suppliers had over their U.S. counterparts.
- Some foreign economies and markets have been increasing at a faster rate than that of the U.S. The rapid surge in the demand in the Middle East countries is a prime example.

6/ U.S. Department of Commerce, 1980 U.S. Industrial Outlook (for 200 industries with projection to 1984), January, 1980.



a/ The data were compiled by JRB Associates from statistics in the Copper Development Association, Inc., Annual Data 1981.

FIGURE 2-1. U.S. EXPORTS AND IMPORTS OF COPPER FORMING PRODUCTS a/

The somewhat concurrent occurrence and timing of these factors have served to enhance the foreign trade position of the U.S. Assuming these trends continue in the future, the U.S. copper forming industry is expected to continue to improve its competitive position in the world market. Other incentives, including various export development programs of the Department of Commerce, and trade liberalization policies negotiated in the Tokyo Round of Multilateral Tariff Negotiations should also enhance U.S. producers' position abroad in future years.

2.5 PRICES

2.5.1 Industry Price Determination

Historically, copper mill products were marketed at prices based on two major price systems. One system consisted of producer prices set independently by major primary United States and Canadian producers. The second price system consisted of prices related to quotations on a metal/commodity exchange. The London Metal and the New York Commodity Exchanges (LME and COMEX) are two organized metal exchanges (markets) where most international copper trading occurs.

U.S. producers have traditionally sold their products at their published prices. These producer prices were influenced by the COMEX and LME copper price, but they were relatively stable over long periods of time. Generally, producer prices moved slowly and at times were above or below the exchange or "outside market" price. During periods of strong demand, U.S. producers tended to change their prices slowly and not by the magnitude often experienced by the COMEX/LME prices so that the producers' prices have generally remained well below those set by the "outside market," thus giving their customers an advantage on raw material costs and retarding substitution by other materials. During periods of weak demand, domestic U.S. producer prices were usually higher than the metal exchange market prices as producers attempted to recover their costs of production.

This behavior resulted in the existence of a two-tier price system for copper products which was characterized by a wide divergence between the outside market price for copper (i.e., the LME price) and the domestic producer price. This system seemed to work as long as the market did not weaken. However, since 1975 a combination of factors appears to have had substantial restraining influence on the pricing decision of the domestic primary producers. Between 1975 and 1978, the world copper market weakened, and "outside market" prices, or imported prices, fell substantially below those of the U.S. producers. Many U.S. copper consumers increasingly switched their purchases to the lower priced copper fabricated product imports. This situation climaxed in the new producers' price policies of mid-1978 when key U.S. producers decided to base their prices on the daily quotes of COMEX. Since 1978, Kennecott Copper and Anaconda Co. have based their spot prices on the daily quotes of the nearest copper futures contracts on COMEX, plus a fixed premium. Other producers have maintained a fixed-price system, but competitive forces have compelled them to change their quotes very frequently. In effect, most companies' prices have become very responsive to changes on the commodity exchange.

2.5.2 Recent Copper Price Trends

In February 1980 copper prices reached a high of $1.45 per pound. This high price resulted from (1) the significant decline in copper stockpiles in 1979, and (2) speculation in a number of metals markets in early 1980. Average prices in 1979 sharply exceeded those in 1978, resulting in substantial earning gains. However, by early April 1980, major producers were charging $0.91 to $0.95 a pound for refined copper, down from February's (1980) domestic high of $1.45. Two major factors influenced the decline in the price of copper. They are:

- The decline in gold and silver prices, and the subsequent speculative spillover effects;
- The Federal Reserve action to raise interest rates;
- The worldwide recession.

The record U.S. copper price of $1.45 a pound reflects a spillover of the speculative demand for precious metals. Copper is viewed as an inexpensive inflation hedge by speculators, therefore, as the price of gold reached a high of $875 an ounce in 1980 compared with $200 in 1974, and silver hit $50 an ounce versus the 1974 record of $6.50, the price of copper soared. However, as gold and silver prices declined in the latter half of 1980, the speculative spillover from these markets dried up and the price of copper receded.

Higher interest rates have also contributed to the recent fall in the prices of copper. High interest rates decrease the demand for durable goods, increase the probability of and/or severity of recessions. The 1981-1982 recession has had a bearish influence on copper prices since copper demand is closely tied to industrial activity. Furthermore, since many copper consumers finance their inventories with short-term credit, the increased cost of money has forced many of them to trim their inventories and capital outlays. This situation is expected to continue as long as these conditions prevail.

2.6 SUMMARY OF MARKET DESCRIPTION

The analysis suggests that the copper forming industry is involved in producing products that are very sensitive to the behavior of the overall economy. In periods of expansion, the industry's end-use markets expand and the supply, demand. and prices for copper forming products increase. On the other hand, during periods of recession and high interest rates, the end-use markets contract and the output, demand, and prices of copper products fall. Substitution from other products and new technologies do exist, but they are not significant enough to reduce the growth of the copper industry market. In 1980 the export of wire mill products increased while imports of some copper forming products stabilized or decreased slightly. This trend is expected to continue as long as U.S producers can continue to market their products aggressively at home and in the world market.

3. INDUSTRY STRUCTURE AND PERFORMANCE

3.1 OVERVIEW

The impact of the proposed effluent regulations on the copper forming industry will be influenced by the performance and pricing behavior of the participants (firms) in the industry. In general, the performance of a firm (participant) in an industry is determined by the conduct (i.e., the pricing and production strategies) of the firms in the market. The firm's market conduct is, in turn, dependent upon the structure and market conditions prevailing at the time. Certain market structures (e.g., monopoly) imply that the participants have higher profit margins and would be able to absorb added costs with less financial difficulty than other firms (i.e., firms in competitive markets).

This chapter examines the market structure, conduct, and financial performance of the copper forming industry. The results of this examination are used in Chapters 4 and 6 to estimate how the industry would behave when faced with the decision to invest in the proposed pollution control equipment. The various types of industry structure and their role in determining economic impacts are discussed. The observed market structure of the copper forming industry is described and key financial ratios are analyzed which establish the profitability and capital structure of the industry.

3.2 TYPES OF MARKET STRUCTURE

The range of market structures is bound by perfect competition and monopoly. The perfectly competitive industry is characterized by:

- A very large number of firms (buyers and sellers) where each firm accounts for an imperceptible share of the market;
- A homogeneous or standardized product;

- A market in which each member is well informed about product quality and each other's prices;
- Relatively easy exit and entry into the industry.

In a perfectly competitive market no individual firm has influence over the market price. The price is given to the firm and the firm decides only how much to produce and sell at the prevailing price. Because each firm's output is an imperceptible part of the total output of the industry, output decisions have no influence on the market price. Also, since the products of the firms are perfect substitutes for one another, the price elasticity of demand facing the firm is infinite. For these reasons, the price that the firm observes is determined by the interactions of supply and demand forces in the entire market where all firms participate.

The type of market structure at the other end of the spectrum is monopoly. This market structure is characterized by:

- One firm in the industry;
- No close substitutes for the product;
- Substantial barriers to entry.

The latter characteristic is important for the maintenance of monopoly power in the long run. Barriers to entry must exist if the monopolist can remain the sole producer of goods in the long run, while at the same time earning large profits which induce entry. Barriers to entry may exist because of (1) weak demand conditions, (2) control of raw materials by one firm, (3) legal and institutional factors imposed by governments, (4) scale economies that satisfy the entire market, (5) large capital requirements, and (6) the lack of technological expertise by outsiders.

In general, the monopolist can fix price and let demand conditions determine output or he can fix output and let demand conditions determine price. He maximizes his profits at the output at which his marginal revenues equal marginal costs. At any given quantity of output sold, the marginal revenues and costs will be less than price, because the demand curve of the industry is downward sloping. By way of contrast with the perfectly competitive firm, the monopolist may (1) charge a higher price, (2) produce fewer units, and (3) operate a less than optimal scale plant.

Between these two extremes are other forms of market structure. Closely related to the perfectly competitive market is monopolistic competition. This market structure is associated with industries in which there are very many firms, but the product which is produced is somewhat differentiated (e.g., the toothpaste industry). As a result, the demand facing the individual firm is not perfectly elastic, but its price elasticity is high due to the existence of close substitutes produced by other firms in the industry. Firms in this market attempt to create separate markets for their products through advertising and product design, in order to have some control over their price and output decisions. To the extent that they can create a separate market for their products, their price will be higher and their output lower than under a perfectly competitive market structure. The difference between monopoly and monopolistic competition is that in the latter barriers to entry are not significant.

Another market structure within this spectrum is the oligopolistic market, which is characterized by a few sellers. There are at least five different types of oligopoly models that are recognized in the economic literature. However, the assumption that unifies them is that the number of sellers in the market is sufficiently small that they recognize the joint mutual interdependence of their activities. One seller recognizes the fact that his actions affect other sellers and the other sellers are likely to react in some fashion to his activities. Since there is no way to determine, a priori, the interactions that may result because of a decision, the market solutions to this type of market structure are indeterminate. The pricing behavior of this market structure is sometimes characterized by price leadership and followership, long periods of stable prices, or by periods of price wars to capture market share. The airline industry provides a good example of this type of market structure.

Market structure influences pricing policy in an industry and, hence, the financial condition and performance of individual firms in the industry. In a perfectly competitive market firms realize normal profit, i.e., profits approach the market rate of interest plus a premium for the risk associated with that business. In a monopoly market, the firm has market power and can earn a greater profit than under perfect competition. The profits of the firms in the other market structures are somewhere betwen these two market extremes.

3.3 MARKET STRUCTURE OF THE COPPER FORMING INDUSTRY

Market structure can be assessed by evaluating the following four factors: (1) buyers and sellers concentration, (2) vertical integration, (3) product differentiation, and (4) ease of entry into the industry.1/ Each of these factors in turn affect the individual firms' performance and price/output decisions.

3.3.1 Conceptual Problems in Determining Market Structure

It is difficult to analyze the financial condition and performance of participants in the copper forming industry in a precise manner because of the heterogeneity of the units (i.e., diverse nature and size) and because of the ownership relationships. The problems arise because some of the participants are subsidiaries of large corporations that are involved in producing and selling products unrelated to copper forming (e.g., oil companies). Others are involved in earlier stages of copper manufacture such as mining, smelting, and refining. To overcome these problems and alleviate some of the biases that these conditions create in analyzing the performance of the participants in the copper forming industry, the analysis was disaggregated into three

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1/ James V. Koch, Industrial Organization and Prices, Englewood Cliffs, N.J., Prentice-Hall, Inc., 1974.

broad categories--corporate, reporting entity, and plant. This grouping provides a more precise definition of the participants in the industry and allows for a meaningful analysis of the financial condition of the industry.

The financial condition at the corporate level provides information on the overall economic and financial viability of all the entities that make up the corporation, and its ability to incur debt or finance new investment in plant, machinery, and equipment. At this level, the analysis is not concerned with the copper forming manufacturing facility, per se. It is mainly concerned with the overall financial picture of the entire company, whether it be a copper producing company or an oil conglomerate that includes a copper forming plant.

The analysis at the reporting entity level provides information on the financial condition of the unit to which individual copper forming plants report directly. This unit may be separate from the parent corporation which may be involved in producing other kinds of products or it may be the copper forming company itself (i.e., if it is engaged in producing only copper forming products). At this level of analysis the unit or reporting entity which is most closely related to the copper forming plants is identified and analyzed.

Finally, the analysis at the plant level examines the profitability of individual copper forming plants. The disaggregation at this level is important because it is doubtful whether a corporation (whether a copper company or an oil company) would continue to subsidize and/or invest further in a sector of its organization that was not making profits over the long run, even though the parent company was making large profits or had the cash flow to invest in pollution control capital equipment.

3.3.2 Industry Concentration

A measure of the industry concentration provides information on the number and size distribution of sellers in the market. It indicates how much of the market sales (or some other unit of output measurement) is held by a portion of firms in that market. For example, it provides the percentage of sales accounted for by the 4, 8, 20, and 50 largest firms in that market. Generally, when concentration is low, there is a large number of firms, and each individual firm's share of the market will be so small that no individual firm would be able to influence prices significantly (i.e., firms are price-takers and not price-setters). On the other hand, in markets where concentration is high, the pricing and production decisions of any one firm will have some effect on the pricing and output of other firms in the relevant market. Consequently, price and output determination by the firms will be interdependent.

Table 3-1 summarizes concentration ratios for the copper forming reporting entities and corporations (including single plant firms) responding to the 308 Economic Survey.[2/] Based on this survey, the largest four reporting entities in 1979 accounted for approximately 52 percent, and the largest eight reporting entities accounted for 74 percent of sales in the industry. The concentration ratios for the corporations are higher. In 1979, the largest four corporations accounted for 69 percent, and the largest eight corporations accounted for 82 percent of sales in the industry.

The concentration ratios at the reporting entity level are considered to be low when compared to other manufacturing industries, such as automobile, steel, and even other stages of copper manufacture. For example, six companies in the copper refining segment controlled over 90 percent of the U.S. refining capacity in 1973.[3/]

3.3.3 Integration

The degree of integration is an important determinant of the industry's conduct and performance. For example, in a firm that is highly vertically

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2/ The concentration ratios shown in the table are greater than those for the entire copper forming industry.

3/ Raymond F. Mikesell, The World Copper Industry, Baltimore, Johns Hopkins University Press, 1979, p. 31-33.

TABLE 3-1. INDUSTRY CONCENTRATION RATIOS

NUMBER OF PARTICIPANTS	REPORTING ENTITY		CORPORATION INVOLVED IN COPPER FORMING	
	CONCENTRATION RATIO (%)	CUMULATIVE 1979 SALES[b] ($000)	CONCENTRATION RATIO (%)	CUMULATIVE 1979 SALES[b] ($000)
Top 4	51.7	2,965,620	69.4	32,709,911
Top 8	73.9	4,237,793	82.1	38,706,266
Top 16	93.3	5,352,251	96.0	45,267,312
Total[a]	100.0	5,737,039	100.0	47,161,297

[a] A total of 41 reporting entities and 43 corporations.

[b] Not all of the sales of these reporting entities and corporations are due to copper sales.

SOURCE: Compiled from data provided in the 308 Economic Survey.

integrated, material costs may be somewhat insulated from the market demand forces at intermediate stages of production. This does not mean that producers, in making price and output decisions, can ignore market forces. Rather, it means that producers have control over some, but not all, of the relevant demand forces emanating from downstream markets.[4]

In addition, the existence of a high degree of integration in a particular market can constitute an effective barier to entry into the industry. For example, a potential entrant to the copper forming stage could face a dilemma if most of the existing firms are highly integrated. Suppose that a firm enters into the copper forming industry when 90 percent of the production of both copper ingots and copper forming products are controlled by vertically integrated firms. If the firm buys from a nonintegrated ingot producer, the copper forming firm can depend on only 10 percent of the industry's ingot capacity, and might find itself dealing in a thin market. The entrant avoids this problem, of course, if the firm enters as an integrated producer. But that strategy may not be possible if one of the production stages is large-scale and capital intensive. The entrant must choose between the costs of integrated entry (high capital investments in fixed assets) and the risks of unintegrated entry so as to minimize his disadvantage. The existence of such barriers to entry into the industry is important it affords opportunities for firms in the industry to indulge in noncompetitive pricing behavior and production behavior of the existing producers.

Several of the domestic primary producers participate either directly or through subsidiaries in all five stages of production: mining, milling, smelting, refining, and fabrication (i.e., copper forming). The principal domestic producers such as Anaconda (ARCO), Inspiration, Kennecott (Standard Oil of Ohio), ASARCO, Magma, Phelps Dodge, and White Pine are all integrated. Of these, Phelps Dodge, ASARCO, Kennecott, and Anaconda control copper forming facilities that account for 50 percent of domestic copper consumption. This

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4/ Buyer concentration is important because copper fabricated products are intermediate goods rather than goods going to final consumers. In times of recession, strong buyers can force prices below average costs.

is a high level of integration but may not be an overriding influence on price and output decisions because of the existence of significant capacity at other domestic and foreign independent producers and because of other market factors discussed below.

Kennecott, the largest U.S. copper producer, is vertically integrated downstream into copper forming through its wholly owned subsidiary, Chase Brass and Copper. Anaconda participates in copper forming through Anaconda Brass and Anaconda Wire and Cable. These subsidiaries consume more copper than is produced by Anaconda. Phelps Dodge produces wire, wire rod, and copper tubes at facilities which consume about 30 percent more copper than the primary production at Phelps Dodge. Similarly, Cities Service owns New Haven Copper and Chester Cable; Cyprus mines (AMACO) owns Cyprus Wire and Cable, and El Paso Natural Gas owns Narragansett Wire. While ASARCO does not own copper forming capacity directly, it owns 33 percent of Revere.5/

The copper forming divisions, subsidiaries, and affiliates of the major copper producers are believed to account for roughly 35 to 55 percent of the total copper forming capacity. Of the three major producers, Anaconda appears to consume the highest percentage of its own copper, Phelps Dodge the next highest, and Kennecott the least. However, the vagaries of the market from year to year and the fact that companies buy and sell to and from each other complicate the picture.6/

The degree of integration is believed to influence the price-output decisions of the companies in several ways. The Standard and Poor's Corporation, in its 1975 Nonferrous Metal Survey, noted that integrated companies have traditionally considered the copper forming stage as an outlet for the primary

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5/ Economic Impact of Environmental Regulations on the United States Copper Industry (prepared for the U.S. Environmental Protection Agency, Washington, D.C., by Arthur D. Little, Inc., January 1978), p. III-24 and Copper, Supplement to American Metal Market, September 28, 1981, p. 8A.

6/ Economic Impact of Environmental Regulations on the United States Copper Industry, op. cit., p. IV-13.

copper produced. For this reason, companies have typically endeavored to maintain low prices on copper forming products, relying on the sale of the primary metal for the bulk of their profits. The largest expense for most independent copper formers is the cost of copper; thus, profitability depends substantially on the copper former's mark-up or spread. As a result, there is often a struggle occurring in the market. The integrated producers seek to keep product prices on its copper forming products low enough to boost demand and provide an expanding market for the more profitable primary and refined output, while the independent copper formers strive to raise their prices and margins. Both groups prosper in a high demand - high price market such as in 1974, but independents suffer less in recessionary periods - low price markets such as 1975, because they can benefit from the lower raw materials costs. During recessions the integrated producers can have substantial sales and earning losses because of their high fixed costs, reduced operating rates, as well as reduced prices.

3.3.4 Product Differentiation

Product differentiation is an important determinant of market share and price/output decisions in some industries. Some firms may significantly influence their profit margins by differentiating their products (i.e., by creating separate markets) which enhance their market share or provide them with the market power to raise prices. However, product differentiation does not play an important role in the copper forming industry. Copper forming products are relatively homogeneous, in that they have well defined physical and performance properties conform to generally accepted standards in the industry. For this reason, copper formers' efforts in advertising and product differentiation are small.

3.3.5 Barriers to Entry

A barrier to entry is simply any advantage held by existing firms over those firms that might potentially produce in a given market. Examples of barriers to entry include the control of sources of key raw materials by existing companies, large capital and technological requirements, the cost and source of financing investment, and vertical and horizontal integration of existing companies.[7/] For example, the size of the investment that is necessary to install a new steel plant and the technology that is required by individuals entering a new area of manufacture may be significant deterrents to entry.

As described in Section 3.3.3 above, vertical integration and access to captive sources of raw materials represent only minor potential barriers for copper formers. Moreover, this industry is not as capital intensive as other manufacturing industries or other stages of copper manufacturing, such as smelting and refining. For these reasons, barriers to entry into the industry are not a significant factor in price determination for copper forming products.

Another factor that has affected the copper forming market structure is the increasing number of new firms and the growing level of production in foreign countries. In recent years foreign countries have been moving into the downstream stages of copper manufacturing and building copper forming and processing plants near the source of the raw material. However, because of the growing demand for copper products abroad and the change in pricing policies of U.S. copper formers over the past four years, the impacts of these overseas developments have been mitigated to some degree.

3.3.6 Summary of Industry Structure Characteristics

After reviewing the four basic industry structure measures it can be inferred that this industry is characterized by (1) relatively moderate four-firm and eight-firm concentration ratios, (2) a moderate degree of vertical integration which has some, but not overriding, effects on market price

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7/ J. S. Bain, Industrial Organization New York, John Wiley and Sons, 1968, pp. 251-301.

formations, (3) a low degree of product differentiation, and (4) moderate entry requirements. For these reasons a relatively high degree of competition exists among the participants of this industry.

As discussed previously, competitive industries are expected to earn "normal" rates of profit. Thus, review of industry financial ratios serve a useful function of checking the conclusions regarding market behavior. In the next section the financial performance of the industry is examined and found to support the conclusion that a fairly competitive market structure operates in the industry.

3.4 FINANCIAL PERFORMANCE OF THE COPPER FORMING INDUSTRY

This section describes the financial condition and performance of participants in the copper forming industry. The financial analysis focuses on measures of profitability, capital structure, and productivity. Measures of these variables provide information on whether the participants in the copper forming industry can raise the required capital for expenditures in pollution abatement equipment, from retained earnings (internally), or from borrowing in the stock or bond markets (externally). Furthermore, they provide indicators of the financial viability (including plant closure potential) of participants under present circumstances, and in the event of the EPA effluent regulation being imposed.

The analysis examines the actual performance of forty-three copper forming corporations[8/] and forty-one reporting entities[9/] that operate 103

8/ For purposes of this analysis, copper forming corporations include not only oil corporations and other conglomerates whose subsidiaries include copper formers but also smaller corporations whose only operation is copper forming.

9/ "Reporting entity" for purposes of this analysis is defined as the management structure that most clearly reflects copper forming operations and only copper forming operatins. Some plants report directly to a corporation and the data from that corporation may not properly be considered data from a "reporting entity" because the corporation may include noncopper forming operations.

copper forming plants. Key financial ratios for the participants in this industry are evaluated over time by entity and firm size. Evaluating the data over a period of time is important because it mitigates the potential for distortions caused by unusual years when losses or gains may have been large. Reviewing the data by entity size provides information on whether size plays an important part in determining performance, i.e., whether economies or diseconomies of scale exist. The information in this section also provides useful benchmarks for comparing the performance of individual participants later in the analysis of high impact plants.

3.4.1 Financial Status of Copper Forming Companies

3.4.1.1 Profitability at Corporation Level

Table 3-2 provides a summary of profitability measures for the corporations involved in copper forming. The data suggest that the performance of the corporations as a whole has been poorer than that of related industries. Over the period of analysis the profit margins after taxes increased slightly from about 2.0 percent in 1976 to 2.5 percent in 1979. The returns on net worth (equity) and assets after taxes were low but showed steady improvements over the 1976-1979 period. The industry averages for these two financial measures increased from approximately 8.5 and 7.4 percent in 1976 to 11.0 and 10.3 percent in 1979, respectively. Despite the recovery during this period, the profitability of the corporations involved in copper forming is still below the average of the total fabricated metal products industry. The profit margin and return on equity after taxes for the fabricated metals products industry as a whole in 1978 were 4.7 and 16 percent, respectively.[10/]

Table 3-3 shows the four year average profitability ratios for these corporations disaggregated by size. The data reveals that the the profit margin

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10/ Federal Trade Commission, Quarterly Financial Report for Manufacturing, Mining and Trade Corporations, First Quarter 1979.

TABLE 3-2. KEY PROFITABILITY RATIOS FOR CORPORATIONS PERFORMING COPPER FORMING
(Percentage)

CORPORATE LEVEL FINANCIAL RATIOS	1976	1977	1978	1979
Profit margin before taxes (returns on sales)	4.12	4.54	4.64	5.74
Profit margin after taxes (returns on sales)	1.96	2.33	2.70	2.49
Return on equity before taxes	17.17	16.30	20.06	23.62
Return on equity after taxes	8.46	9.30	13.37	11.01
Return on assets before taxes	14.86	14.01	15.24	24.13
Return on assets after taxes	7.41	7.09	8.82	10.31

SOURCE: Compiled by JRB from data provided in the 308 Economic Survey.

TABLE 3-3. KEY FINANCIAL RATIOS FOR CORPORATIONS BY SIZE CATEGORIES 1976-1979[a]
(Percentage)

TOTAL CORPORATE SALES (MILLIONS OF 1979 DOLLARS)[b]	PROFIT MARGIN[c]		RETURN ON EQUITY		RETURN ON ASSETS	
	BEFORE TAXES	AFTER TAXES	BEFORE TAXES	AFTER TAXES	BEFORE TAXES	AFTER TAXES
Very Large $10,000+	7.95	4.45	20.66	11.62	19.76	10.90
Large $9,999, -- 1,000	5.32	2.65	18.62	8.81	22.65	11.14
Medium-Large $999 -- 100	5.35	2.70	13.43	6.09	12.74	6.45
Medium $99 -- 20	4.63	2.53	22.85	16.46	21.74	7.36
Medium-Small $19, -- 5	3.15	1.99	22.98	10.29	14.79	8.52
Small under $5	3.05	1.90	23.67	16.35	14.41	9.06
Total	4.62	2.50	19.47	10.75	16.99	8.43

a Average over the 1976-1979 period.

b Sales are not exclusively from copper forming but include sales from other corporate activities.

c Return on sales.

SOURCE: Compiled by JRB Associates from data provided in the 308 Economic Survey.

after taxes for the large corporations is 4.5, compared to 2.5 for all corporations involved in copper forming. The return on equity and return on assets, however, show mixed results. Return on assets for large corporations being significantly greater than for small ones, but the reverse is true for return on equity. Larger firms appear to have higher profit margins, but lower asset-turnover rates. Other than these observations, there does not appear to be a direct relationship between profitability and size. The superior performance of the larger corporations may not necessarily reflect the performance of large firms in the copper forming segment, per se, becasue the larger firms are generally conglomerates, and copper forming is only subsidiaries of an oil or coal corporation. The analysis at the reporting entity level (Section 3.4.2) provides further insights into profitability and whether size plays a part in the performance of the copper forming segment of these companies.

3.4.1.2 Capital Structure Analysis at the Corporation Level

The capital structure is examined to provide information on the ability of the corporations involved in copper forming to finance initial capital outlays. Six key ratios that provide a profile of the industry debt structure, leverage, and ability to finance current debt are summarized in Table 3-4. The first measure, the debt coverage ratio, is the ratio of net profits before interest and taxes to interest expense. Based on the 308 Economic Survey data this ratio is high for the industry as a whole. A high ratio suggests that the corporations are able to service their debts in the near term.

The debt/equity and the long-term debt/total capitalization ratios provide measures of credit-worthiness and financial risk involved in the manufacture of copper forming products (see Table 3-4). The debt/equity ratio provides a measure of debt to net worth of the corporation, while the long-term debt/total capitalization provides a measure of the long-term capital structure of the corporations. These ratios indicate that the industry debt structure has been deteriorating since 1976. In 1979 the debt/equity ratio of the corporations reached 64.5 percent.

TABLE 3-4. KEY CAPITAL STRUCTURE FINANCIAL RATIOS OF CORPORATIONS INVOLVED IN COPPER FORMING
(Percentage)

CORPORATE LEVEL FINANCIAL RATIOS	1976	1977	1978	1979
Debt coverage ratio	697.88	680.33	850.28	931.36
Long term debt/total capitalization	31.39	33.90	36.60	33.68
Debt/equity	51.78	54.62	67.33	64.49
Capital expenditures/sales	3.90	5.35	4.99	4.79
Pollution capital expenditures/sales	.93	.66	.41	.37
Assets/sales	40.28	41.39	37.22	32.80

SOURCE: Compiled by JRB from data provided in the 308 Economic Survey.

The fourth parameter, the capital expenditures to sales ratio, is relatively low for the industry. This is expected because of the slow growth of this industry and the longevity of the capital equipment. Investment in other pollution abatement equipment, the fifth parameter, is also low for the industry as a whole. Since 1976 there has been a decline from 0.9 percent of sales for these types of expenditures to 0.4 percent of sales in 1979. The assets to sales ratio, the sixth parameter, is high, but there are indications that the industry as a whole has been utilizing its assets in a more efficient manner over the four year period. The assets/sales ratios dropped from 40.3 percent in 1976 to 32.8 percent in 1979.

Table 3-5 provides a profile of the capital structure of corporations by size classifications. The debt coverage ratio of the medium sized corporations appears to be in a better position than the rest of the corporations in the industry. The other data shows no clear pattern in financial health related to corporate size.

3.4.2 Financial Status of Reporting Entities

The financial profile of the reporting entities is provided in this section. The analysis at this level is important because it examines the unit or corporate structure that is most closely related to the copper forming operations. As stated earlier, copper forming is carried out by many different types of companies. Some copper forming operations are segments of large vertically integrated metal products companies; some are subsidiaries of other types of large corporations (e.g., subsidiaries of oil companies). By identifying the reporting entity and analyzing this segment, a better understanding of the financial condition of the copper forming industry segment is realized.

Two important groups of profitability ratios are analyzed. The first group shows profitability in relation to the long-term investments of the copper forming reporting entities: return on gross and net assets. These ratios provide information on the earning power of the reporting entities'

TABLE 3-5. CAPITAL STRUCTURE BY SIZE OF CORPORATION INVOLVED IN COPPER FORMING 1976-1978[a/]
(Percentage)

TOTAL SALES (MILLIONS OF 1979 DOLLARS)	DEBT COVERAGE RATIO	DEBT/EQUITY	LONG-TERM DEBT/TOTAL CAPITALIZATION	CAPITAL EXPENDITURES/ SALES RATIO	POLLUTION CAPITAL EXPENDITURES/ SALES RATIO	ASSETS/SALES
Very Large $10,000	802.44	35.57	25.35	4.49	.18	43.22
Large $9,999 -- 1,000	523.98	27.96	20.88	4.96	2.39	45.36
Medium-Large $999 -- 100	581.16	84.07	44.00	5.19	.20	39.56
Medium $99 -- 20	1,963.34	73.42	39.80	4.11	.12	39.84
Medium-Small $19 -- 5	690.99	55.83	39.04	3.18	1.37	27.91
Small under 5	435.98	55.56	27.12	9.33	.49	34.73
Total	786.61	59.55	34.25	4.76	.60	38.02

a/ Average over the 1976-1979 period. Data are for all corporate activities, not only for the corporation's copper forming operations.

SOURCE: Compiled by JRB Associates from data provided in the 308 Economic Survey.

assets. The second group of ratios shows profitability in relation to sales - profit margins before taxes and profit margins before taxes and metal input expense (gross profit margin). Examination of these two ratios at the reporting entity level provides greater insights into the efficiency of the copper forming operations than by examining a single ratio. For example, if the gross profit margin (i.e., profit margin before taxes and the cost of metal inputs) is unchanged over a period of years, but the profit margin before taxes has declined over the same period, then this change can be attributed to the higher costs of the metal inputs. On the other hand, if the gross profit margin falls, then the cost of the metal inputs in relation to sales is going down. This type of analysis is especially important when vertically integrated plants are involved, since integrated plants can benefit or suffer depending on the price of the metal input, especially during periods of high or low demand for copper forming products.

Table 3-6 provides a summary of the average profitability ratios for 43 copper forming reporting entities over the 1976-1979 period.[11/] The data suggest that the profitability of the reporting entity has been improving, although they suffered slight profit losses in 1977. For example, the return on gross assets dropped from 19.2 percent in 1976 to 18.6 percent in 1977, but recovered to 21.8 percent in 1978, and by 1979 the return on gross assets reached 23.7 percent. The profit margins for the reporting entities also shared a similar trend. The reporting entities experienced a small decrease in profit margins in 1977, but their profitability improved from 5.2 percent for that year to 6.1 percent in 1979. The spread between the profit margin before taxes, and the profit margin after taxes plus the cost of metal inputs, remain relatively constant, suggesting that the metal input price did not fluctuate significantly over the period of analysis.

Table 3-7 summarizes the data that are available on the profitability of the copper forming reporting entities by size classifications. Four-year

11/ A copper forming reporting entity may include one or more copper forming plants.

TABLE 3-6. KEY FINANCIAL RATIOS FOR THE COPPER FORMING REPORTING ENTITIES
(Percentage)

FINANCIAL RATIOS	1976	1977	1978	1979
Return on Gross Assets	19.17	18.56	21.82	23.67
Return on Net Assets	36.41	36.92	45.17	49.37
Profit Margin Before Taxes (Net)	6.01	5.19	6.06	6.11
Profit Margin Before Taxes and Cost of Metal Input (Gross)	13.01	11.95	13.06	13.60

SOURCE: Compiled by JRB from data provided in the 308 Economic Survey.

TABLE 3-7. PROFITABILITY ASSESSMENT BY SIZE OF THE REPORTING ENTITY 1976-1979[a]
(Percent)

TOTAL 1979 SALES[b] ($ MILLIONS)	RETURN ON GROSS ASSETS	RETURN ON NET ASSETS	PROFIT MARGIN BEFORE TAXES	PROFIT MARGIN BEFORE TAXES AND METAL INPUT
Very Large 2,000 - 500	22.29	43.05	6.40	8.68
Large 499 - 100	15.68	31.53	4.32	10.73
Medium 99 - 25	25.38	44.40	7.00	16.55
Medium-Small 24 - 5	21.35	47.99	7.05	12.24
Small under 5	22.23	45.90	4.85	10.72
All Entities	20.79	41.88	5.85	12.96

[a] Average financial ratios for the 1976-1979 period.

[b] Not all of these sales are due to copper forming. 1979 dollars.

SOURCE: Compiled by JRB from data provided in the 308 Economic Survey.

averages are analyzed to mitigate the effects of annual variances in performance. The data indicate no reason to expect variances in financial performance because of entity size. Moreover, they indicate that there are differences in the operating characteristics among the entities that cannot be explained by the given data. These differences include such items as asset turnover rates, metal costs, depreciation schedules used, and product mix.

3.4.3 Plant Level Assessment

Although a more comprehensive analysis at the plant level is presented in Chapter 6, this section briefly reviews some important characteristics of the copper forming plants. It is estimated that there are about 176 plants in the copper forming industry. These plants can be divided into two basic categories: "brass mills" that are involved in producing brass and bronze products (sheet, plate, rod and bar, etc.) and "wire mills" involved in producing only copper wire. A sample of 99 of these plants (see Table 3-8) indicates that there are many small to medium sized plants in the industry. Only seven of the copper forming plants responding to the 308 Economic Survey had over 1,000 employees, whereas 78 of the plants had less than 500 employees. The average annual production of the plants was approximately 60 million pounds of copper.

3.5 CONCLUSIONS

The analysis on the market structure and on conduct and performance of the copper forming industry reveal that the industry is relatively competitive. Although a large segment of the market is vertically integrated, the nature of the copper forming industry is such that individual firms are unable to control or influence market forces or prices in a perceptible manner. Market concentration is low and entrance into the industry is relatively easy. The empirical data on the industry's performance confirm this finding. The financial data reveal that the industry as a whole is earning profits below that of comparable industries, although not alarmingly low. Moreover, the industry appears to be in a position to finance moderate levels of additional debt. The results also suggest that economies of scale are not an important factor in this industry.

TABLE 3-8. SAMPLE OF COPPER FORMING PLANTS AND PRODUCTION BY EMPLOYMENT SIZE IN 1979

NUMBER OF EMPLOYEES	NUMBER OF PLANTS	AVERAGE PRODUCTION (000 lbs)[a]
1 - 24	6	2,303
25 - 49	4	7,868
50 - 99	13	14,888
100 - 199	25	23,085
200 - 299	15	30,563
300 - 399	8	60,849
400 - 499	7	151,994
500 - 999	14	153,791
> 1,000	7	164,404
TOTAL IN SAMPLE	99[b]	60,406

[a] Average per plant production for employment-size classification.

[b] 176 plants in total but only 99 of the copper forming plants responding to the Section 308 Economic Survey provided enough data to be included in this table. Four additional copper forming plants which responded to the 308 Economic Survey did not provide the data needed for this table.

SOURCE: Compiled by JRB Associates from data provided in the 308 Economic Survey.

4. BASELINE PROJECTIONS OF INDUSTRY CONDITIONS

This section provides projections of economic conditions that are likely to exist in the copper forming industry markets over the 1980-1990 time period. The baseline projections assume compliance with the Clean Air Act Amendments of 1970 and 1977, and the Federal Water Pollution Control Act Amendments of 1972. These baseline projections assume that no water pollution control requirements mandated by the Clean Water Act, including the proposed regulation, are imposed on the copper forming industry during this period. The demand and supply projections and parameter estimates of the equations developed in this section, will be used together with other information, including estimated compliance costs, to assess the effects of the effluent control requirements on future industry conditions.

The baseline projections in this report provide a general point of reference from which the relative and absolute magnitudes of the impacts from EPA's proposed copper forming regulation can be measured. These projections provide a plausible picture of future developments and are to be used as a benchmark for comparison, and not as a comprehensive, authoritative forecast of future industry conditions. However, even though minor changes to the baseline projections may result from more sophisticated forecasting techniques, they are not likely to significantly alter the study's overall conclusions.

The basic approach followed in developing the projections begins with the development of explicit demand and supply functions that explain the behavior of the copper forming market over the 1960-1979 historical period. The forecasts of the future levels of demand and supply are then calculated based on the established historical relationships and on projections of the explanatory variables in the demand and supply functions. Supply factors were also assessed to determine if there would be any significant changes in the level of capital requirements or growth in the number of plants over the regulatory impact period.

4.1 DEMAND-RELATED FACTORS

The demand for copper forming products refers to the quantity buyers are willing to purchase at different prices, everything else being equal. However, an analysis of demand requires a distinction between the uses and the demand for copper forming products. These variables are not definitionally identical. Uses of copper refer to the disposition of copper on hand (e.g., copper is used in the transportation, building, and communication industries). On the other hand, demand for copper forming products refers to specific types of copper products (e.g., copper sheets, plates, tubes, etc.). Moreover, since data on copper forming product flows are usually collected in terms of production, consumption by end-use, inventories, imports, and exports, it is necessary to determine the annual demand for copper forming products. The copper forming products' demand is estimated by adding imports to, and subtracting exports and changes in inventories from, the annual production figures. Using this approach, the quantity demanded is estimated (i.e., point estimates of demand over time) for four copper forming product categories: sheet, strip and plate; rod, bar, and mechanical wire; tube and pipe; and wire mill products.

4.1.1 Theoretical Considerations

There are a number of factors that must be considered when analyzing the demand for copper forming products. First, the demand for copper forming products is inversely related with its price [i.e., as the relative price rises (falls), the demand for copper products decreases (increases)]. Second, the demand for copper is a derived demand which arises from the final demand for the goods for which it is an input. Consequently, there is a direct relationship between the general utilization of copper forming products and the industrial production of durable manufactured goods. As industrial production of durable manufactured goods increases, the demand for copper forming products increases. For greater specificity, the demand for each of the copper forming products can be analyzed by relating it with its specific end-use. The demand for wire mill products, for example, can be associated with the demand for communication and building materials. Finally, the demand for copper is directly related to the price of substitute goods. In the manufacturing process of various end-users of copper forming products, there exist other materials which could be used instead of copper, even though they are not "perfect" substitutes. The most important substitutes for copper include aluminum, stainless steel, fiber optics, and plastics. Each substitute is a competitor to copper in limited situations. For example, aluminum is a substitute for copper mainly in wire products, and plastics are more important substitutes in the case of consumer products. Each of these factors are considered in the estimation of explicit demand functions for the copper forming industry segments.

4.1.2 Econometric Analysis and Considerations

Econometric analysis is a statistical technique which is used within an economic framework to analyze the relationship of key explanatory variables to the movement of select variables under study. It is an empirical approach that is extensively used in economic and business analysis to quantify relationships among variables and to predict market phenomena. In demand analysis it is used to quantify and empirically test the influence of the product's price, the prices of substitutes and complements, and general income levels (i.e., economic activity) on the demand for a product. Once a relationship is made explicit (i.e., a forecast of future demand), conditions can be based on predictions of the explanatory variables and the estimated behavioral coefficients.

4.1.2.1 Long-Run Dynamic Adjustment Process

In this analysis the demand for copper forming products is specified as a function of its relative price and the level of economic activity related to the specific copper forming product. However, since the purchasers of copper forming products do not generally change their consumption patterns in response to short-term movements in the price or changes in price within a given time period, a dynamic model specification is used to capture this long-run adjustment process.

In general, purchasers of copper forming products would not reduce their consumption of copper, due to short-run movements in the price or activity variables, because of technological and institutional constraints. This is so because, even though aluminum, steel, wood, and plastics are some of the materials that can be substituted for copper products in some applications, it is often not possible to make a direct substitution of one material for another in an ongoing manufacturing process as the price of copper increases. Substitution generally requires new types of manufacturing equipment or major modifications to existing equipment, and the substitute material must offer rather decisive advantages in cost and performance over the long term to justify the cost of adopting a new manufacturing process or designing and constructing a new manufacturing plant to use it. As a result, the substitution of one material for another usually takes place over a relatively long period of time and then, only under overwhelming conditions such as the following:

- The substitute material maintains desirable properties at low costs;
- The substitute is perceived to be available in sufficient quantities;
- The substitute is adaptable to commercial manufacturing processes.

In most cases, major consumption decisions are made on the basis of changes that occur over an extended period of time and not to changes in a single point in time. In the short run, producers may not be able to switch to substitutes because of higher prices. If prices are expected to remain high in the long run, copper producers may switch to aluminum. Hence, short- and long-run elasticities of demand may be different. Also, in the copper forming industry, less copper per dollar of output may be used in the long run as compared to the short-run, i.e., there is induced technological change as the price of raw copper rises (or falls).

To explain this type of demand behavior in the copper forming industry, a distributed lag equation structure (Koyck model specification) is used to capture the long run adjustment process that is observed as prices and the industrial activity variables (income) change over time. An example of a demand function of the Koyck type (i.e., assuming that the lag weights decline geometrically) is given in equation (4.1) below.

(4.1) $$c_t = a_o + a_1 \sum_{i=0}^{n} \lambda^i y_{t-1} + a_2 \sum_{i=0}^{n} \lambda^i p_{t-1}$$

where:

c_t = consumption of copper forming products in period t

y_t = industrial activity or income in period t

p_t = price of copper in period t

and where λ is defined as the reaction coefficient and takes on values from $0 \leq \lambda \leq 1$. Estimated values of λ are normally obtained through the use of a transformed equation. This requires multiplying the above equation lagged one period by λ,

(4.2) $$\lambda c_{t-1} = \lambda a_o + a \sum_{i=1}^{n} \lambda^i y_{t-1} + a_2 \sum_{i=1}^{n} \lambda^i p_{t-1}$$

and subtracting it from the original equation to obtain

(4.3) $$c_t = a_o(1-\lambda) + a_1 y_t + a_2 P_t + \lambda c_{t-1}$$

Equation (4.3) can be stated in a set of composite coefficients and a stochastic disturbance term that would result from estimation.

(4.4) $$c_t = b_o + b_1 P_t + b_2 y_t + b_3 c_{t-1} + u_t$$

Since the parameters λ, a_o, a_1, and a_2 can be determined uniquely from b_o, b_1, b_2, and b_3, equation (4.3) is approximately identified and can be estimated using the ordinary least squares regression method. The estimated parameters would correspond as follows:

$$\lambda = b_3 \qquad a_1 = b_1$$

$$a_o = b_o/(1-\lambda) \qquad a_2 = b_2$$

A useful property of the Koyck lag function is that it permits a distinction to be drawn between short run and long run adjustments or elasticities. The estimates of b_1 and b_2 represent the short run income and price coefficients and the values of $b_1(1-\lambda)$ and $b_2(1-\lambda)$ represent the respective long run elasticities.[1/] A priori, the short run adjustment (elasticity) must be less than the long run elasticity, since in the long run consumers have time to switch over to substitutes.

4.1.2.2 Data Availability

The specification of the above model was developed and estimated using annual time series data over the 1960-1979 period. The historical consumption data were derived from information provided by the Copper Development Association. Since actual consumption figures are not available, an estimate of the

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1/ Walter C. Labys, Dynamic Commodity Models: Specification, Estimation, and Simulation, Chicago, Lexington Books, 1973.

apparent consumption for each year is calculated by subtracting exports and inventory changes from, and adding imports to, production. The price of copper wire bar is used as a proxy for the price of copper forming products. This is appropriate since this price is used as the basis for changes in the copper forming industry price. Generally, the price of copper forming products is determined by adding a fixed processing fee (toll) to the price of wire bar. The annual average price quotations for wire bar products were obtained from the American Metal Market, 1979 Metal Statistics. The price series was transformed into constant dollars or relative prices by dividing the current price series by the copper mill price index. Since the demand for copper forming products is highly related to changes in the total fabrication metal industry, the Federal Reserve Board production index for fabricated metal products was used as the activity variable.

4.1.3 Empirical Results

The ordinary least squares technique was used to estimate the demand functions (equation 4.4) for each of the copper forming products. The results of the analysis for each of the product groups, including the total brass mill product group, are shown in Table 4-1. The signs of all the coefficients meet with *a priori* expectations (i.e., the signs of price coefficients are all negative and the signs of the income coefficients are all positive for each of the product groups). The coefficients are significant at the 90 percentile level for all segments, except those of the plumbing and commercial tube and pipe subcategory. The relatively high R^2 indicates that the explanatory variables are explaining most of the movement in the dependent variable.

In addition to these statistical criteria, the price elasticities from each of the structural equations were calculated and evaluated. The price elasticities of demand (calculated at the means) for each product group are shown in Table 4-2. In each case the implied long run elasticity is greater than the short run elasticity. Moreover, the short run elasticity estimates are consistent with other elasticity estimates calculated for the entire copper

TABLE 4-1. EMPIRICAL RESULTS OF ANALYSIS OF DEMAND FOR COPPER FORMING PRODUCTS*

COPPER FORMING DEMAND PRODUCT GROUPS	CONSTANT	LAG DEPENDENT VARIABLE	PRICE VARIABLE	ECONOMIC ACTIVITY VARIABLE	R^2	D.W.	SER
Sheet, Strip, and Plate	1,742.8	0.06542	-3,471.13	6.61	0.7	1.2	108.9
Plumbing and Commercial Tube and Pipes	686.54 (1.2)	0.579 (3.02)	-811.43 (-0.7)	0.27 (0.2)	0.4	1.5	111.5
Rod, Bar, and Mechanical Wire	1,298.6 (2.5)	-0.0393 (-0.18)	-2,100.59 (-1.7)	4.842 (3.6)	0.6	1.4	108.7
Total Brass Mill Products	3,710.1 (2.3)	0.229 (1.1)	-6,181.1 (-1.7)	10.12 (2.5)	0.5	1.3	321.8
Wire Mill Products	1,294.38 (1.5)	0.289 (1.5)	-2,791.3 (-1.3)	14.49 (3.7)	0.9	1.1	187.1

*The 't' statistics are in parentheses.

SOURCE: Compiled by JRB Associates.

TABLE 4-2. PRICE ELASTICITY ESTIMATES FOR THE DEMAND FOR COPPER FORMING PRODUCTS[a]

DEMAND PRODUCT GROUPS	SHORT RUN PRICE ELASTICITY	LONG RUN PRICE ELASTICITY
Sheet, Strip, and Plate	-1.3	-1.4
Plumbing and Commercial Tube and Pipe	-0.4	-0.9
Rod, Bar, and Mechanical Wire	-0.9	-1.0
Wire Mill Products	-0.5	-0.7

a/ Elasticity estimates are calculated at the means.

SOURCE: Compiled by JRB Associates.

industry.[4] The short run elasticity estimate ranges from a high of -1.3 (fairly elastic) for the sheet, strip, and plate product group, to -0.4 (inelastic) for the tube and pipe product group.

4.1.4 Demand Forecasts

The demand forecasts were generated by fitting the estimated coefficients with predictions of future values for the explanatory variables. In the baseline projections it is assumed that the industry prices will increase in relation to the level of inflation in the economy over the forecast period. Since relative prices and not current prices are considered in a demand function, the real price of copper does not change over the entire forecast period. The forecast of the FRB fabricated metal index is based on the growth rate of the fabricated metal products index provided by Predicast.

Table 4-3 provides the results of the forecasting exercise for each of the product groups. Overall, the results indicate that the demand for copper forming products is not likely to increase uniformly over the 1980-1990 period. Increases (in relative terms) are predicted to be the greatest for the sheet, plate, and strip product group which is expected to expand to 1.7 billion pounds or by 65 percent over its 1980 level. The smallest increases in demand growth is projected for the commercial plumbing tube and pipe subcategory. This subcategory is forecast to decrease in 1981, then to increase to 928 million pounds by 1990. The quantity of products demanded for the rod, bar, and mechanical wire, and the wire mill product groups are expected to increase by approximately 54 percent over the 1980-1990 period.

4/ Estimates of elasticities are provided in the following publications: Charles River Associates, Policy Implications of Producer Country Supply Restrictions: The World Copper Market, Cambridge, Massachusetts, August 1976; and F. N. Fisher, P. H. Coutneau, and M. N. Baily, "An Econometric Model of the World Copper Industry," Bell Journal of Economics and Management Science, Vol. 2 (Autumn 1972), pp. 568-664.

TABLE 4-3. COPPER FORMING PRODUCTS DEMAND FORECASTS[a/]

YEAR	DEMAND PRODUCT GROUPS (MILLIONS OF POUNDS)			
	SHEET, STRIP, AND PLATE	PLUMBING AND COMMERCIAL TUBE AND PIPE	ROD, BAR, AND MECHANICAL WIRE	WIRE MILL PRODUCTS
1980	1,020.0	1,008.8	859.4	2,730.6
1981	1,246.5	807.4	1,042.1	2,913.8
1982	1,324.1	846.3	1,080.9	3,104.3
1983	1,392.0	871.4	1,125.3	3,296.9
1984	1,459.2	888.4	1,169.6	3,490.1
1985	1,526.4	900.8	1,213.9	3,490.1
1986	1,561.2	909.3	1,234.4	3,806.0
1987	1,593.9	915.4	1,255.9	3,908.0
1988	1,626.5	920.1	1,277.3	4,004.1
1989	1,659.0	924.1	1,298.7	4,098.4
1990	1,691.5	927.6	1,320.2	4,192.3

a/ 1980 actual figures and forecasts for the 1981-1990 period.

SOURCE: Compiled by JRB Associates.

4.2 SUPPLY FACTORS

In this section baseline projections for future levels of supply are provided for each of the four groups. In addition to the projected production levels, estimates are provided for capital expenditures in plant and equipment and the growth in new plants necessary to satisfy the projected production levels. These baseline estimates assume that no additional resources are expended to meet effluent pollution control requirements that may result from the Clean Water Act.

4.2.1 Theoretical and Empirical Considerations

4.2.1.1 Long Run Dynamic Adjustment Process

The supply of copper forming products refers to the quantity of products producers are willing to produce (supply to the market) at a given price, assuming other factors remain constant. *A priori*, the supply of copper forming products is positively related to the relative price of copper [i.e., as relative prices increase (decrease) the supply of copper forming products increases (decreases)].

Prices, however, are not the only variable that influences the supply of copper forming products. The ability to expand output in this industry also depends on variable costs and/or the ability to utilize the current stock of machinery more intensively. For example, it is doubtful whether a plant could expand its production significantly if wages or other production costs per unit of output increase precipitously as output expands or if the machinery is being used at its full capacity. Therefore, information on the level of capacity utilization of the copper forming industry would provide some indication of this industry's ability to expand its output over time. At low levels of capacity utilization current production would be low and expansion of output possible. On the other hand, at high levels of capacity utilization the industry would be producing close to its limit and at this point the industry would not be able to significantly increase its output in the short run. Increased output can be forthcoming only as new plants and machinery come on stream or as existing plants are expanded.

Furthermore, the supply response to price changes is not immediate in most cases, but is spread over a long period of time. It takes time to build up new productive capacity (i.e., to train new workers, and construct new plants). To capture this long run response the supply function uses the Koyck lag structure, as explained above. The supply curves are expressed in the form:

$$S_t = \alpha_o + \alpha_1 P_t + \alpha_2 CU_t + \alpha_3 S_{t-1} + e_t \qquad (4.5)$$

where

S = supply of copper forming products

P = price of copper forming products

CU = level of capacity utilization in the copper forming industry

t = annual time period

and α_o, α_1, α_2, and α_3 are the estimated coefficients of the explanatory variables, and e_t is the stochastic error, respectively. The distributive lag form of this model (i.e., the Koyck model specification) is derived similarly to the demand model above. It assumes that the supply response is dependent on price and industry capacity changes spread over a long period of time.

4.2.1.2 Data Availability

Annual time series data over the 1960-1979 period are used for each of the product groups. The annual production data for each of the four product groups are obtained from the Copper Development Association, Annual Data Reports. The price information is from the American Metal Market, 1979 Metal Statistics. For brass mill products the price of copper scrap is used as a proxy for the price of the brass products. Copper scrap prices are a good proxy for the brass mill product sectors for the following reasons:

- A significant amount of scrap is consumed by these product groups

- Prior to 1978 producer list prices were relatively stable, while scrap prices varied according to market forces.

One possible reason for relatively stable prices in the domestic market may be because producers tend to provide discounts (which are not observable) to their customers while maintaining their list prices on the books. Scrap prices, however, are competitive and do reflect changes in the market. On the other hand, wire mills do not consume any scrap, therefore, the use of this variable would be inappropriate for explaining copper wire supply. In the wire mill product group equation the price of copper wire is used.

The data on capacity utilization for the copper forming industry are from the Federal Reserve Board. The time series data from this source has missing observations for years prior to 1966 (and had to be estimated). Since the level of capacity utilization is highly related to the level of demand in the copper forming industry, the 1960-1966 capacity utilization levels are estimated from established relationships between these two variables over the period for which data are available. Using the capacity utilization/demand relationship and data on the industry demand over 1960-1966, estimates of the missing observations are generated.

4.2.2 Empirical Results

The results of the empirical analysis for the supply of copper forming products are provided in Table 4-4. Overall, these results are reasonable. All the price variable coefficients, except for the wire mill category, are statistically significant at the 95 percentile level. Both the signs and magnitudes of the price coefficients are consistent with our a priori expectations. The signs on all the price coefficients are psitive, and the responsiveness of supply in the short and long run are consistent, i.e., the long run coefficients are greater than the short run coefficients (see Table 4-5). The

TABLE 4-4. EMPIRICAL RESULTS OF ANALYSIS OF SUPPLY FOR COPPER FORMING PRODUCTS*

COPPER FORMING SUPPLY PRODUCT GROUPS	CONSTANT	LAG DEPENDENT VARIABLE	PRICE VARIABLE	CAPACITY UTILIZATION RATE	R^2	D.W.	SER
Sheet, Strip, and Plate	-183.9 (1.4	0.190 (1.6)	858.5 (3.0)	9.28 (5.5)	0.8	2.3	73.5
Plumbing and Commercial Tube and Pipes	42.8 (0.3)	0.078 (0.4)	1,094.5 (2.9)	5.04 (3.1)	0.7	1.1	74.2
Rod, Bar, and Mechanical Wire	-55.3 (-0.6)	-0.75 (-0.8)	402.2 (2.0)	11.46 (9.9)	0.9	2.2	50.8
Total Brass Mill Products	-92.3 (-0.4)	-0.05 (0.6)	2,534.7 (5.0)	27.8 (9.8)	0.9	2.5	123.3
Wire Mill Products	-745.97 (3.3)	0.432 (4.9)	342.6 (0.6)	24.6 (7.5)	0.9	1.4	114.0

*The 't' statistics are in parentheses.

SOURCE: Compiled by JRB Associates.

TABLE 4-5. SUPPLY PRICE ELASTICITY ESTIMATES FOR THE COPPER FORMING INDUSTRY[a]

SUPPLY PRODUCT GROUPS	SHORT RUN ELASTICITY	LONG RUN ELASTICITY
Sheet, Strip, and Plate	0.3	0.3
Plumbing and Commercial Tube and Pipe	0.4	0.4
Rod, Bar, and Mechanical Wire	0.1	0.2
Total Brass Mill Products	0.3	0.3
Wire Mill Products	0.1	0.2

a/ Elasticity estimates are calculated at the means.

SOURCE: Compiled by JRB Associates.

short run elasticity estimates (calculated at the means) range from a low of 0.1 for the wire mill product group to a high of 0.4 for the rod, bar, and mechanical product group. The supply price elasticities are slightly more responsive in the long run.

4.2.3 Supply Forecasts

Predictions of the explanatory variables are fitted to the estimated coefficients to generate forecasts for each of the product groups over the 1980-1990 period. Since it is assumed that prices will increase at the same rate as inflation, real prices are assumed to remain constant over the forecast period. The forecast of capacity utilization for the copper forming industry is based on future levels of copper consumption in the economy. The relationship that is established to provide estimates of the missing data for the capacity utilization levels (i.e., over the 1960-1966 period) is used to predict values for the copper forming capacity utilization rates over the 1980-1990 period.

Using the supply functions developed above, forecasts of production levels for each of the product groups are generted based on the estimated coefficients and forecasts of the explanatory variables in each product group. Table 4-6 shows the results of the baseline supply forecasts for the copper forming industry. Overall, the rate of growth in the future supply of copper forming products is less than the rate of increase in the demand forecasts. The sheet, strip, and plate product group is forecast to increase the most over the regulatory impact period. This segment of the industry is projected to increase by about 47 percent over its 1970 level of production. The supply of rod, bar, and mechanical wire products shows the next largest increases. This product group is expected to increase by 40 percent over the 1980-1990 period. The tube and pipe product group is expected to grow the least, at about 32 percent above its 1980 levels. The supply forecast for wire mill products is expected to be about 33 percent over its 1980 production level.

TABLE 4-6. COPPER FORMING PRODUCTS SUPPLY FORECASTS[a]

YEAR	DEMAND PRODUCT GROUPS (MILLIONS OF POUNDS)			
	SHEET, STRIP, AND PLATE	PLUMBING AND COMMERCIAL TUBE AND PIPE	ROD, BAR, AND MECHANICAL WIRE	WIRE MILL PRODUCTS
1980	908	748	860	2,870
1981	1,050.7	855.3	1,006.3	2,883.5
1982	1,110.5	881.4	1,035.7	2,975.8
1983	1,154.5	901.1	1,073.8	3,102.2
1984	1,195.5	920.4	1,111.2	3,243.2
1985	1,235.9	939.6	1,148.7	3,390.6
1986	1,259.4	949.7	1,165.4	3,496.1
1987	1,279.7	959.1	1,183.7	3,583.6
1988	1,299.3	968.4	1,201.8	3,663.2
1989	1,318.9	977.7	1,220.0	3,739.5
1990	1,338.4	987.0	1,238.1	3,814.3

[a] 1980 actual figures and forecasts for the 1981-1990 period.

SOURCE: Compiled by JRB Associates.

4.3 ANTICIPATED GROWTH AMONG TYPES OF PLANTS

Growth in industry can come about in at least four different ways:

(1) By expanding the current capacity of the plant (i.e., assuming that there is some excess capacity or the plant is not working at 100 percent of its capabilities a plant can produce more by working its machinery and labor more intensively);

(2) By addition of new plant, equipment, and technology to the existing plant. Given the space and the existence of scale economies a plant may expand its output by replacing old machinery with new or adding to existing machinery;

(3) If adjacent space is limited and scale economies do not exist, firms may build new plants in order to expand; or

(4) Assuming the rate of return is much higher than the market rate of interest and the risk associated with the copper forming, new firms may enter the industry.

In recent years the copper forming industry has been operating below its production capacity. This has been especially true during periods of cyclical fluctuations in the economy, and/or when the producer price deviates widely from the prices quoted on the commodity markets. In periods of recession, producers in the copper forming industry reduce their production significantly or carry large inventories. In periods when the domestic producers' price was higher than the commodity market quotations, purchasers bought copper forming products from abroad; consequently, producers were forced to cut back levels or increase inventories. Additionally, the profitability of these copper forming companies has not been significantly above that of companies with comparable risk. These factors have tended to keep the copper forming industry output below its potential capacity levels in most years and to discourage new entries into this segment of the industry.

The copper forming industry is a very mature industry that has not grown rapidly during the last decade. Generally, most of the new capacity has come from existing plants and from new plants built overseas where low cost inputs are available. This trend appears likely to continue when the high costs in meeting environmental and other regulations for new sites are considered. New productive capacity over the next decade is likely to come predominantely from investment in improvements to machines in place, introduction of new machines, and from the construction of new plants abroad.

5. COST OF COMPLIANCE

5.1 INTRODUCTION

The water treatment control systems, costs, and effluent limitations and pretreatment standards recommended for the copper forming industry are enumerated in the Development Document for Effluent Limitation Guidelines and Standards of Performance for the Copper Forming Point Source Category. That document identifies various characteristics of the industry including manufacturing processes, products manufactured, volume of output, raw waste characteristics, sources of waste and wastewaters, and the constituents of wastewaters. Using that data, pollutant parameters requiring effluent limitations and pretreatment standards were selected by EPA, and the costs of the treatment control systems to achieve certain standards of performance were estimated.

The EPA Development Document identifies and assesses the range of control and treatment technologies which apply to copper forming wastes. This assessment involved an evaluation of both in-plant and end-of-pipe technologies that could be designed for this category. This information was then evaluated for existing direct industrial dischargers to determine the effluent limitations achievable based on the "best practicable control technology currently available" (BPT), and the "best available technology economically achievable" (BAT). Similar evaluations were performed for new direct dischargers to develop new source performance standards (NSPS). Finally, pretreatment standards for existing sources (PSES) and pretreatment standards for new sources (PSNS) were developed for dischargers to publicly owned treatment works (POTW). Each of the technologies identified was analyzed to calculate cost and performance. Cost data were expressed in terms of investment and operating and maintenance costs.

A further discussion of the cost methodology is provided in Section VIII of EPA's Proposed Development Document for Effluent Limitations Guidelines and Standards for the Copper Forming Point Source Category.

5.2 CONTROL TREATMENT OPTIONS

EPA considered the following treatment and control options as the basis for BPT, BAT, NSPS, PSES, and PSNS for facilities within the copper forming industry.

Option 1 - Option 1 is end-of-pipe treatment consisting of lime precipitation and settling, and preliminary treatment, where necessary, consisting of chemical emulsion breaking, oil skimming, and chromium reduction. This combination of technology reduces toxic metals, conventional pollutants, and also toxic organics through oil skimming.

Option 2 - Option 2 is equal to Option 1 plus flow reduction for three waste streams: annealing water, solution heat treatment, and pickling rinse. Flow reduction of the annealing water and solution heat treatment streams is based on recycle, and flow reduction of the pickling rinse stream is based on spray rinsing and recirculation. The Option 1 flows for these streams are reduced by approximately 60 percent, and this reduction will result in a similar decrease of toxic metals and conventional pollutants.

Option 3 - Option 3 is equal to Option 2 plus filtration for further reduction of toxic metals and TSS.

Option 4 - Option 4 is equal to Option 3 plus further flow reduction gained by countercurrent cascade rinsing applied to the pickling rinse stream. This technology is demonstrated in the copper forming category, as well as other industries, and is proven as an economical and technically effective means of reducing water use and pollutant discharges.

Option 5 - Option 5 is equal to Option 1 plus filtration for further reduction of toxic metals and TSS. This option is different from Option 3 in that flow reduction is not included.

Each of these proposed control options is expected to generate more solid wastes than are generated by the current treatment systems in use in copper forming plants. The costs of the proposed control options include estimates for the cost of hauling and disposing of these additional solid wastes. The cost estimates reflect EPA's view that the solid wastes generated by the proposed control options are not expected to be classified as hazardous under the regulations of the Resource Conservation and Recovery Act (RCRA).

5.3 ESTIMATED OPTIONS COSTS

The number of plants in the copper forming industry is estimated at 176. Of this total number, 37 plants are considered direct dischargers and 45 plants indirect dischargers (i.e., they discharge their wastewater to POTWs). The remaining 94 plants do not discharge any wastewater and therefore would not incur treatment costs.

Tables 5-1 and 5-2 provide the estimated total industry costs in 1978 dollars for the first three pollution control options considered for BAT and PSES. The total industry investment costs for direct dischargers are approximately \$1.8 million, \$4.6 million, \$6.9 million, and the annual costs which include the operating and maintenance costs plus depreciation and interest are \$0.7 million, \$1.5 million, and \$2.2 million for Options 1, 2, and 3, respectively.[1/] For the indirect dischargers the total industry investment costs range from \$3.0 million to \$8.3 million, with annual costs of \$2.3 million to \$4.7 million.

1/ Annual costs are calculated using a capital recovery factor of 0.22.

TABLE 5-1. COMPLIANCE COSTS FOR COPPER FORMING INDUSTRY DIRECT DISCHARGERS[a]

POLLUTION CONTROL TECHNOLOGIES	NUMBER OF PLANTS NEEDING ADDITIONAL TREATMENT[b]	TOTAL COSTS ENTIRE INDUSTRY		
		INVESTMENT	O&M	ANNUAL[c]
Option 1	11	$1,812,926	$347,208	$ 746,052
Option 2	30	$4,620,227	$473,341	$1,489,791
Option 3	30	$6,910,309	$641,436	$2,161,704

a/ Costs are in 1978 dollars. To convert to 1982 dollars, multiply by 1.34

b/ Out of total of 37 direct dischargers.

c/ Includes O&M plus depreciation and interest expenses. The capital recovery factor is 0.22.

SOURCE: Compiled by JRB Associates from data provided by EPA, Effluent Guidelines Division.

TABLE 5-2. COMPLIANCE COSTS FOR COPPER FORMING INDUSTRY INDIRECT DISCHARGERS[a]

POLLUTION CONTROL TECHNOLOGIES	NUMBER OF PLANTS NEEDING ADDITIONAL TREATMENT[b]	TOTAL COSTS ENTIRE INDUSTRY		
		INVESTMENT	O&M	ANNUAL[c]
Option 1	30	$3,099,090	$1,662,045	$2,343,845
Option 2	38	$5,961,420	$2,657,850	$3,969,362
Option 3	38	$8,341,425	$2,858,160	$4,693,274

a/ Costs are in 1978 dollars. To convert to 1982 dollars, multiply by 1.34

b/ Out of total of 45 direct dischargers.

c/ Includes O&M plus depreciation and interest expenses. The capital recovery factor is 0.22.

SOURCE: Compiled by JRB Associates from data provided by EPA, Effluent Guidelines Division.

Options 4 and 5 are not costed for existing sources because early in the evaluation process, they were rejected for existing sources based on engineering judgment. However, Option 4 is considered for new sources (NSPS and PSNS). EPA estimates that Option 4 will not cost more for new sources than Options 2 or 3 are estimated to cost for existing sources. Option 4 is based on Option 2 plus filtration and greater flow reduction achieved by countercurrent rinsing. For new sources, countercurrent rinsing can be designed and built at less cost than for existing sources, where countercurrent rinsing involves expensive retrofit costs. The additional costs of filtration for Option 4 are estimated to be offset by the lower treatment costs associated with smaller wastewater flows using countercurrent rinsing. Therefore, new sources, regardless of whether they are plants with major modifications or greenfield sites, would have costs for Option 4 approximately equal to the costs existing sources would incur in achieving Option 2.

6. ECONOMIC IMPACT ANALYSIS

6.1 INTRODUCTION

This chapter describes the economic impacts likely to occur as a result of the costs of alternative pollution control regulatory options on the copper forming industry. The results focus on the following:

- Price and Output Impacts: An analysis of the impact of the pollution abatement costs on price and output in the U.S. domestic market;
- New Capital Financing Impacts: An analysis of the ability of plants in the copper forming industry to invest in new capacity and pollution control equipment out of current and future income;
- Plant Closures: An analysis of a) baseline plant closures (i.e., plant closures that may result even without the costs of the regulation), b) plant closures as a result of the regulation, and c) impact of the regulation on new plants;
- Employment Effects: An analysis of the amounts of layoffs that may result due to the estimated plant closures and the reduction in the output levels;
- Commmunity Impacts: An analysis of indirect effects on employment and earnings outside the copper forming industry as a result of layoffs in the copper forming industry within specific geographic areas;
- Balance of Trade Impacts: An analysis of the effects of price increases on the international competitiveness of domestic copper formers.
- Social Costs: An analysis of the value of goods and services that may be lost to society because of the effluent regulations;
- Small Entity Impacts: An analysis of the impacts of the proposed pollution control options on small copper forming plants.

The impact assessment procedure uses the estimated investment and annual operating and maintenance costs for each option as the basis for the potential impacts. If these costs are small for individual plants in the industry, then there are likely to be no significant impacts. On the other hand, if the costs are large, the industry and related industries may face serious problems if the proposed pollution control systems are required.

6.2 PRICE AND PRODUCTION IMPACTS

6.2.1 Measuring Cost Increase Impacts on Price

Compliance with the effluent regulations impose added costs of doing business on copper forming plants. Assuming that these plants can raise the necessary capital funds to install the proposed pollution control systems the plants will attempt to adjust their price and output decisions so that their financial performance after compliance is as good as it was prior to regulation. This implies that a plant will attempt to recover annualized compliance costs by raising their product prices. The success of this attempt will be governed by the ability of the plants to raise prices without experiencing large losses in sales volumes and profits.

The extent of the impacts of the pollution control costs on specific plants in the copper forming industry, therefore, would depend on the ability of plants in the industry to pass along the added costs to their customers. If all or a significant amount of the added costs can be passed through to the customers without affecting the volume of sales of plants in the industry, then the impacts of the proposed effluent regulation on the plants would be small. On the other hand, if the pollution control costs cannot be passed along to the customers of the copper forming products in the form of higher prices or if significant reductions in quantity demanded result from the price increases, then the plants in the industry will have to bear the burden of the proposed effluent regulation. Consequently, it is important to estimate the likely extent of the price pass through that may occur in the copper forming product markets.

The effects of an increase in production cost on price depends on both demand and supply conditions in the industry. In markets where the demand for the product is growing and price inelastic (i.e., the demand is insensitive to price changes) producers can usually pass cost increases through to their customers without losing sales. Under other market conditions (e.g., a stagnant product market and elastic product price) a smaller amount of the increased costs is likely to be passed through since the firms would lose significant amounts of sales if they raised their prices significantly. Under the latter circumstances firms have to absorb some or all of the increased costs, which may result in reduced output and profit levels in the short run and probable closures in the long run. Furthermore, price increases are more likely to be generated on the supply side when capacity utilization in the industry is high. In such times prices may rise faster than costs. When excess capacity exists in the industry, suppliers are less likely to bid up prices and may be more willing to absorb some of the regulatory costs.

An approach to measure the impacts of additional costs on price, that capture these market forces, is to construct explicit demand and supply curves for each of the industry product markets. These curves can then be used to estimate the effects the increase in production costs (attributable to pollution control) may have on the prices of specific products in the copper forming industry.

6.2.2 Price Impact Model

In general, the impact of additional costs on a firm can be interpreted as a shift in the supply curve (i.e., an increase in the marginal costs) of the firm. The increase in price is determined in the market by the interaction of the supply curve to a new position on the demand curve. As long as the price increase is not too large, the assumption about the change in the supply curve due to the change in costs can be measured precisely from information provided by the supply and demand curves. It can be shown that the change in price (ΔP) due to a change in cost (ΔMC) is equal to:

(6.1) $$\frac{\Delta P}{\Delta MC} = \frac{\eta}{\eta - \varepsilon}$$

where η represents the supply price elasticity, and ε the demand price elasticity for the specific copper forming product. Using Equation (6.1) the price increase due to change in pollution control cost can be estimated as follows:

(6.2) $$\Delta P = \frac{\eta}{\eta - \varepsilon} \times \Delta MC$$

where ΔMC represents the additional pollution control costs per pound.

6.2.3 Price Impact Model Results

Table 6-1 summarizes the results of the price impact assessment. The demand and supply elasticities for each product group are used together with the formula above (Equation 6.1) to calculate the change in prices that may result from a change in costs. The analysis presented here uses the long-run price elasticities for the specific copper forming product groups. This is necessary because short run adjustments in the copper forming markets are small, while in the long run, the quantity of a product demanded and supplied may change significantly, since consumers and suppliers have sufficient time to adjust to price changes.

The results suggest that the price increases due to changes in costs are predicted to be small. The predicted ratio of price change due to cost increase is shown to be fairly small for each of the copper forming product segments. The results of the analysis indicate that as the per unit cost of production increases at the industry level, the price of the product groups would increase by a much smaller percentage. The price change would range from about 0.2-0.3 percent for each percentage change in costs for the range of products in the copper forming market.

TABLE 6-1. DEMAND/SUPPLY ASSESSMENT OF EACH PRODUCT GROUP IN THE COPPER FORMING INDUSTRY

PRODUCT GROUPS	DEMAND OUTLOOK (PREDICTED ANNUAL GROWTH RATE 1981-1990)	DEMAND ELASTICITY (Long-Run)	SUPPLY ELASTICITY (Long-Run)	PREDICTED RATIO OF PRICE INCREASE TO COST INCREASE
Sheet, Strip, and Plate (1)	3.3	-1.4	0.3	0.18
Rob, Bar, and Mechanical Wire (2)	2.6	-1.0	0.2	0.17
Commercial and Plumbing Tube and Pipe (3)	1.4	-0.9	0.4	0.31
Wire Mill Products (4)	4.0	-0.7	0.2	0.22

SOURCE: Compiled by JRB Associates.

The price increases that may occur from the proposed regulation are estimated using Equation 6.2. The results of the price impact assessment for each copper forming product (i.e., the last column in Table 6-1) are multiplied by the additional average annual compliance costs per pound of copper for the three pollution options (from Chapter 5). Table 6-2 presents the results of this exercise. The results show the expected price increases that may result from the average added pollution control costs for each of the copper forming product groups. The results indicate that the added pollution control costs will have a negligible impact (i.e., less than 0.02¢/lb) on the price of the copper forming products. These empirical results are consistent with the market structure analysis in previous chapters (which indicated a competitive market for the copper forming products). The remainder of the economic impact analysis, therefore, focuses on the extent to which plants in the copper forming industry can remain financially viable and competitive domestically and abroad with added compliance costs imposed on them.

6.3 CAPITAL AVAILABILITY ANALYSIS

The capital availability analysis examines the ability of the copper forming plants to finance investments in new capacity and pollution control. The approach focuses on the ability of individual plants to finance pollution control and capacity expansion from current cash flow without relying on outside sources of capital. The assessment of this ability is based on the assumption that the plant manager would invest in pollution abatement if the plant still remains profitable after the investment. The capital availability analysis uses data on the cash flow, and the investment and annual pollution control costs, to determine whether the plants after the investment in pollution control can continue to be profitable.

Information on the cash flow was estimated from data provided in the 308 Economic Survey. The cash flow for each plant was estimated as follows:

$$\text{Cash flow} = \text{net profits} + \text{depreciation} \quad (6.3)$$

TABLE 6-2. EXPECTED PRICE INCREASES BY COPPER FORMING PRODUCT GROUP (¢/lb)[a]

POLLUTION CONTROL TREATMENT OPTIONS	PRODUCT GROUP			
	SHEET, STRIP, AND PLATE	ROD, BAR, AND MECHANICAL WIRE	TUBE AND PIPE	WIRE
Option 1	.01026	.00969	.01767	.01254
Option 2	.018	.017	.031	.022
Option 3	.02286	.02159	.03937	.02794

a/ 1979 dollars

SOURCE: Compiled by JRB Associates.

A capital budgeting approach is used to determine whether a plant can afford to install the required pollution control equipment. For each plant, the present value of the future stream of revenues (cash flow) is calculated assuming that the plant invests in pollution control. The expected future cash flows of the plant are discounted back to the present year, using an interest rate that reflects the plant's current cost of capital. The analysis takes into account the cash returns expected over the life of the plant and equipment, because the plant will remain open for many years if the operator invests to meet pollution control standards.

The plant will make the investment in pollution control, if the expected future revenues are greater than the future annual expenditures, plus the capital investment in pollution control. The capital availability analysis is summarized in the formula below.

$$(6.4) \qquad NPV = \sum_{\eta=1}^{\eta} \frac{CASH_{\eta}}{(1+i)^{\eta}} - \sum_{\eta=1}^{\eta} \frac{C_{\eta}}{(1+i)^{\eta}} - I$$

where

NPV = net present value
CASH η = cash flow over η periods
i = average cost of capital
C = annual pollution costs
I = capital investment in pollution control.

The decision rule is if the NPV is positive the plant would invest; if the NPV is negative or zero the plant could not afford to invest in pollution control. Furthermore, it can be assumed that if the firm can invest in pollution control and still remain profitable, then the financial markets would also be willing to finance the installation of the pollution control equipment.

The capital impact analysis uses the information provided by the copper forming industry 308 Economic Survey to calculate the expected cash flows for the individual plants. This analysis assumes that the cash flow of the plant will remain constant in real terms over the expected life of the plant (10 years). The estimated cost of capital over this period is 13 percent.

6.3.1 Capital Effects (Existing Plants)

The capital availability analysis examines a sample of plants in the copper forming industry to predict the number of plants that should be able to afford to install the proposed pollution control systems. The use of sample plants is necessary because adequate financial data and compliance cost information are not available for all the 82 plants that discharge wastewater (i.e., information on profits and depreciation). Of the 103 plants responding to the 308 Economic Survey, only 39 that provided adequate financial data for inclusion in this capital availability analysis were wastewater dischargers. Of these, 20 are indirect dischargers and 19 direct dischargers. Additionally, actual compliance cost estimates were not available for all of the 39 plants. For those plants without actual compliance cost information, the analysis was carried out using the highest compliance cost that was estimated for a plant in the sample. The results of the capital availability analysis indicate that all of the plants examined can afford to install any of the proposed pollution control options. Based on the sample of copper forming plants examined, all the copper formers can afford to install the proposed pollution control options.

6.3.2 Capital Effects (New Sources)

Based on available information, we concluded that no new plants will be built in the United States over the next ten years. In the past five years all of the new copper forming capacity has come from expansion of existing plants and from overseas operations. This trend is expected to continue in the future. Additionally, for reasons explained in 5.3 above, available information indicates that the costs of treatment controls for new sources would be no more than the treatment control costs for existing sources. The analysis of capital availability for new sources is analagous to that of existing sources. Based on this analysis, we do not expect any of the proposed pollution control requirements to impose significant barriers to entry for new sources, whether these new sources are plants with major modifications or greenfield sites.

6.4 PLANT CLOSURE ANALYSIS

6.4.1 Plant Closure Methodology

The decision to close a plant is extremely complex, involving an array of factors, many of these subjective. Some of the more important factors to consider are:

- Present and expected profitability of the plant;
- Current market or salvage value of the plant, i.e., the opportunity costs of keeping the plant open;
- Required pollution control investment;
- Expected increase in annual costs due to pollution control requirements;
- Expected product price, production costs, and profitability of the plant after pollution control equipment is installed and operating;
- Other major economic developments expected for the plant (i.e., change in the competitive position, market growth, etc.).

Each of these factors is addressed to some extent in this plant closure analysis. Our efforts at this stage are to identify the plants that may close under the alternative regulatory options.

In general a manager faced with pollution control requirements must decide whether to make the additional investment or to sell the plant. A rational manager would decide to keep the plant, if the before and after pollution control cash flows are greater than the salvage value of the plant. If the expected cash flows are less than the salvage value the manager would be better off selling his plant. Since the plant will remain open for many years if the investment is made in pollution control, the analysis takes into account the cash flow expected over the life of the plant and equipment plus the salvage value at the end of the last period. The present value of future cash flows is calculated by discounting the expected income stream by the current cost of capital. The plant will remain open if the present value of the expected cash flows less the costs of investing in pollution control exceed the expected salvage value. If the expected cash flows are less, the owner will sell the plant. Thus, the owner will close the plant if:

$$(6.5) \qquad S_o > \sum_{n=1}^{n} \frac{CASH_n}{(1+i)^n} - \sum_{n=1}^{n} \frac{C}{(1+i)^n} + \frac{S_n}{(1+i)^n} - I$$

where S is the salvage value of the plant and the other variables are the same as defined above.

Plant specific financial data (i.e., profits, depreciation, and salvage value) were provided by the copper forming industry 308 Economic Survey. The annual cash flow of the plants are predicted to remain constant in real terms (i.e., increase at the level of the inflation rate) over the life of the plant and the cost of capital is estimated at 13 percent. The investment and annual operating and maintenance costs for each of the pollution control options were determined in a separate study.

6.4.2 Predicted Plant Closures

The analysis examines a sample of plants (discussed above) to predict the number of plant closures that may result from the regulation. The cash flow plant closure analysis is based on data from 39 plants that responded to the 308 Economic Survey. These 39 plants include all the survey respondents that both discharge wastewater and also provided the adequate data. The results of the plant closure analysis indicate that although the profitability of the plants will be reduced, none of the plants is likely to close if any of the proposed pollution control options are imposed. Based on this plant closure analysis, we do not expect any of the copper forming plants in the industry to close as a result of the proposed effluent regulation.

An analysis using the 308 Economic Survey data was also conducted to determine baseline closures and our results indicated no closures. However, it should be noted that recent market conditions in a number of the product sectors may produce a number of baseline closures even in the absence of the proposed regulation. Generally, the smaller, older, nonintegrated plants will be more vulnerable to a combination of increased competition from abroad and the recession over the 1981-1983 period. This situation is likely to affect the brass mills (especially tube and pipe plants) more significantly than the wire mills. The results of the market analysis and the closure analysis indicate that, though neither brass nor wire mill closures are expected as a result of the proposed regulation, wire mills are in a better financial and market position to afford the costs of pollution controls than the brass mills.

6.5 OTHER IMPACTS

6.5.1 Employment Impacts

The proposed pollution control options are not expected to cause any loss of jobs in the copper forming industry. Layoffs are not expected because no plant closures or output reductions are predicted to result from the proposed pollution control options considered.

6.5.2 Community Impacts

Since no plant closures or unemployment is expected for any of the pollution control options examined, the proposed regulation will not create any community impacts.

6.5.3 Balance of Trade Impacts

The regulation would impact on the balance of trade depending on (1) the extent that copper forming product prices in the domestic market rise faster than prices in the rest-of-world market, and (2) the extent to which the domestic production losses are replaced by imports from foreign countries. There should be no foreign trade impacts since the regulation will have only negligible price or domestic output capacity effects.[1/] Thus, domestic producers' competitive position vis-a-vis foriegn producers will not change.

6.6 SOCIAL COSTS

This section assesses the total social costs that can be associated with the alternative pollution control options proposed by EPA on the copper forming industry. Social cost is a measure of the value of goods and services lost by society because of a given regulatory action. These costs generally include the use of resources needed to comply with a regulation, the use of resources to implement and enforce a regulation, the value of the output that is foregone because of a regulation, and the welfare loss (i.e., the added costs of the product to consumers because of the regulation).

6.6.1 Conceptual Framework

The partial equilibrium analytical framework is conceptually the most practical means for estimating total social costs. This framework, in its most sophisticated form, is based on an analysis of supply and demand relationships in the directly affected market(s). When an industry is regulated, compliance requirements result in increased unit costs of production. This, in turn, leads to an upward shift in the industry's supply curve. The supply curve shift normally results in higher prices and a lower production level.

1/ Price increases, if they occur at all, are expected to be negligible. See Section 6.2 above.

Compliance costs, production losses, and net welfare losses incurred by producers and consumers due to decreased output are measurable within this framework. There are other costs that are not measurable within this framework. Costs of implementing and enforcing a regulation must be added. Also, other social costs do not appear in this static analysis such as productivity effects, innovation impacts, and costs of reallocating resources that become unemployed. Unfortunately, the data are not available to carry out such analysis for the copper forming industry at this time, and a compromise which captures the major costs to society was carried out.

6.6.2 Social Cost Analysis

For this analysis only the real resource costs are considered. This provides a reasonable estimate of social costs, since in this case other costs to society are estimated to be insignificant. For example, the costs associated with the regulation are not likely to affect the prices of copper forming products. Consequently, there are not going to be any price increase and output reductions in the copper forming market because of the regulation. As a result, the costs to consumers or producers from price increases or from output losses would be zero.

Social cost in this analysis is calculated by adding the discounted stream of the estimated total annual operating and maintenance costs to the initial investment costs. The analysis assumes a 10 percent discount rate over perpetuity.

Table 6-3 summarizes the results of this analysis for each of the pollution control treatment options by the discharge status of the copper forming plants and for the total industry. The social costs of the regulation will be greater for the indirect dischargers than for the direct dischargers. The greatest social costs are expected under treatment option 3. If the proposed regulation was imposed on the entire industry, treatment option 1 would create the least cost on society.

TABLE 6-3. TOTAL SOCIAL COSTS FOR THE COPPER FORMING INDUSTRY

TECHNOLOGIES	THOUSANDS OF 1978 DOLLARS			THOUSANDS OF 1982 DOLLARS
	DIRECT	INDIRECT	TOTAL INDUSTRY	TOTAL INDUSTRY
Option 1	5,285	19,719	25,004	33,505
Option 2	9,353	32,539	41,894	56,557
Option 3	13,324	36,923	50,247	67,331

SOURCE: Compiled by JRB Associates.

6.7 SMALL ENTITY ANALYSIS

Public Law 96-354, known as the Regulatory Flexibility Act, states that all Federal regulatory agencies must perform a Regulatory Flexibility Analysis for any regulation that has a significant impact on a substantial number of small entities. If there is a significant impact, the act requires that alternative regulatory approaches be examined to minimize significant economic impacts on small businesses. This small entity analysis is performed to identify whether or not small entities of the copper forming industry are significantly impacted by the proposed regulation and to ascertain if a Regulatory Flexibility Analysis is needed for this industry.

6.7.1 Defining Small Entities

The definition of small business is not precise or universal. The Small Business Administration (SBA) definition of "small business" generally means a specific number of employees for each manufacturing industry by Standard Industry Classification (SIC). For service, wholesale, retail, and other nonmanufacturing businesses, "small" is limited in SBA regulations by dollar amount of gross sales. On the other hand, EPA has used discharge volumes of plants on a substance-by-substance basis as a size standard. For some of its regulation limiting effluent discharge, this standard may make more sense than either employees or gross sales. However, this definition may not be useful for all cases.

6.7.2 Impact on Small Entities

Several techniques (e.g., plant production, employment, wastewater flows, etc.) establishing discrete size criteria among plants in the copper forming industry were analyzed. However, based on available data, no criteria that provide distinct size classifications or reveal unique biases could be found. For example, Table 6-4 presents a disaggregation of the sample of 39 plants by employment size classification for key variables. It shows the discharge status

TABLE 6-4. ANALYSIS OF COPPER FORMING SAMPLE PLANTS BY EMPLOYMENT CLASSIFICATION

EMPLOYEE CLASSIFICATION	DISCHARGE STATUS	# PLANTS RANKED BY EMPLOYEES	# EMPLOYEES	VALUE ADDED ($000)a/	PRODUCTION (000/lbs)	AVERAGE PROFIT MARGIN (%)b/
Total Employees	Total	39	42,186	1,563,596	3,610,177	19.22
	Indirect	20	28,835	882,393	2,300,160	19.4
	Direct	19	13,351	681,203	1,310,017	19.11
1 - 99 Employees	Total	5	286	23,539	34,241	20.0
	Indirect	3	103	4,862	7,745	20.0
	Direct	2	183	18,677	26,496	20.1
100 - 299 Employees	Total	11	1,978	272,663	472,885	19.5
	Indirect	4	696	57,800	106,152	15.8
	Direct	7	1,282	214,863	366,733	21.6
300 - 499 Employees	Total	5	1,780	67,944	137,653	10.5
	Indirect	1	385	19,999	52,050	3.0
	Direct	4	1,395	47,945	85,603	13.0
500 - 999 Employees	Total	10	6,579	346,603	1,776,359	22.6
	Indirect	7	4,405	255,512	1,486,202	25.6
	Direct	3	2,174	91,091	290,157	15.7
> 1,000 Employees	Total	8	31,563	852,847	1,189,039	17.3
	Indirect	5	23,246	544,220	648,011	5.0
	Direct	3	8,317	308,627	541,028	23.5

a/ 1978 dollars

b/ Profit margin is equal to the net profit divided by the value added of the plant.

SOURCE: Compiled by JRB Associates from the 308 Economic Survey.

(i.e., direct and indirect dischargers), value added, output, and the average profit margins of the copper forming plants in each employment category. The information on profit margins indicates that medium-sized plants with 300-499 employees are in the worst financial position. Consequently, they would be likely to be most affected by the regulation. It also indicates that the smallest plants (those with less than 100 employees) and the largest plants (those with more than 1,000 employees) are in the best financial position, and are likely to be be least impacted by the regulation. Based on this preliminary analysis, the impact on small entities does not appear to be more significant or different than for plants of larger sizes. Therefore, a formal Regulatory Flexibility Analysis for the copper forming industry is not required.