Prepublication issue for EPA libraries
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ECONOMIC IMPACT ANALYSIS OF ANTICIPATED HAZARDOUS WASTE MANAGEMENT REGULATIONS ON THE BATTERIES, ELECTRONICS, AND SPECIAL MACHINERY INDUSTRIES

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U.S. ENVIRONMENTAL PROTECTION AGENCY

1978

This report was prepared by Kearney: Management Consultants, under contract No. 68-01-4714.

Publication does not signify that the contents necessarily reflect the views and policies of the U.S. Environmental Protection Agency, nor does mention of commercial products constitute endorsement by the U.S. Government.

An environmental protection publication (SW-160c) in the solid waste management series.

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I - EXECUTIVE SUMMARY

INTRODUCTION

The U.S. Environmental Protection Agency (EPA) is responsible for developing hazardous waste management regulations under the Resource Conservation and Recovery Act of 1976 (PL 94-580). Hazardous waste management regulations applicable to industrial waste generators are now being formulated by EPA's Office of Solid Waste, Hazardous Waste Management Division. In developing waste management cost estimates for affected industries, EPA engaged A. T. Kearney, Inc. to assess the economic impacts associated with these costs for the following manufacturing industry groups:

- Storage and Primary Batteries (SIC 3691 and 3692)
- Electronic Components (SIC 367)
- Special Machinery Manufacturing (SIC 355 and 357)

It is expected that the results of this economic impact analysis will be incorporated into another study report entitled, "Integrated Economic Impact of Hazardous Waste Management Regulations," being coordinated by another private contractor.

At the outset of this study, it was determined that the three industry groups listed above would fall into a "secondary impacts" category. This category was defined as an industry group for which incremental hazardous waste management costs are less than 0.5 percent of product sales. The main objectives of this study were to review and verify the overall economic impacts for each of the three groups and to determine the extent of any special differential impacts which might be explained within these groups.

INDUSTRY CHARACTERIZATIONS

(a) Storage and Primary Batteries

Battery manufacturing is usually segmented between the two major end products: storage (secondary) batteries and primary batteries. There are about 170 companies operating close to 250 manufacturing plants, although ten major firms dominate the industry. The value of shipments from battery plants was $1.764 billion in 1975, 74 percent of which was accounted for by storage batteries. During the period 1958-1975, sales for both primary and secondary batteries rose at a compound annual rate of approximately 7.5 percent. The estimated annual real growth in shipments during 1975-1985 is 3.5 percent and 2.3 percent for storage and primary batteries, respectively.

Industry employment is estimated at 30,000 persons, 73 percent of whom are employed in the manufacture of storage batteries. Primary battery plants are concentrated in the North Central region of the country, while storage battery manufacturing facilities are evenly distributed throughout the United States.

The automotive market accounted for more than half of the total value of storage battery shipments in 1973, while the consumer market accounted for roughly 75 percent of the total value of primary battery shipments.

(b) Special Industry Machinery

The special machinery industry is segmented by the Bureau of the Census into food products machinery, textile machinery, woodworking machinery, paper industries machinery, printing trades machinery, and miscellaneous special industry machinery. Shipment values for these segments ranged from $448 million to $2.604 billion in 1972. About 190,000 people were employed in special machinery manufacturing in 1972, two-thirds of whom were production workers. Plants are concentrated within the major manufacturing regions of the country like the Northeast, the Midwest, and the West Coast.

The value of shipments is projected to increase at an average annual compound rate of 9 percent between 1977 and 1985 in the food products machinery segment. During the same period, growth rates of 7.5 percent are anticipated for the printing machinery and textile machinery segments, respectively.

(c) Office, Computing, and Accounting Machines

Office, computing, and accounting machines manufacturing encompasses these industry segments: typewriters; electronic computing equipment; calculating and accounting machines, except electronic computing equipment; scales and balances, except laboratory; and miscellaneous office machines, not elsewhere classified. Industry data for typewriters and miscellaneous office machines were combined by the Bureau of the Census, thus requiring that these segments be analyzed as one in this study.

The major industry segments are rapidly changing as a result of major innovations in production technologies, increasingly sophisticated electronic applications, and accelerating import competition from Japanese manufacturers. Shipment values for the computer segment of the industry increased 70 percent between 1967 and 1972 and were expected to increase by another 88 percent between 1972 and 1977, reaching $12 billion. The other major segments contrast sharply, with both experiencing declines in the real value of shipments during this period.

Computer segment employment has grown rapidly since 1967, reaching about 175,000 in 1976. Employment in the manufacture of calculating and accounting machines, typewriters, and miscellaneous office machines declined since 1967. The computer segment is highly regionalized, with 55 percent of the manufacturing plants located in California, Massachusetts, New York, and New Jersey. The other segments are more evenly distributed across the country with the more industrialized states having higher concentrations of manufacturing plants.

Rapid growth is expected to continue in the computer segment of the industry between 1977 and 1985, averaging eight percent at compound annual rates. Calculators and accounting machines sales are projected to increase by five percent over this period, while growth rates for the typewriters and miscellaneous office machines sector cannot be realistically estimated.

(d) Electronic Components

The electronic components industry is complex and rapidly changing. It covers the manufacture of the following components: electron tubes; semiconductors; capacitors, resistors, and inductors; and integrated circuit packages. The structure of the industry is complicated due to the range of product markets, the volatile nature of demand, the frequency of technological innovation, and the interrelationships between component markets.

The value of electronic components shipments increased by 70 percent during the past ten years to $12.6 billion in 1977. Total industry employment declined by 8 percent from 293,000 workers during this same period, partially as a result of production employment being shifted to overseas facilities owned by American firms. Other contributing factors were advances in production technology, market-related trends toward more capital-intensive production processes, and a more highly-skilled mix of production workers in the United States.

Electronic components manufacture is concentrated in the major manufacturing regions along the East and West Coasts and the Great Lakes. In 1972, there were approximately 2,855 electronic components manufacturing plants in the United States.

Real growth in the value of electronic components shipments is expected to average 6-7 percent during the next eight years.

COST OF
COMPLIANCE

The costs of compliance with the proposed hazardous waste regulations were derived from secondary data sources. These were comprised of contractor assessments of industrial hazardous waste practices in the three major industry groups plus a recent draft report by Battelle Columbus Laboratories entitled, Cost of Complying with Hazardous Waste Management Regulations.

The cost data were based on three different levels of technology for the treatment and disposal of each hazardous waste stream generated by manufacturing establishments. These technology levels, as defined by the EPA Office of Solid Waste, are based on the most prevalent industry-wide practice (Level I); the best technology presently used which is amenable to more widespread use (Level II); and the technology required to provide adequate health and environmental protection (Level III).

For the purposes of this study, it was assumed that Level III technology will be required to comply with the new hazardous waste regulations. In evaluating economic impacts, Level III technology was compared to Level I practices. (Specified in Battelle's Cost Of Complying with Hazardous Waste Management Regulations as Pathways Level III Technology.)

Level I treatment and disposal for the hazardous wastes of the three major industry groups generally consists of on-site or off-site landfilling. Level III technology, based on the Battelle draft report, was usually assumed to be either secured landfilling or incineration.

The total national costs for the treatment and disposal of hazardous wastes of each industry group are shown in Tables 1-4. In each industry group the cost of Level III technology implementation is roughly twice that of Level I technology.

TABLE 1

TOTAL NATIONAL COSTS FOR HAZARDOUS WASTE TREATMENT AND DISPOSAL: STORAGE AND PRIMARY BATTERIES
(thousand dollars/year)

Industry Segment	Level I	Level II	Level III
Lead-Acid Storage (lime sludges)	$ 460	$739	$1,570.0(1) 665.3(2)
Lead-Acid Storage (caustic sludges)	89	31	63.0
Nickel-Cadmium and Magnesium-Carbon (sludges)	17.8	0	14.5
All Segments (manufacturing scrap)	133	160	195.0
Total	$599.8	$830	$937.8(3)

Key to alternatives:

(1) Chemical fixation of lime sludges and simple landfill.

(2) Secured landfill.

(3) Total assumes secured landfill for lime sludges.

Source: Battelle Columbus Laboratories, Cost of Complying with Hazardous Waste Management Regulations (Draft Report).

TABLE 2

TOTAL NATIONAL COSTS FOR HAZARDOUS WASTE DISPOSAL IN 1977 - SIC 355
(thousand dollars/year)

Process Waste	Level I	Level II	Level III
Machine Shop	$4,359	$7,582	$ 9,319
Paint Shop	71	75	238
Heat Treating	378	658	809
Electroplating	25	29	139
Total	$4,833	$8,344	$10,505

Sources: Table 29 and Table 31.

TABLE 3

TOTAL NATIONAL COSTS FOR HAZARDOUS WASTE DISPOSAL - SIC 357
(thousand dollars/year)

Process Waste	Level I	Level II	Level III
Machine Shop	$1,156	$2,011	$2,472
Paint Shop	192	203	645
Heat Treating	378	658	809
Electroplating	134	152	741
Total	$1,860	$3,024	$4,667

Sources: Table 31 and Table 34.

TABLE 4

TOTAL NATIONAL COSTS FOR HAZARDOUS WASTE DISPOSAL IN THE ELECTRONIC COMPONENTS INDUSTRY
(thousand dollars/year)

Waste Stream	Level I	Level II	Level III
Halogenated Solvents	$ 948	$ 962	$1,487
Nonhalogenated Solvents	1,262	1,280	1,980
Wastewater Treatment Sludges	232	263	1,284
Lubricating and Hydraulic Oils	157	159	246
Paint Wastes	3	4	12
Total	$2,602	$2,668	$5,009

Source: Table 36 and Table 38.

ECONOMIC IMPACTS

The aggregate economic impacts associated with a shift from Level I technology to Level III will be negligible for each industry group as shown in Table 5. Aggregate industry costs as a percent of industry shipment values range from 0.02 to 0.06 percent. It is expected that these costs would constitute less than one percent of industry profits.

TABLE 5

AGGREGATE HAZARDOUS WASTE TREATMENT AND DISPOSAL COSTS ASSOCIATED WITH A SHIFT FROM LEVEL I TO LEVEL III TECHNOLOGY

Industry	Estimated 1975 Value of Shipments (million dollars)	Incremental Hazardous Waste Treatment Costs (million dollars)	Cost as a Percent of Shipment Values
Storage and Primary Batteries	$ 1,764.5	$0.3	0.02
Special Industry Machinery	8,932.4	5.7	0.06
Office, Computing, and Accounting Machines	11,568.4	3.8	0.03
Electronic Components	10,024.4	2.4	0.02

Sources: Annual Survey of Manufactures; and Battelle Columbus Laboratories, Cost of Complying with Hazardous Waste Management Regulations (Draft Report).

The possibility of differential impacts affecting particular plant sizes, industry segments, or regional locations was also evaluated. With the exception of a small number of the largest lead-acid battery plants (plants which are now using lime for acid neutralization and precipitation in their wastewater treatment systems), no such differential impacts were found. Although a few lead-acid battery plants will incur disproportionately high hazardous waste management costs, these costs are considered negligible for the large-scale operations involved.

Due to the limited nature of capital requirements associated with prospective hazardous waste management practices, no financing difficulties are anticipated within any of the industries studied. Price and employment effects attributable to more stringent management practices will be negligible, if not nonexistent. The possibility of plant closures directly or indirectly attributable to incremental hazardous waste management costs is considered extremely remote, and the costs will not affect import and export patterns within the industry groups.

II - GENERAL INTRODUCTION

BACKGROUND

The Resource Conservation and Recovery Act of 1976 (PL 94-580) charged the Environmental Protection Agency with responsibility for evaluating the economic consequences of various provisions of the Act, including hazardous waste management regulations. Having developed waste management cost estimates for industries affected by prospective hazardous waste management regulations, EPA engaged Kearney Management Consultants to assess the economic impacts associated with these costs for three specific industry groups.

INDUSTRIES UNDER INVESTIGATION

Kearney was assigned responsibility for these industry groups:

- Storage and Primary Batteries (SIC 3691 and 3692)
- Electronic Components (SIC 367)
- Special Machinery Manufacturing (SIC 355 and 357)

The special machinery manufacturing group was subdivided by Kearney for purposes of analysis. Thus, this report focuses upon four industry groups, designated as follows:

- Storage and Primary Batteries (SIC 3691 and 3692)
- Electronic Components (SIC 367)
- Special Industry Machinery (SIC 355)
- Office, Computing and Accounting Machines (SIC 357)

The results of Kearney's assessment will be used in the preparation of a report entitled, "Integrated Economic Impact of Hazardous Waste Management Regulations," being coordinated by Arthur D. Little, Inc.

Prior to conducting this study, EPA expected that the industry groups identified above would fall into a "secondary impacts" category. This category was defined as an industry segment for which incremental hazardous waste management costs are expected to be less than 0.5 percent of product selling price.(1) For this reason, the economic impact assessments for the batteries, electronics, and special machinery industries (three unrelated industry groups) were organized together to review the overall economic impacts and to determine the extent of any special differential impacts which might be experienced by particular industry groups.

CONTENTS OF THE REPORT

Kearney's report is organized into three major sections (Sections III through V). Section III contains industry characterizations for each of the four industry groups identified above. These descriptions are for use in Section VI. B. of the proposed A. D. Little report outline.

Section IV includes a review of hazardous waste streams generated by each of the four industry groups, together with estimates of compliance costs associated with alternative management technologies. These descriptions correspond to those specified as IX. B. n. Secondary Segments, a. Cost of Compliance, in the integrated report outline.

Section V provides Kearney's assessment of economic impacts associated with incremental hazardous waste management costs for the four industry groups. The four industry groups have been handled jointly for purposes of discussion, rather than treated separately, as in Sections III and IV. The consistency of the analytical process and the nature of findings which resulted warranted a more comprehensive presentation for this section. Section V satisfies the integrated report outline requirements for IX. B. n. Secondary Segments, b. Economic Impacts.

III - INDUSTRY CHARACTERIZATIONS

STORAGE AND PRIMARY BATTERIES

(a) Industry Segments

The battery manufacturing industry is typically segmented by distinguishing between the two major end products: storage (secondary) batteries and primary batteries. Storage batteries are rechargeable by connection to a source of direct current to reverse the chemical reaction that provides the electrical current. Primary batteries are not usually rechargeable and are, therefore, expendable after their charge has been depleted. Batteries range in size from lead-acid storage batteries weighing several tons to "button-cells" weighing a fraction of an ounce. A common example of each battery type is the automobile battery (storage) and the flashlight battery (primary).

The industry can be further subdivided by battery type. The two most widely used types of storage batteries are lead-acid and nickel-cadmium. Starting, lighting, and ignition (SLI) batteries are the best example of lead-acid storage batteries, and are basic equipment in automobiles, trucks, buses, airplanes, boats, and motorcycles. Nickel-cadmium storage batteries are commonly used for emergency and stand-by power, cordless appliances, hand calculators, and hearing aids.

The two principal primary battery types are carbon-zinc and alkaline-manganese. Carbon-zinc batteries are used in flashlights, toys, lanterns, transistor radios and hand calculators. Alkaline-manganese batteries are also used in flashlights, toys, photographic products, transistor radios, and hand calculators.

(b) Firms in the Industry

The battery industry consists of approximately 170 companies which operate close to 250 manufacturing plants. Despite the relatively large number of firms in the industry, ten major firms dominate the field. Many of these firms are diversified in other products. The firms include some of the nation's largest companies, including General Motors, General Electric, Union Carbide and International Nickel. The leading battery manufacturers are identified in Table 6.

TABLE 6

LEADING BATTERY MANUFACTURERS BY PRODUCT TYPE AND SHIPMENTS VALUE - 1973

Storage Batteries Only	Estimated Shipments (million dollars)
Globe-Union, Inc.	$195
Delco-Remy (Division of General Motors Corp.)	190
Eltra, Inc.	125
General Battery (Division of Northwest Industries, Inc.)	90
General Electric	18
Eagle-Picher	17
Storage & Primary Batteries	
ESB, Inc. (Division of International Nickel Company)	360
Gould, Inc.	233
Primary Batteries Only	
Union Carbide	185
P. R. Mallory and Company	60

Source: Annual Reports; Thomas Register, 1976; IBMA, "Starting, Lighting, Ignition and Generating Systems," 4th Edition Buyers' Guide, 1975.

There are approximately 250 manufacturing plants in the industry. Of these, 200 manufacture lead-acid storage batteries; 10 manufacture nickel-cadmium storage batteries; 12 manufacture carbon-zinc primary batteries; and 4 manufacture alkaline-manganese primary batteries.(2) Since many plants manufacture multiple battery types, particularly in the primary battery industry, these figures overlap to some extent.

(c) Industry Sales and Output

Industry sales in terms of value of shipments (Table 7) more than tripled in the period 1958-1975. Sales grew at a compound average annual rate of over 7.5 percent during this period. Increases were comparable for both storage and primary batteries, which exhibited compound average annual sales growth of 7.7 and 7.4 percent, respectively. During this same period, the Wholesale Price indices for storage and primary batteries increased at compound average annual rates between 1.5 and 2.5 percent.(3)

TABLE 7

BATTERY INDUSTRY VALUE OF SHIPMENTS
(million dollars)

Battery Type	1958	1963	1967	1972	1975
Storage	369.0	516.5	577.5	971.3	1,302.3
Primary	138.2	195.3	307.6	348.1	462.2
Total	507.2	711.8	885.1	1,319.4	1,764.5

Sources: 1972 Census of Manufactures: Industry Statistics; and Annual Survey of Manufactures: 1975.

Value added by manufacturing provides a measure of industry output. Nominal output increased over three times in the period 1958 to 1972, equivalent to a compound average annual increase of 8.4 percent. Growth in output was similar for both battery industry segments: storage was 8.6 percent; and primary was 8.0 percent. Real output growth, adjusted for increases in wholesale prices during this period, was somewhat more rapid for storage batteries than for primary batteries.

(d) Industry Employment

Approximately 30,000 persons are employed in the manufacture of batteries. Seventy-three percent of these persons are employed in the manufacture of storage batteries, which are comparatively more labor-intensive in terms of production requirements. Storage battery manufacturing employment is highest in Pennsylvania, California, and Texas. Primary battery manufacturing employment is concentrated most heavily in the north central region of the country.

Although there are many plants which employ less than 100 employees, close to 90 percent of the total value of battery shipments originates from plants which employ 100 or more.

(e) Distribution of Establishments

Storage battery plants are evenly distributed throughout the United States. Plant locations tend to be clustered near motor vehicle assembly plants or battery distribution points. Primary battery plants are concentrated in the north central United States.

(f) Product Markets

The automotive market (including trucks and buses) accounted for over half of the total value of storage battery shipments in 1973. According to the Census of Manufactures, over 75 percent of the value of automotive battery shipments were attributed to the replacement market, with the balance of shipments devoted to the original equipment market. Together, the automotive and industrial markets accounted for over 80 percent of the total value of storage battery shipments in 1973. The consumer market accounted for almost three-fourths of the total value of primary battery shipments in 1973. End-use market shares displayed relative stability between 1963 and 1973 in all major categories.

(g) Channels of Distribution

Battery plants may be classified as:

- Captive plants of major original equipment manufacturers;
- Plants owned by one of the major, publicly-owned companies; and
- Plants owned by small, independent, privately-owned firms.

Captive plants produce primarily for use in original equipment, but may also distribute to other users.

The replacement market is served directly by many small plants. However, a variety of distributors are active in the market, including large retailers, parts dealers, service stations, and dealer service departments. Drugstores, discount stores, toy stores and other retailers handling battery-operated products are also active in the replacement market for primary batteries. Eighty percent of the SLI batteries are sold to replacement distribution channels.

Due to the seasonal demand and limited shelf-life which characterize storage batteries, companies strive for a balanced mix of sales to original equipment and replacement markets. Industrial and speciality batteries are typically sold directly to industry or government purchasers.

(h) Pricing Patterns

Pricing patterns for SLI batteries are complex, reflecting the number and variety of distribution channels available. Typically, SLI batteries are sold by the manufacturer at 10 to 15 percent ($1 to $2 per battery) above cost. According to industry sources, margins are smallest in sales to original equipment manufacturers and small wholesalers. The markup for the retailer to SLI batteries is on the order of 100 percent. A typical battery is estimated to cost between $8 and $15 to manufacture. The finished product is sold to the retailer for $10 to $20, and is eventually retailed at a price ranging from $18 to $35. Prices vary directly as a function of cranking performance and reserve power capacity.

Primary batteries are generally much smaller physically and much lower in price than storage batteries. Estimated sales margins for primary battery manufacturers are comparable to those obtained by storage battery manufacturers (i.e., 10 to 15 percent above manufacturing costs). Observed variations in prices between small retailers, discount outlets, and military exchange outlets suggest markups of as much as 100 percent at the retail level.

Batteries sold in the industrial and military markets tend to be manufactured pursuant to custom specifications, and are not generally inventoried. The manufacturer tends to realize larger per-unit profits in these markets, but production volumes are much smaller relative to the consumer market.

(i) Price History

Price increases for storage batteries averaged 2.2 percent per year from 1963 to 1974. Primary battery prices increased by 3.8 percent per year during the same period. Price increases in both industries were considerably lower than the average for all commodities, which increased at a rate of 5.5 percent per year. Two factors contributing to the relatively small price increases were automation in the industry, particularly among the major firms, and long-term price stability in the cost of raw materials until the very end of the period.

(j) Competitive Environment

The majority of battery shipments originate from a relatively small number of major publicly owned companies: 92 percent of the total value of primary battery shipments from the four leading firms, and 85 percent of storage battery shipments from the leading eight firms. Industry concentration is depicted in Table 8.

TABLE 8

BATTERY INDUSTRY CONCENTRATION

Primary Batteries	
Union Carbide ESB, Inc. P.R. Mallory & Co. Gould, Inc.	92% total value of shipments
Storage Batteries	
ESB, Inc. Gould, Inc. Globe-Union, Inc. Delco-Remy Eltra, Inc. General Battery Corp. General Electric Eagle-Picher	85% total value of shipments

Source: 1974 and 1975 Annual Reports. Predicasts, Inc. Batteries & Electric Vehicles E36, Cleveland, Ohio, 1974.

The concentration ratios reported in the Census of Manufactures for storage batteries have varied little from 1947 to 1972. Value of shipments accounted for by the eight leading firms increased from 78 percent to 85 percent of total shipments, while corresponding shares for the four leading firms declined from 62 percent to 57 percent. Value of primary battery shipments accounted for by the eight leading firms remained virtually constant during this period, beginning at 95 percent and closing at 97 percent. Primary battery shipments attributed to the four leading firms increased from 76 percent to 92 percent of total shipments value, however.

The primary batteries sector is more concentrated than the storage batteries manufacturing sector for several reasons. First, storage batteries are heavy and, thus relatively expensive to transport. This helps to economically justify building storage battery manufacturing plants close to their market areas. Primary batteries are generally much smaller and the shipping costs from centralized plants are more reasonable. Second, a higher level of technology exists in primary battery development and manufacture, thus restricting participation in the industry. Finally, primary batteries manufacturing plants require higher capital investments than storage battery plants.

Despite the high level of economic concentration in the battery industry, battery manufacturing operations appear to be supplied on a relatively competitive basis. Economic analysis of the industry suggests that, over the long-term at least, supply should remain competitive. For example, no single storage batteries manufacturing firm accounts for over 20 percent of the total market. Battery manufacturing accounts for less than half of total corporate revenues from seven of the ten major companies. The distributors of replacement batteries (which account for over three-fourths of automobile battery sales) constitute a large and diverse market, where long-term supplier relationships are difficult to maintain, and price differentials are important. Moreover, firms operating battery plants include auto manufacturers, lead refiners, and general electrical equipment manufacturers. Other such firms are believed capable of establishing battery manufacturing operations in response to favorable movements in prices and earnings. Storage battery plant capital requirements, in particular, tend to be low relative to plant capital requirements in related industries, and the requisite production technology (with a few specified exceptions) is old, stable, and relatively unsophisticated.

The role of smaller plants and firms in the industry appears to be declining in response to competitive and regulatory pressures which favor larger-scale operations. The number of storage and primary battery manufacturing plants with 20 or more employees is reported by the Census of Manufactures to have increased from 135 to 152 between 1958 and 1972. During the same period, the number of establishments with less than 20 employees decreased from 183 to 109. Industry contacts, especially at surviving small plants, believe the attrition rate of such plants has accelerated since 1972. Expenditures required to achieve compliance with various government regulatory actions affecting the industry are frequently volunteered as a major precipitator of small plant closures. Inability to maintain a competitive posture with respect to larger manufacturers is also frequently cited as a factor influencing small plant closures.

Industry contacts have claimed that the combination of Federal regulations dealing with water pollution control, air pollution control, Occupational Safety and Health Act compliance, and solid waste disposal will prove expensive for battery manufacturers. An analysis of this point was made in a study for EPA of the lead-acid storage battery industry. This analysis showed that the combination of these regulations would result in annualized compliance costs of roughly $1 million for a 6,500 battery/day (bpd) plant and about $200,000 for a 500 bpd plant. These costs are provided in Table 9.(4)

TABLE 9

ANNUALIZED COSTS OF COMPLIANCE WITH ENVIRONMENTAL REGULATORY REQUIREMENTS FOR TYPICAL NEW LEAD-ACID BATTERY MANUFACTURING PLANTS

Environmental Regulatory Requirements	Annualized Cost by Plant Size (thousand dollars)		
	500 bpd	2,000 bpd	6,500 bpd
Water Pollution Control(1)	106	240	466
Solid Waste Disposal(2)	21.5	62.1	162
OSHA	22.5	72.9	223
Air Pollution Control			
SIP(3)	15.3	25.7	33.5
NSPS(4)	37.3	67.3	138
Total	202	468	1,022

Notes: (1) Based on BAT controls.

(2) Assumes lime neutralization of waste and on-site land storage with leachate collection and treatment system.

(3) State implementation plans.

(4) New source performance standards.

Source: Standards Support and Environmental Impact Statement: Control of Emissions from the Manufacture of Lead-Acid Storage Batteries.

(k) Industry Profile

The 10 major publicly-owned firms engaged in battery manufacturing operations are identified in Table 10. Most of these firms are diversified, with batteries accounting for only a portion of total sales. Total sales and estimated battery sales together provide an indication of the importance of battery sales to the firms' total operations.

TABLE 10

1975 BATTERY SALES BY PUBLICLY-OWNED FIRMS MANUFACTURING BATTERIES
(million dollars)

Firm	Total Sales	Battery Sales	Batteries as a Percent of Sales
ESB, Inc. (1)	$ 550.0	$ 456.6	83%
Globe-Union	262.0	208.9	80
Gould	770.0	215.6	28
P. R. Mallory	248.0	67.0	27
Eltra(1)	763.0	91.6	12
Northwest Industries	1,200.0	120.0	10
Union Carbide	5,700.0	285.0	5
Eagle-Picher Industries	347.1	17.4	5
General Motors(2)	35,700.0	190.0	1
General Electric	13,400.0	20.0	1

Note: (1) 1974 Annual Reports.

(2) Includes intra-company shipments valued at market prices.

Source: 1974 and 1975 Annual Reports.

The ten major firms can generally be characterized as profitable ventures, as illustrated in Table 11. Profit margins on battery sales are reputed to be somewhat lower than margins on other product lines. However, this may reflect relatively low levels of net capital invested per dollar of sales. In any case, confidence in the battery portion of these firms' battery operations is evidenced by substantial investments made or underway in new plant construction or expansion of existing facilities.

While the industry tends to be dominated by a few large firms, the majority of the plants are owned by small, private companies which have established positions by catering to particular facets of the market. Little public information is available on these companies. However, those contacted during the course of the study indicated apprehension over their future position in the market. In particular, these companies are concerned about the capital costs for new equipment to remain competitive with the major companies, as well as capital and overall cost requirements to meet various government regulations. Estimates of plant costs to deal with these regulations were given in Table 9.

TABLE 11

PROFITABILITY OF MAJOR BATTERY MANUFACTURERS: 1974-75

Firm	Before Tax Profits: Million Dollars	Before Tax Profits: Percent of Sales	After Tax Profits: Million Dollars	After Tax Profits: Percent of Sales
ESB, Inc.(1)	$ 24.8	5.7%	$ 19.3	4.4%
Globe-Union	13.1	5.0	6.7	2.6
Gould	60.1	7.8	37.1	4.8
P. R. Mallory	3.6	1.5	2.0	0.9
Eltra(1)	67.4	8.8	35.4	4.6
Northwest Industries	177.4	14.9	101.1	8.5
Union Carbide	745.5	13.2	387.7	6.7
Eagle-Picher	26.3	7.6	18.7	5.4
General Motors	2,371.2	6.6	1,253.1	3.5
General Electric	949.6	7.1	581.0	4.3

Note: (1) 1974 Annual Reports. Figures for remaining firms drawn from 1975 Annual Reports.

Sources: 1974 and 1975 Annual Reports.

There is no evidence to indicate that these small companies are presently any less profitable than the major companies. They do appear to be less flexible when faced with unanticipated new costs of doing business. Many of these companies, finding their manufacturing operations to be less profitable, have chosen to abandon these operations and simply to distribute and service batteries purchased from major manufacturers. Industry contacts revealed that approximately 50 percent of those plants which have discontinued manufacturing operations during the past 10 years have done so in favor of distributing and servicing standard products, usually automotive batteries.

(l) Availability of Substitutes

There are no substitutes for batteries as a source of electrical power in most cases. In some cases, batteries of another type can be substituted for particular applications. For example, alkaline-manganese batteries have supplanted carbon-zinc batteries in many uses.

Among storage batteries, the major product type is the standard automotive battery. There are no apparent substitutes for SLI batteries as a group, although there are quality alternatives among batteries of this type, such as rebuilt batteries, used batteries, short-lived batteries or top-of-the-line units. SLI battery consumption is directly related to automobile usage and new car production. Sales are affected by the number and age of automobiles in service, and are inversely related to battery service life. Storage battery costs constitute a relatively small percentage of total vehicle costs, whether measured by the initial purchase price or by the overall annual cost of ownership. The average automobile consumes one standard battery every 2.5 years(5). Although higher battery prices may have some effect on the consumer's efforts at maintenance, and therefore on the frequency with which most batteries must be replaced, a new battery will ultimately be required unless the vehicle is scrapped. The lack of substitutes and the low proportion of battery costs to overall auto costs suggests that demand for SLI batteries is relatively inelastic.

Primary batteries are used in a wide variety of consumer products, and the total purchase and ownership costs of these products vary over a considerable range. In many applications, primary battery costs represent a considerable proportion of the total cost of the end-use product, especially when battery replacement is related to "operating" costs of owning the product. A sharp increase in primary battery prices might reduce consumption of some inexpensive end products. In general, however, there are no substitutes for battery usage in these applications. Moreover, primary battery life cannot be extended through improved maintenance, so that extending battery life requires reduced usage of the end-product. Considering these factors, demand for primary batteries is inelastic, but probably less inelastic (i.e., relatively more elastic) than demand for storage batteries.

(m) Imports and Exports

Historically, imports and exports have played a minor role in the market for storage batteries. The problem of shipping a heavy battery filled with corrosive electrolyte (sulfuric acid), coupled with the tendency for the battery to self-discharge, encourage the location of battery manufacturing plants near end-product assembly plants or distributors. With the advent of dry-charge batteries and, more recently "maintenance-free" batteries, transportation costs are somewhat less critical a locational determinant. However, they remain sufficiently high to limit the potential importance of imports for domestic consumption.

Storage battery imports constitute about 2 percent of the domestic consumption of batteries. This may represent a conservative estimate. Batteries imported as part of a finished product, particularly automobiles, often are not counted in published statistics. However, since annual imports of cars have never exceeded 1.6 million and annual SLI storage battery shipments exceed 50 million, the proportion of imported batteries to domestic consumption would total barely more than 5 percent, even with a maximum adjustment for those contained in imported automobiles.(6)

The major direct SLI import at present is the motorcycle battery. However, foreign motorcycle battery producers are beginning to find it advantageous to manufacture their products in the United States. In the future, the majority of motorcycle batteries for domestic use are expected to be made in this country.

Canada receives the major share of SLI battery exports from the U.S., although there are significant exports of battery components to Mexico and other countries. Exports account for about 4 percent of the value of battery shipments, but the growth rate in dollar volume for exports has been less than for imports.

In contrast to the market for storage batteries, imports and exports have played a more significant role in the market for primary batteries. For example, Japan and Taiwan have provided a source for domestic consumption of flashlight and transistor radio batteries. However, rising material and labor costs overseas have narrowed the competitive advantage of imports. In recent years, U.S. technology has developed diverse sizes and varieties of miniature batteries and end-products using these batteries which have successfully penetrated export markets.(7)

Annual import and export statistics from 1965 to 1974 are summarized in Table 12 on the following page. The table shows the steady growth of battery imports, reaching $52.7 million in 1974.

TABLE 12

BATTERY INDUSTRY IMPORTS AND EXPORTS
1965 - 1974
(million dollars)

	Imports				Exports			
	Storage	Percent of Domestic Consumption(1)	Primary	Percent of Domestic Consumption(1)	Storage	Percent of Domestic Production	Primary	Percent of Domestic Production
1965	6.2	1.0	7.4	3.2	9.6	1.6	12.1	5.2
1966	7.5	1.2	10.4	3.8	17.8	2.9	11.6	4.2
1967	7.8	1.4	8.5	2.8	16.0	2.8	10.3	3.4
1968	8.9	1.4	11.2	3.4	18.2	2.9	12.0	3.6
1969	11.7	1.7	12.2	3.6	19.5	2.8	12.6	3.7
1970	13.2	1.7	11.1	3.4	22.7	3.0	14.7	4.5
1971	12.8	1.6	12.2	3.5	21.6	2.6	15.1	4.3
1974	31.2	2.6	21.5	5.6	32.9	2.7	29.6	7.5

Note: (1) Domestic consumption estimates do not include changes in stock.

Sources: U.S. General Imports, December 1974; U.S. Exports, December 1974; and U.S. Commodity Exports and Imports as Related to Output, 1970 and 1971; Bureau of the Census: Foreign Trade Division.

(n) Projected Growth

The value of battery shipments is projected to grow at an average annual rate of 3 percent during the next 5 to 10 years. Based on the previous history of the SLI battery segment, cyclical declines in total battery sales of as much 10-15 percent may be experienced periodically. However, the longer-term trend is for continued solid increases, provided the technical and market development of the maintenance-free battery is not significantly more rapid and dramatic than presently anticipated by most industry analysts.

While the battery industry is expected to grow at about 3 percent annually, some segments will exhibit significantly different growth rates. Alkaline-manganese batteries are capturing an increasing share of the dry cell market at the expense of carbon-zinc batteries, primarily due to the longer life and greater power available for comparable batteries. Sales of carbon-zinc batteries are expected to decline moderately, while sales of alkaline-manganese batteries increase at a rate of 5 percent annually. Estimated annual growth rates in the value of shipments for major battery types are outlined in Table 13.

TABLE 13

ESTIMATED ANNUAL REAL GROWTH IN SHIPMENTS
BATTERY INDUSTRY 1975-1985

Storage Batteries = 3.5%		Primary Batteries = 2.3%	
Battery Type	Annual Growth	Battery Type	Annual Growth
Lead-Acid	2.5%	Carbon-Zinc	-1.4%
Nickel-Cadmium	3.2%	Alkaline-Manganese	5.1%
Silver Oxide-Zinc and Other Storage	16.4%	Mercury	1.0%
		Other primary	6.8%

Source: Kearney estimates based on a regression analysis of census data, and estimates of market shares based on past trends.

Total employment in the battery industry is estimated at 30,000 in 1975. This is expected to increase to 38,000 by 1985, or by approximately 2.7 percent per year, provided shipments increase at projected rates. Most of the growth in employment will be in the SLI battery segment, which is labor intensive. Total employment in primary battery plants is expected to increase only slightly. Output increases in that segment have largely been achieved by process and equipment improvements and not by increased manpower. Some minor employment increases are expected as new plants and plant expansions are completed to meet increased future demand for batteries.

SPECIAL INDUSTRY MACHINERY

(a) Industry Segments

Special industry machinery manufacturing (SIC 355) encompasses the following industry segments:

- Food products machinery (SIC 3551)
- Textile machinery (SIC 3552)
- Woodworking machinery (SIC 3553)
- Paper industries machinery (SIC 3554)
- Printing trades machinery and equipment (SIC 3555)
- Miscellaneous special industry machinery (SIC 3559)

The different industry segments are essentially independent of one another, with manufacturing plants specializing in machinery for a single purchasing industry.

The economic background discussion for special industry machinery will focus upon the five industry segments specifically identified above. The miscellaneous category will be largely ignored, in spite of the fact that special industry machinery "not elsewhere classified" accounts for over 40 percent of total shipments in this industry. The miscellaneous category consists of a diverse and unrelated conglomeration of individual segments which are not of sufficient consequence to be designated separately at the 4-digit SIC classification level. Discussion of data for the miscellaneous category of smaller industry segments, as if these data encompassed an integrated segment of the industry, is unwarranted. This segmentation of smaller, unrelated industry groups has been excluded from the discussion which follows.

(b) Industry Output

Shipment values for the five special machinery industry segments (excluding SIC 3559 manufacturers) ranged from under $500 million to over $1 billion in 1972 (see Table 14). Ranking industry segments by shipment values provides the following hierarchy: food products ($1.0 billion); printing trades ($824 million); and paper industries ($448 million). Among these segments, woodworking, food products, and textile machinery experienced significant growth in shipment values between 1967 and 1972 (see Tables 14 and 15). In contrast, printing trades machinery exhibited moderate growth (less than 10 percent), while paper industry machinery shipment values actually declined by 20 percent.

TABLE 14

SIC 355 INDUSTRY SHIPMENT VALUES, EMPLOYMENT AND PRODUCTIVITY: 1972

	SIC 3551	SIC 3552	SIC 3553	SIC 3554	SIC 3555	SIC 3559
Value of Shipments (million dollars)	1,001.1	822.8	488.0	447.8	823.5	2,603.9
Number of Establishments	688	578	241	218	574	1,382
Total Employment (thousands)	31.9	32.7	13.5	15.3	23.9	72.2
Production Workers (thousands)	20.6	23.3	9.3	9.0	15.3	44.9
Value Added (million dollars)	605.2	487.6	280.3	254.0	503.6	1,587.1
Value Added per Worker Production Hour ($)	14.87	10.29	14.75	13.58	16.62	17.42

Source: 1972 Census of Manufactures: Industry Statistics.

TABLE 16

CONCENTRATION RATIOS FOR MAJOR SEGMENTS OF THE SPECIAL INDUSTRY MACHINERY MANUFACTURING INDUSTRY

Industry Segment	Value of Shipments (million dollars)	Percent Accounted for by: 4 Largest Firms	8 Largest Firms	20 Largest Firms	50 Largest Firms
Food Products Machinery	1,000.1	18	27	42	62
Textile Machinery	822.8	31	46	61	75
Woodworking Machinery	488.0	40	53	70	87
Paper Industries Machinery	447.8	32	46	65	85
Printing Trades Machinery	823.5	42	51	66	82

Source: Concentration Ratios in Manufacturing, 1972 Census of Manufactures: Special Reports.

(g) Foreign Trade

With the exception of the textile machinery segment, the major segments of this industry have consistently generated trade surpluses during the past 5-10 years. Imports are of negligible importance in the woodworking machinery segment, while exports account for roughly 10 percent of domestic production.(12) Import and export values are of comparable magnitude in the paper industries machinery segment.(13) Export markets constitute major sources of demand for food products and printing trades machinery, accounting for 30 to 40 percent of domestic production. Although export markets have also accounted for as much as 30 percent of domestic production for textile machinery, imports have captured close to 40 percent of domestic consumption in recent years.(14)

(h) Projected Growth

Expected increases in shipment values between 1977 and 1985 have been obtained for the three segments of this industry gen-nerating output values on the order of $1 billion or more. Shipments value are projected to increase at a compound average annual rate of 9 percent between 1977 and 1985 in the food products machinery segment. Growth rates of 7.5 and 5.0 percent are expected for the printing machinery and textile machinery segments, respectively.(15)

OFFICE, COMPUTING, AND ACCOUNTING MACHINES

(a) Industry Segments

Office, computing, and accounting machines manufacturing (SIC 357) encompasses the following industry segments:

- Typewriters (SIC 3572)
- Electronic computing equipment (SIC 3573)
- Calculating and accounting machines, except electronic computing equipment (SIC 3574)
- Scales and balances, except laboratory (SIC 3576)
- Miscellaneous office machines, not elsewhere classified (SIC 3579)

Data for typewriters and miscellaneous office machines (SIC 3572 and SIC 3579) were presented jointly in the 1972 Census of Manufactures, and will be handled accordingly. The resulting four industry segments are highly specialized, and are essentially independent of one another. It is therefore reasonable to consider each segment separately.

Scales and balances account for only two percent of aggregate industry shipment values, and have been excluded from further consideration in this study. The economic background discussion will be concerned with the three major industry segments: electronic computing equipment; calculating and accounting machines; and typewriters and miscellaneous office machines.

(b) Industry Output

All three major industry segments are rapidly changing in character due to major innovations in production technologies, increasingly sophisticated electronic applications, and accelerating import competition from Japanese manufacturers. These conditions are dramatized by the calculating and accounting machines segment, in which many established firms have been displaced by entrants from the semiconductor and computer industries. (16)

Shipment values have increased dramatically in the computer segment of the industry. Between 1967 and 1972, value of shipments increased by 70 percent (see Tables 17 and 18), equivalent to an 11 percent compound average annual rate of growth. By 1977, the value of computer shipments is expected to reach $12 billion (17), an increase of 88 percent above 1972 values.

TABLE 17

SIC 357 INDUSTRY SHIPMENT VALUES, EMPLOYMENT AND PRODUCTIVITY: 1972

	SIC 3573	SIC 3574	SIC 3572/3579
Value of Shipments (million dollars)	6,387.0	637.2	1,296.1
Number of Establishments	601	79	217
Total Employment (thousands)	144.6	22.6	34.4
Production Workers (thousands)	64.5	17.8	20.8
Value Added (million dollars)	3,410.7	407.1	867.4
Value Added Per Worker Production Hour ($)	26.22	12.23	21.69

Source: 1972 Census of Manufactures: Industry Statistics.

TABLE 18

SIC 357 INDUSTRY SHIPMENT VALUES, EMPLOYMENT AND PRODUCTIVITY: 1967

	SIC 3573	SIC 3574	SIC 3572/3579
Value of Shipments (million dollars)	3,770.9	707.8	1,112.10
Number of Establishments	178	138	202
Total Employment (thousands)	98.9	38.4	46.7
Production Workers (thousands)	50.7	31.3	33.4
Value Added (million dollars)	1,926.4	518.2	797.2
Value Added Per Worker Production Hour ($)	18.49	8.85	12.19

Source: 1972 Census of Manufactures: Industry Statistics.

The other two industry segments contrast sharply, with both experiencing declines in the real value of shipments (adjusted for increases in wholesale price indices) during this period. In the calculating and accounting machines segment, nominal shipment values (unadjusted) actually declined between 1967 and 1972 (see Tables 17 and 18), and again between 1974 and 1976. Calculator and accounting machine sales are expected to approach $900 million in 1977, however, resulting in an increase of eight percent over 1976 shipment values.(18)

(c) Employment

Employment in the computer segment of the industry increased by 46 percent between 1967 and 1972, and by an additional 21 percent between 1972 and 1976. During this nine-year period, the number of production workers increased by only 49 percent, indicating a relative increase in capital-intensity.(19)

Total employment in the manufacture of calculating and accounting machines declined precipitously between 1967 and 1972, and has alternately increased and declined in moderate proportions since 1972. Employment in the typewriter and miscellaneous office machines segment also decreased substantially between 1967 and 1972, due to reductions in production employment induced by a shift toward greater capital-intensity in the production process.

(d) Productivity

Rapid innovation in production technologies and the accompanying increase in capital investment per production worker have generated major increases in worker productivity in both the computer and the typewriter and miscellaneous office machines segments of the industry. Increases in productivity have been somewhat less significant in the manufacture of calculators and and accounting machines. Furthermore, worker productivity in this segment is well below the levels achieved in the other two industry segments (see Tables 17 and 18). Increased reliance upon electronic applications in the manufacture of calculators and accounting machines may reduce this disparity in future years.

(e) Location of Establishments

The computer industry is highly regionalized. Among 595 manufacturing plants identified in the 1972 Census, 170 were located in California. Three northeastern states - Massachusetts, New York, and New Jersey - accounted for 159 establishments. Together, these four states contain 55 percent of the plants in the industry.(20)

Both the calculating and accounting machines and the typewriters and miscellaneous office machines segments conform to the more generalized distribution of establishments common to aggregate manufacturing activity in the U.S. Manufacturing activity tends to be most highly concentrated in the Northeast (New York, New Jersey, Massachusetts, Pennsylvania); the Midwest (Illinois); and the West Coast (California). In addition to these regional concentrations of activity, Texas is an area of importance in the production of calculators.

(f) Industry Concentration

Economic concentration, measured in terms of the percent of industry shipment values attributed to the largest firms in the industry, is pronounced in all three major industry segments. Concentration ratios range from 51 to 73 percent for the four largest firms within each segment (see Table 19). Surprisingly, the computer segment of the industry is comparatively less concentrated than either the calculating and accounting machines or the typewriters and miscellaneous office machines segments. Although concentration ratios for the latter two industry segments remained relatively stable between 1967 and 1972, concentration ratios for computer manufacturing have diminished substantially since 1967. Competitive pressures intensified in this segment during the period in question, as evidenced by a four-fold increase in the number of competitors.

TABLE 19

CONCENTRATION RATIOS FOR MAJOR SEGMENTS OF THE OFFICE, COMPUTING, AND ACCOUNTING MACHINES INDUSTRY

Industry Segment	Value of Shipments (million $)	Percent Accounted for by: 4 Largest Firms	8 Largest Firms	20 Largest Firms	50 Largest Firms
Electronic Computing Equipment	3,418.9(1)	51	63	78	90
Calculating and Accounting Machines	637.2	73	89	98	100
Typewriters and Misc. Office Machines	1,296.1	60	75	88	96

Note: (1) Value added by manufacture is shown for this industry rather than value of shipments because the latter contains a substantial and unmeasurable amount of duplication.

Source: Concentration Ratios in Manufacturing, 1972 Census of Manufactures: Special Report Series.

(g) Foreign Trade

American manufacturers have dominated the international computer market for 25 years. Despite increased competition from Japanese manufacturers, the U.S. is expected to retain a major share of this expanding world-wide market. Computer exports are expected to total approximately $3 billion in 1977, against imports of $190 million. A trade surplus of $2.8 billion is therefore anticipated.(21)

Imported calculating and accounting machines are expected to account for 44 percent of domestic consumption in 1977. Under these circumstances, this industry segment will generate a trade deficit of $550 million.(22) Competition from Japanese manufacturers is already a major factor in the domestic market, and competitive pressure from these manufacturers appears to be accelerating.

(h) Projected Growth

Real shipment values in the computer segment of the industry are expected to exhibit continued rapid growth between 1977 and 1985, averaging eight percent at compound annual rates. Sales of calculators and accounting machines are projected to increase at a compound annual rate of five percent.(23) If these growth rates are sustained, respective product shipment values of $21 billion and $1.3 billion (in current dollars) would be attained.

ELECTRONIC COMPONENTS

(a) Introduction

The electronic components industry is a complex and rapidly changing industry. The industry encompasses manufacturers of the following components: electron tubes; semiconductors; capacitors, resistors, and inductors; and integrated circuit packages. Component demand is derived from consumer, commercial, and industrial demand for electronic equipment and service. Electronic components are integral elements in the production of a vast array of final products, including computers, automotive electronic systems, industrial controls, communications and navigation systems, television sets, radios, and calculators.

The structure of the electronic components industry is complicated by the range of product markets, the volatile nature of demand, the frequency of technological innovation, and the interrelationships between component markets. For example, integrated circuits have displaced resistors, capacitors, and discrete transistors in many conventional applications. At the same time, technology transfers have engendered new applications of these components in products such as calculators and automotive electronic systems. Shifting product markets are characteristic of the industry.

(b) Industry Output

The value of electronic components industry shipments increased 70 percent during the past ten years (see Table 20). Real shipment values (adjusted for increases in the wholesale price index for electronic components) increased at a compound average rate of 3.3 percent per year between 1967 and 1976.

TABLE 20

ELECTRONIC COMPONENTS INDUSTRY SHIPMENT
VALUES, EMPLOYMENT AND
PRODUCTIVITY: 1967 - 1977

	1967	1972	1973	1974	1975(1)	1976(1)	1977(1)
Value of Shipments (million dollars)	7,453	8,798	10,783	11,192	10,215	11,575	12,560
Number of Establishments	587	2,855	—	—	—	—	—
Total Employment (thousands)	403	335	395	382	340	355	370
Production Workers (thousands)	293	232	283	266	205	215	230
Value Added (million dollars)	4,359	5,290	6,598	6,900	n/a	n/a	n/a
Value Added Per Worker Production Hour ($)	7.57	11.43	11.86	13.27	—	—	—

Note: (1) Estimated by Bureau of Domestic Commerce (BDC).

Source: U.S. Industrial Outlook 1977.

(c) Employment

Total employment in electronic components declined by 8 percent over the past 10 years. Substantial increases in non-production employment have been outweighed by a 22 percent decrease in production employment during this period. Major domestic manufacturers are increasingly relying upon overseas production facilities to take advantage of lower wage rates for operations requiring less highly-skilled laborers. Production employment has thus been partially shifted to overseas facilities owned by American firms.

(d) Productivity

Worker productivity increased 75 percent from 1967 to 1974. This increase can be attributed to advances in production technology, market-related trends toward more capital-intensive production processes, and a more highly-skilled mix of production workers in the United States, resulting from the transfer of less skilled production employment overseas.

(e) Location of Establishments

Production of electronic components is concentrated in the major manufacturing regions along the East and West Coasts and the Great Lakes. Largest numbers of manufacturing plants are found in California, New York, New Jersey, Illinois, Massachusetts, and Pennsylvania. According to Table 20, there were a total of 2,855 electronic components manufacturing plants in the United States in 1972.

(f) Industry Concentration

Economic concentration within the electronic components industry varies considerably (see Table 21). Segments of the industry producing electron tubes and integrated microcircuits are highly concentrated, with eight firms controlling approximately 90 and 80 percent of these markets, respectively. Those segments producing semiconductors, capacitors, resistors, and inductors appear to be much more competitive, with eight-firm concentration ratios ranging from two-thirds to as little as one-quarter of the respective product markets. Key variables influencing high concentration within segments of the electronic components industry include:

- The sophistication and relative capital-intensiveness of production technologies;
- The comparative level and frequency of technological innovation, requiring major investments in research and development.

TABLE 21

CONCENTRATION RATIOS FOR MAJOR SEGMENTS OF THE ELECTRONIC COMPONENTS INDUSTRY

Industry Segment	Value of Shipments (million dollars)	Percent Accounted for By: 4 Largest Firms	8 Largest Firms	20 Largest Firms	50 Largest Firms
Electron Tubes	1,187.9	73	88	98	99+
Semiconductors(1)	1,088.1	34	51	63	83
Integrated Microcircuits	1,273.9	69	79	91	98
Capacitors	454.4	38	56	80	94
Resistors	438.5	40	60	83	96
Inductors(2)	391.8	14	25	46	70

Notes: (1) Excluding semiconductor networks (integrated microcircuits).

(2) Coils, transformers, and chokes for electronic applications could not be disaggregated from Census figures in order to isolate inductors. Although concentration ratios apply to all four products, inductors account for approximately 75 percent of total shipments in this category.

Source: Concentration Ratios in Manufacturing, 1972 Census of Manufactures: Special Report Series.

(g) Foreign Trade

The electronic components industry has generated trade surpluses which have increased almost continuously during the past ten years. Net exports of electronic components increased from 1/4 million dollars in 1967 to over $1 billion in 1976. A trade surplus on the order of $1.2 billion is expected in 1977. The only major industry segment to run a trade deficit in recent years has been the integrated circuit segment. This deficit is attributable to heavy imports from American-owned production facilities overseas, resulting in net imports valued at over $400 million in 1976.(24)

(h) Projected Growth

Real growth in electronic components shipments value is expected to average from 6 to 7 percent during the next eight years.(25) Advances in semiconductor technology and increased demand for electronic products in both consumer and industrial markets should more than offset increased import penetration for certain products and the transfer of labor-intensive production operations overseas.

IV - COST OF COMPLIANCE WITH HAZARDOUS WASTE REGULATIONS

INTRODUCTION

The EPA Office of Solid Waste has set forth three levels of technology for the treatment and disposal of each hazardous waste stream generated by manufacturing establishments. These levels of technology are based on the most prevalent industry-wide practice (Level I); the best technology presently used which is amenable to more widespread use (Level II); and the disposal practice required to provide adequate health and environmental protection (Level III).

Level I and Level II technologies have been taken from the various Assessment Reports, but the Cost Report was used in specifying Level III technology (specified there as Pathways Level III technology). All cost data used in this report were derived from the Battelle Cost Report.

For the purposes of this study, it is assumed that Level III technology will be required to comply with the new hazardous waste regulations. In evaluating economic impacts, Level III technology will be compared to Level I practices. This should allow the determination of economic impacts on a "worst-case" basis since the Battelle Cost Report generally specifies incineration or secured landfill as Level III technology. These practices are usually more expensive than certain waste reclamation and reuse technologies which may be implemented to some extent for the various hazardous waste streams.

For example, the Battelle Cost Report specifies incineration as Level III technology for waste lubricating and hydraulic oils at a cost of $107/kkg. However, the Assessment Report on electronics industry hazardous wastes specifies oil reclamation and claims that this would cost only $27/kkg. Thus, if oil reclamation services were generally available, industrial plants could save roughly $80/kkg by reclaiming rather than disposing of their waste oils.

The general availability of environmentally adequate "off-site" hazardous waste disposal facilities has not been addressed in this report. This is an important consideration, however, since many of the industrial hazardous wastes considered in this study will be amenable to off-site hazardous waste management practices.

As noted earlier, Level III technology generally entails incineration or secured landfill for the industries studied. These operations would normally be conducted off-site from the industrial plants generating the hazardous wastes due to the relatively small quantities generated per plant for the industries as a whole. Thus, it is not expected that the industries covered in this study will incur significant capital expenditure requirements for incinerators or land disposal operations to comply with the proposed hazardous waste management regulations. Plants within one of the industrial sectors which may choose to make capital investments are certain lead-acid storage battery manufacturing plants which may convert from wastewater treatment using lime systems to caustic systems which generate substantially less sludge.

STORAGE AND PRIMARY BATTERIES

(a) Hazardous Waste Characteristics

Eight industry segments produce hazardous waste streams. These waste streams vary in magnitude from lead-acid storage battery plants using lime neutralization and precipitation for wastewater treatment, which generate about 1260 kg per kkg of product output, to the carbon-zinc and alkaline-manganese dioxide primary battery plants, with 1 kg per kkg of product (see Table 22).

TABLE 22

HAZARDOUS WASTE STREAMS:
STORAGE AND PRIMARY BATTERIES

Industry Segment		Potential Hazardous Waste	Quantity/ kkg Output (kg/kkg)
Lead-Acid Storage	(1)	lime neutralization sludge	1260
	(2)	caustic neutralization sludge	0.6
Nickel-Cadmium	(1)	caustic wastewater treatment sludges	20
	(2)	solid scrap and reject cells	12
Carbon-Zinc		rejected and scrap cells	1
Carbon-Zinc (air)		rejected and scrap cells	1
Alkaline-Manganese		rejected and scrap cells	1
Mercury-Ruben		scrap cells and furnace residue	8
Magnesium-Carbon		wastewater treatment sludge	27.6
Lead-Acid Reserve	(1)	scrap and reject cells	330
	(2)	wastewater treatment sludges	8.2

Sources: Versar, Inc., Assessment of Industrial Hazardous Waste Practices: Storage and Primary Batteries Industries; and Battelle Columbus Laboratories, Cost of Complying with Hazardous Waste Management Regulations (Draft Report).

Output per plant, estimated in terms of product weight, varies from the typical lead-acid battery producing plant with 8,200 kkg per year, to the nickel-cadmium storage battery plant producing 447 kkg per year (see Table 23).

TABLE 23

TYPICAL MANUFACTURING PLANTS:
STORAGE AND PRIMARY BATTERIES

Industry Segment	Typical Production Output (kkg/year)
Lead-Acid Storage	8,200
Nickel-Cadmium	447
Carbon-Zinc	2,270
Carbon-Zinc (air)	1,500
Alkaline-Manganese	2,000
Mercury-Ruben	450
Magnesium-Carbon	1,350
Lead-Acid Reserve	454

Source: Versar, Inc., Assessment of Industrial Hazardous Waste Practices: Storage and Primary Batteries Industries.

Estimates derived from Versar and Battelle data show that lead-acid battery plants using lime neutralization and precipitation of process wastewater generate the greatest volume (by weight) of hazardous waste per metric ton of product and the largest total volume per year. Of the 200 plants manufacturing lead-acid batteries, an estimated ten or less use lime neutralization. At least one larger plant, which is classified by EPA as a direct discharger of wastewater to a navigable waterway, must use lime neutralization by the terms of its NPDES discharge permit.

Storage and primary battery manufacturing generates an estimated 543,033 kkg per year hazardous wastes on a net basis. Hazardous wastes generated by each industry segment are estimated in Table 24.(26, 27)

TABLE 24

HAZARDOUS WASTES GENERATION BY SEGMENT IN THE MANUFACTURE OF STORAGE AND PRIMARY BATTERIES

Industry Segment	Quantity of P.H.W.(1)/Product Dry	Wet	Total Volume of P.H.W./Year Dry	Wet
	(kg of waste/kkg product)		(kkg/year)	
Lead-Acid Storage(2)	0.5	0.6	412	515
(3)	440	1260	189,000	541,000
Nickel-Cadmium	32	68.9	19.3	49.8
Carbon-Zinc	10	10	410	1,121
Carbon-Zinc (air)	10	10	1.6	55.2
Alkaline-Manganese	10	10	28	164.7
Mercury-Ruben	8	8	5.3	7.5
Magnesium-Carbon	28	56	47.8	119.4
Lead Acid Reserve	341	356	21.4	25.3
			189,945	543,033

Notes: (1) P.H.W. = Potentially Hazardous Wastes
(2) Plants using caustic neutralization of process wastewater.
(3) Plants using lime neutralization of process wastewater.

Sources: Kearney estimates from Versar, Inc., Assessment of Industrial Hazardous Waste Practices: Storage and Primary Batteries Industries; and Battelle Columbia Laboratories, Cost of Complying with Hazardous Waste Management Regulations, (Draft Report).

(b) Waste Treatment and Disposal Practices

The most prevalent (Level I) treatment and disposal technology for all battery industry wastes is some type of on-site landfilling. Level II technology consists of sanitary landfilling and the sale of metal scrap to reclaimers.

Three types of Level III disposal technology are applicable to the industries in general. With those segments which generate sludges, the sludges may be chemically treated and landfilled, disposed of by secured landfill off-site, or sold to a reclaimer for resource recovery. For those using lime neutralization, only the first two alternatives are available. For those generating manufacturing scrap, alternatives are sale for scrap reclamation, in-plant reclamation, or disposal off-site in a secured landfill. The Level III alternatives for individual industry segments are enumerated in Table 25.

TABLE 25

LEVEL III WASTE MANAGEMENT TECHNOLOGY: STORAGE AND PRIMARY BATTERIES

Industry Segment	Level III Technology
Lead-Acid Storage	(1) Chemical fixation and landfill (lime sludges only) (2) Secured landfill (3) Reclamation of lead (caustic sludges only)
Nickel-Cadmium	(1) Secured landfill (2) Sale to scrap reclaimer (3) Chemical fixation and landfill (sludges only)
Carbon-Zinc and Carbon-Zinc (air)	(1) Secured landfill (2) In-plant reclamation
Alkaline-Manganese	(1) Secured landfill (2) In-plant reclamation
Mercury-Ruben	Secured landfill
Magnesium-Carbon	(1) Chemical fixation and landfill (2) Secured landfill
Lead-Acid Reserve	Secured landfill

Source: Versar, Inc., Asessment of Industrial Hazardous Waste Practices: Storage and Primary Batteries Industries.

Total national costs for the disposal of storage and primary battery hazardous waste streams at Level III are estimated at $937,800 (see Table 26). The largest costs will be borne by the lead-acid storage battery plants using lime neutralization.

TABLE 26

TOTAL NATIONAL COSTS FOR HAZARDOUS WASTE TREATMENT AND DISPOSAL: STORAGE AND PRIMARY BATTERIES
(thousand dollars/year)

Industry Segment	Level I	Level II	Level III
Lead-Acid Storage (lime sludges)	$460	$739	$1,570.0(1) 665.3(2)
Lead-Acid Storage (caustic sludges)	89	31	63.0
Nickel-Cadmium and Magnesium-Carbon (sludges)	17.8	0	14.5
All Segments (manufacturing scrap)	133	160	195.0
Total	$599.8	$830	$ 937.8(3)

Key to alternatives:

(1) Chemical fixation of lime sludges and simple landfill.

(2) Secured landfill.

(3) Total assumes secured landfill for lime sludges.

Source: Battelle Columbus Laboratories, Cost of Complying with Hazardous Waste Management Regulations (Draft Report).

All battery industry segments exhibit Level III hazardous waste management costs equivalent to less than one percent of product sales value (see Table 27). Incremental costs vary from 0.3 percent for lead-acid reserve plants to less than 0.01 percent for nickel-cadmium and mercury-ruben plants.

The lead-acid reserve segment will incur the largest cost impact of any segment of the battery industry with Level III costs at 0.7 percent of sales value and incremental costs at 0.3 percent of sales value. However, this segment should not have difficulty in recovering incremental hazardous waste management costs because the single known lead-acid reserve plant in the country manufactures specialty batteries for military uses.(28)

TABLE 27

TREATMENT COSTS VS. SALES VALUES
BY INDUSTRY SEGMENT: STORAGE AND PRIMARY BATTERIES

Industry Segment	Sales Value ($/kkg of product)	Level III Costs as a Percent of Sales Value (%)	Incremental Costs as a Percent of Sales Value (%)
Lead-Acid Storage	950(1)	0.01	---(3)
	950(2)	0.5	0.1
Nickel-Cadmium	21,000	0.1	0.01
Carbon-Zinc	1,500	0.1	0.03
Carbon-Zinc (air)	1,700	0.1	0.01
Alkaline-Manganese	1,500	0.1	0.03
Mercury-Ruben	25,000	0.01	0.01
Magnesium-Carbon	8,000	0.04	0.02
Lead-Acid Reserve	11,000	0.7	0.3

Notes: (1) Costs for plants using caustic neutralization.

(2) Costs for plants using lime neutralization.

(3) Negative incremental cost.

Sources: Kearney estimate from data reported in Versar, Inc., Assessment of Industrial Hazardous Waste Practices: Storage and Primary Batteries Industries; and Battelle Columbus Laboratories, Cost of Complying with Hazardous Waste Mangement Regulations (Draft Report).

SPECIAL INDUSTRY MACHINERY

(a) Typical Manufacturing Establishments

The processes listed in Table 28 must generally be used in the manufacture of special industrial machinery. However, a prior industry survey(29) and the data shown in Table 28 clearly indicate that all these processes, from foundry to product painting operation, are rarely, if ever, found in a single manufacturing establishment.

Machine shops, plate or structural fabrication, and painting operations are the most prevalent manufacturing processes found in SIC 355 establishments. A crude process flow diagram for a typical SIC 355 plant is shown in Figure 1. It consists of a machine shop followed by a plate or structural fabrication shop and a paint shop. The typical plant employs only 17 people and is generally located in an urban area within industrialized states such as California, New York, or Illinois.

Since the typical plant in this industry has only 17 employees, it is not surprising that there are relatively few manufacturing processes per plant. In fact, only about 11 percent of the plants have more than 100 employees, as indicated on Figure 2, which shows the size distribution of SIC 355 manufacturing establishments. It is thus expected that processes which are relatively scarce in the special industrial machinery industry are predominantly operated in the larger plants. Such processes are found in less than 10 percent of the SIC 355 industry plants. Thus, a substantial portion of the metal processing required to produce special industry machinery is conducted in plants classified in other SIC categories, such as electroplating job shops (SIC 3471).

TABLE 28

MANUFACTURING PROCESSES IN SIC 355 - 1972

Manufacturing Process	Number of Plants Using Process	Percent of Total Plants in SIC 355 Using Process
Ferrous Foundry	63	1.7
Nonferrous Foundry	31	0.9
Nonferrous Die Casting	3	0.1
Forging-Presses	6	0.2
Electroplating and Other Plating	28	0.8
Galvanizing and Other Hot-Dip Coating	4	0.1
Heat Treating	137	3.8
Automatic Screw Machine Dept.	119	3.3
Machine Shop	2,511 (1)	69.0
Tool and Die Shop	220	6.0
Foundry Pattern Shop	110	3.0
Plate or Structural Fabrication	1,940 (1)	53.3
Stamping, Blanking and Forming	259	7.1
Painting, Lacquering, and Enameling	2,085 (1)	57.3

Note: (1) Kearney estimates. Establishments with less than ten employees were typically excused from filing special metalworking reports by the Bureau of the Census. Thus, data on such plants, comprising about 45 percent of the industry, are not generally included. Census normally relies on the Social Security Administration and the Internal Revenue Service for data on small plants. Kearney estimates that establishments with less than ten employees typically consist of a small machine shop, a fabrication department, and some type of painting operation.

Sources: 1972 Census of Manufactures: Industry Statistics.

FIGURE 1

TYPICAL MANUFACTURING ESTABLISHMENT IN SIC 355

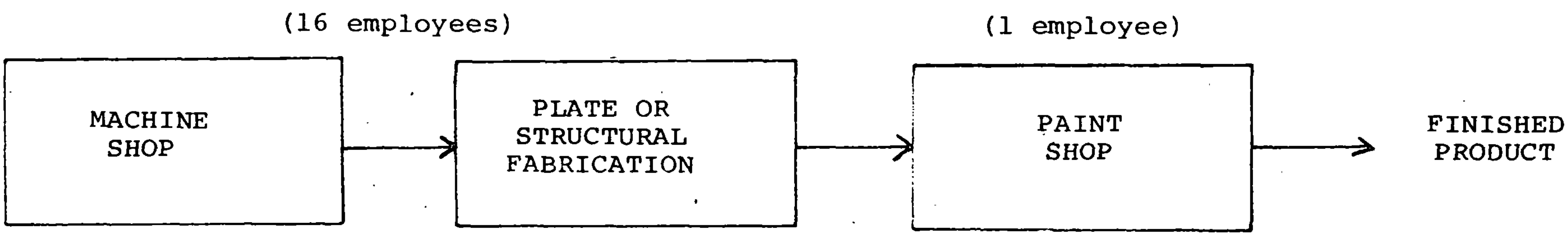
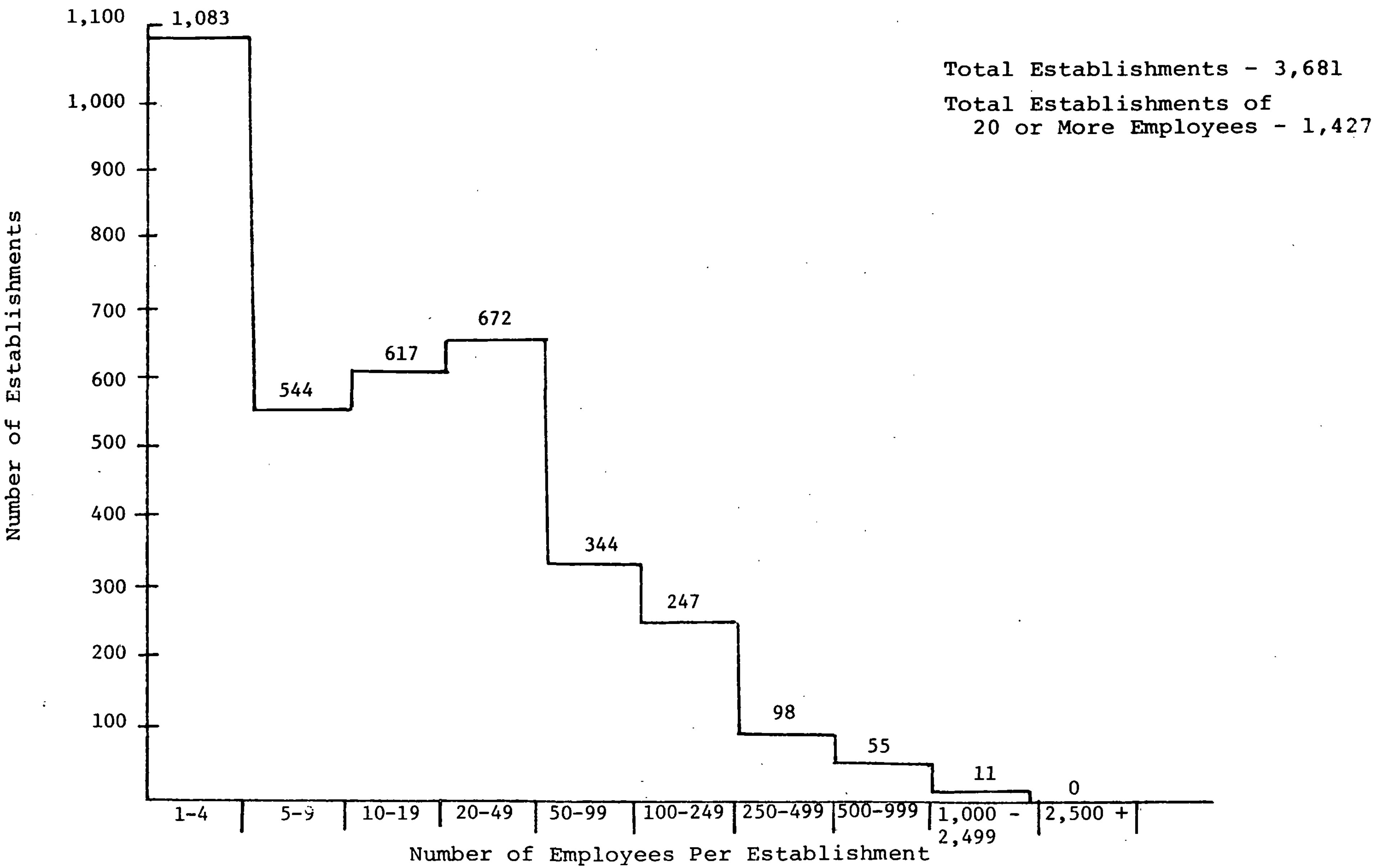


FIGURE 2

SIZE DISTRIBUTION OF SIC 355
MANUFACTURING ESTABLISHMENTS



Source: U.S. Department of Commerce, Bureau of the Census

(b) Hazardous Waste Characteristics

Process wastes from typical SIC 355 establishments are considered hazardous, and have the following characteristics:

Process/Waste Stream	Hazardous Constituents	Quantity of Waste Generated (kkg/employee-yr.)
Machine Shop (including fabrication)	Flammable Solvents, Heavy Metals, Oils	3.35
Paint Shop	Flammable Solvents, Heavy Metals, Oils	1.05

These wastes primarily consist of lubricating and grinding oils, cleaning solvents, paint residues, sweepings, and metal grindings. Typically, these wastes are combined in some type of heavy trash container within the plant.

Other manufacturing processes used in special industrial machines manufacturing which generate hazardous wastes are electroplating and heat treating. However, these processes will not be discussed in this study (except to include their waste quantities and disposal costs in aggregate totals for the industry) because it is estimated that less than four percent of the plants in SIC 355 actually use these processes.

(c) Hazardous Waste Generation

Using the waste generation factors derived in the Assessment Report(30) along with Kearney's revised estimates of production employees per process and number of plants from the 1972 Metalworking Directory(31), the total 1977 hazardous waste generation rates from SIC 355 are provided in Table 29.

TABLE 29

HAZARDOUS WASTE GENERATION IN SIC 355 - 1977

Manufacturing Process(1)	Waste Generation Per Process Employee (kkg/yr-employee)		Employees Per Process	Total Waste Generation (thousand kkg/yr)	
	Dry	Wet		Dry	Wet
Machine Shop	2.14	3.35	18(2)	106.6	167.0
Paint Shop	0.78	1.05	1.7(3)	3.1	4.1
Heat Treating	0.86	1.99	26	6.3	14.5
Electroplating	1.02	2.52	44	1.7	4.2
				117.7	189.8

Notes: (1) Manufacturing processes in SIC 355 generating insignificant quantities of hazardous waste include foundries, forging, die casting, and galvanizing.

(2) Kearney estimates.

(3) Kearney estimates.

Sources: WAPORA, Inc., Assessment of Industrial Hazardous Waste Practice - Special Machinery Manufacturing Industries; and Battelle Columbus Laboratories, Cost of Complying with Hazardous Waste Management Regulations. (Draft Report).

The total machine shop hazardous waste generation was approximately 167,000 kkg/yr on a wet-weight basis. This was comprised of spent coolants (65,000 kkg/yr), sweepings and metal grindings (62,000 kkg/yr), and spent cleaning solvents (40,000 kkg/yr). Paint shop wastes in 1977 were 4,100 kkg/yr, consisting of almost equal portions of paint sludge and cleaning solvent.

The typical SIC 355 establishment, described earlier, generates about 40 kkg/yr of machine shop wastes plus one kkg/yr of paint shop waste, using the factors from Table 29.

(d) Waste Treatment and Disposal Practices

The Office of Solid Waste has set forth three levels of technology for the treatment and disposal of each hazardous waste stream generated by SIC 355 manufacturing establishments as noted at the beginning of this section. These levels of technology are based on the most prevalent industry-wide practice (Level I); the best technology presently used which is amenable to more widespread use (Level II); and the disposal practice required to provide adequate health and environmental protection (Level III).

For the purposes of this study, it is assumed that Level III technology will be required to comply with the new hazardous waste regulations. In evaluating economic impacts, Level III technology will be compared to Level I practices.

In addition, only the wastes from typical plants will be covered in this analysis (see Figure 1), since less than seven percent of the industry's establishments use any other processes which generate hazardous wastes.

1. Level I Technology. The most prevalent technology for treating and disposing of SIC 355 establishment process waste consists of collection in a 15-cubic meter (20-cubic yard) trash container for hauling by a private contractor on a weekly to monthly basis. The wastes are taken by the contractor to an off-site sanitary landfill for disposal. The landfill disposal site is typically not owned by the SIC 355 establishment.

This technology is used for both machine shop wastes and paint shop wastes. Approximately 70 percent of the special machinery manufacturing plants are estimated to be using these practices. In addition, it is estimated that roughly 90 percent of the hazardous wastes generated within SIC 355 received some form of off-site disposal in 1975.(32)

2. Level II Technology. According to the Assessment Report(33), the best technology currently used which is amenable to more widespread use (Level II) begins with waste segregation. Oils are recovered at off-site re-refining operations, and solvents are reclaimed at off-site reprocessing facilities. The residues generated in the reclaiming operations are incinerated, with ash disposal in sanitary landfills.

Paint wastes are incinerated by a private contractor, with ash disposal in sanitary landfills.

Only about 50 plants in SIC 355 and 357 combined, representing less than one percent of the industry, were expected to be using Level II technology for machinery waste in 1975. Roughly 100 plants were thought to be using Level II technology for paint waste.

3. Level III Technology. The technology that assures adequate health and environmental protection (Level III) consists of practices outlined in Table 30.(34)

TABLE 30

LEVEL III WASTE DISPOSAL TECHNOLOGY FOR SIC 355

Process Waste Stream	Description
Machine Shop	Secured Landfill
Paint Shop	Incineration
Heat Treating	Secured Landfill
Electroplating	Secured Landfill

These methods differ from those described in the Assessment Report, which were more oriented toward resource recovery and the Level II technology described above.

(e) Treatment and Disposal Costs

The total costs to treat and dispose of hazardous wastes generated by SIC 355 plants are shown in Table 31.

TABLE 31

HAZARDOUS WASTE TREATMENT AND DISPOSAL COSTS FOR THE SPECIAL MACHINERY MANUFACTURING INDUSTRY

	Cost ($/kkg)		
Process Waste	Level I	Level II	Level III(1)
Machine Shop	26.1	45.4	55.8
Paint Shop	17.3	18.3	58.1
Heat Treating	26.1	45.4	55.8
Electroplating	6.0	6.8	33.1

Note: (1) Applies to Pathways Level III technology.

Source: Battelle Columbus Laboratories, Cost of Complying with Hazardous Waste Management Regulations (Draft Report).

These costs are principally based on treatment and disposal off-site by private contractors. No capital costs are included in these data, since it is not envisioned that SIC 355 plants will be required to make significant capital investments to achieve Level III technology, and thus to comply with hazardous waste management regulations.

Only the very largest plants in this industry are expected to practice any degree of on-site treatment and disposal of hazardous wastes (less than 12 percent of the establishments employ more than 100 people). Such plants could incur capital costs for the installation of oil re-refining incineration, and solvent reprocessing equipment and the construction of secured landfill sites. Neither the Assessment Report nor the Battelle Cost Report data provided any basis for capital cost estimations.

The cost data provided in Table 31 are representative of the costs expected to be incurred by special industry machinery manufacturers in disposing of their wastes through private contractors. No significant differences are expected between the costs to be incurred by small plants (i.e., those having less than 20 employees) vs. larger plants.

The typical SIC 355 manufacturing establishment (generating 40 kkg/yr of paint waste) spends approximately $1060/yr to dispose of its hazardous wastes using Level I technology. The implementation of Level II technology would require that the typical establishment increase its disposal expenses by 73 percent to about $1830/yr. Level III technology is 25 percent higher in estimated cost than Level II, at $2,290/yr.

Total hazardous waste treatment and disposal costs at each level of technology for the special machinery manufacturing industry are presented in Table 32. Current industry costs for Level I technology are approximately $4.8 million per year. If Level III technology were adopted for all the industry's wastes (including heat treating and electroplating wastes), treatment and disposal costs would more than double to $10.5 million per year. Implementation of Level III technology by the special industry machines manufacturing industry will thus result in increased annual expenditures of approximately $5.7 million.

TABLE 32

TOTAL NATIONAL COSTS FOR
HAZARDOUS WASTE DISPOSAL IN 1977 - SIC 355
(thousand dollars/year)

Process Waste	Level I	Level II	Level III
Machine Shop	$4,359	$7,582	$ 9,319
Paint Shop	71	75	238
Heat Treating	378	658	809
Electroplating	25	29	139
Total	$4,833	$8,344	$10,505

Sources: Table 29 and Table 31.

OFFICE, COMPUTING AND ACCOUNTING MACHINES

(a) Typical Manufacturing Establishments

The processes listed in Table 33 must be used in the manufacture of office, computing, and accounting machines. However, all these processes are seldom, if ever, employed at a single plant based on the results of the Assessment Report(35) and the data in Table 33.

The manufacturing processes most often encountered in SIC 357 establishments are machine shops and product assembly operations.(36) A process flow diagram for a typical SIC 357 plant is shown in Figure 3. The typical plant has 15 employees and is located in an urban area, probably in California.

It is expected that roughly half the manufacturing establishments implement only 2-3 manufacturing processes, based on the size of the plants. Figure 4 shows the size distribution of plants in the industry. One-quarter of the plants have less than five employees, and half the plants have less than 20 employees. About nine percent of the plants employ more than 500 people.

For the purposes of this study, only the typical plant processes (machine shop and assembly operation) will be considered in any detail. Other hazardous waste generating processes such as painting; stamping, blanking, and forming; electroplating; and heat treating are normally not found in SIC 357 establishments, and their total waste quantities are small compared to machine shop wastes. Further, it is expected that these other hazardous waste generating processes are primarily found in the larger plants, where the cost impacts of compliance with hazardous waste regulations will be smaller.

TABLE 33

MANUFACTURING PROCESSES IN SIC 357 - 1972

Manufacturing Process	Number of Plants Using Process(1)	Percent of Total Plants in SIC 357 Using Process
Ferrous Foundry	3	<1
Nonferrous Foundry	2	<1
Forging	1	<1
Electroplating and Other Plating	78	7.9
Galvanizing and Other Hot-Dip Coating	1	<1
Heat Treating	45	4.5
Automatic Screw Machine Dept.	42	4.2
Machine Shop	550	55.4
Tool and Die Shop	124	12.5
Plate and Structural Fabrication	36	3.6
Stamping, Blanking, and Forming	133	13.4
Painting, Lacquering, and Enameling	124	12.5
Plastics Molding	34	3.4
Product Assembly	676	68.1

Note: (1) Establishments with less than ten employees were excused from filing special metalworking reports by the Bureau of the Census, which relies on Internal Revenue Service and Social Security Administration records for data on small plants. Based on the plant surveys conducted in the Assessment Report, Kearney estimates that the smaller plants typically consist of a machine shop and assembly operation.

Source: 1972 Census of Manufactures: Industry Statistics.

FIGURE 3

TYPICAL MANUFACTURING
ESTABLISHMENT IN SIC 357

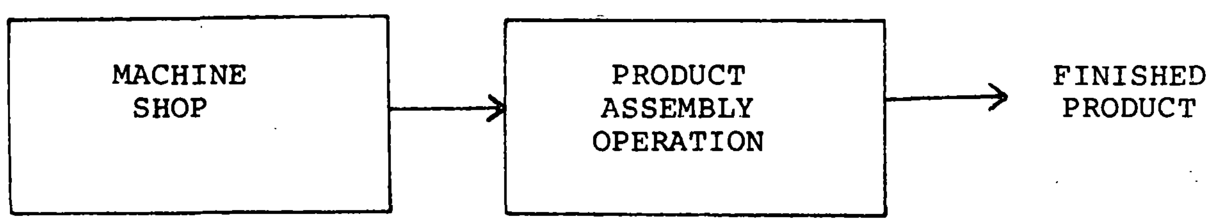
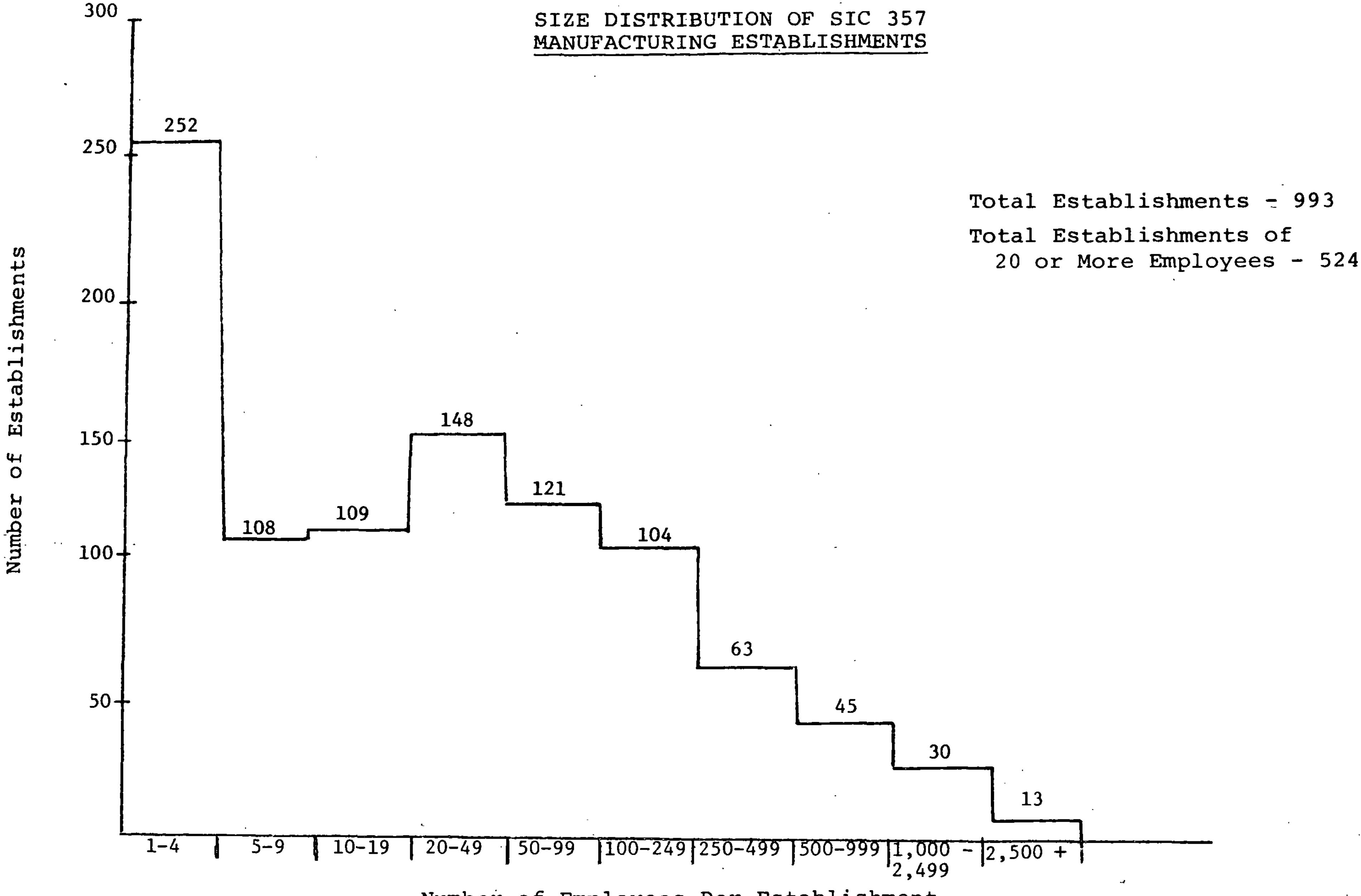


FIGURE 4

SIZE DISTRIBUTION OF SIC 357
MANUFACTURING ESTABLISHMENTS



Source: U.S. Department of Commerce, Bureau of the Census.

(b) Hazardous Waste Characteristics

The process wastes generated by the typical SIC 357 manufacturing operation are considered hazardous, and are generated almost entirely within the machine shop area. These wastes consist of lubricating and grinding oils, cleaning solvents, paint residues, and metal grindings. They are considered hazardous due to the inherent presence of flammable solvents, heavy metals, and oils. It has been determined that these wastes are generated at the rate of 3.35 kkg/yr.-dept. employee.(37)

These wastes are normally collected manually and stored in some type of heavy trash container within the plant.

(c) Hazardous Waste Generation

Hazardous waste generation rates for SIC 357 in 1977 are shown in Table 34. Using the waste generation rate of 3.35 kkg/yr.-dept. employee along with revised estimates of production employees per machine shop from the 1972 Metalworking Directory (38), the total hazardous waste generation rates for SIC 357 machine shops were revised slightly upward to 44,300 kkg/yr. on a wet-weight basis. The typical manufacturing plant in SIC 357 generates about 50 kkg/yr. of hazardous wastes.

TABLE 34

HAZARDOUS WASTE GENERATION IN SIC 357 - 1977

Manufacturing Process(1)	Waste Generation Per Process Employee (kkg/yr-employee)		Employees Per Process	Total Waste Generation (thousand kkg/yr)	
	Dry	Wet		Dry	Wet
Machine Shop	2.14	3.35	13(2)	28.3	44.3
Paint Shop	0.78	1.05	33	8.6	11.1
Heat Treating	0.86	1.99	74	6.1	14.5
Electroplating	1.02	2.52	118	8.6	22.4
Total				51.6	92.3

Notes: (1) Manufacturing processes in SIC 357 generating insignificant quantities of hazardous waste include foundries, forging, die casting, and galvanizing.

(2) Kearney estimates.

Sources: WAPORA, Inc., Assessment of Industrial Hazardous Waste Practice - Special Machinery Manufacturing Industries; and Battelle Columbus Laboratories, Cost of Complying with Hazardous Waste Management Regulations (Draft Report).

(d) Waste Treatment and Disposal Practices

Hazardous waste management practices will be discussed in terms of the three levels of technology which were defined earlier in the presentations of waste treatment and disposal in the batteries and special industry machinery groups.

1. Level I Technology. The most common method for treating and disposing of SIC 357 wastes consists of collection in a trash container with periodic hauling by a private contractor to an off-site sanitary landfill.

According to the Assessment Report, about 90 percent of the SIC 357 hazardous wastes received some form of off-site disposal in 1975.(39)

2. Level II Technology. Based on the findings of the Assessment Report, the best technology currently used which is amenable to more widespread use begins with waste segregation. Oils are recovered at offsite re-refining operations, and solvents are reclaimed at off-site reprocessing facilities. The residues generated in the reclaiming operations are incinerated, with ash disposal in sanitary landfills.

Only about 50 plants in SIC 355 and 357 combined, representing less than one percent of the industry, were expected to be using Level II technology in 1975.(40)

3. Level III Technology. The Battelle Cost Report suggests that the technology for adequate health and environmental protection is as previously shown in Table 30. These practices differed from those in the Assessment Report.

(e) Treatment and Disposal Costs

The total costs for treatment and disposal of the waste found in SIC 357 plants were presented earlier in Table 31. These costs are based on waste treatment and disposal by private contractors. It is estimated that only the largest plants in the industry will elect to treat and/or dispose of any of their wastes on-site. About nine percent of the SIC 357 plants, employing more than 500 people each, would be in a size range that could warrant the consideration of on-site treatment.

The typical SIC 357 plant, which generates 50 kkg/yr of hazardous waste, spends approximately $1300/yr to dispose of its wastes using Level I technology. The implementation of Level II or Level III technology would require that the typical establishment increase its disposal expenses by $2,300/yr or $2,800/yr, respectively.

Estimated total hazardous waste treatment and disposal costs are shown in Table 35 for each level of technology. Current industry costs for Level I technology are approximately $1,860,000/yr. If Level III technology were implemented for all the industry's wastes (including heat treating, electroplating, and painting), treatment and disposal costs would more than double to $4.67 million/yr.

TABLE 35

TOTAL NATIONAL COSTS FOR
HAZARDOUS WASTE DISPOSAL - SIC 357
(thousand dollars/year)

Process Waste	Level I	Level II	Level III
Machine Shop	$1,156	$2,011	$2,472
Paint Shop	192	203	645
Heat Treating	378	658	809
Electroplating	134	152	741
Total	$1,860	$3,024	$4,667

Sources: Table 31 and Table 34.

ELECTRONIC COMPONENTS

(a) Hazardous Waste Characteristics

Manufacturing establishments within the electronic components industry are highly diverse. They produce a variety of products and components, using varying combinations of manufacturing processes, and a broad range of raw materials. The Assessment Report(41) did not attempt to define a typical plant in the industry, except in terms of the quantities of wastes generated.

The hazardous wastes generated in SIC 367 plants may be categorized as follows:

- o Halogenated solvents (i.e., trichloroethylene, carbon tetrachloride, Freon, methylene chloride, etc.)
- o Nonhalogenated solvents (i.e., methyl ethyl ketone, methanol, acetone, xylene, etc.)
- o Wastewater treatment sludges
- o Lubricating and hydraulic oils
- o Paint wastes

These wastes were judged by the assessment contractor to be potentially hazardous based in general on the flammability, corrosivity, toxicity, or bioconcentration characteristics of the waste constituents.(42)

(b) Hazardous Waste Generation

Using the waste generation factors from the Assessment Report(43) and the Cost Report(44), hazardous waste generation rates for SIC 367 plants in 1977 have been estimated in Table 36. Approximately 73,700 kkg/yr and 40,500 kkg/yr of hazardous wastes are generated on a wet-weight basis and dry-weight basis, respectively. About half the wet-weight total is comprised of wastewater treatment sludge, with most of the remainder halogenated and nonhalogenated solvents. Paint wastes and oils account for only about three percent of the total industry hazardous waste stream on a wet-weight basis.

TABLE 36

HAZARDOUS WASTE GENERATION IN SIC 367 -- 1977

	Waste Generation per Output Unit (kkg/million $ shipments)		Total Waste Generation (thousand kkg/yr)	
Waste Stream	Dry	Wet	Dry	Wet
Halogenated Solvents	1.02	1.02	13.9	13.9
Nonhalogenated Solvents	1.47	1.47	18.5	18.5
Wastewater Treatment Sludges	0.52	2.64	7.7	38.8
Lubricating and Hydraulic Oils	0.013	0.15	0.2	2.3
Paint Wastes	0.019	0.019	0.2	0.2
Total			40.5	73.7

Source: Battelle Columbus Laboratories, Cost of Complying with Hazardous Waste Management Regulations (Draft Report).

(c) Treatment and Disposal Practices

The industry practices for the treatment and disposal of electronic component industry manufacturing wastes are shown in Table 37. In general, Level I technology entails oil and solvent wastes reclamation with residues from the reclaiming operation going to an unspecified type of landfill operation (probably either a sanitary landfill or an open dump). Wastewater treatment sludges and paint wastes receive some form of land disposal.

Level II technology for oils and solvents involves reclamation with residue disposal in secured landfills. Wastewater treatment sludges are dewatered and placed in secured landfills while paint wastes are incinerated, with ash going to off-site landfills. Level I and Level II technology were originally specified in the Assessment Report.

Level III technology is taken from the Cost Report.(45) Thus, the cost data used in the next sub-section are consistent with the technologies involved. Oils, solvents, and paint wastes are incinerated (it is assumed that residual ash is deposited in secured landfills), while wastewater treatment sludges are sent directly to secured landfills.

Although both the Assessment Report and the Cost Report recognize that waste reclamation and reuse are viable, cost-effective measures for many types of oils and solvents, and that such measures will be practiced by the industry to some extent, this study has assumed that all hazardous wastes will be disposed of rather than reclaimed. This is to allow the evaluation of economic impacts on a "worst-case" basis.

(d) Treatment and Disposal Costs

The costs per metric ton (kkg) to treat and dispose of hazardous wastes in the electronic components industry are shown in Table 38. These costs do not account for any waste reclamation by the industry (which could normally be done at lower costs), in order to evaluate economic impacts on a "worst case" basis. In addition, the cost data generally do not reflect capital costs, since most of the waste treatment and disposal is conducted off-site by private contractors.

TABLE 37

TREATMENT AND DISPOSAL OF HAZARDOUS WASTES IN THE ELECTRONIC COMPONENTS INDUSTRY

Waste Stream	Level I(1)	Level II(2)	Level III(3)
Halogenated Solvents	On and off-site reclamation; drummed unreclaimable residue disposal in landfill.	Same as Level I with disposal in secured landfill.	Incineration.
Nonhalogenated Solvents	Off-site reclamation by distillation with still bottoms to landfill; drummed unreclaimable residue disposal in landfill.	Same as Level I with disposal in secured landfill.	Incineration.
Wastewater Treatment Sludges	Off-site landfill.	On-site sludge dewatering with secured landfill disposal.	Secured landfill.
Lubricating and Hydraulic Oils	Off-site landfill.	On- and off-site reclamation with landfill disposal of sludge.	Incineration.
Paint Waste	Mixed with plant trash. Off-site disposal.	Segregation from plant trash. Incineration with ash to off-site landfill.	Incineration.

Sources: (1) WAPORA, Inc., Assessment of Industrial Hazardous Waste Practices - Electronic Components Manufacturing Industry.

(2) ibid.

(3) Battelle Columbus Laboratories, Cost of Complying with Hazardous Waste Management Regulations (Draft Report)

TABLE 38

HAZARDOUS WASTE TREATMENT AND DISPOSAL COSTS IN THE ELECTRONIC COMPONENTS INDUSTRY -- 1977

Waste Stream	Cost ($/kkg) Level I	Level II	Level III(1)
Halogenated Solvents	68.2	69.2	107
Nonhalogenated Solvents	68.2	69.2	107
Wastewater Treatment Sludges	5.99	6.77	33.1
Lubricating and Hydraulic Oils	68.2	69.2	107
Paint Wastes	17.3	18.3	58.1

Note: (1) Refers to Pathways Level III Technology.

Source: Battelle Columbus Laboratories, Cost of Complying with Hazardous Waste Management Regulations (Draft Report).

Total SIC 367 hazardous waste treatment and disposal costs for 1977 are shown in Table 39. These costs were calculated from the data in Tables 36 and 38. It was assumed that all wastes would be treated and disposed of using the prescribed technologies at the unit costs shown in Table 38.

Level I disposal technology currently costs the industry approximately $2.6 million/year. These costs would roughly double to $5.0 million/year if Level III technology (compliance with the proposed hazardous waste regulations) were implemented. These costs could be expected to decline as waste reclamation practices are adopted by the industry. The major cost factor is expected to be incurred in treating and disposing of solvent wastes.

The Assessment Report(46) estimates that an average plant in the industry generates 22.2 kkg/yr of hazardous wastes. Using the cost data from Table 38, the costs for Levels I, II, and III treatment and disposal technology are $824; $845; and $1,559 per year, respectively. These costs are developed in Table 40. Although the Assessment Report does not describe the characteristics of an average plant, it is estimated that such a plant would employ less than 50 people and have a value of shipments less than $1.3 million per year.

TABLE 39

TOTAL NATIONAL COSTS FOR HAZARDOUS WASTE DISPOSAL IN THE ELECTRONIC COMPONENTS INDUSTRY
(thousand dollars/year)

Waste Stream	Level I	Level II	Level III
Halogenated Solvents	$ 948	$ 962	$1,487
Nonhalogenated Solvents	1,262	1,280	1,980
Wastewater Treatment Sludges	232	263	1,284
Lubricating and Hydraulic Oils	157	159	246
Paint Wastes	3	4	12
Total	$2,602	$2,668	$5,009

Source: Table 36 and Table 38.

TABLE 40

HAZARDOUS WASTE TREATMENT AND DISPOSAL COSTS FOR AN AVERAGE ELECTRONIC COMPONENTS MANUFACTURING PLANT

Waste Stream	Waste Generation Rate (kkg/yr)	Plant Cost ($/yr) Per Level		
		I	II	III
Halogenated Solvents	4.3	293	298	460
Nonhaolgenated Solvents	6.2	423	429	663
Wastewater Treatment Sludges	11.1	66	75	367
Lubricating and Hydraulic Oils	0.6	41	42	64
Paint Wastes	0.08	1	1	5
Total	22.3	$824	$845	$1,559

V - ASSESSMENT OF ECONOMIC IMPACTS

METHODOLOGY

Economic impacts were assessed first by screening aggregate costs for each industry, followed by a closer examination of possible differential costs within each industry. Consistent with accompanying economic impact assessments for other industry groups, a threshold of 0.5 percent of shipment values was utilized to distinguish between negligible and non-negligible aggregate incremental hazardous waste costs. Aggregate costs were found to be negligible for each industry here reviewed.

Each industry was analyzed for possible differential cost impacts by segment, production scale, or geographic location. For industry segments, production levels, or regional concentrations, costs in the range of 0 to 2 percent were considered insignificant in the absence of strong competitive pressures or demonstrated impact sensitivity (elasticity). Additional impact considerations included financing (access to capital), price effects and cost incidence, employment effects, the likelihood of induced plant closures, and balance of trade effects.

AGGREGATE IMPACTS

Aggregate economic impacts associated with a shift from Level I to Level III hazardous waste management technology will be negligible for the following industries: storage and primary batteries; electronic components; special industry machinery; and office, computing, and accounting machines. Aggregate industry costs as a percent of industry shipment values range from 0.02 to 0.06 percent (see Table 41). These costs would constitute less than one percent of industry profits. Costs of this magnitude would be indistinguishable from impacts generated by random fluctuations in other conditions affecting the industry.

TABLE 41

AGGREGATE HAZARDOUS WASTE TREATMENT AND DISPOSAL COSTS ASSOCIATED WITH A SHIFT FROM LEVEL I TO LEVEL III TECHNOLOGY

Industry	Estimated 1975 Value of Shipments (million dollars)	Incremental Hazardous Waste Management Costs (million dollars)	Cost as a Percent of Shipment Values
Storage and Primary Batteries	$ 1,764.5	$0.3	0.02
Special Industry Machinery	8,932.4	5.7	0.06
Office, Computing, and Accounting Machines	11,568.4	3.8	0.03
Electronic Components	10,024.4	2.4	0.02

Sources: Annual Survey of Manufactures; and Battelle Columbus Laboratories, Cost of Complying with Hazardous Waste Management Regulations (Draft Report).

DIFFERENTIAL IMPACTS WITHIN THE INDUSTRIES

(a) Size

Hazardous waste management costs for application of Level III technology will vary directly with output. The usual economies of large-scale treatment typical of wastewater treatment facilities will not be a factor for this technology. Costs are largely restricted to contractor hauling for off-site disposal, and accompanying capital costs are minimal. Since operating costs tend to vary directly with output, smaller establishments will not be confronted with unit treatment costs significantly above those experienced by larger manufacturers.

(b) Segment

Hazardous waste-generating production processes are not distributed such that particular industry segments absorb a disproportionate share of aggregate industry costs. Furthermore, given the magnitude of aggregate industry costs, individual segment costs would have to be as much as 50 to 100 times higher than those affecting the entire industry in order to warrant special concern.

Although no major industry segments will experience disproportionately high hazardous waste management costs, differentially high costs may be a problem for those lead-acid storage battery plants with wastewater treatment facilities dependent upon lime for acid neutralization and solids precipitation. Among 150 lead-acid battery plants neutralizing their wastewater effluents in 1972 (another 50 plants were not treating their wastewater), an estimated 14 were neutralizing and precipitating with lime.(47) An estimated 46 plants were neutralizing and precipitating with caustic soda. The remaining 90 plants were using ammonia or caustic soda for simple neutralization and discharging their effluent (without sludge sedimentation) into municipal wastewater treatment facilities.

Neutralization and precipitation systems used in wastewater treatment which utilize lime will generate substantially larger quantities of sludge than systems which use caustic soda or ammonia. The lime sludge is a hazardous waste and thus is covered by the proposed hazardous waste management regulations. Lead-acid battery plants using lime in their wastewater treatment facilities will incur higher treatment and disposal costs for the resultant lime sludge than plants with wastewater treatment systems built to use caustic soda or ammonia.

Versar's assessment of hazardous waste practices in the storage and primary battery industries compared hazardous waste management costs for a "typical" lead-acid battery plant (producing 1,800 batteries per day) using lime vs. caustic soda in wastewater treatment. According to these estimates, lime-dependent plants were already incurring hazardous waste disposal costs of $27,000 per year.(48) These plants would be faced with incremental costs of either $10,000 or $65,000 per year in shifting from Level I to Level III technology, depending upon whether approved landfilling of sludge is acceptable or a requirement for chemical fixation is imposed. Plants using caustic soda in their wastewater treatment system were incurring annual hazardous waste management costs of $1,400 for on-site disposal and less than $500 for off-site, contractor disposal. Annual costs in application of Level III technology were $1,000, based on outside contractor costs, and net zero, if lead were reclaimed.(49) Neutralization and precipitation using caustic soda generates a wastewater treatment sludge with a much more highly concentrated lead content, enhancing the feasibility of lead reclamation.

As previously noted, 14 lead-acid battery plants were estimated to be using lime for acid neutralization and precipitation in their wastewater treatment systems. According to the original technical contractor for this study, several plants are known to have since converted their facilities from dependence upon lime to caustic soda.(50) Therefore, there are probably no more than 10 lead-acid battery plants remaining with lime-dependent wastewater treatment facilities. Working in conjunction with EPA, Kearney has identified five of these plants.

Lime-dependent wastewater treatment systems are believed to be restricted to the larger manufacturing plants.(51) Among the five known plants in this lead-acid battery category, one produces approximately 1,500 batteries per day, while the other four produce in the range of 5,000 - 10,000 batteries per day.(52) One of the five plants does not segregate its lead-acid battery waste stream from the waste streams originating from its battery cracking and lead smelting operations. This plant is a direct discharger, and is required under the terms of its discharge permit to utilize a lime-dependent wastewater treatment system. Two of the remaining plants recycle all process water and achieve full lead recovery. These plants therefore incur no hazardous waste management costs, and would be unaffected by more stringent hazardous waste management requirements.

The remaining two plants are absorbing the costs of landfilling their lime wastewater treatment sludges. These plants may consider conversion to a caustic soda process if more stringent hazardous waste management practices are required. The capital costs associated with such a process conversion of this nature are estimated to be no more than $30,000 for an establishment in this production range. By comparison, incremental costs associated with a shift from Level I to Level III hazardous waste management technology for plants using lime might range from $30,000 to $60,000 per year in this output range. Incremental costs would run considerably higher if chemical fixation of the lime sludge is required. However, these differential hazardous waste management costs imposed upon lime-dependent lead-acid battery plants with output capacities in the 5,000-10,000 battery per day range are unlikely to amount to a competitive disadvantage of more than 0.1 percent of gross revenues (less than one percent of corresponding profit margins).

Based on the preceding assessment, differential hazardous waste management costs imposed upon a small number of the largest lead-acid storage battery plants (those with lime-dependent wastewater treatment facilities now in place) do not appear to warrant further concern. Consideration of hazardous waste management requirements should preclude future investments in wastewater treatment facilities incorporating a lime neutralization/precipitation process in all but a few special cases.

(c) Region or Locality

Hazardous waste management costs are considered negligible regardless of output range or segment characteristics. Differentially high cost requirements are therefore extremely unlikely to be experienced by any particular region or locality, including any which may exhibit unusual concentrations of industry activity or plant characteristics.

SPECIAL IMPACT CONSIDERATIONS

(a) Availability of Facilities

Current technology cost calculations have been predicated upon the availability of hazardous waste incinerators and secured landfills meeting the requirements of Pathways Level III Technology (see preceding section). Lack of access to facilities or inadequate treatment capacity at available facilities could pose potentially serious compliance problems for manufacturers legally required to achieve prospective hazardous waste management regulations. These concerns are beyond the scope of this study, however, and have been addressed independently by EPA.

(b) Financing

As previously discussed, capital costs associated with Level III hazardous waste management technology are minimal. No financing difficulties are foreseen for industry participants.

(c) Prices

Associated hazardous waste management costs are considered negligible both in aggregate and by individual plant, segment, or geographic location within the industry. Price effects will therefore be negligible.

(d) Employment

There should be no change in industry employment directly or indirectly attributable to the imposition of more stringent hazardous waste management regulations. Consistent with the preceding analysis, no special employment difficulties affecting particular establishments, segments, or geographic locations are anticipated.

(e) Plant Closures

The magnitude of costs enumerated above does not warrant concern about possible inducement of plant closures. Costs are sufficiently small that it would be unreasonable to attribute them with any potential for adverse cumulative impacts on the industry, even in conjunction with other environmental or related regulatory requirements.

(f) Balance of Trade

The proposed hazardous waste management regulations are expected to result in negligible product price effects for the industries considered in this study. Thus, the effects of the proposed regulations on imports and exports will be insignificant.

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