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Solid Waste

EPA

Draft Economic Impact Analysis Subtitle C, Resource Conservation and Recovery Act of 1976

Regulatory Analysis Supplement

DRAFT

ECONOMIC IMPACT ANALYSIS

(REGULATORY ANALYSIS SUPPLEMENT)

FOR

SUBTITLE C, RESOURCE CONSERVATION
AND RECOVERY ACT OF 1976 (RCRA)

PREPARED BY
OFFICE OF SOLID WASTE
U.S. ENVIRONMENTAL PROTECTION AGENCY

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JANUARY 1979

DRAFT ECONOMIC IMPACT ANALYSIS

OF SUBTITLE C

RESOURCE CONSERVATION AND RECOVERY ACT OF 1976

(Regulatory Analysis Supplement)

Prepared By

Arthur D. Little, Inc.

for

Office of Solid Waste
U.S. Environmental Protection Agency

January 1979

SUMMARY SHEET

DRAFT ECONOMIC IMPACT ANALYSIS
OF SUBTITLE C

RESOURCE CONSERVATION AND RECOVERY ACT
OF 1976 (RCRA)

(REGULATORY ANALYSIS SUPPLEMENT)

1. Type of Action

Administrative Action (Regulatory)

2. Brief Description of Action

The Resource Conservation and Recovery Act of 1976 (RCRA) Subtitle C provides EPA with the authority to regulate the generation, transportation, treatment, storage and disposal of hazardous waste in a manner that protects human health and the environment. RCRA also authorizes states to implement their own program for the management of hazardous waste if it is, at a minimum, equivalent to the Federal regulations. Compliance with the proposed regulations is mandatory; non-compliance is subject to penalty of law.

3. Summary of the Economic Impacts

The total incremental cost of compliance for selected hazardous waste streams of 17 generator industries is estimated to be $630 million annually. Of this amount, $120 million is for compliance with financial requirements, and $260 million is for the technical cost of building and operation of waste management facilities. The capital cost of initially coming into compliance with the regulations is $550 million.

Nine of the 69 industry segments in the 17 industries studied are projected to experience a high economic impact as a result of compliance with the regulations. These nine segments had estimated sales of $2.7 billion in 1977 and are expected to have compliance costs of more than 2% of annual sales. Twenty industry segments with total sales of $12 billion are projected to face compliance costs of 0.5% to 2.0% of annual sales.

4. Alternatives Considered

a. Proposed Action

b. Lesser Degree of Public Health and Environmental Protection

c. Enhanced Public Health and Environmental Protection.

5. Date Available to the Public

The Draft Economic Impact Analysis has been provided to the Office of Federal Activities, EPA, for the purpose of publishing an official public notice of availability in the *Federal Register.* This notice is anticipated by January 22, 1979. The 90-day public comment period for the Draft Economic Impact Analysis ends March 16, 1979. Copies of the Draft Economic Impact Analysis may be obtained by writing: Draft Economic Impact Analysis, Edward Cox, Solid Waste Information Office, USEPA, 26 W. St. Claire, Cincinnati, Ohio 45268. Comments may be submitted to: Michael Shannon, Office of Solid Waste, (WW-565) USEPA, 401 M Street, S.W., Washington, D.C. 20460.

6. Federal, State, and Local Agencies from which Written Comments have been Requested

The proposed Subtitle C regulations have been distributed to hundreds of individuals and organizations representing all sectors of our society. The Draft Economic Impact Analysis is also being distributed to a diverse group of individuals and organizations, including, but not limited to, the following:

Other Federal Agencies

Department of Interior

Department of Health, Education, and Welfare

Department of Agriculture

Department of Commerce

Department of Energy

Department of Defense

U.S. General Accounting Office

Department of Housing and Urban Development

State Government

All 50 State Solid Waste Management Offices

National Governors' Association

National Conference of State Legislators

National Association of State Attorneys General

Local Government

National Association of Regional Councils

National Association of Counties

National League of Cities/U.S. Conference of Mayors

International City Management Association

Council of State Governments

Solid Waste Management Professional Groups

National Solid Waste Management Association

American Public Works Association

Professional Associations

American Society of Civil Engineers

American Consulting Engineers Council

Water Pollution Control Federation
American Institute of Chemical Engineers
Mining and Reclamation Council of America

Environmental, Health and Citizens Groups

Sierra Club
Environmental Action, Inc.
Environmental Action Foundation
Environmental Defense Fund
Natural Resources Defense Council
National Wildlife Federation
National Environmental Health Association
Izaak Walton League
League of Women Voters
Citizens for a Better Environment
Central and Southwest Corporation, et al.

Trade Associations

American Mining Congress
American Petroleum Institute
Manufacturing Chemists Association
American Water Works Association
National Water Well Association
American Textile Manufacturers Institute
American Iron and Steel Institute
National Forest Products Association

PREFACE

The Draft Economic Impact Analysis (Regulatory Analysis Supplement) for Subtitle C of RCRA presents an analysis of the proposed Subtitle C regulations as drafted in September 1978, as well as an analysis of alternatives to the proposed regulations which were considered. It was necessary to analyze the September 1978 version of the regulations because of time constraints involved in preparing the proposed regulations and conducting an economic impact analysis of them. As one would expect, the regulations as analyzed in this document and the regulations as proposed differ slightly. However, these differences do not significantly change the impacts as identified in this report. The differences between the September 1978 regulations and the proposed regulations are highlighted here to assist the reader. Although an attempt was made to identify all the differences, it is possible that some differences may not be noted.

Section 3002 Differences:

- Generators who ship hazardous waste to a foreign country are required to inform the foreign government within one week of the shipment by sending a copy of the manifest to the appropriate regulatory agency of the foreign country having jurisdiction over the designated facility.

- Clarification of the Waste Oil Assumption of Duties Contract, and expansion to include all waste mineral oil, not just automotive oil.

Section 3004 Differences:

- *Interim Status:* Section 250.40(c)(2) has been included in the proposed regulations. This section lists the applicable standards for treatment, storage, and disposal facilities that have been granted interim status.

- *General Site Selection:* No longer prohibits location of facilities in permafrost areas. Replaces regulations regarding location of facilities in 100-year floodplains with two regulations: (1) prohibition on facilities locating in a "regulatory floodway," and (2) restriction on facilities locating in a "coastal high-hazard area."

- *Air:* Air human health and environmental standard specifies compliance with Clean Air Act. Places non-point source air contaminant limits in "Treatment/Disposal Standards" (Section 250.45) as a "Note." Replaces ACGIH limits by OSHA permissible airborne contaminant exposure levels.

- *Groundwater and Leachate Monitoring:* Adds basis for deviation to the regulation, i.e., requires a minimum of four groundwater monitoring wells.

- *Storage:* Requires that storage tanks and containers now also comply with OSHA's standards for storage of flammable and combustible liquids.

- *Landfills:* No longer requires that landfilled wastes have a percent solids content equal to or greater than 20%. Instead, requires bulk liquids to be treated to make waste of a non-flowing consistency.

- *Landfarms:* Deletes regulation prohibiting landfarming of wastes containing arsenic, boron, molybdenum and/or selenium. Addition of regulation which requires stoppage of landfarming operations after wastes have migrated three times the depth of the zone of incorporation. Prohibits growth of food chain crops in landfarms.

- *Incineration:* Specifies control technology standards (1200°C, 3 seconds, 2% O_2) for halogenated aromatic hydrocarbon wastes (PCBs, PBBs, etc.). Specifies fuel and waste flow rate monitoring.

- *Human Health and Environmental Standards:* Deletes these from all "Notes" as being a basis for deviation; will use them only to impose more stringent requirements, as necessary, when design and operating standards do not adequately protect human health and the environment.

- *Ignitable/Volatile/Reactive/Incompatible Wastes:* Prohibits disposal of these wastes in landfills, landfarms, and surface impoundments. However, "Note" allows deviations if facility owner/operator demonstrates it can be done safely.

- *Residential and Agricultural Use Restrictions:* Changes the restrictions on using land for residential and agricultural purposes on which hazardous waste has been disposed. New standard allows any use which does not damage the structural integrity of the site.

The reader may also note some differences between the industry segments (and wastes from them) analyzed in this report and the wastes listed in Subpart A of the regulations (40 CFR 250) proposed in the *Federal Register* on December 18, 1978. Work on this report commenced long before generation of the lists of wastes to be regulated. Also, the compliance cost information used in this report necessarily was based on data generated in previous studies. Thus, the industry segments and waste streams included in this study are generally those identified as "potentially hazardous" in previous studies.

The Draft Economic Impact Analysis is only one of a number of draft documents issued in support of the proposed regulations. To adequately evaluate the advantages and disadvantages of the proposed regulations, one must also review the Draft Environmental Impact Study issued as a corollary to this document. Also available at EPA offices is a Draft Regulatory Analysis and a series of Draft Background Documents which explain how various regulations were developed, why they took the form proposed, and the nature of the various issues which were identified during the development of the regulations.

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I. INTRODUCTION

In response to Subtitle C of the Resource Conservation and Recovery Act of 1976 (RCRA), the Environmental Protection Agency on December 18, 1978 proposed regulations applicable to generators and transporters of hazardous wastes, and to owners and operators of hazardous waste treatment, storage, and disposal facilities. The Agency has undertaken the following studies related to the mechanisms and economic consequences of implementing the Subtitle:

- assessments of hazardous waste management practices by selected industries;
- an update and synthesis of compliance cost estimates for these industries;
- economic impact analyses for selected industries;
- environmental impact assessment of the Subtitle;
- analysis of economic impacts on the hazardous waste management industry;
- analysis of economic impacts on those who transport hazardous waste.

The purpose of this report is to provide a broad assessment of the economic implications of implementing the proposed regulations. This Economic Impact Assessment (EIA) Report summarizes the results of the earlier studies and presents the results of additional integration and analysis in so far as data available at this time permits.

The economic implications of three regulatory alternatives have been evaluated. They are described by EPA as the enhanced public health and environmental protection alternative, the proposed action alternative, and the lesser degree of public health and environmental protection alternative. The alternatives are called Options A, B, and C respectively in the report.

The cost of compliance estimates and the resulting economic impacts flow in part from the requirements that operators of hazardous waste treatment, storage, and disposal facilities (TSDF's) treat, store, or dispose of hazardous waste in an environmentally adequate manner. Current environmentally inadequate practices are called Level I, and environmentally adequate practices are called Pathways Level III. The compliance costs are the incremental costs to generators of changing from Level I to Pathways Level III practices.

Hazardous waste generators, transporters, and off-site TSDF's make up a network of related activities which will be affected individually and as a whole by the hazardous waste management regulations. In this report this network has been called the Hazardous Waste Management Network (HWMN).

Seventeen industries generating significant volumes of hazardous waste are covered. The industries are subdivided into 69 industry segments representing major products or product groups. Not all of the hazardous waste streams from the 17 industries are included, but EPA believes that the majority of significant streams have been covered for most of the 17 industries. Preliminary estimates of impacts on seven other industries determined in a separate study, are discussed in Appendix B. Hazardous wastes generated by industries other than these 24 have not been considered.

In addition to the waste generating industries, the transportation and off-site TSDF activities have been evaluated. The unit cost of compliance for these activities has been estimated. Since the generators buy transportation and off-site TSDF services the costs associated with these activities are included in the costs of compliance to generators.

The costs of compliance with RCRA Subtitle C have been estimated quantitatively for the identified waste streams for each of the 69 generator industry segments. The economic impact implications of the compliance costs in terms of the potentials for plant closures, job losses, production cutbacks, price increases, and balance-of-payment changes have been evaluated judgmentally for each of the 69 generator industry segments.

The flow of hazardous waste in the Hazardous Waste Management Network is likely to change as a result of the regulations. The price of environmentally acceptable off-site waste management capacity is likely to increase, at least in the short run, more than in proportion to the increased cost of operating the off-site facilities. However, this report assumes no change in the current proportion of on-site versus off-site waste management and the price of off-site capacity is assumed to increase in proportion to the cost. In the longer term the cost of compliance with the regulations will more closely reflect the costs of on-site and off-site waste management and the shift of many generators to less expensive (large scale) off-site facilities. As part of the sensitivity analysis, the cost implications of a major shift of waste off-site have been estimated.

II. EXECUTIVE SUMMARY

A. MAJOR FINDINGS

This report assesses two principal categories of impacts resulting from the implementation of RCRA Subtitle C. They are:

- costs of compliance
- economic impacts resulting from the compliance costs

The costs of compliance are estimated as a range from high to low reflecting the ranges in the unit cost estimates, numbers of generators, volumes of waste and other key variables. A most likely estimate is identified within the ranges. The most likely values are discussed in the following text.

The major findings of the impact analysis based on the currently available data are the following:

The total, annual, incremental cost of compliance for selected hazardous waste streams of 17 generator industries under the proposed regulation (Option B) is estimated to be $630 million above current expenditures for hazardous waste management. Of this amount, $120 million is for compliance with financial requirements,[a] and $260 million is for the technical cost of building and operating waste management facilities.

The enhanced public health and environmental protection regulatory alternative (Option A) is estimated to have a total, annual, incremental compliance cost of $1.8 billion. Under this option, the financial responsibility costs increase to $1.1 billion whereas the technical costs are approximately the same as for Option B. The annual cost of monitoring and testing is approximately two and one half times as large under Option A as under Option B.

The total, annual, incremental cost of hazardous waste management under Option C, a lesser degree of public health and environmental protection, is estimated to be $500 million. The technical costs are equivalent to those under Option B, whereas the financial requirement costs are reduced by about 50%.

The capital cost of initially coming into compliance with the regulations is approximately $560 million each for Options A and B and $480 million for Option C. The startup costs are dominated by the cost of providing technically adequate waste management capacity. The total volume of waste managed is identical for Options A and B and slightly less for Option C.

A major portion of the compliance cost falls upon two industries. The incremental, annual, compliance costs for the metals smelting and refining industry are estimated to be $280 million under Option A, $130 million under Option B, and $120 million under Option C. The compliance costs for the textile industry are estimated to be $170 million for Option A, $64 million for Option B, and $46 million for Option C.

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a. Financial Requirements include provision for liability for claims arising from environmental damage (financial responsibility), a fund for site closure, a fund for post closure monitoring and maintenance, and under Option A a post closure financial responsibility.

The 17 industries studied are estimated to have generated twenty three million metric tons of hazardous waste (wet basis) in 1977 from the selected waste streams identified in the EPA assessment reports. The total hazardous waste generated by these industries is believed to be somewhat higher. Thirteen of the 23 million tons are produced by the metals smelting and refining industry. About 80% of the waste is believed to be currently managed (treated, stored, or disposed, TDS) at the site of its generation.

As part of the sensitivity analysis the compliance costs have been estimated assuming that almost all industry segments disposing of waste on-site which have potentially lower off-site disposal costs will shift their waste disposal off-site. The total incremental compliance costs are reduced by 44%, 33%, and 34%, under Options A, B, and C respectively, under this assumption. Large-scale off-site capacity is assumed to be available though this is not likely to be the case in the short run.

Of the 69 industry segments studied in the 17 generator industries, nine are projected to experience a high economic impact as a result of Option B. These segments represent $2.7 billion in 1977 production value and are expected to experience compliance costs higher than 2% of annual production value. Under Option A, 24 segments with $10.4 billion in production value would experience a high economic impact. Eight segments with $2.7 billion in 1977 production value would experience a high economic impact as a result of Option C.

Twenty segments, with a total of $12 billion in production value, are projected to experience a moderate economic impact under Option B as a consequence of compliance costs ranging from 0.5% to 2% of annual production value. Under Option A, 26 industry segments with $83 billion in production value would experience a moderate impact. Implementing Option C would moderately impact 19 industry segments with $8.8 billion in 1977 production value.

Thirty-four segments, with a total of $151 billion in production value, are projected to experience a low economic impact as a result of compliance costs ranging from 0.01% to 0.5% of production value under Option B. Implementing Options A and C would result in 14 and 33 segments respectively experiencing a low impact. The segments' 1977 total production values were $164 and $138 billion, respectively.

The impact of the regulations on hazardous waste transportation activities is projected to be relatively insignificant because they generally conform to current Department of Transportation requirements.

The cost of off-site hazardous waste incineration will increase from 10% to 60% under Option A and 10% to 50% under Options B and C depending on the type of material incinerated and the method of incineration. The cost of off-site hazardous waste landfill will increase by 260% under Option A, 160% under Options B and C. In the short run, there is likely to be a serious shortfall of acceptable hazardous waste management capacity. The magnitude of this shortfall has not been estimated.

An analysis of the economic impacts on electric utilities, pulp and paper manufacturers, gasoline service station and automotive repair shops, drum reconditioners, chemical warehouses, and agricultural services was performed in a separate EPA study. The results have not been included in the summaries of compliance costs for the 17 generator industries. According to that separate analysis, the additional compliance cost for the seven industries of Option B will be $230 million. Under Option A, the cost would be $1.1 billion, of which 90% is attributed to the electric utility and pulp and paper industries. (See Appendix B.)

B. COMPLIANCE COSTS

Hazardous waste generation estimates are not available for most federal facilities. NASA, the Air Force and the Navy estimate that their facilities annually produce 6,000, 50,000 and 97,000 metric tons of waste. Because of the lack of waste generation inventories, estimates cannot be made of the total cost of compliance with RCRA Subtitle C for all federal facilities. Generally, the unit costs of compliance will be the same as those for similar wastes from private generators.

The incremental cost of compliance with the proposed regulations for implementing RCRA Subtitle C (Option B) is estimated to be $630 million annually for 17 private industries generating hazardous waste. (See Table II-1.) The technical cost of building and operating the waste management facilities, $260 million, is the largest single component of the annual cost. In addition, the financial requirements and monitoring and testing add $120 and $100 million, respectively. The uncertainty in the unit costs of compliance is reflected in an error range of -32% to +94% in the total cost estimate.

TABLE II-1

TOTAL ANNUAL INCREMENTAL COST OF HAZARDOUS WASTE MANAGEMENT, OPTION B[a] ($MM)

Activity	Annual Cost[b]	Low	High
Technical Requirements	258	145	581
Financial Requirements	121	92	153
Recordkeeping/Reporting	14	13	26
Monitoring/Testing	104	68	206
Administration	70	69	135
Training	32	22	55
Contingency Planning	31	18	50
Total	630	427	1,206
		−32%	91%

a. Costs for selected waste streams of 17 industries generating hazardous waste.
b. Most likely estimate

Source: Arthur D. Little, Inc., estimates.

The compliance cost estimates for the regulatory alternatives, Options A and C, are shown on Tables II-2 and II-3. The annual costs of these options to hazardous waste generators is $1.8 billion and $500 million, respectively. The largest single change in the costs is in the financial requirements which are $1.1 billion for Option A and $65 million for Option C.

Table II-4 lists the 17 industries and their respective segments. The SIC codes of the segments and their estimated 1977 production values are listed. The incremental annual compliance cost and the cost as a percentage of production value is shown for each segment for each option.

TABLE II-2

TOTAL ANNUAL INCREMENTAL COST OF
HAZARDOUS WASTE MANAGEMENT, OPTION A[a]
($MM)

Activity	Annual Cost[b]	Low	High
Technical Requirements	264	149	597
Financial Requirements	1,060	511	1,576
Recordkeeping/Reporting	41	39	77
Monitoring/Testing	261	170	516
Administration	97	96	187
Training	32	22	55
Contingency Planning	31	18	50
Total	1,786	1,005	3,058
		-44%	+71%

a. Costs for selected waste streams of 17 industries generating hazardous waste.
b. Most likely estimate.

Source: Arthur D. Little, Inc., estimates.

TABLE II-3

TOTAL ANNUAL INCREMENTAL COST OF
HAZARDOUS WASTE MANAGEMENT, OPTION C[a]
($MM)

Activity	Annual Cost	Low	High
Technical Requirements	249	139	562
Financial Requirements	65	56	76
Recordkeeping/Reporting	8	7	13
Monitoring/Testing	75	49	149
Administration	53	52	102
Training	26	18	45
Contingency Planning	24	15	40
Total	501	336	987
		- 32%	100%

a. Costs for selected waste streams of 17 industries generating hazardous waste.
b. Most likely estimate.

Source: Arthur D. Little, Inc., estimates.

TABLE II-4

INDUSTRY INCREMENTAL HAZARDOUS WASTE MANAGEMENT COSTS

Industry and Segments	SIC Code	Estimated 1977 Production Value ($MM)	Option B: Total Incremental HWM Cost[a] ($MM)	Option B: Incremental HWM Cost as % of Production Value (%)	Option A: Total Incremental HWM Cost[a] ($MM)	Option A: Incremental HWM Cost as % of Production Value (%)	Option C: Total Incremental HWM Cost[a] ($MM)	Option C: Incremental HWM Cost as % of Production Value (%)
Textile Mill Products								
Wool Scouring	2299	165.0	1.009	0.6	1.283	0.8	0.777	0.5
Wool Fabric Dyeing and Finishing	2231	515.0	4.913	1.0	20.914	4.1	4.248	0.8
Woven Fabric Dyeing and Finishing	2261, 2262	7,425.0	16.383	0.2	26.699	0.4	14.799	0.2
Knit Fabric Dyeing and Finishing	2251, 2254, 2257, 2259	3,480.0	19.650	0.6	31.601	0.9	18.226	0.5
Carpet Dyeing and Finishing	2272	6,675.0	11.456	0.2	48.736	0.7	0.000	0.0
Yarn and Stock Dyeing and Finishing	2269	3,175.0	9.001	0.3	38.315	1.2	7.783	0.2
Inorganic Chemicals								
Chlorine (Mercury Cell)	2812	225.0	3.511	1.6	10.506	4.7	3.092	1.4
Chlorine (Downs and Diaphragm Cell)	2812	800.0	3.364	0.4	13.334	1.7	2.956	0.4
Titanium Dioxide	2816	625.0	10.321	1.7	13.877	2.2	9.163	1.5
Chrome Pigments	2816	110.0	1.272	1.2	4.822	4.4	1.124	1.0
Hydrofluoric Acid	2816	200.0	0.000	0.0	0.000	0.0	0.000	0.0
Aluminum Fluoride	28196	55.0	1.319	2.4	2.224	4.0	1.228	2.2
Nickel Sulfate	2819	10.0	0.000	0.0	0.000	0.0	0.000	0.0
Phosphorus Pentasulfide	2819	45.0	0.456	1.0	1.960	4.4	0.394	1.0
Phosphorus	2819	420.0	1.938	0.5	2.212	0.5	1.761	0.4
Phosphorus Trichloride	2819	60.0	0.453	0.8	1.957	3.3	0.391	0.7
Sodium Chromates	2819	85.0	1.480	1.7	1.950	2.3	1.205	1.4
Boric Acid	28194	25.0	0.173	0.7	0.470	1.9	0.160	0.6
Plastics	282	18,000.0	49.230	0.3	190.811	1.1	43.098	0.2
Pharmaceuticals								
Active Ingredients	2833, 2831	3,000.0	7.906	0.3	26.516	0.9	6.063	0.2
Formulations and Packaging	2834	11,000.0	18.893	0.2	73.541	0.7	0.000	0.0

a. Most likely estimate

TABLE II-4 (Continued)

Industry and Segments	SIC Code	Estimated 1977 Production Value ($MM)	Option B: Total Incremental HWM Cost ($MM)	Option B: Incremental HWM Cost as % of Production Value (%)	Option A: Total Incremental HWM Cost ($MM)	Option A: Incremental HWM Cost as % of Production Value (%)	Option C: Total Incremental HWM Cost ($MM)	Option C: Incremental HWM Cost as % of Production Value (%)
Paints	2851	6,000.0	20.496	0.3	30.755	0.5	7.329	0.1
Organic Chemicals								
Perchloroethylene	28692	125.0	4.537	3.6	5.866	4.7	3.491	2.8
Nitrobenzene	28612	100.0	0.411	0.4	1.624	1.6	0.362	0.4
Chloromethanes	28692	330.0	2.853	0.9	7.302	2.2	2.618	0.8
Epichlorohydrin	28692	110.0	0.328	0.3	0.569	0.5	0.247	0.2
Toluene Diisocyanate	28651	335.0	1.683	0.5	4.084	1.2	1.585	0.5
Vinyl Chloride Monomer	28692	720.0	4.157	0.6	7.703	1.1	4.005	0.6
Methyl Methacrylate	28692	290.0	0.612	0.2	1.058	0.4	0.387	0.1
Acrylonitrile	28692	410.0	0.526	0.1	1.416	0.3	0.491	0.1
Maleic Anhydride	28692	95.0	0.454	0.5	1.947	2.0	0.390	0.4
Lead Alkyls	28692	425.0	0.253	0.1	0.880	0.2	0.217	0.1
Chlorobenzene	28651	65.0	1.463	2.3	3.899	6.0	1.361	2.1
Ethanolamines	28692	120.0	0.599	0.5	1.426	1.2	0.480	0.4
Furfural	28651	85.0	1.435	1.7	2.047	2.4	1.340	1.6
Benzylchloride	28651	30.0	0.179	0.6	0.787	2.6	0.000	0.0
Fluorocarbons	28651	400.0	0.360	0.1	1.559	0.4	0.312	0.1
Explosives	2892	650.0	58.260	9.0	71.935	11.1	57.073	8.8
Pesticides	2879	3,000.0	35.945	1.2	84.674	2.8	21.687	0.7
Petroleum Refining	2911	90,090.0	18.115	0.02	62.194	0.1	14.286	0.02
Petroleum Rerefining	2992	40.0	1.037	2.6	2.438	6.1	0.604	1.5
Rubber								
Tires and Inner Tubes	3011	10,200.0	0.680	0.007	2.412	0.02	0.552	0.005
Other Rubber Products	3021, 3041, 3069	6,275.0	4.954	0.1	18.957	0.3	4.213	0.1
Leather Tanning and Finishing								
Cattlehide Chrome	3111	662.0	1.794	0.3	5.043	0.8	1.115	0.2
Cattlehide Through to Blue	3111	271.0	1.206	0.4	1.512	0.6	0.400	0.1
Cattlehide Splits	3111	21.0	0.194	0.9	0.254	1.2	0.069	0.3
Sheepskins	3111	118.0	0.225	0.2	0.878	0.7	0.186	0.2
Leather Finishers	3111	21.0	0.505	2.4	1.999	9.5	0.419	2.0

TABLE II-4 (Continued)

Industry and Segments	SIC Code	Estimated 1977 Production Value ($MM)	Option B: Total Incremental HWM Cost ($MM)	Option B: Incremental HWM Cost as % of Production Value (%)	Option A: Total Incremental HWM Cost ($MM)	Option A: Incremental HWM Cost as % of Production Value (%)	Option C: Total Incremental HWM Cost ($MM)	Option C: Incremental HWM Cost as % of Production Value %)
Metal Smelting and Refining								
Tungsten (APT)	3339	18.0	0.991	5.5	1.576	8.8	0.967	5.4
Mercury	3339	4.6	0.323	7.0	0.903	19.6	0.290	6.3
Primary Copper Smelting	3331	2,500.0	2.072	0.1	6.333	0.3	1.897	0.1
Primary Lead Smelting	3332	361.0	0.687	0.2	2.237	0.6	0.618	0.2
Primary Zinc Smelting	3333	313.0	1.244	0.4	2.481	0.8	1.186	0.4
Primary Aluminum Smelting	3334	4,600.0	4.563	0.1	14.189	0.3	4.096	0.1
Primary Antimony Smelting	3339	48.0	0.102	0.2	0.407	0.8	0.090	0.2
Primary Titanium Smelting	3339	263.0	0.145	0.1	0.467	0.2	0.127	0.05
Primary Tin Smelting	3339	50.0	0.013	0.03	0.014	0.03	0.013	0.03
Secondary Copper Smelting	3341	450.0	7.342	1.6	30.429	6.8	6.403	1.4
Secondary Lead Smelting	3341	430.0	7.454	1.7	31.136	7.2	6.493	1.5
Secondary Aluminum Smelting	3341	1,600.0	11.798	0.7	39.569	2.5	10.645	0.7
Iron and Steel	331	35,000.0	88.560	0.3	137.353	0.4	86.099	0.2
Ferrous Foundries	332	6,500.0	0.111	0.002	0.111	0.002	0.111	0.002
Ferroalloys	3312	400.0	4.108	1.0	8.046	2.0	3.931	1.0
Electroplating and Metal Finishing	3471	1,700.0	60.360	3.6	233.793	13.8	48.267	2.8
Special Machinery Manufacturing								
Special Industry Machinery	355	10,000.0	40.470	0.4	165.370	1.7	17.249	0.2
Office, Computing & Accntg. Mach.	357	15,000.0	10.208	0.1	41.578	0.3	6.229	0.04
Electronic Components	367	15,000.0	43.761	0.3	165.538	1.1	25.361	0.2
Batteries								
Storage Batteries	3691	2,000.0	8.498	0.4	33.581	1.7	7.198	0.4
Primary Batteries	3692	700.0	0.550	0.1	2.328	0.3	0.471	0.1

Source: Arthur D. Little, Inc., estimates.

C. INDUSTRY IMPACTS

One measure of the economic impact of the proposed regulations on an industry segment is ratio of the estimated incremental hazardous waste management cost to annual production value in 1977. Depending on this ratio or percentage, each industry segment can generally be classified as experiencing a high, moderate or low impact. If a segment's estimated 1977 incremental annual hazardous waste management cost to go from Level I to Pathways Level III is higher than 2.0% of estimated 1977 production value, it is categorized as a high impact segment. Percentages of 0.5% to 2.0% were defined as having a moderate impact. If a segment's estimated incremental cost is less than 0.5% of production value, it is categorized as having a low impact. Plant closures and job losses are most likely to occur in the high impact segments or in segments with a history of low profitability.

The industry segments in the high impact category had a total production value in 1977 of more than $2.5 billion (Table II-5). At the same time, the segments incurring moderate impact had a 1977 production value of more than $12 billion. Of the 17 industries analyzed, six have segments in the high impact category, and three of these six also have segments in the moderate impact category. The industry segments in which the impact is expected to be relatively low (with incremental costs between 0.1% and 0.5% of the production value) have a total production value of about $260 billion.

In the addition to the general categorization of high, moderate and low impacts, the implications of the compliance costs for the industry segments have been evaluated in terms of plant closures, job losses, production curtailments and other key measures. The likelihood of a non-trivial change (i.e., greater than 0.5%) in the impact measures has been judgmentally evaluated. Table II-6 describes the qualitative impacts by segment and industry. Where the probability of change in the measure is greater than about 75%, the impact is said to be likely. Probably means between 51% and 75% chance of adverse impact; possibly means between 26% and 50% chance; unlikely means between 11% and 25% chance; negligible means between 0.5% and 10% chance and none means no impact is expected.

In the textile mill products industry, plant closures are probable in wool fabric dyeing and finishing. On the other hand, adverse economic effects are considered unlikely, negligible or none in woven fabric dyeing and finishing, wool scouring, knit fabric dyeing and finishing, yarn/stock dyeing and finishing and carpet dyeing and finishing.

Within the inorganic chemicals industry, plant closures are probable in mercury cell process chlorine production, and unlikely, negligible or none in the other segments under study, namely; aluminum fluoride, chrome pigments, phosphorus pentasulfide, boric acid, downs and diaphragm cell process chlorine production, phosphorus trichloride, sodium chromates, titanium dioxide, hydrofluoric acid, and nickel sulfate.

Plant closures are unlikely in the plastics industry, the pharmaceutical industry, the paint industry, the organic chemicals industry, the explosives industry, the pesticides industry, the petroleum refining industry, the petroleum rerefining industry and the rubber products industry.

TABLE II-5

INDUSTRY SEGMENTS BY DEGREE OF ESTIMATED IMPACT
OPTION B

POTENTIAL IMPACT Industry Segment	1977 Estimated Incremental Waste Management Cost as a Percent of Production Value (%)	1977 Production Value (MM$)
High (over 2%)		
Explosives	9.0	650
Metals Smelting and Refining		
Mercury Production	7.0	5
Tungsten (APT)	5.5	18
Electroplating and Metal Finishing	3.6	1,700
Organic Chemicals		
Perchloroethylene	3.6	125
Petroleum Rerefining	2.6	40
Leather Tanning and Finishing		
Leather Finishers	2.4	21
Inorganic Chemicals		
Aluminum Fluoride	2.4	55
Organic Chemicals		
Chlorobenzene	2.3	65
Total 9 segments		2,679
Moderate (0.5-2.0%)		
Metals Smelting and Refining		
Secondary Lead Smelting	1.7	430
Organic Chemicals		
Furfural	1.7	85
Inorganic Chemicals		
Titanium Dioxide	1.7	625
Sodium Chromates	1.7	85
Chlorine (Mercury Cell)	1.6	225
Metals Smelting and Refining		
Secondary Copper Smelting	1.6	450
Inorganic Chemicals		
Chrome Pigments	1.2	110
Pesticides	1.2	3,000
Inorganic Chemicals		
Phosphorus Pentasulfide	1.0	45
Textile Mill Products		
Wool Fabric Dyeing and Finishing	1.0	515

TABLE II-5 (Continued)

POTENTIAL IMPACT Industry Segment	1977 Estimated Incremental Waste Management Cost as a Percent of Production Value (%)	1977 Production Value (MM$)
Moderate (0.5-2.0%)		
Metals Smelting and Refining		
Ferroalloys	1.0	400
Organic Chemicals		
Chloromethanes	0.9	330
Leather Tanning and Finishing		
Cattlehide Splits	0.9	21
Inorganic Chemicals		
Phosphorus Trichloride	0.8	60
Boric Acid	0.7	25
Metals Smelting and Refining		
Secondary Aluminum Smelting	0.7	1,600
Organic Chemicals		
Benzylchloride	0.6	30
Vinyl Chloride Monomer	0.6	720
Textile Mill Products		
Knit Fabric Dyeing and Finishing	0.6	3,480
Wool Scouring	0.6	165
Total 20 segments		12,401
Low (0.00-0.5%)		
Organic Chemicals		
Maleic Anhydride	0.5	95
Toluene Diisocyanate	0.5	335
Ethanolamines	0.5	120
Inorganic Chemicals		
Phosphorus	0.5	420
Chlorine (Downs and Diaphragm Cell)	0.4	800
Batteries		
Storage Batteries	0.4	2,000
Special Machinery Manufacturing		
Special Industry Machinery	0.4	10,000
Organic Chemicals		
Nitrobenzene	0.4	100
Metals Smelting and Refining		
Zinc Smelting	0.4	313
Leather Tanning and Finishing		
Cattlehide through to Blue	0.4	271
Cattlehide Chrome	0.3	662
Pharmaceuticals		
Active Ingredients	0.3	3,000

TABLE II-5 (Continued)

POTENTIAL IMPACT Industry Segment	1977 Estimated Incremental Waste Management Cost as a Percent of Production Value (%)	1977 Production Value (MM$)
Low (0.00-0.5%) (Continued)		
Paints	0.3	6,000
Organic Chemicals		
Epichlorohydrin	0.3	110
Metals Smelting and Refining		
Iron and Steel	0.3	35,000
Electronic Components	0.3	15,000
Plastics	0.3	18,000
Textile Mill Products		
Yarn/Stock Dyeing and Finishing	0.3	3,175
Woven Fabric Dyeing and Finishing	0.2	7,425
Carpet Dyeing and Finishing	0.2	6,675
Leather Tanning and Finishing		
Sheepskins	0.2	118
Pharmaceuticals		
Formulations and Packaging	0.2	11,000
Metals Smelting and Refining		
Antimony Smelting	0.2	48
Lead Smelting	0.2	361
Organic Chemicals		
Methyl Methacrylate	0.2	290
Acrylonitrile	0.1	410
Fluorocarbons	0.1	400
Lead Alkyls	0.1	425
Metals Smelting and Refining		
Aluminum Smelting	0.1	4,600
Copper Smelting	0.1	2,500
Titanium Smelting	0.1	263
Rubber		
Other Rubber Products	0.1	6,275
Batteries		
Primary Batteries	0.1	700
Special Machinery Manufacturing		
Office Computing and Accounting Machines	0.1	15,000
Petroleum Refining	0.0	90,090
Rubber		
Tires and Inner Tubes	0.0	10,200

TABLE II-5 (Continued)

POTENTIAL IMPACT Industry Segment	1977 Estimated Incremental Waste Management Cost *as a Percent of* Production Value (%)	1977 Production Value (MM$)
Low (0.00-0.5%) (Continued)		
Metals Smelting and Refining		
Tin Smelting	0.0	50
Ferrous Foundries	0.0	6,500
Inorganic Chemicals		
Hydrofluoric Acid	0.0	200
Nickel Sulfate	0.0	10
Total 40 segments		258,941
Grand Total 69 segments		274,021

Source: Arthur D. Little, Inc., estimates

In leather tanning and finishing, plant closures are considered probable in leather finishing and negligible or none in other segments of the industry.

Within the metals smelting and refining industry, plant closures are likely in the mercury production, secondary copper smelting and secondary lead smelting segments; and probable in secondary aluminum smelting. Adverse economic effects are unlikely or none in the other segments of the industry.

Plant closures are considered probable in electroplating and metal finishing, and negligible in the special industry machines segment of the special machinery manufacturing industry. No impact is expected in the office, computing and accounting machines segment of the special machinery manufacturing industry or in the electronic components industry. Within the batteries industry, plant closures are expected to be negligible in the storage batteries segment and none in the primary batteries segment.

Some industry segments will experience production curtailments and job losses even though no plants will be closed as a result of compliance with RCRA. These segments are identified on Table II-6.

TABLE II-6

OPTION B
POTENTIAL ECONOMIC IMPACT BY INDUSTRY AND SEGMENT

Industry and Segments	Number of Existing Plants in 1976	Plant Closures	Job Losses	U.S. Production Cutbacks	Price Increases	U.S. Demand Reduction	Balance of Payments Effects
Textile Mill Products							
Wool Scouring	15	unlikely	unlikely	unlikely	small	unlikely	possibly
Wool Fabric Dyeing and Finishing	110	probably	probably	probably	small	possibly	probably
Woven Fabric Dyeing and Finishing	450	negligible	negligible	negligible	slight	negligible	negligible
Knit Fabric Dyeing and Finishing	577	unlikely	unlikely	unlikely	small	unlikely	possibly
Carpet Dyeing and Finishing	254	none	none	none	small	none	none
Yarn/Stock Dyeing and Finishing	200	negligible	negligible	negligible	small	negligible	none
Inorganic Chemicals							
Chlorine (Mercury Cell)	27	probably	probably	likely	small	probably	negligible
Clorine (Downs and Diaphragm Cell)	40	none	none	none	small	none	none
Titanium Dioxide	13	negligible	negligible	unlikely	small	negligible	negligible
Chrome Pigments	15	unlikely	possibly	probably	small	unlikely	unlikely
Hydrofluoric Acid	12	none	none	none	none	none	none
Aluminum Fluoride	5	negligible	negligible	unlikely	small	none	negligible
Nickel Sulfate	4	none	none	none	none	none	none
Phosphorus Pentasulfide	7	negligible	negligible	unlikely	small	none	negligible
Phosphorus	9	none	none	none	small	none	none
Phosphorus Trichloride	7	negligible	negligible	unlikely	small	negligible	negligible
Sodium Chromates	3	negligible	negligible	negligible	small	negligible	negligible
Boric Acid	3	none	none	negligible	small	none	negligible

TABLE II-6 (Continued)

Industry and Segments	Number of Existing Plants in 1976	Plant Closures	Job Losses	U.S. Production Cutbacks	Price Increases	U.S. Demand Reduction	Balance of Payments Effects
Plastics							
Plastics Materials and Synthetic Fibers	581	none	negligible	negligible	small	negligible	negligible
Pharmaceuticals							
Active Ingredients	161	none	negligible	negligible	small	negligible	negligible
Formulations and Packaging	468	none	negligible	negligible	small	negligible	negligible
Paints and Allied Products							
Paints	743	negligible	negligible	negligible	small	negligible	none
Organic Chemicals							
Perchloroethylene	10	unlikely	possibly	probably	moderate	unlikely	possibly
Nitrobenzene	6	none	none	negligible	small	none	negligible
Chloromethanes	19	negligible	negligible	unlikely	small	negligible	unlikely
Epichlorohydrin	3	none	none	none	none	none	none
Toluene Diisocyanate	10	none	none	negligible	small	none	negligible
Vinyl Chloride Monomer	15	none	none	negligible	small	none	negligible
Methyl Methacrylate	4	none	none	none	none	none	none
Acrylonitrile	5	none	none	none	none	none	none
Maleic Anhydride	7	negligible	negligible	negligible	small	negligible	negligible
Lead Alkyls	4	none	none	none	none	none	none
Chlorobenzene	10	unlikely	unlikely	unlikely	small	unlikely	negligible
Ethanolamines	5	none	none	negligible	small	none	negligible
Furfural	4	negligible	negligible	unlikely	small	negligible	unlikely

TABLE II-6 (Continued)

Industry and Segments	Number of Existing Plants in 1976	Plant Closures	Job Losses	U.S. Production Cutbacks	Price Increases	U.S. Demand Reduction	Balance of Payments Effects
Organic Chemicals (Continued)							
Benzylchloride	3	negligible	negligible	negligible	small	negligible	negligible
Fluorocarbons	6	none	none	none	none	none	none
Explosives and Pesticides							
Explosives	56	unlikely	unlikely	unlikely	large	unlikely	none
Pesticides	185	unlikely	possibly	possibly	small	possibly	none
Petroleum Refining							
Petroleum Refining	266	none	none	none	slight	none	none
Petroleum Rerefining							
Petroleum Rerefining	33	unlikely	unlikely	unlikely	small	unlikely	none
Rubber Products							
Tires and Inner Tubes	120	none	none	none	slight	none	none
Other Rubber Products	920	none	negligible	negligible	small	negligible	none
Leather Tanning and Finishing							
Cattlehide Chrome	105	negligible	unlikely	unlikely	small	negligible	unlikely
Cattlehide Through to Blue	3	*none*	*none*	*none*	small	none	none
Cattlehide Splits	15	negligible	unlikely	unlikely	small	negligible	unlikely
Sheepskins	32	negligible	unlikely	unlikely	small	negligible	unlikely
Leather Finishers	60	probably	likely	likely	small	possibly	probably

TABLE II-6 (Continued)

Industry and Segments	Number of Existing Plants in 1976	Plant Closures	Job Losses	U.S. Production Cutbacks	Price Increases	U.S. Demand Reduction	Balance of Payments Effects
Metal Smelting and Refining							
Tungsten (APT)	4	unlikely	unlikely	unlikely	large	unlikely	none
Mercury	4	likely	likely	likely	small	none	likely
Primary Copper Smelting	16	none	negligible	negligible	small	negligible	none
Primary Lead Smelting	7	none	negligible	negligible	small	negligible	none
Primary Zinc Smelting	6	none	negligible	negligible	small	unlikely	unlikely
Primary Aluminum Smelting	31	none	negligible	negligible	slight	negligible	none
Primary Antimony Smelting	3	none	negligible	negligible	small	negligible	unlikely
Primary Titanium Smelting	3	none	none	none	slight	none	none
Primary Tin Smelting	1	none	negligible	negligible	slight	negligible	none
Secondary Copper Smelting	80	likely	likely	likely	small	unlikely	possibly
Secondary Lead Smelting	82	likely	likely	likely	small	unlikely	none
Secondary Aluminum Smelting	97	probably	probably	probably	small	negligible	none
Iron and Steel	155	none	unlikely	unlikely	small	none	none
Ferroalloys	22	none	unlikely	unlikely	small	unlikely	unlikely
Ferrous Foundries	1,760	none	none	none	slight	none	none
Electroplating and Metal Finishing							
Electroplating and Metal Finishing	5,000	probably	likely	likely	moderate	likely	none

TABLE II-6 (Continued)

Industry and Segments	Number of Existing Plants in 1976	Plant Closures	Job Losses	U.S. Production Cutbacks	Price Increases	U.S. Demand Reduction	Balance of Payments Effects
Special Machinery Manufacturing							
Special Industry Machinery	4,000	negligible	unlikely	unlikely	small	negligible	negligible
Office, Computing and Accounting Machines	1,000	none	none	none	slight	none	none
Electronic Components							
Electronic Components	3,000	none	none	none	small	none	none
Batteries							
Storage Batteries	230	negligible	negligible	none	small	none	none
Primary Batteries	20	none	none	none	slight	none	none

Source: Arthur D. Little, Inc., estimates.

III. BACKGROUND — THE PROPOSED HAZARDOUS WASTE MANAGEMENT REGULATORY PROGRAM

A. INTRODUCTION

This chapter reviews and summarizes the essential features of the hazardous waste management regulatory scheme proposed to implement the statutory provisions of the 1976 Federal Resource Conservation and Recovery Act (RCRA). Its purpose is to identify how the proposed regulations affect persons who generate hazardous waste, those who transport hazardous waste, and those who own and operate treatment, storage or disposal facilities (TSDF's).

The emphasis in this chapter is on the requirements of the proposed federal regulations. However, several states enacted similar kinds of regulatory programs for hazardous waste prior to RCRA. Indeed, it seems clear that the proposed federal regulations were substantially influenced by these earlier state programs. As a result, persons associated with hazardous waste activities in those states are already bearing costs for compliance with requirements which are similar, and in some cases, identical, to those imposed by the federal proposal. Therefore, this chapter also includes a brief discussion of state regulations.

Of the entire set of proposed regulations pertaining to hazardous waste management, five subsets are of primary importance to the economic analysis in this report. They are listed immediately below in terms of their respective RCRA authorizing section and briefly described in terms of the categories of persons immediately affected:

- *Section 3001,* pertaining to the definition of hazardous waste and the scope of the regulatory scheme, primarily affects waste generators.
- *Section 3002,* pertains to waste generator duties and responsibilities.
- *Section 3003,* pertains to transporters of hazardous waste.
- *Section 3004,* pertains to hazardous waste TSDF's.
- *Section 3005,* pertains to permitting requirements for TSDF's and related administrative requirements and procedures.

Three alternative sets of regulations were analyzed for economic impacts. These are referred to as Options A, B, and C. Option B is the proposed set of regulations (to be printed in the Federal Register) and represents the core regulatory scheme. It served as the base line set for the economic analysis. Options A and C present alternative approaches to certain features of the base scheme of Option B. Option A represents a more costly approach and Option C a less costly one. Option A is designed to provide a greater degree of control and protection, and Option C, a lesser degree.

B. REGULATORY SCHEME

The overall thrust of the regulatory scheme is to channel hazardous wastes from sources of generation to sites with resources, expertise, and facilities appropriate to treat, store or dispose of the wastes in a manner which protects human health and the natural environment. To achieve this goal, TSDF's are subject to permitting requirements intended to assure, among other things, that financial requirements, technical standards and adequate procedures are maintained. Generators can direct waste only to lawfully permitted TSDF's.

Transporters are regulated to maintain control over wastes in shipment. A central device for the monitoring and control of waste movement is the shipping manifest. The document(s) involved serve different purposes. As executed by the waste generator, the manifest identifies the waste, directs it to its ultimate destination, and provides appropriate handling information. The transporter uses the manifest and related documentation for transportation purposes. The end-point TSDF uses the manifest as a delivery document to be executed and returned to the generator/shipper as proof of receipt.

A combination of record retention, reporting requirements and identification codes is created for administration and enforcement. Under the regulations proposed for RCRA Section 3010, a notification scheme is created which enables the EPA to assign unique identification codes to each person affected by the regulations.

Pursuant to RCRA Section 3006, the hazardous waste management program may be administered by either the federal EPA or authorized state agencies. For the sake of convenience, in this chapter references to the administrative body have been confined to the EPA.

1. Generator Obligations

An overview of waste generator obligations under the proposed regulations is depicted in Figure III-1. The initial step is to determine the existence of hazardous waste. There are some exclusions by types or amounts of waste and by classes of persons (e.g., farmers), and provision is made in the proposed regulations (Option B), and in the Option C alternative, for special treatment for waste oil. The generator who produces waste subject to the regulatory requirements must notify the EPA and obtain an identification code.

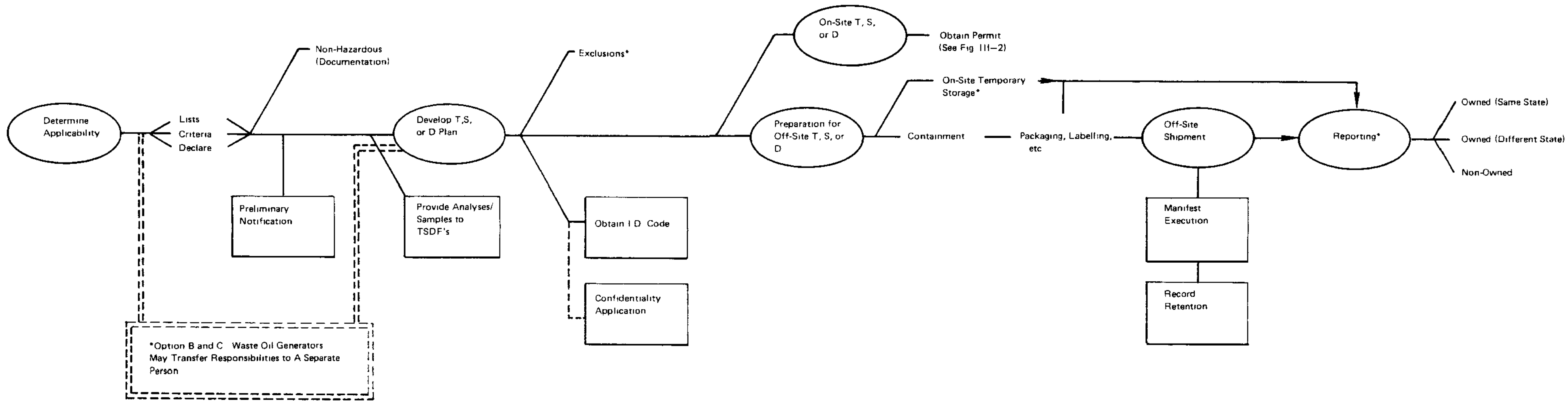
Hazardous waste may be managed only by a permitted TSDF. A generator may treat, store or dispose of waste on-site, but must obtain a permit to do so. The regulations allow temporary storage on-site (e.g., while awaiting shipment) for a prescribed period.

In preparation for shipment off-site, a generator must follow requirements relating to containment of the waste, packaging, labelling and marking. The waste must be transported pursuant to a shipping manifest containing prescribed information. A copy of the manifest must be retained for a certain time. Periodic reports summarizing waste movements must be prepared and provided to the EPA.

2. Transporter Obligations

Under current regulations of the U. S. Department of Transportation, transporters are subject to compliance obligations with respect to hazardous waste shipments. As a result, the proposed EPA regulations are intended to minimize duplication of regulatory requirements.

Transporters of hazardous waste must obtain an identification code, but there are no proposed permitting requirements. The basic legal obligation is to deliver the waste only to the



*Denotes Differences Among Options

FIGURE III–1 COMPLIANCE PROCESS. HW GENERATORS permitted TSDF indicated on the shipping manifest. Hazardous waste is not to be accepted for transport unless the waste is properly described, labelled, packaged, and placarded and unless it is accompanied by a fully executed shipping manifest or equivalent document.

During shipment, appropriate handling, loading, and storage standards must be observed, together with vehicle marking and placarding requirements. In the event of a spill (seepage, leaks or other improper discharge), the transporter is obligated to clean up the spill (or take the appropriate action required by law), to notify certain public agencies, and to provide spill reports. Recordkeeping requirements are tailored to existing requirements for shipping papers. However, periodic reports are not required.

3. TSDF Obligations

An overview of obligations for existing TSDF's under the proposed regulations is provided in Figure III-2. Facilities constructed after the effective date of the regulations will have similar obligations, the major exceptions being that a single application must be filed and a permit issued before construction can begin. There are also provisions in the regulations (not depicted in Figure III-2) for special limited-purpose TSDF's and for limited-duration emergency disposal.

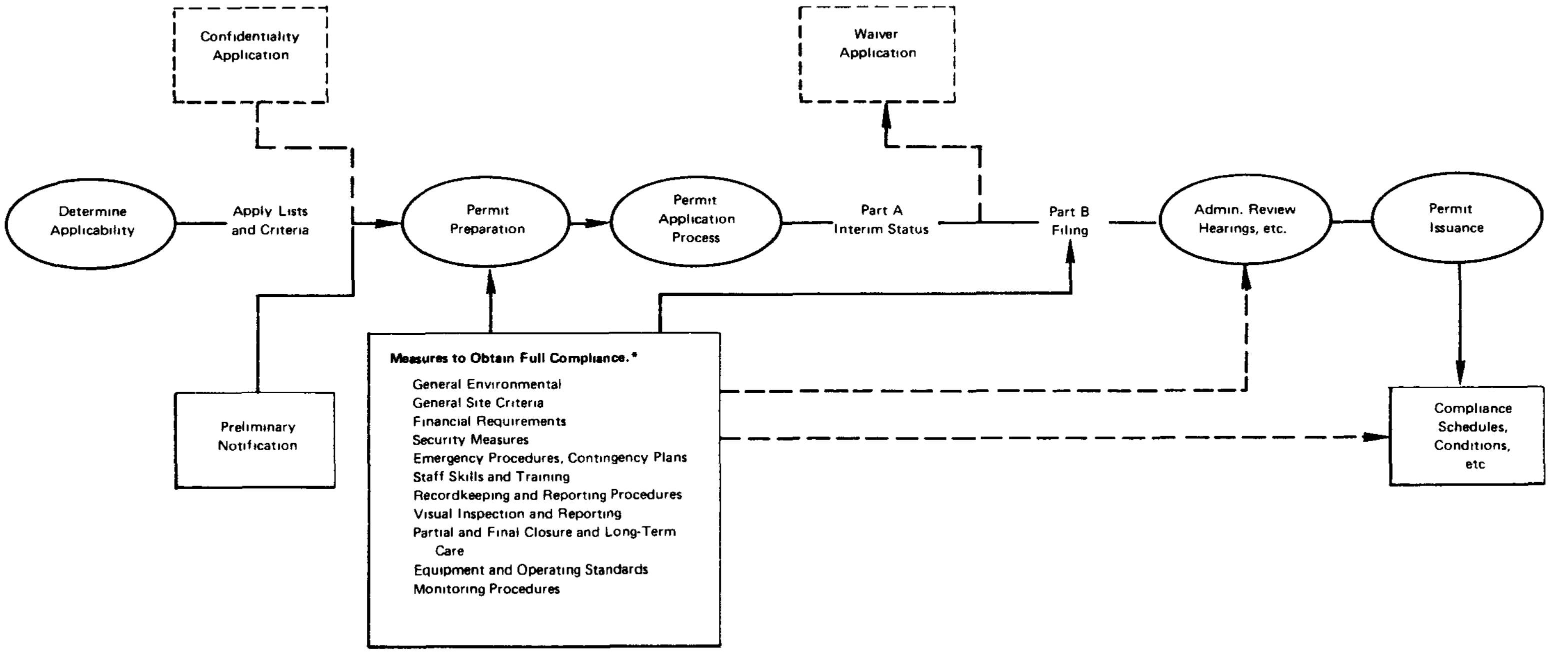
Once applicability of the regulations is determined, an existing TSDF will have to obtain a permit to continue to operate. This applies both to generator-owned facilities, whether located on or off the site of generation, and to independently owned facilities. The initial step is to obtain interim regulation status by submitting a permit application within six months of the effective date of the regulations. At a later time, and after technical review and hearings, the agency (or a state) will issue a permit which will contain a compliance schedule to allow time for making modifications necessary to comply with the regulations. Existing facilities are allowed to continue operating under interim status, pending agency action on the permit application. To obtain and maintain a permit, each TSDF must demonstrate full compliance with the technical standards, financial requirements, and operating, monitoring and other procedures imposed.

The various standards, requirements and procedures required for TSDF's are briefly listed in Figure III-2. The requirements can be considerably detailed, depending on the nature of the TSDF and the kind of hazardous waste involved. The proposed regulations contain provisions for waiver of requirements that are inappropriate for a particular TSDF. In addition, to encourage innovation, the regulations allow alternative facility designs if an equivalent degree of protection and control can be demonstrated. The permitting procedures are substantially dependent on technical documentation of TSDF compliance. Public participation and input is contemplated and hearings will be held at the discretion of the EPA Regional Administrator.

C. SPECIFIC REQUIREMENTS

1. Criteria, Identification and Listing of Hazardous Wastes

The proposed regulations (Option B) establish criteria for identifying and listing hazardous waste, the identification methods that can be used, and a hazardous waste list pursuant to Section 3001 of RCRA. The Option A alternative provides a broader scope of hazard, which expands the amount of waste covered by the regulations, whereas Option C provides a lesser scope.



*Denotes difference among options.

FIGURE III–2 COMPLIANCE PROCESS: EXISTING HW FACILITIES

The underlying approach to implementing RCRA Section 3001 is similar in each option. This approach involves the provision of characteristics for waste hazards, with testing methods and test result interpretation instructions along with a list of hazardous wastes.

a. The Base Set: Option B

Figure III-3 depicts the compliance activity flow required by the regulations proposed pursuant to Section 3001. The numbered nodes in the figure correspond to the numerical designations for the summary of activities listed below:

1. The regulations are directed to all waste generators, transporters and TSDF's. They provide a uniform definition of waste hazard, testing and identification methods and lists of hazardous wastes for every point of compliance activity. All waste generators are expected to make an initial determination of the hazard characteristics of their wastes. The regulations provide alternative means of making an initial determination: apply the lists of hazardous wastes or processes; or, apply the criteria of hazard characteristics and associated identification methods. In addition, a generator may declare its wastes to be hazardous.

   1.1 If the application of the list of hazardous wastes or processes results in a positive finding, the generator must presume his waste to be hazardous or demonstrate that his waste (contrary to others in the same category) is not hazardous because it does not have the characteristics which caused the waste to be listed.

   1.2 If the application of the criteria and testing methods results in a positive finding, the generator may apply tests for exclusion or accept the positive finding.

2. If the generator declares a waste to be hazardous, or otherwise determines a waste to be hazardous, a notification must be filed in accordance with Section 3010 regulations.

The generator may wish to record and document these initial determinations for future administrative needs related to continuing compliance or for protective purposes. The regulations do not explicitly require recording and documenting activities. The need to do so would be related, however, to the existence of the Section 3001 requirements and changes in the lists or characteristics. The method of documenting the determination is not specified, but left to the generator.

b. Option A

The Option A alternative to the proposed regulations includes a broader spectrum of hazard characteristics than Option B and an extended range of tests under the toxic characteristic. In addition, Option A specifies only two principal means of determining waste hazards: apply the list of hazardous wastes and processes; or apply criteria and tests for determining hazard characteristics. Declaration is implied but not specified.

c. Option C

The Option C alternative is narrower in scope than the baseline Option B in certain respects: the characteristic for toxic wastes is eliminated and the list of hazardous wastes is

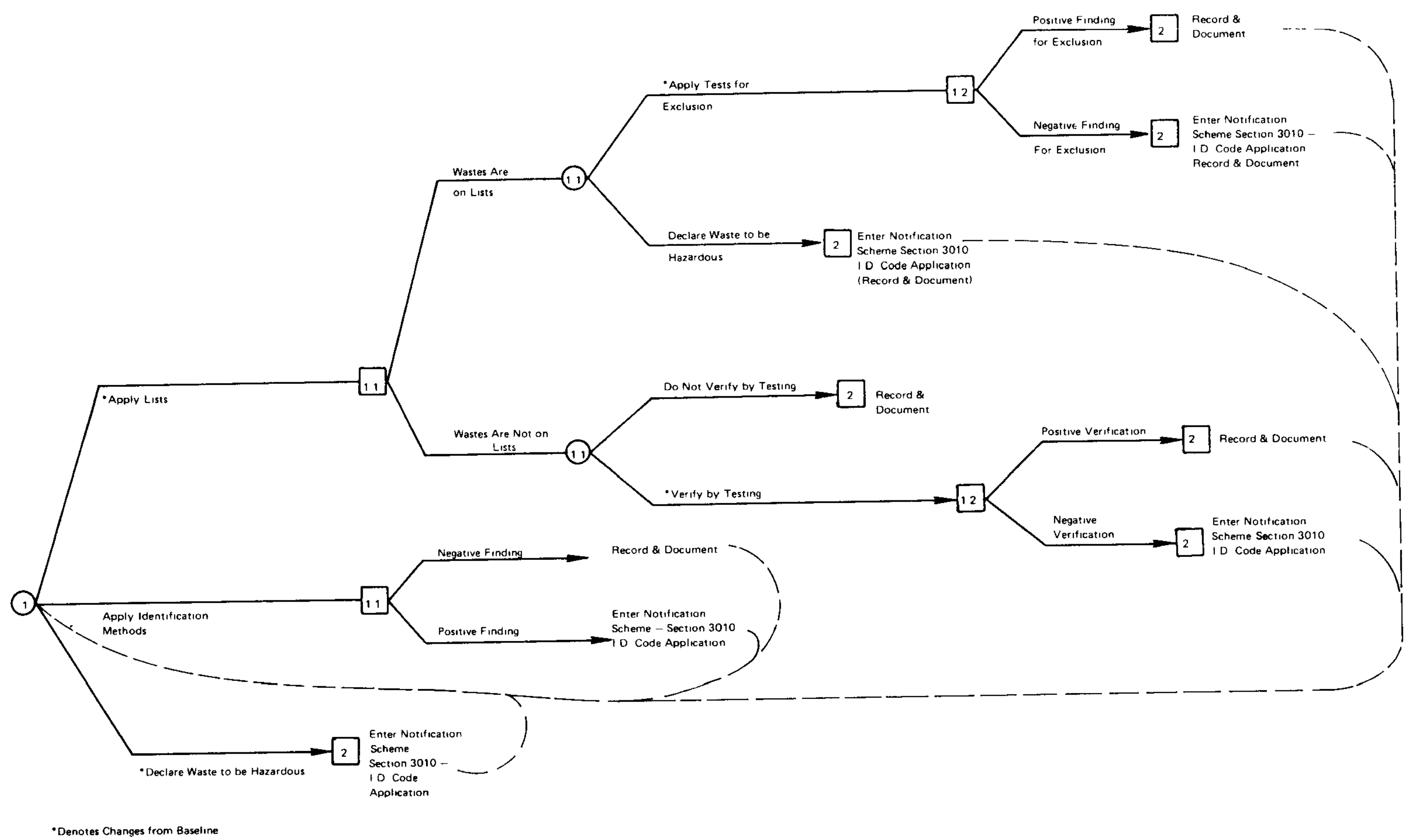


FIGURE III–3 DECISION PROCESS FOR COMPLIANCE ACTIVITIES ASSOCIATED WITH SECTION 3001: CRITERIA, IDENTIFICATION METHODS, AND LISTING OF HAZARDOUS WASTES

reduced by excluding cement kiln dust wastes, utility wastes, phosphate rock mining and processing wastes, uranium mining/milling wastes, oil drilling mud/brines, and any wastes based solely on the toxicity characteristic. The enumerated wastes (and the industries that generate them) were not included in this economic analysis. These changes from the baseline option do not involve a change in the fundamental approach to determining compliance; they constitute a more narrow scope of applicability.

2. Waste Generator Compliance Activities

The compliance requirements for hazardous waste generators are established in the regulations proposed pursuant to RCRA Section 3002. These requirements apply after the Section 3001 determination that hazardous waste subject to the regulatory management scheme is or will be generated.

While there are variances in specific requirements among the three options, the underlying approach is similar; generators are required to treat, store, or dispose of hazardous waste only in facilities legally permitted under the Section 3005 regulations. Wastes destined for off-site must be transported pursuant to the shipping manifest, and generators must follow certain requirements with respect to reporting, manifest handling and retention, and containment, packaging, labelling and marking of shipments.

a. The Base Set: Option B

Figure III-4 depicts the compliance activity flow required by the proposed Section 3002 regulations. The numbered nodes in the figure coincide with the numerical designation for the summary of activities below:

1. All generators of waste (excluding individuals with respect to household refuse or septic tank pumpings) must determine whether the waste is hazardous under the Section 3001 regulations discussed above.

   1.1 Persons (including farmers and retailers) generating less than 100 Kg of hazardous waste in any month are relieved of the obligation to comply with most requirements of the proposed regulations. However, the hazardous waste must be disposed of in facilities complying with RCRA Section 4004, facilities permitted under the RCRA 3005 regulations, or on-site under certain RCRA 3004 requirements.

   1.11 Farmers generating more than 100 Kg of hazardous waste must dispose of waste pesticides pursuant to FIFRA regulations, triple rinse each pesticide container, and either ship the containers to SWDA or RCRA permitted facilities, or bury them.

   1.2 Persons, other than farmers and retailers, generating more than 100 Kg of hazardous waste monthly must comply with the Section 3002 requirements (described below). An initial requirement is to notify EPA and obtain a generator's identification code.

1.3 The proposed regulations allow generators of waste oil to transfer their compliance obligations to persons (e.g., transporters, facility operators, etc.) who will assume their obligations under the regulations. Waste oil generators must still obtain an identification code and must retain copies of the assumption contracts. In turn, the persons assuming the duties of the waste oil generators become liable for performance of regulatory obligations to the extent agreed upon in the contract with the generator.

1.4 Application may be made for confidential treatment of information supplied pursuant to the manifest and reporting obligations.

2. Generators, including those persons who assume the duties of waste oil generators, will probably need to develop a treatment, storage and disposal plan. An actual plan is not required by the proposed regulations. But, compliance with the specific obligations imposed appears to be most efficiently achieved through a coordinated program involving assessment of internal waste streams, decisions on record retention and information storage for reporting, and other activities such as employee training.

2.1 If hazardous waste remains on-site over 90 days, the generator must comply with the 3004 and 3005 regulations, i.e., obtain a permit for a TSDF. A recordkeeping system for waste treated, stored or disposed of on-site is necessary, because annual reports are required.

2.2 If hazardous waste is shipped off-site, there are specific requirements:

- The waste must be contained in a proper package in accordance with DOT regulations. The shipment must be labelled, placarded and marked in accordance with DOT regulations. Additional marking requirements exist for each package.
- A shipping manifest must be prepared in an original and three copies and one copy retained until the original of the manifest or delivery document (with receipt documented by the permitted facility) is returned, or for three years. A retention, storage and retrieval plan is necessary, because the documents must be accessible and available for inspection by enforcement authorities.

3. Reporting obligations vary somewhat. The basic requirement is that generators prepare and submit (a) quarterly reports summarizing all off-site shipments in the prior quarter to foreign countries and those domestic shipments for which the signed original manifest (or delivery document) has not yet been returned, and (b) annual reports summarizing all shipments to permitted facilities within the U.S. Implicit in this requirement is the establishment of an efficient record retention and retrieval system.

- Annual reports are required for wastes managed on-site;
- Transporters (and TSDF's) that assume a generator's duties for waste oil must submit annual reports for domestic shipments and quarterly reports for inter-

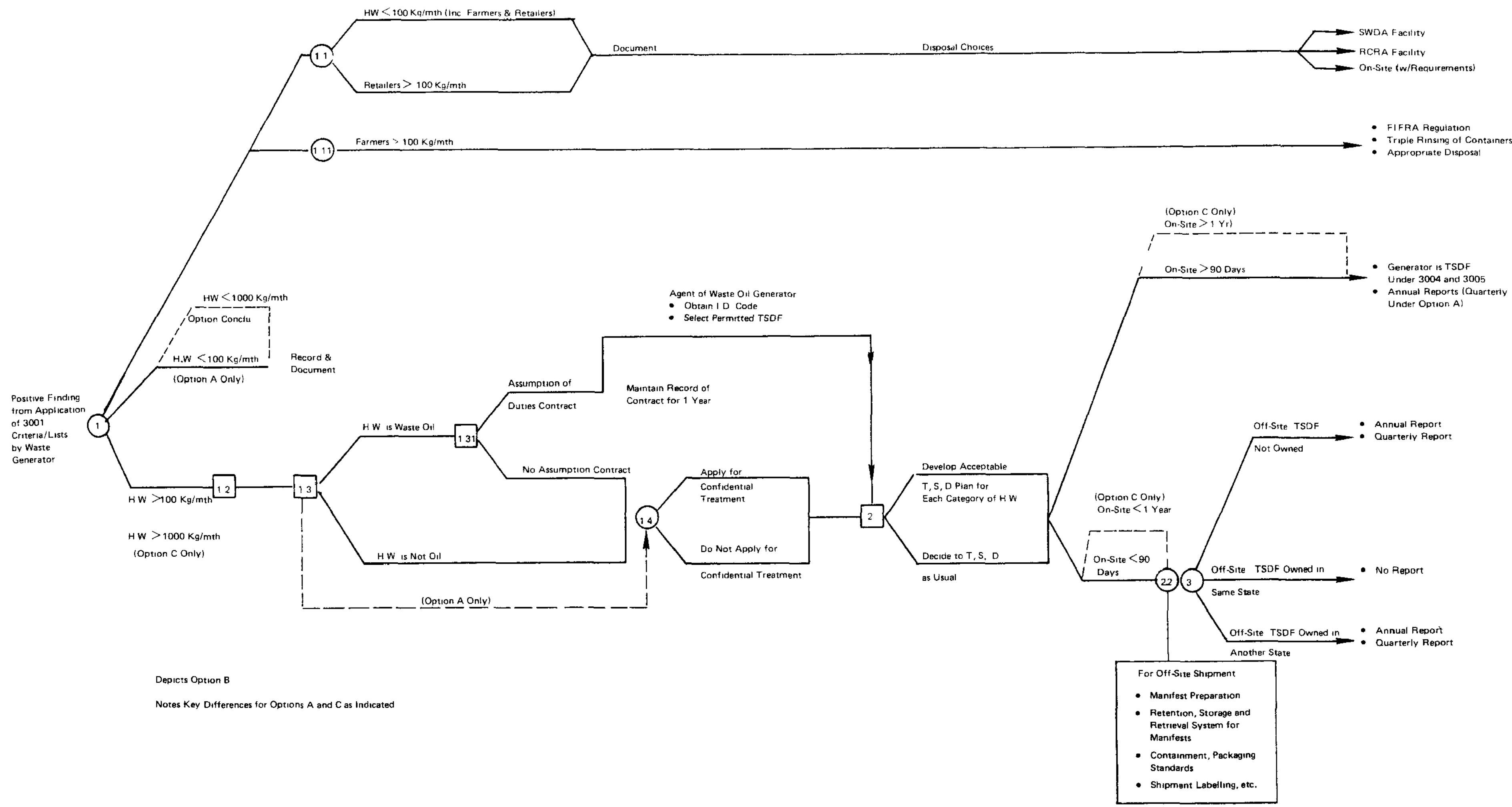


FIGURE III–4 GENERATOR COMPLIANCE ACTIVITIES (SECTION 3002 PROPOSED REGULATIONS)

national shipments and for domestic shipments for which the signed original manifest (or delivery document) has not been returned.

- Reporting is not required if the off-site facility is owned by the generator and located in the state of generation. However, the record retention requirements still apply.
- Quarterly reports are required for international shipments. In addition, a copy of the manifest must be sent to the appropriate regulatory agency of the foreign country within one week of shipment.

b. Option A

The Option A alternative is more rigorous than the base line Option B in several respects:

- The exclusion from generator compliance obligations is simply defined as all those generating less than 100 Kg of hazardous waste in any month. Option A does not include special provisions for farmers and retailers who generate more than 100 Kg monthly. This substantially expands the scope of waste generation subject to regulatory obligations.
- There is no provision for the Assumption of Duties of waste oil generators. This also substantially expands the scope of waste generation subject to the regulations (e.g., most automobile service stations).
- Generators storing on-site over 90 days file quarterly instead of annual reports.
- No distinction is made between foreign and domestic off-site shipments.
- Reports for off-site shipments to independently owned TSDF's (and to those owned by the generator but located in a different state) are required quarterly instead of annually.
- There is no provision for reporting waste shipments for which the signed original manifest (or delivery document) has not yet been received back by the generator.

c. Option C

The Option C alternative is less stringent than the base line Option B in certain important respects:

- The exclusion from generator compliance is increased from 100 to 1,000 kg of hazardous waste per month, substantially reducing the number of generators and the amount of hazardous waste subject to the regulatory scheme.
- Waste from commercial pesticide applications is excluded.
- The manifest requirements for off-site shipments are simplified to existing shipping paper/bill of lading documentation which designate the TSDF and fulfill the requirements of DOT regulations. Record retention for the shipping paper/bill of lading copy is reduced to one year.
- The quarterly reporting requirement for shipments for which the signed original manifest (or delivery document) has not yet been returned is eliminated. This confines the quarterly report to international shipments only.

- The length of time for the permit exclusion for generators temporarily storing hazardous waste on-site is increased from 90 days to one year.

3. Compliance Activities for Transporters

Requirements for transporters of hazardous waste are contained in the regulations proposed pursuant to Section 3003 of RCRA. In this area, only two options were examined. The base set was considered in the economic analysis for both Options A and B and is published in the April 28, 1978 Federal Register (43 F.R. 18506). The only alternative approach examined is in Option C.

In general, the proposed regulations for transporters require notification to the EPA and establishment of a transporter identification code; acceptance of waste for transport in compliance with the manifest system; delivery of hazardous waste to the designated TSDF; recordkeeping; marking and placarding of vehicles; and cleanup and reporting of spills.

a. The Base Set: Options A and B

The proposed regulations apply to persons transporting hazardous waste within the United States. Transportation on the site of a waste generator or of a permitted (under Section 3005 regulations) TSDF is excluded. Transporters must also comply with applicable regulations of the U. S. Department of Transportation. Thus, the proposed RCRA regulations are drafted to promote consistency between the two sets of requirements and to eliminate unnecessary duplication.

(1) Identification Code. A transporter must notify the EPA or authorized state agency that it transports or intends to transport hazardous waste. Upon notification, the transporter will obtain from the EPA an identification code. This code must appear on (1) all manifests for shipments of hazardous waste, (2) any incident report, and (3) the delivery document, if one is issued.

(2) Acceptance/Manifest Compliance. In accepting a shipment of hazardous waste, the transporter must obtain a manifest signed by the generator designating the shipment to a permitted TSDF. The transporter must sign the manifest acknowledging acceptance of the waste and retain a copy (or a delivery document with the same information) to accompany the waste at all times. Only sound containers that are properly labelled or marked may be accepted for shipment. At delivery, the transporter must retain a copy of the manifest signed by the facility.

(3) Recordkeeping. Transporters are required to maintain for at least three years a copy of either the manifest or the delivery (or other shipping) document that contains certification of delivery of the waste at a permitted TSDF, or the transfer to another transporter.

(4) Marking of Vehicles. Placarding requirements apply to those hazardous wastes that meet DOT's definition of a hazardous material. All hazardous waste transporters must mark their vehicles with:

- The name of the transporter, and
- The city or community of the home office.

(5) Delivery. Hazardous waste may be delivered only to the permitted TSDF designated by the generator. Upon delivery:

- the transporter must obtain certification of delivery on the manifest or delivery document from an authorized agent of the TSDF, or
- if the transporter cannot obtain immediate certification, it must be acquired within five working days after delivery of the shipment.

(6) Spills and Reporting. The proposed regulations require immediate removal of spilled waste to protect human health or the environment. The transporter is required to telephone immediately the National Response Center, U.S. Coast Guard, or a predesignated on-scene coordinator. It must also file a written report to the DOT and clean up the spill or take other action as may be required by Federal, state or local agencies.

b. Option C

Under the Option C alternative, the paper work requirements of the baseline Option B are somewhat reduced. Specifically:

- The manifest required to support a waste shipment need only be a shipping paper/bill of lading which designates delivery to a permitted TSDF and fulfills the requirements of DOT regulations. This is consistent with the corresponding change in the Option C version of the 3002 requirements for generators shipping off-site and eliminates the need for transporter signature.
- The recordkeeping requirement for the shipping paper/bill of lading (which replaces the manifest document) is reduced to one year if not otherwise required by DOT regulations.
- In the case of an accidental spill or discharge of hazardous waste, the requirement that a transporter notify certain designated officials is eliminated. In addition, reports of the incident are confined to those required by the DOT regulations only.

4. Compliance Activities for Hazardous Waste Treatment, Storage and Disposal Facilities

Requirements for TSDF's are contained in the regulations being proposed pursuant to Section 3004 of RCRA. In this area, three options were considered. Again, the baseline set is Option B. The greater degree of public health and environment protection is considered in Option A, and the lesser degree in Option C.

These regulations specify performance standards for human health and environmental protection objectives. The performance standards cover general facility operations, storage, treatment/disposal operations and special wastes. The principal differences between Options A, B and C involve several specific elements of these standards. However, the overall approaches and the human health and environmental objectives are quite similar.

a. *The Base Set: Option B*

Figure III-5 groups the compliance activity categories specified in the proposed regulations. The categories in the figure correspond to those in the summary discussion below.

(1) Human Health and Environmental Standards. These standards are the human health and environmental objectives used by EPA in reviewing permits and other applications of the regulations. Compliance with these objectives, covering groundwater, surface water and air, is mandatory for all TSDF's. However, TSDF's need only demonstrate compliance with applicable standards for facility design or operations, for storage, for treatment/disposal, and for special wastes in order to be in compliance with these objectives. EPA will bear the burden of proof to demonstrate non-compliance with these objectives unless a TSDF is not in compliance with applicable standards.

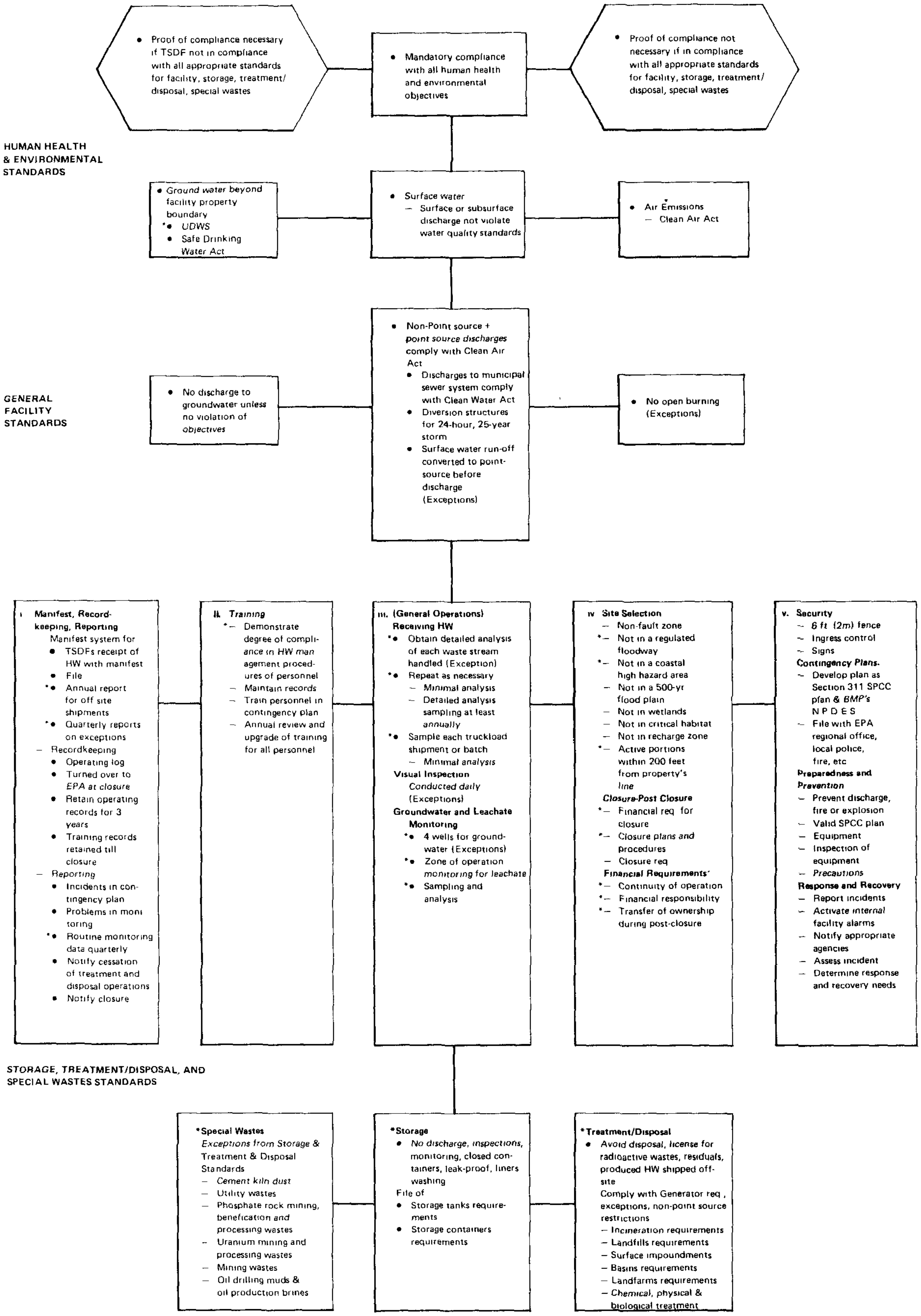
(2) General Facility Standards. There are basically two types of compliance activities for TSDF's in this area: for existing facilities, an initial phase of activity is necessary to establish baseline requirements in each of the requirements areas; and a continuing phase is necessary to maintain compliance. For new facilities, the initial phase of activity will be part of the design specifications in the permitting preparation process specified in regulations pursuant to Section 3005.

The general facility standards (Figure III-5) indicate two levels of compliance activity. The first level of activities are derived from the human health and environmental objectives. They specify activities disallowed in keeping with the groundwater and air objectives (discharge to groundwater and open-burning) and requirements for compliance with surface water objectives (compliance with clean air act, clean water act, diversion structures, and surface water runoff conversion).

The second level of compliance activities include specific operating procedures and practices, technical requirements and testing and monitoring requirements. These activity categories are grouped into five broad areas:

- Manifest, recordkeeping and reporting;
- Training;
- General Operations;
- Site selection and ownership responsibilities; and
- Site Security.

2.1 *Manifest, Recordkeeping and Reporting* — All TSDF's must initiate and maintain a system for receiving manifests or shipping documents for hazardous waste shipments. The receipt of hazardous wastes by a TSDF must be accompanied by an appropriate manifest or delivery document or, if a manifest or delivery document is missing, must be reported to the EPA Regional Administrator quarterly. When a manifest or delivery document is provided, the TSDF must certify receipt and supply one copy to the transporter, forward one copy to the generator, and retain one copy of the certified document for a period of three years. Special requirements are indicated for TSDF's accepting off-site deliveries of hazardous waste.



*Denotes modifications in Options A and C

FIGURE III–5 SCHEMATIC REPRESENTATION OF TSDF COMPLIANCE ACTIVITIES UNDER SECTION 3004 REGULATIONS

All TSDF's must maintain a daily operating log as the principal means of recordkeeping. The regulations specify a number of items which are to be entered into this log on a regular basis. This log is to be made available upon request to EPA inspectors and turned over to the EPA upon closure of the facility. In addition, all operating records are to be retained for three years and all training records, until closure.

All TSDF's must initiate and maintain a system to report on the following activities: all incidents which initiated a contingency plan action; any problems detected by monitoring of leachate, groundwater or other systems; and routine monitoring data. In addition, all TSDF's must notify the EPA upon cessation of any treatment or disposal operation and the closure of the facility.

2.2 *Training* — All TSDF's must provide means for its personnel to acquire competence in the hazardous waste management practices and procedures relevant to particular job assignments. This may be accomplished by training programs or demonstration of equivalent experience. Records of this competence and the means by which it was achieved must be maintained for each of its personnel. Also, all personnel must be trained in the contingency plan requirements for the TSDF and must be given an annual review and update of their training and competence.

2.3 *General Operations* — The operation of all TSDF's must include a system for analyzing incoming hazardous waste shipments. The regulations being proposed require TSDF's to obtain initially a detailed analysis of each waste stream they handle. This analysis, with a detailed analysis and sampling, must be performed annually. In addition to this analysis of waste streams, each truckload or shipment must be sampled and a minimal analysis performed to verify that its contents have been accurately represented on the manifest or delivery document. Visual inspections of the facilities operations, equipment and characteristics of the site must be made daily and the results entered into the operating log. Groundwater and leachate monitoring systems must be installed and monitoring data collected and analyzed on a regular basis. The results of the sampling and analysis must also be entered into the operating log and a quarterly report summarizing them must be sent to the EPA Regional Administrator.

2.4 *Site Selection and Ownership Responsibilities* — Regulations under this category bar sites from being located in specified areas such as fault zones or wetlands. Closure and post-closure requirements and financial responsibility requirements are also included under this category.

2.5 *Site Security* — All TSDF's must comply with site security requirements. These include the means to control entry to the site, a contingency plan to permit effective response to emergencies, preparedness and prevention measures, and response and recovery capabilities.

(3) Storage, Treatment/Disposal and Special Wastes Standards. The final level of performance standards specified in the proposed Section 3004 regulations focus on specific hazardous waste storage/treatment/disposal practices and on special waste categories. These standards apply to TSDF's which engage in these specific practices and which treat, store or dispose of the special wastes indicated. Requirements are specified for six methods of treatment/disposal, for storage tanks and containers, and for the management of these general practices. Six special waste categories are exempted from the requirements for storage, treatment, and disposal standards.

b. Option A

The Option A alternative contains different requirements for several categories of standards in Option B:

- The 500-year flood plain and the coastal high hazard area regulations of Option B are changed to a 100-year flood-plain regulation.
- Sites in a permafrost zone are disallowed in Option A.
- The required distance between the property line and active portions of the facility is modified from the 200 foot limit in Option B to 100 feet from any public road and 200 feet from any residence.
- The period indicated for training is expanded from 6 months in Option B to 12 months.
- Manifest, recordkeeping and reporting requirements are modified to require quarterly reporting of all manifest or delivery documents rather than the Option B provision for quarterly reporting for exceptions and annual reporting for off-site deliveries only.
- The detailed analysis of each waste stream is expanded to include a detailed analysis of each type of waste from each source with regular sampling to confirm that each shipment matches the analysis. Option B indicates a minimum and detailed analysis level.
- The basis for deviation from the groundwater and for leachate monitoring has been removed and the requirements for a comprehensive analysis are expanded.
- Surface water monitoring requirements are added.
- Visual inspections must be conducted daily, with no exceptions granted.
- Closure and post-closure requirements are expanded to require public hearing for exception from post-closure requirements.
- The "transfer of ownership during post-closure" is not included as an option under financial requirements. The financial responsibility requirements are expanded to include a 40-year post-closure responsibility requirement and a more stringent cost-estimation procedure.
- Standards for commercial products are included.
- Some technical requirements for storage, treatment/disposal are changed to increase the level of environmental protection.
- Special waste categories included in Option B are excluded in the Option A approach.

c. *Option C*

The modifications to the baseline regulations considered under Option C involve reductions in the level of human health and environmental protection:

- The minimum distance between the facility's property line and the active portion of the facility is reduced from 200 feet to 100 feet.
- The minimum distance between the facility's surface impoundments, active portions of landfills and treated areas of landfarms and public or private water supply or livestock water supply is reduced from 500 feet to 250 feet.
- The financial responsibility requirements are reduced from a minimum of $5 million to a minimum of $2 million and the time after closeout during which the owner/operator of the TSDF is responsible is reduced from 20 years to 10 years. This modification is to be reflected in the trust fund for post-closure monitoring and maintenance.
- The threshold limit value for air contaminants from non-paint emission sources is to be applied as a time-weighted average over a 24-hour day rather than as a time-weighted average over an 8-hour day and 40-hour week.
- The quarterly monitoring and minimum analysis of samples from the groundwater and leachate detection system is dropped.
- Except for landfarms, the groundwater monitoring requirement is limited to groundwaters that are underground drinking water sources.
- For all landfills and surface impoundments, the required permeability of the soil liner and the final cover is decreased from less than or equal to 1×10^{-7} cm/sec. to less than or equal to 1×10^{-6} cm/sec.
- The restriction on the maximum vapor pressure of wastes that may be treated, stored or disposed is eliminated.
- The time requirements for training personnel are increased from 6 months to one year.
- The requirements for recordkeeping of manifest copies are replaced by requirements for recordkeeping of a shipping paper/bill of lading.
- The requirement for signatures on shipping papers/bill of lading is deleted.
- Special waste standards for cement kiln dust wastes, utility wastes, phosphate rock mining and processing wastes, uranium mining/milling wastes, and oil drilling mud/brines are deleted and these wastes are excluded from Section 3004 regulations.

5. Permitting Procedures for TSDF's

The administrative procedures for applying for and obtaining a TSDF permit are contained in regulations proposed pursuant to RCRA Section 3005. In this area, only two options were considered. The baseline set applies to the economic analysis for Options A and B alike. The only alternative approach examined is in Option C.

In general, the regulatory scheme created by the 3005 proposed regulations is in the nature of licensing. All TSDF'S are required to obtain a permit, whether on-site and owned by the generator, or off-site and independently owned and operated. The proposed regulations take an "interim" approach to allow for start-up implementation; existing facilities are phased into the permittimg scheme through a two-step application process, dependent on a comprehensive application and administrative review with provisions made for public participation and hearings in appropriate cases.

At the time of this analysis, the EPA is in the process of integrating the permitting regulations mandated by Section 3005 of RCRA with similar regulations prescribed under the National Pollution Discharge Elimination System (NPDES) of the Clean Water Act (CWA) and the Underground Injection Control Program (UIC) of the Safe Drinking Water Act (SDWA). The end result of this process is expected to be a single administrative procedure which will allow submittal of a single integrated permit application and granting of a single integrated permit covering the requirements of all of the acts. Thus, facilities subject to more than one federal Act will have to go through the permitting procedure only once.

Because the final product of the integration effort has not been completed as this report goes to press, it has been necessary to use a previous version (July 1978) of the proposed Section 3005 regulations. While the integrated regulations are expected to be procedurally less complex than those currently in use in granting NPDES permits, they are expected to be similar to the RCRA regulations used in the cost estimates. Therefore, there will be some savings for TSDF's seeking any one of these permits for the first time.

a. The Base Set: Options A and B

Figure III-6 depicts the permitting processes created by the proposed Section 3005 regulations. The numbered paragraphs below correspond to the key numbers in the figure.

(1) *Obligation to Obtain Permit.* All TSDF'S *must* have a permit to operate. Distinctions are made — because of start-up considerations — between the administrative processing required for different types of facilities:

- Existing Facilities — pursue a two-step application process — interim status and full permitting.
- New Facilities — those which plan to start construction after the effective date of the regulations, will pursue a single application.
- Special Facilities — a category of four narrowly defined types (i.e., experimental technologies, hospital/medical care waste, publicly owned treatment works and certain ocean dumping vessels).
- Special Wastes — TSDF'S that manage six classes of special wastes identified under Section 3004 will be considered as having a "permit by rule" (not shown in Figure III-6).
- Emergency — a limited, not to exceed 90 days, non-renewable permit authorization.

If desired, any of the above categories can apply for confidential treatment of some of the information required to be submitted.

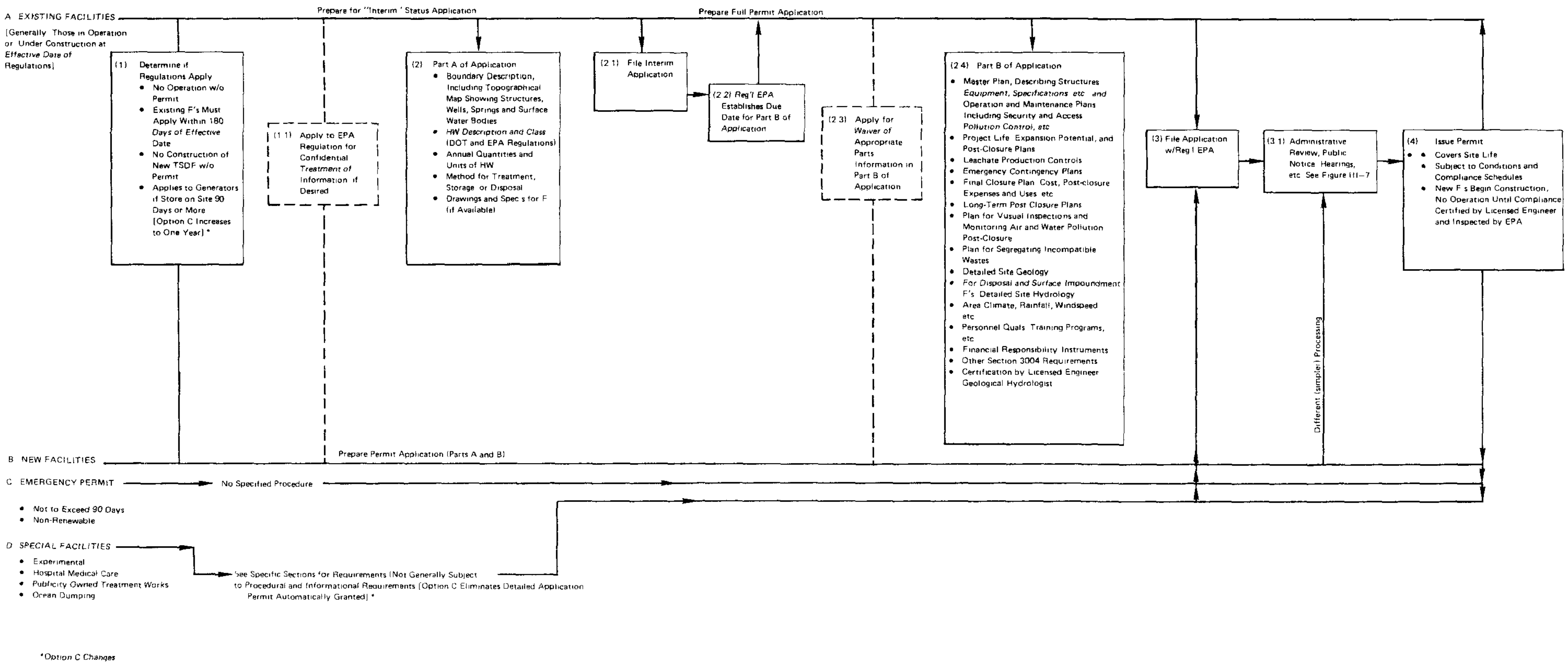


FIGURE III–6 PERMITTING PROCESS FOR TSDF's (SECTION 3005 PROPOSED REGULATIONS)

(2) *Fulfillment of Permitting Requirements.* These include compliance with the Section 3004 requirements discussed above, e.g., technical standards, financial responsibility, record-keeping, etc. They also include additional requirements imposed by the proposed Section 3005 regulations, e.g., topographical maps, geologic and hydrologic details, and climatic conditions.

For existing TSDF'S, the proposed permitting process requires applications in two stages. The Part A application is due within six months of the effective date of the regulations, with the more complex Part B due at a later date to be established by the appropriate EPA Regional Administrator for each particular application.

New TSDF'S must submit the equivalent of Parts A and B in a single application. The permit is to be issued before construction begins, and the completed facility certified to be in compliance with the permit before operation may begin. Also, the facility may be inspected by EPA before operations are begun.

Special (limited waste) facilities have separate, somewhat streamlined requirements due to the narrowly defined functions involved.

An unresolved issue is the extent to which applying TSDF'S will have to fulfill requirements related to other (aesthetic) environmental considerations. One option under consideration by EPA is a simple certification of compliance with all applicable state and local laws (e.g., zoning, air, noise and water pollution controls, etc.). This would be the least costly. A more costly option would be to require the applicant to prepare a Supplementary Environmental Analysis and allow the EPA to insert appropriate additional conditions in the permit.

The proposed regulations provide a waiver procedure for unnecessary information pertaining to compliance with the Section 3004 standards. The waiver must be sought by the applicant with written justification and is intended to reduce permit application costs, because it allows elimination of unnecessary or inappropriate requirements.

(3) *Preparation and Filing of Application and Administrative Review.* This is basically an exercise involving paper documentation of compliance with requirements and standards. However, the potential for public hearings, disputes as to standards, etc., may inject possible additional cost considerations, uncertainties and time delays.

The proposed regulations create a public participation process designed to fulfill "due process" considerations, but to minimize protracted proceedings. Reliance is placed on staff determinations; hearings are discretionary with the EPA Regional Administrator. The administrative process is depicted in Figure III-7.

(4) *Permit Issuance.* The proposed regulations contemplate that EPA can impose appropriate terms and conditions and schedules of compliance on any permit issued. These conditions and schedules will follow the existing requirements and will be primarily used during the start-up period as a mechanism to provide time and opportunity for existing TSDF'S to obtain full compliance while continuing to operate.

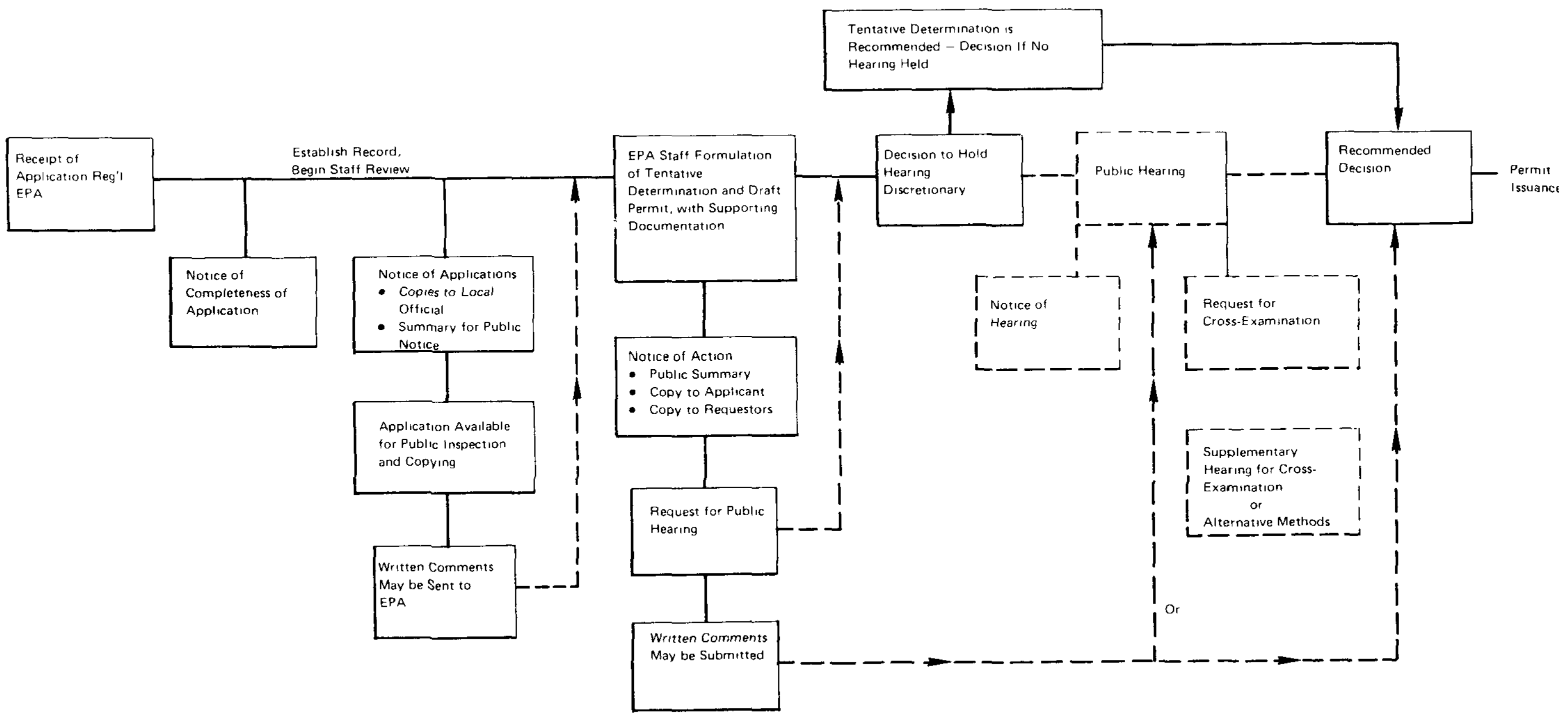


FIGURE III–7 ADMINISTRATIVE PROCESS FOR PERMITTING: (SECTION 3005 PROPOSED REGULATIONS)

b. Option C

The Option C alternative makes only two minor changes to the baseline set proposed for both Options A and B.

- The length of time for permit exclusion for generators who temporarily store on-site is increased from 90 days to one year.
- The limited-purpose TSDF's entitled to special facility permits are automatically granted permits, eliminating the need to pursue the application process.

These changes are depicted in Figure III-6, which also depicts the Options A and B approach.

D. STATE REGULATORY REQUIREMENTS

1. Background

In the decade between 1965 and 1975, a sizable number, perhaps a majority of the states, developed solid waste regulatory programs. As a general rule, these solid waste provisions provided the basis for the evolution of regulatory approaches for hazardous waste. For the most part, this evolutionary process began in the early 1970's, but only in a minority of the states.

The enactment of RCRA by the U. S. Congress in October, 1976, contributed to a rapid increase in the enactment of similar state provisions. The latter statutes demonstrate the considerable influence of the federal provisions. Accordingly, they were considered as "RCRA induced" and were not included in the baseline of state regulatory schemes that impose compliance costs independent of the new federal requirements.

Ten states had significant hazardous waste regulatory requirements prior to the 1976 RCRA: California, Illinois, Indiana, Iowa, Louisiana, New York, Ohio, Oregon, Texas, and Wisconsin. Unfortunately, no two of these states take an identical approach. It is not possible to determine accurately whether requirements were strictly or loosely enforced. Further, it is not possible to identify whether informal, but important, requirements existed. As a result, an average state regulatory approach was fashioned and pre-RCRA state-imposed costs were assessed on the basis of that average. The requirements described below reflect the average standards.

A few states, in addition to those cited, had some hazardous waste management requirements prior to RCRA. However, these states were excluded from the baseline computation because the requirements were minimal in terms of cost impacts.

2. Specific Requirements

The average regulatory requirements for the ten states are summarized below. The summary is organized in terms of RCRA Section numbers to permit comparison of compliance obligations. In general, the average pre-RCRA state program depends on a manifest system. Transporters or haulers are regulated or licensed and monitoring and enforcement data are provided through reporting obligations. Hazardous waste is determined by established lists and criteria. Once identified, the waste is directed to regulated TSDF's. However, the average pre-RCRA state regulatory scheme was confined to off-site facilities, and did not apply to on-site TSDF's.

a. 3001 Requirements

The state definition of hazardous waste is substantially similar to that in the proposed federal regulations. The common purpose is to protect both public health and the natural environment. There are no substantial exceptions analogous to that proposed in Option B (and also considered in Option C) for waste oil.

The average state program follows the lists and criteria approach of the proposed federal regulations. Thus, the 3001 compliance costs are substantially the same as existing costs in the ten states.

b. 3002 Requirements

A shipping document/manifest system lies at the heart of the average state program. This imposes generator recordkeeping and reporting requirements that are similar to the proposed federal approach. Confidential treatment is extended to those who seek it. The shipping preparation obligations for containment, packaging, and labelling are also substantially similar, largely because of the common influence of the DOT regulations on state transportation regulatory schemes.

However, the state programs generally do not provide the exception in the Section 3002 proposed regulations for waste generated below specific amounts. Nor are identification codes required, although it seems implicit in the reporting requirements that there be a simple means of identifying information sources.

c. 3003 Requirements

Because of reliance on the manifest system, the average state approach is similar to that of the federal proposal in terms of impacts on transporters. The initial regulatory measure of many states was to regulate waste transporters. All programs examined show the influence of the U. S. DOT regulations.

d. 3004 and 3005 Requirements

The major difference between pre-RCRA state hazardous waste programs and the proposed federal approach is in the area of "permitting." Prior to 1976, regulatory approaches of the different states varied. For example, California, Illinois and Texas developed a fairly detailed approach to TSDF regulation over a period of years. Other states adopted a simple "registration" approach pursuant to which it was required that TSDF's identify themselves, provide reports, and be subject to inspection and controls over new construction. In a few states, the appropriate state agency provided expertise (in the form of advice and technical assistance) to facilities and directed generators, or assisted in the selection of a particular facility for a particular waste.

As a result, some of the proposed 3004 standards and requirements are in addition to those routinely enforced in the ten pre-RCRA state programs. Further, the pre-1976 state standards and requirements did not apply to on-site facilities.

Because of this relaxation of 3004 type requirements, few states before 1976 imposed formal permitting obligations comparable to those in the proposed 3005 regulations. The average pre-1976 state program lacked comprehensive application and paperwork requirements and did not attempt public participation/input through notices and hearings. Geological, hydrological or engineering surveys were required in appropriate cases and technical standards were fulfilled largely through informal mechanisms such as technical assistance and advice. Financial requirements were not imposed. Thus, as in the case of 3004, some of the compliance requirements proposed for 3005 are in addition to those imposed by the average state program.

IV. ANALYSIS METHODOLOGY

A. INTRODUCTION

The economic impact assessment considers the cost of compliance and the consequent economic impact on generator industries. The methodology for making the cost and impact assessments is outlined in this chapter. In addition, a brief description is included of the Hazardous Waste Management Network as a conceptual framework for evaluating changes in on-site and off-site waste management practices.

The impact assessment includes four major steps. The first is a detailed listing of the compliance activities required of generators, transporters, and off-site TSDF's under the three regulatory options. These activities are summarized in Chapter III. The second step is the development of the unit costs of compliance for each of the required activities. These costs are detailed in Chapter V. The third step is the estimation of the compliance costs. The procedures for this step are discussed in this chapter, and the results are included in Chapters VII and VIII. The final step is a qualitative assessment of the economic impacts resulting from the compliance costs. The procedures are discussed in this chapter, and the results are shown in Chapter VIII. The limits of the analysis are discussed in Chapter XI.

B. THE HAZARDOUS WASTE MANAGEMENT NETWORK CONCEPT

The pathways approach to hazardous waste management is intended to control the entire life cycle of hazardous waste streams. Hazardous waste generators, transporters, and off-site TSDF's comprise a network of related activities which will be affected individually and as a whole by the hazardous waste management regulations. In this report, the network has been called the Hazardous Waste Management Network (HWMN).

The HWMN concept is used as a conceptual framework for categorizing the different activities of its component parts and the parameters of the potential effects of RCRA on the flow pattern of hazardous waste through the network. The regulatory requirements for any one segment of the network also can impact the other segments. For example, if the regulations are very restrictive on the hazardous waste generators, the flow of waste material will tend to shift off-site into the transportation segment and the off-site disposal segment. Capacity constraints could occur in both of these segments. The reverse could also be true; tight restrictions on off-site facilities could keep the waste materials on-site, with potentially higher environmental risks.

Figure IV-1 illustrates the general relationships among the principal components of the HWMN. The three principal segments of the network are:

- hazardous waste generators,
- hazardous waste transporters, and
- off-site disposal and reprocessing facilities.

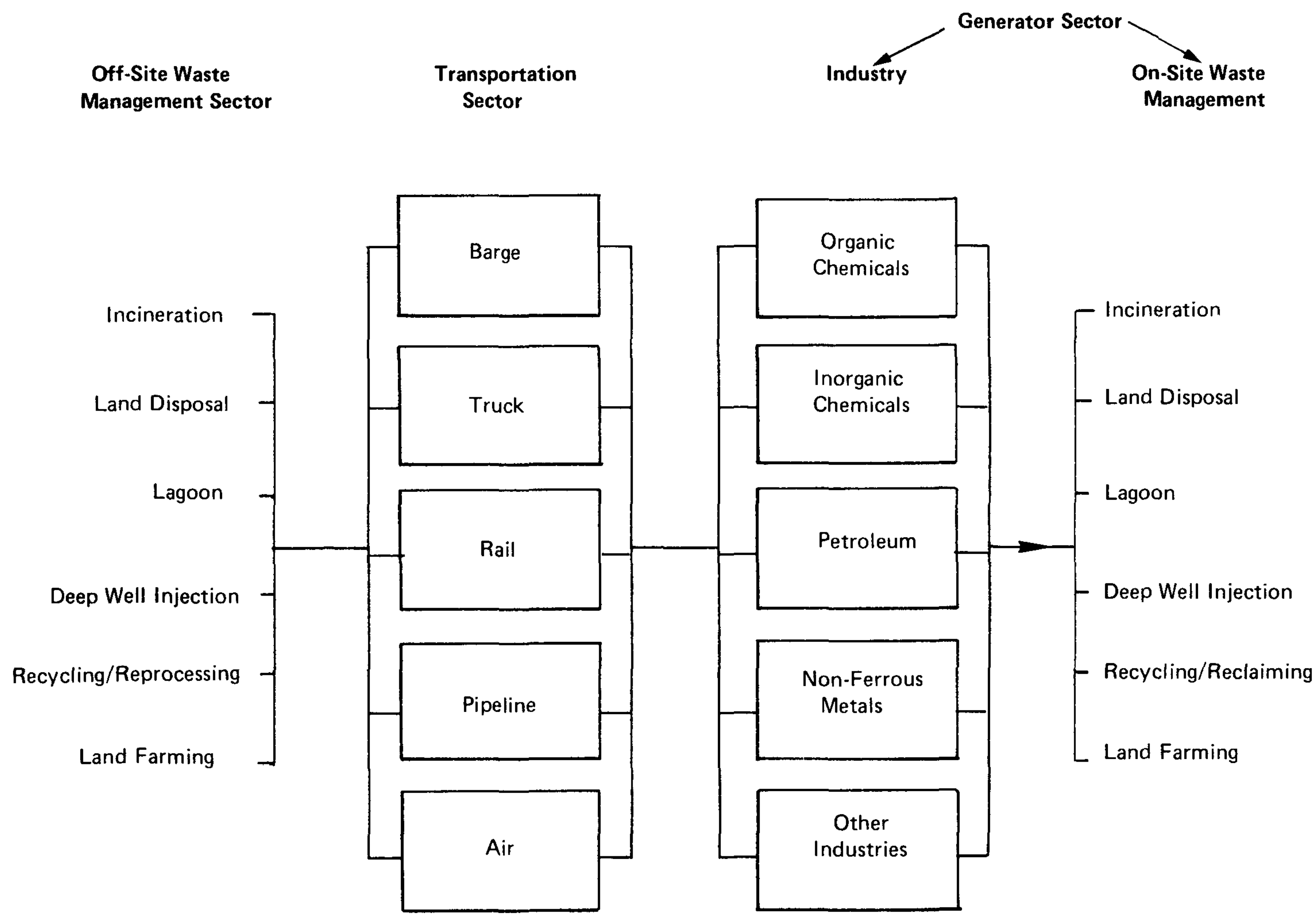


FIGURE IV–1 GENERALIZED HAZARDOUS WASTE MANAGEMENT NETWORK

Each generator of hazardous waste has an array of alternatives for managing the waste. They include:

- on-site landfill,
- on-site incineration,
- on-site reprocessing or recycling,
- on-site deep well injection,
- on-site lagoon,
- all of the above alternatives off-site, and
- waste reduction.

The specific alternatives will vary for each generator, depending on the type of hazardous waste, land availability, availability of disposal/reprocessing contractors, etc. In the absence of RCRA requirements, these options are available to generators now. Of the approximately 23 million metric tons of waste generated annually from the selected waste streams of the industries studied, about 80% is now stored, treated or disposed of at the generation site. The 80% reflects the decisions of the individual generators about the least-cost alternative available to them.

The effect of RCRA will be to change the costs of the alternatives available to the generators. Of particular importance is the dramatically increased cost of operating small land disposal facilities. For many generators, on-site disposal may no longer be a cost-effective solution, and they will choose to send their waste off-site. With 80% of the waste currently managed on-site, a shift of 10% of this 80% to off-site locations would increase the demand for off-site capacity by 50%. Changes in the materials flow of the HWMN have not been estimated.

C. COMPLIANCE ACTIVITIES

To make estimates of the cost of compliance activities, it was necessary to identify the obligations imposed by the proposed regulations. In turn, the obligations were broken down into distinct compliance tasks which provided the basis for cost assessment and estimation.

The initial step in this process was to analyze the text of the proposed regulations. Once obligations were determined, they were reduced to lists, charts and other appropriate forms of graphic illustration. Compliance flow charts were then prepared to illustrate any alternative courses of action and the sequential steps necessary to initiate and complete prescribed courses of conduct. The purpose of the approach was to identify each specific task involved and to identify the relationships among various tasks.

This process was repeated for each set of proposed regulations, for each category of person affected thereby, and for each of the three regulatory options. This enabled isolation of the individual tasks required under each option for waste generators, for transporters, and for hazardous waste treatment, storage, or disposal facilities. The tasks so identified, together with the supporting flow charts, were then examined and analyzed to achieve an understanding of the nature of the requirements and to ensure that there were no omissions nor any double counting of compliance activities.

D. METHODOLOGY FOR ESTIMATING THE COST OF COMPLIANCE

The cost of compliance estimate depended upon a thorough analysis of the regulations, which have many cost implications both implicit and explicit. The costs have been estimated for three regulatory options (Option B was proposed) which differ on both major and minor points.

1. Procedure for Estimating Compliance Costs

The methodology followed five basic steps:

- defining the compliance activities resulting from each section (3001-3005) of RCRA, Subtitle C;
- estimating unit costs for each activity;
- estimating the multiplier for each unit cost, (i.e., number of facilities, waste tonnage, or number of waste streams);
- separation of states with prior regulation of hazardous waste from states without laws; and
- performing the calculations and aggregating the results.

a. Defining the Compliance Activities

The sections of Subtitle C of RCRA contain two types of requirements, explicit and implicit. Explicit requirements are those that compel specific actions on the part of generators, transporters or TSDF's, such as quarterly reporting, or the signing and transferring of manifests. However, the regulations also have implicit requirements, such as administrative and overhead actions, e.g., supervising the monitoring and testing procedures, or gathering information for a permit application.

The flow diagrams of Chapter III outline the steps by which firms fall under and come into compliance with the proposed regulations.

b. Estimating the Unit Costs

Once the regulations have been disaggregated into a series of discrete activities, unit costs could be estimated for each step. The estimates were based on a number of sources, including previous EPA studies by Battelle Columbus Laboratories, Arthur Young and Company, and International Research and Technology, as well as discussion with Environmental Protection Agency officials.

(The estimated cost and nature of each step are discussed in detail in Chapter V.)

c. Estimating the Multiplier

The goal of the analysis was to estimate the total cost of compliance with RCRA regulations for each of the 69 segments studied. Once unit costs were devised, a basis for multiplication was also necessary to convert the unit costs to the total cost.

As indicated in Chapter V, the unit costs have many different bases; i.e., they can be per ton, per facility, or per waste stream. For example, the cost of system development for TSDF's is $2,312 per facility. To calculate the total cost of systems development for a given segment, the cost must be multiplied by the number of TSDF's in the segment.

The methodology was not as simple as multiplying all costs by all multipliers for each segment. It was recognized that some firms may be close to compliance levels, and that other activities are site-specific (e.g., monitoring activities). Calculating the incremental costs of RCRA regulations required these factors be taken into account.

Thus, facilities located in states that had regulations controlling some aspects of the hazardous waste cycle to substantially the same degree were removed from this analysis because they are already in compliance.

The following multipliers were also used:

Section 3001

90% of covered wastes are declared hazardous through application of the list;
10% of wastes undergo the testing protocol.

Section 3003

75% of wastes drummed in truck;
25% of wastes liquid in tank car.

Section 3004

10% of sites will not require zone of aeration monitoring;
80% will require leachate sampling, of which 25% will uncover leachate, needing analysis.

One further estimation was made with regard to the multipliers. Although the estimates with respect to the amount of waste managed on-site or off-site were available, no similar data were available on the number of facilities which manage their waste on-site or off-site. This is an important figure, because many costs are incurred by the firm that manages on-site. The model assumed that the percentage of plants that managed on-site was equal to the percentage of waste tonnage managed on-site. If the electroplating industry, for example, with 5,000 firms had 60% of its waste managed on-site, then it was assumed that 3000 (i.e., 0.60 x 5000) firms were on-site management facilities, and 2000 off-site.

d. Separation of States

As discussed in the previous section, certain states had passed regulations in force prior to the passage of RCRA. Any actions taken by firms in those states under those regulations if attributed to RCRA would be overstating those costs. Generally, the hazardous waste regulation program in other states prior to RCRA was considered to be insufficiently developed to significantly affect RCRA induced costs.

However, 10 states had passed some prior regulations. These were: California, Illinois, Indiana, Iowa, Louisiana, New York, Ohio, Oregon, Wisconsin and Texas. The activities regulated and the extent of regulation differed for each state. The approach was to classify the regulations by the activity regulated — administration, monitoring/testing — and the phase of the hazardous waste process regulation — generation, transportation or disposal.

Once classified, the stringency of the regulation was estimated and put into the analysis for each state on a scale of 0 to 1.0

This scale factor was multiplied by the cost of compliance estimated for firms located within those ten states. For example, if the cost of recordkeeping/reporting for generators for the Special Machinery industry within those ten states was $45 million (arrived at by multiplying the unit costs times the number of facilities and other bases), then it was multiplied by 0.75 to estimate the total incremental cost of compliance.

e. Performing Calculations

This section presents the equations, constants and procedures used to calculate the incremental costs of compliance. A detailed flow chart of the program is found in Appendix A. Costs vary depending upon the section of the regulation, the activity and the option, requiring a large number of equations. These equations are presented in the following order: regulation section, activity and option. A definition of terms is included at the end of this section.

1. Section 3001

(a) Monitoring and Testing

i. Option A

Initial cost of applying criteria = (number of facilities) x (number of waste streams) x 0.1 x $1,900.

ii. Option B

Initial cost of applying criteria = (number of facilities) x (number of waste streams) x 0.1 x $750.

iii. Option C

Initial cost of applying criteria = (number of facilities) x (number of waste streams) x 0.1 x $175.

(b) Administration (no difference among options)

Initial cost of documenting inventory = (number of facilities) x (number of waste streams) x $71.

Initial cost of documenting results of criteria testing = (number of facilities) x (number of waste streams) x 0.1 x $169.50.

Initial cost of applying list = (number of facilities) x (number of waste streams) x $71.

Initial cost of incremental supervision = (number of facilities) x (number of waste streams) x $50.

Annual cost of re-evaluating list = (number of facilities) x $35/year.

2. Section 3002

(a) Recordkeeping and Reporting

i. For All Options

Initial cost of ID code/notification = (number of facilities) x $31.50.

ii. Option A

Annual cost of reporting quarterly = (number of facilities disposing off-site) x $146.50 x 4/year.

iii. Option B

Annual cost of reporting on exceptions = (number of facilities disposing off-site) x ($25.75 x 4 + $36)/year.

Annual cost of manifest storage and filing = (number of facilities disposing off-site) x $68/year.

iv. Option C

Annual cost of reporting yearly = (number of facilities disposing off-site) x $36.

(b) Administration

i. Options A and B

Initial cost of designing and implementing compliance procedures = (number of facilities disposing off-site) x $776.50.

Initial cost of supervision = (number of facilities disposing off-site) x $150.

Annual cost of filling out manifest = (number of manifests) x $2.67.

Annual cost of ongoing supervision = (number of facilities disposing off-site) x $450/year + (number of facilities disposing on-site) x $300/year.

ii. Option C

Initial cost of designing and implementing compliance procedures = (number of facilities disposing off-site) x $492.50.

Initial cost of supervision = (number of facilities disposing off-site) x $125.

Annual cost of ongoing supervision = (number of facilities) x $300/year.

3. *Section 3003*

(a) Recordkeeping and Reporting

i. For All Options

Initial cost of ID code application/notification = (number of transporters) x $49.20.

ii. Options A and B

Annual cost of manifest storage = (number of transporters) x $116 x 24/50.

(b) Administration

i. Options A and B

Initial cost of manifest handling system = (number of transporters) x $196.80.

Initial cost of truck marking = (number of transporters) x 8 (trucks/transporter) x $9.15

Annual cost of manifest signature = 0.75 x ($1 + x 1/6 x $3) + 0.25 ($2 + 1/6 x $3) x (number of manifests)/year.

Annual ongoing supervision = (number of transporters) x $300/year.

ii. Option C

Annual ongoing supervision = (number of transporters) x $25/year.

(c) Contingency Plan

Annual cost of contingency reporting = (number of incidents) x $49.20.

4. *Section 3004*

(a) Technical Requirements

Initial capital cost of technical requirements = (number of disposers on-site) x (capital technical costs).

Annual on-site costs of disposal = (volume of waste disposed on-site) x (Level III cost of disposal minus Level I cost of disposal) x (percent of facilities at Level I)/year.

Annual off-site costs of disposal = (volume of waste disposed off-site) x (Level III price of TSDF minus Level I price of TSDF) x (percent of facilities at Level I)/year.

(b) Financial Requirements

Annual on-site financial requirement cost = (number of disposers) x (cost of financial requirements)/year.

Annual off-site financial requirement cost = (volume of waste disposed off-site) x (unit cost of financial requirements)/year.

(c) Recordkeeping and Reporting

Annual on-site recordkeeping/reporting costs = (number of disposers) x (cost of recordkeeping/reporting)/year.

Annual off-site recordkeeping/reporting cost = (volume of waste disposed off-site) x (unit cost of recordkeeping/reporting)/year.

(d) Monitoring and Testing

Annual on-site monitoring/testing cost = (number of disposers) x (cost of monitoring/testing)/year.

Annual off-site monitoring/testing cost = (volume of waste disposed off-site) x (unit cost of monitoring/testing)/year.

(e) Administration

i. Annual Costs for All Options

Financial requirements plan design = (number of disposers) x $1,440.

Site assessment and redesign plan = (number of disposers) x $1,880.

ii. Annual Costs for Options A and B

Systems design = (number of disposers) x $2,312.

iii. Annual Costs for Option C

Systems design = (number of disposers) x $2,008.

iv. Annual Costs

On-site administration cost = (number of disposers) x (cost of administration)/year.

Off-site administration cost = (volume of waste disposed off-site) x (unit cost of administration)/year.

(f) Training

Annual training cost = (number of disposers) x 15 x 300 + (number of off-site disposers) x 25 x 300.

(g) Contingency

Annual on-site contingency cost = (number of disposers) x (cost of contingency)/year.

Annual off-site contingency cost = (volume of waste disposed off-site) x (unit cost of contingency)/year.

5. Section 3005

(a) Recordkeeping and Reporting

i. For All Options

Initial ID code application/notification = (number of disposers) x $34.

Initial development of technical standards = (number of disposers) x $42,800

(b) Administration

i. For All Options

Initial analysis of permit and schedule = (number of disposers) x $1,840.

Annual update of systems and trucking schedule = (number of disposers) x $876/year.

(c) Training

i. For All Options

Initial development of training program = (number of disposers) x $9,750.

(d) Contingency

i. For All Options

Initial development of contingency plan = (number of disposers) x $830.

6. Definition of Terms

Number of facilities = Column 1 of Table VI-7.

Number of waste streams = Column 3 of Table VI-7.

Number of facilities disposing on-site = number of facilities x Column 6 of Table VI-8.

Number of facilities disposing off-site = 1 — number of facilities disposing on-site.

Amount of waste disposed off-site = Column 2 of Table VI-7 x Column 6 of Table VI-8.

Number of manifests = amount of waste disposed off-site ÷ 20 tons/shipment.

Number of transporters = 3,000.

Number of incidents = 213.

Percent of facilities at Level I = Column 5 of Table VI-8.

Number of disposers = number of facilities disposing off-site + 200 TSDF's.

Unit cost of **x*** = Table IV-1.

Cost of **x*** = Table IV-2.

Capital technical costs = Table IV-3.

Level I cost of disposal = Column 3 of Table VI-8.

Level III cost of disposal = Column 4 of Table VI-8.

Level III price of TSDF — Level I price of TSDF = Table IV-4.

E. GENERATOR INDUSTRY ECONOMIC IMPACT ANALYSIS

For purposes of this report, the economic impact of the hazardous waste management regulatory Options A, B, and C is defined by the following economic impact parameters:

- plant closures,
- job losses,
- U.S. production cutbacks,
- price increases,
- U.S. demand reduction, and
- increased imports.

The degree of anticipated adverse economic impact on a generator industry segment is determined by the extent to which the regulatory options are likely to cause any of these adverse occurrences.

The analytical steps required to assess the likelihood of such adverse economic impacts are as follows:

First, the cost of the hazardous waste management regulatory options was estimated for each of the 69 segments of the 17 generator industries studied.

Second, the 17 industries and their 69 segments are characterized in terms of their size, competitiveness, and pricing flexibility according to the following indicators:

- production value,
- production volume,
- number of producers,
- number of plants,
- four-firm concentration ratio,
- unit demand growth over the next five years,

---

* Where x represents the activities of technical requirements, financial requirements, etc.

- price elasticity of demand,
- production substitution,
- import competition,
- capacity utilization, and
- profitability.

Third, the magnitude of the cost increases which each generator industry segment is likely to experience because of the regulations was determined. The expected cost increase for each segment is defined as the cost of the regulation for that segment divided by the segment's production value. The resulting percentage is an indication of the increase in product cost which firms in each industry segment face in order to cover the cost of the regulation.

Fourth, the cost increase for an industry segment having been determined, its capacity to translate the cost increase into a price increase was evaluated. The evaluation takes into account the segment's characteristics (i.e., size, competitiveness, pricing flexibility) and the percentage price increase required. If the required price increase is greater than 1-2%, it may not be possible for all the firms in an industry segment to cover the full cost of the regulatory option in question by raising their price. If substitutable products are readily available or there is significant import competition or high elasticity of demand, a weaker firm may be forced to accept a reduction in profit margin which might already be low. In such cases, adverse economic effects such as a partial or complete plant closure may result in job losses. Further, even if the price can be increased to cover the cost of the regulation, if the profitability of the whole industry segment historically has been low (implying a poor cash flow position), some plants may have to close because they cannot make the required capital investment in hazardous waste management.

Table IV-5 portrays the words used in the qualitative economic impact analysis to indicate the likelihood that the compliance costs would result in changes in the economic impact measures. The matrix differentiates the magnitude in the change and likelihood of a change. These qualititative assessment words are used on the economic impact tables in Chapter VIII. The judgmental impact assessment differentiated between very small changes in the impact measures, and larger changes. Whereas a precise dividing line was not possible because of the qualitative nature of the analysis, potential changes in the impact measures less than 0.5% generally were described as negligible even if there was a high probability of their occurrence.

In Chapter VIII, the 17 generator industries, with their 69 segments, are characterized in terms of their size, competitiveness and pricing flexibility. Then, the cost of each of the regulatory Options A, B, and C is determined. Finally, an assessment of the economic impact of the regulatory Options A, B, and C is made for each of the 69 industry segments.

TABLE IV-1

UNIT COSTS OF COMPLIANCE (PER TON)
SECTION 3004 ANNUAL OPERATING COSTS

Activity	Landfill Offsite	Landfill Onsite	Lagoon Offsite	Lagoon Onsite	Incineration Offsite	Incineration Onsite
Option A						
Technical	$ .25	$ 2.50	$ .05	$ .50	$ .23	$ 2.34
Financial	11.89	56.13	2.37	11.23	11.89	56.13
Rec/Rep	.05	.50	.01	.10	.05	.50
Mon/Test	5.24	13.20	1.05	2.64	5.32	14.00
Admin	.32	2.47	.064	.49	.32	2.47
Training	.20	1.22	.20	1.22	.20	1.22
Contingency	.61	.61	.07	.70	.32	3.20
Option B						
Technical	.23	2.31	.046	.46	.18	1.82
Financial	2.06	6.30	.41	1.26	2.06	6.30
Rec/Rep	.038	.38	.008	.08	.038	.38
Mon/Test	4.35	4.35	.87	.87	4.40	.48
Admin	.16	.90	.03	.18	.16	.90
Training	.20	1.22	.20	1.22	.20	1.22
Contingency	.61	.61	.07	.70	.32	3.20
Option C						
Technical	.23	2.31	.046	.46	.18	1.82
Financial	1.54	4.27	.308	.854	1.34	4.27
Rec/Rep	.037	.37	.007	.07	.037	.37
Mon/Test	2.56	4.05	.51	.81	2.59	4.45
Admin	.08	.80	.016	.16	.08	.80
Training	.20	1.22	.20	1.22	.20	1.22
Contingency	.61	.61	.07	.70	.32	3.20

Source: Arthur D. Little, Inc., estimates.

TABLE IV-2

UNIT COSTS OF COMPLIANCE (PER FACILITY)
SECTION 3004 ANNUAL OPERATING COSTS

	Landfill		Lagoon		Incineration	
Activity	**Offsite**	**Onsite**	**Offsite**	**Onsite**	**Offsite**	**Onsite**
Option A						
Technical	$ 0	$ 0	$ 0	$ 0	$ 0	$ 0
Financial	594,331	280,647	118,866	56,129	594,331	280,647
Rec/Rep	2,638	2,638	2,638	2,638	2,638	2,638
Mon/Test	262,000	66,000	52,400	13,200	266,000	70,000
Admin	15,927	12,327	15,927	12,327	15,927	12,327
Training	10,150	6,100	10,150	6,100	10,150	6,100
Contingency	30,350	3,350	3,400	3,400	15,800	15,800
Option B						
Technical	0	0	0	0	0	0
Financial	103,234	31,501	31,501	20,647	6,300	31,501
Rec/Rep	1,948	1,948	1,948	1,948	1,948	1,948
Mon/Test	217,733	21,733	21,733	21,733	220,233	24,233
Admin	8,099	4,497	8,097	4,497	8,097	4,497
Training	10,150	6,100	10,150	6,100	10,150	6,100
Contingency	30,350	3,350	3,400	3,400	15,800	15,800
Option C						
Technical	0	0	0	0	0	0
Financial	76,872	21,388	15,374	4,278	76,872	21,388
Rec/Rep	1,832	1,832	1,832	1,832	1,832	1,832
Mon/Test	128,283	20,283	128,283	20,283	130,783	22,783
Admin	4,028	4,497	4,028	4,028	4,028	4,028
Training	10,150	6,100	10,150	6,100	10,150	6,100
Contingency	30,350	3,350	30,350	3,350	15,800	15,800

Source: Arthur D. Little, Inc., estimates.

TABLE IV-3

INCREMENTAL INITIAL COST OF TECHNICAL EQUIPMENT FOR WASTE MANAGEMENT

	Landfill		Lagoon		Incineration	
Activity	**Offsite**	**Onsite**	**Offsite**	**Onsite**	**Offsite**	**Onsite**
Option A	$77,000	$77,000	$77,000	$77,000	$72,000	$72,000
Option B	71,000	71,000	71,000	71,000	56,000	56,000
Option C	71,000	71,000	71,000	71,000	56,000	56,000

Source: Arthur D. Little, Inc., estimates.

TABLE IV-4

INCREMENTAL PRICE OF DISPOSAL FOR OFFSITE WASTE MANAGEMENT

Type of Site	Level III – Level I Price/Ton
Landfill	$ 8.60
Incinerator	$54.00
Lagoon	$ 1.80

Source: Arthur D. Little, Inc., estimates.

TABLE IV-5

QUALITATIVE INDICATORS OF THE LIKELIHOOD OF CHANGE IN THE MEASURES OF ECONOMIC IMPACT

		% Change in the Impact Measure	
% Probability of Change in the Impact Measure		0-0.5%	0.6% and Above
	0.0	none	none
	0-10	negligible	negligible
	11-25	negligible	unlikely
	26-50	negligible	possibly
	51-75	negligible	probably
	76-100	negligible	likely

V. UNIT COMPLIANCE COSTS

A. INTRODUCTION

The estimated unit costs of compliance with the provisions of the regulations are reported in this chapter. The unit costs are for an individual compliance activity such as a single test, the cost of one secure landfill cell, or the cost of obtaining one permit. These costs are used with information on the numbers of waste generators and waste generation rates to estimate the compliance costs for the industry segments.

The major categories of unit costs are: technical; financial requirements; monitoring and testing; recordkeeping/reporting; contingency; training; and administration. Some of the unit cost estimates were developed by Arthur D. Little, Inc., as part of the economic analysis whereas others came from reports sponsored separately by EPA.

Ranges have been estimated for the unit costs and these ranges were used in the sensitivity analysis. The financial responsibility requirement costs are subject to a particularly high uncertainty because the type of insurance coverage envisaged is not generally available and future loss rates cannot be confidently projected from available data.

B. TECHNICAL

For each generator segment investigated, the unit incremental technical costs of compliance were calculated as the difference between an environmentally adequate treatment/storage/disposal (TSD) method (designated as Pathways Level III) and the current TSD method (designated as Level I). Pathways Level III and Level I defined the required change in TSD practice for each segment. Standardized costs were used for the major TSD methods: landfill, incineration, lagooning, and landfarming.

Level I TSD methods were derived primarily from the following 15 EPA reports on Assessment of Industrial Hazardous Waste Practices prepared between the years 1973 and 1976:

1. Versar, Inc., "Assessment of Industrial Hazardous Waste Practices: Storage and Primary Battery Industries," U.S. Environmental Protection Agency, Contract No. 68-01-2276 (1975).

2. Battelle-Columbus Laboratories, "Assessment of Industrial Hazardous Waste Practices: Electroplating and Metal Finishing Industries," U.S. Environmental Protection Agency, Contract No. 68-01-2264 (September 1976).

3. Wapora, Inc., "Assessment of Industrial Hazardous Waste Practices: Paints Industry," U.S. Environmental Protection Agency, Contract No. 68-01-2656 (1976).

4. Jacobs Engineering Co., "Assessment of Industrial Hazardous Waste Practices: Petroleum Refining," U.S. Environmental Protection Agency, Contract No. 68-01-2288.

5. Arthur D. Little, Inc., "Hazardous Waste Generation, Treatment, and Disposal in the Pharmaceutical Industry," U.S. Environmental Protection Agency, Contract No. 68-01-2684 (1976).

6. Calspan Corporation, "Assessment of Industrial Hazardous Waste Practices in the Metal Smelting and Refining Industry," U.S. Environmental Protection Agency, Contract No. 68-01-2604.

7. Foster D. Snell, Inc., "Assessment of Industrial Hazardous Waste Practices: Rubber and Plastics Industry," U.S. Environmental Protection Agency, Contract No. 68-01-3194.

8. SCS Engineering, Inc., "Assessment of Industrial Hazardous Waste Practices: Leather Tanning and Finishing Industry," U.S. Environmental Protection Agency, Contract No. 68-01-3261 (November 1976).

9. Wapora, Inc., "Assessment of Industrial Hazardous Waste Practices: Special Machinery and Manufacturing," U.S. Environmental Protection Agency, Contract No. 68-01-3193.

10. Versar, Inc., "Assessment of Industrial Hazardous Waste Practices: Textiles Industry," U.S. Environmental Protection Agency, Contract No. 68-01-3178 (June 1976).

11. Midwest Research Institute, "A Study of Waste Generation, Treatment, and Disposal in the Metals Mining Industry," U.S. Environmental Protection Agency, Contract No. 68-01-2665.

12. Swain, Jr., John W., "Assessment of Industrial Hazardous Waste Management Practices: Petroleum Rerefining Industry," U.S. Environmental Protection Agency Consultant.

13. TRW Systems Group, TRW, Inc., "Assessment of Hazardous Waste Practices: Organic Chemicals, Pesticides, and Explosives Industries," U.S. Environmental Protection Agency, Contract No. 68-01-2919 (1976).

14. Versar, Inc., "Assessment of Industrial Hazardous Waste Practices: Inorganic Chemical Industry," U.S. Environmental Protection Agency, Contract No. 68-01-2246.

15. Wapora, Inc., "Assessment of Industrial Waste Practices: Electronic Components Manufacturing Industry" (January 1977).

Level I, as defined in the assessment reports, corresponded to the TSD method in most common use at the time the reports were prepared. Unit Level I TSD costs given in the reports for each industry segment were converted to January 1977 dollars using the Chemical Engineering Plant Cost Index. In cases where initial estimates of impacts appeared to be unusually high, or where there was reason to believe that hazardous waste management practice had changed since preparation of the assessment reports, plant managers were contacted by telephone for updated Level I information. In many industry segments some of the plants were using environmentally adequate technology. Incremental technical costs were assigned only to that fraction of the industry reported as using an environmentally inadequate Level I technology. (In rare instances, Level I was equivalent to Pathways Level III, and already in conformance with subsequently proposed RCRA regulations.)

The environmentally adequate TSD method for each waste stream was identified, for purposes of this impact analysis, with the Pathways Level III (PA Level III) approach specified by Battelle[1]. Pathways Level III corresponds to technology acceptable under the proposed RCRA regulations for generic types of wastes (e.g., heavy metal sludges, organic still bottoms, mining and mineral tailings, etc.), irrespective of the industrial source. All of the hazardous waste streams identified in the aforementioned assessment reports have been assigned to one of the following PA Level III methods: secure chemical landfill; controlled incineration; landfarming; lined lagoon; deepwell injection (one waste); ocean disposal (one waste); and several recycling processes specific to particular waste streams. Unit costs for each PA Level III method were estimated as follows:

Unit costs for disposal of wastes in PA Level III secure (chemical) landfills are given in Table V-1 as a function of landfill capacity. The costs are representative of a landfill with six-meter-deep trenches which are lined with impermeable barriers and equipped with leachate collection and treatment facilities. The unit costs include both capital amortization and operation and maintenance.

TABLE V-1

UNIT COSTS FOR SECURE LANDFILL DISPOSAL AS A FUNCTION OF SITE CAPACITY

Landfill Capacity (MT/Yr)	Unit Disposal Cost ($/MT)*
< 3,500	55
4,200	50
4,800	45
5,400	42
6,000	38
7,200	33
12,000	29
19,200	25
30,000	20
> 70,000	15

*January, 1977, dollars

Source: "Cost of Compliance with Hazardous Waste Management Regulations," Battelle Columbus Laboratories, October 12, 1977.

1 Battelle Columbus Laboratories, "Cost of Compliance with Hazardous Waste Management Regulations," U.S. Environmental Protection Agency, Contract No. 68-01-4360 (1978)

For the wastes from each industry segment assigned to secure landfill under PA Level III, unit costs were estimated from Table V-1 as follows. The total annual waste generated by the industry segment was divided by the number of plants in the industry segment to obtain an average annual quantity of waste per plant. For those plants disposing on-site, the landfill capacity was assumed to be equal to the average quantity of waste per plant, and the unit costs were interpolated from Table V-1. For plants generating more than 3500 MT/year and disposing off-site, a minimum disposal cost of $15/MT was assigned, corresponding to disposal at a very large landfill facility. For plants generating less than 3500 MT/year, a disposal cost of $55/MT was assigned, corresponding to off-site disposal at a relatively small facility.

Unit costs of PA Level III incineration for organic chemical, pesticide and explosives wastes (Table V-2) were obtained from a recent EPA report[1]. For other wastes assigned to PA Level III incineration, unit costs of $100/MT and $200/MT were used for non-halogenated and halogenated wastes, respectively. These estimates are based on a review of current charges by contract disposal firms and an analysis of field experience[2].

Unit costs of landfarming, the PA Level III method assigned to many petroleum refining industry wastes, were derived from the industry assessment study. These were updated to 1977 dollars using the Chemical Engineering Plant Cost Index. The results are plotted in Figure V-1.

Lagoons or tailing ponds were selected as the PA Level III approach for metals smelting and refining wastes (i.e., some or all of the wastes from primary iron and steel, ferroalloys, primary copper, primary zinc, primary antimony, secondary copper, secondary lead, and secondary aluminum), and for wool scouring, woven fabric, and knit fabric wastes.

For metals smelting and refining wastes, the PA Level III lagoon costs were estimated from prior EPA studies. For the three textile industry segments likely to use lined lagoons, the calculated PA Level III costs were based on costs for metals smelting and refining lagoons of similar capacity. The resultant estimates, which range from $3.50 to $8.60 per MT for lined lagoons handling from 1,203,000 to 150,000 MT/year respectively, are believed to be conservative.

C. FINANCIAL REQUIREMENTS

TSD facilities must demonstrate the availability of financial resources to settle claims arising from release of hazardous waste into the environment (financial responsibility) as well as to provide for site closure and long-term care. The costs of compliance with the financial requirements provisions of the act fall into the following categories:

- A trust fund for closure costs;
- A trust fund for post-closure monitoring and operating costs (disposal facilities only); and
- Site life liability insurance or other proof of financial responsibility.

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1 Battelle Columbus Laboratories, "Cost of Compliance with Hazardous Waste Management Regulations," U.S. Environmental Protection Agency, Contract No. 68-01-4360 (1978).

2 Arthur D. Little, Inc /TRW Defense and Space Systems Group, "Destroying Chemical Wastes in Commercial Scale Incinerators," U.S. Environmental Protection Agency, Contract No. 68-01-1966 (1977).

TABLE V-2

ESTIMATED REPRESENTATIVE COSTS FOR INCINERATION OF ORGANIC CHEMICALS, PESTICIDES, AND EXPLOSIVES INDUSTRIES WASTE STREAMS IN TYPICAL PLANTS[a, b]

Stream No.	Product and Typical Plant Size	Annual Amount Waste, MT	Wet Waste Feed Rate to Incinerator, MT/hr	Approx. Ht. Value KgCal/Kg	Type Incinerator [a]	Installed Incinerator System Cost[a], $	Annual Capital Costs, $	Annual Utility Cost, $	Annual Maintenance Cost, $	Annual Labor Cost, $	Unit Annualized Capital Costs, $/MT	Unit Annualized Operating & Maintenance Costs, $/MT	Unit Combined Capital $ O&M Costs, $/MT
1	Perchloroethylene 39,000 MT/year	12,000	1 700	2,200	Fluid bed reactor	1,276,000	306,000	134,000	52,000	49,000	25 5	19 2	45
3	Chlorinated solvents[c] 50,000 MT/year Chloromethane	300	0.042	1,800	Rotary kiln	184,000	48,000	6,400	8,000	24,300	160	129	288[c]
4	Epichlorohydrin 75,000 MT/year	4,000	0 560	2,700	Fluid bed reactor	938,000	225,000	25,000	37,500	49,000	56.3	27 8	84
5	Toluene diisocyanate 27,500 MT/year	558	0 078	7,200	Rotary kiln	173,000	42,000	7,000	7,000	73,000	75 3	156	231
6	Vinyl chloride monomer 136,000 MT/year	1,400	0 660	4,100	Fluid bed reactor	946,000	228,000	8,000	38,000	17,000	163	45	208
7	Methyl methacrylate 55,000 MT/year	4,730	0 660	7,200	Liquids incinerator	371,000	89,200	11,300	15,000	24,000	18 9	10 6	30
8	Acrylonitrile[c] 80,000 MT/year	160	0 055	8,400	Liquids incinerator	153,000	37,000	5,000	6,100	8,000	231	119	350[c]
9	Maleic anhydride 11,000 MT/year	333	0 047	4,800	Rotary kiln	160,000	38,600	3,000	6,400	73,000	116	247	363
11	Ethanolamines mfr. 14,000 MT/year	1,120	0 155	7,300	Rotary kiln	198,000	47,500	5,000	8,000	73,000	42 4	76.8	119
12	Furfural mfr 35,000 MT/year	19,600	2 720	7,400	Fluid bed incinerator	1,699,000	408,000	110,000	68,000	49,000	20 8	11 6	32
16	Chlorobenzene mfr 32,000 MT/year	1,400	0 195	2,500	Rotary kiln	205,000	49,200	5,000	8,200	73,000	35.1	61 6	97
18	Trifluralin mfr 10,000 MT/year	1,150	0 160	5,600	Rotary kiln	225,000	54,100	5,000	9,000	73,000	47 0	75 6	123
19	Malathion mfr 14,000 MT/year	1,826	0.255	8,000	Rotary kiln	313,000	75,000	6,000	12,500	73,000	41 1	50 1	91
21	Parathion mfr 20,000 MT/year	2,300	0 320	2,600	Rotary kiln	282,000	67,500	7,000	11,300	73,000	29 3	39 7	69
22	Explosives mfr, 93,000 MT/year (TNT)	350	0.042 0 071	3,300	Rotary kiln	649,000	115,800	11,000	26,000	113,000	445	429	874
23	Explosives mfr 30,000 MT/year (TNT)	15,000	2 090	—	Tampella process included	13,200,000	3,168,000	110,000	528,000	219,000	211	57 1	268
24	Explosives mfr 125,000 MT/year	250	0 052	2,600	Rotary kiln	544,000	130,000	11,000	21,700	113,000	520	583	1,103

(a) Data were taken or derived from Alternatives document dealing with the Organic, Pesticides, and Explosives Industries, Reference 25

(b) The overall incinerator system cost includes a packed column scrubber The capital costs include (1) interest at 10%/year, (2) straightline depreciation over a 10-year period or 10%/year, and (3) taxes and insurance at 4% of installed capital cost

(c) Costs for treatment and disposal for the waste streams are based on 300 operating days per year and three shifts per day except for Streams 3 and 8 which were processed on a 1-shift/day basis.

Source Versar, Inc, "Alternatives for Hazardous Waste Management in the Inorganic Chemicals Industry" U S Environmental Protection Agency, Contract Number 68-01 4190 (January, 1977) (Draft)

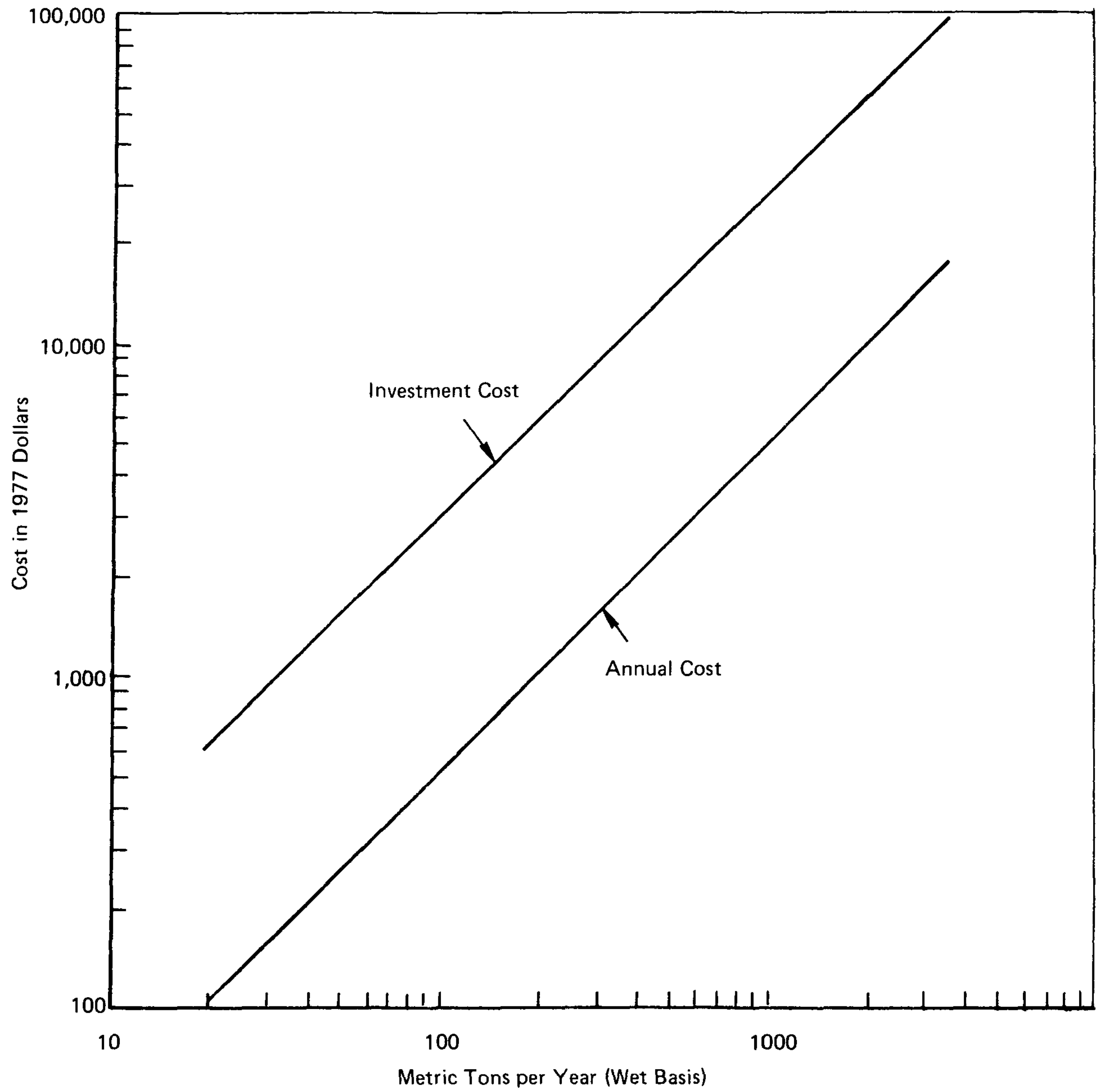

FIGURE V–1 ANNUAL AND INVESTMENT COSTS FOR LANDFARMING OF PETROLEUM WASTES (1977 DOLLARS)

A trust fund for closure cost is required under all three options. The trust fund for post-closure monitoring and maintenance differs for each option while the site life financial responsibility costs differ with respect to required liability level.

1. Insurance Premium Cost

Annual insurance premium costs will differ with financial responsibility liability requirements; Options A and B require a liability level of $5 million per occurrence whereas Option C requires a liability level of $2 million.

Another difference among the options that results in different cost is the requirement for post-closure financial responsibility. Under Option A, annual liability insurance premiums are part of the annual post-closure costs; neither Option B nor Option C requires post-closure financial responsibility.

Liability insurance for non-sudden occurrences is not generally purchased and has not been available until recently. Therefore, the cost of insurance to cover liability for non-sudden occurrences represents an incremental cost of compliance with RCRA because it would not be covered by TSDF's existing insurance policies.

A currently available insurance product that will probably fulfill RCRA financial responsibility requirements is called an "Environmental Impairment" policy and is written on a "claims made" basis, where claim is defined as "any single claim or any series of claims resulting from one and the same isolated, repeated or continuing environmental impairment."[1] It is a liability coverage (i.e., it provides for damages to persons or property other than that of the TSD facility operator and his employees), and the price will not be directly proportional to size. Further, the current pricing is based totally upon subjective views of the underwriter because data necessary for an actuarial estimate are not available.

In the view of a broker placing the Environmental Impairment Coverage,[2] the smaller generator-owned and operated TSD facilities (5,000 M^3 per year of waste) could expect a premium of about $20,000 per year for a $4 million per claim, $8 million aggregate liability coverage, whereas a large TSD facility in the business of handling wastes from all sources could expect a premium of about $80,000 per year.

In the latter case, according to the broker, a corporate entity could have the same premium cost to cover one large site or more than one large site; the maximum deviation in premium from perceived risk would be on the order of plus or minus 15% around those levels. For a liability limit of $5 million per claim the premium would probably be about the same as the $4 million/$8 million. For a liability limit of $2 million, the premium for each type/size of TSDF would be about 25% less, or $15,000 for a small generator TSDF and $64,000 for a large TSDF. These premium costs have been used in the analysis of compliance cost on the assumption that the RCRA definition of "occurrence" and the Environmental Impairment policy definition of "claim" are compatible.

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1. "Environmental Impairment Liability Insurance," brochure distributed by Wohlreich & Anderson Group Ltd., Cranford, New Jersey.
2. Howden Agencies Ltd., Cranford, New Jersey.

2. Cost of Site Closure

All RCRA options require that TSDF's be closed in such a manner that the land is amenable to some productive use by the time of closure. This requirement implies that some restoration of a TSDF may be necessary, and that TSDF's utilizing large land areas will incur higher incremental costs to comply with RCRA closure requirements than hazardous waste treatment facilities such as incinerators.

The closure requirements of RCRA resemble those for strip mines, in the sense that both types of operations must restore the land to usable condition. Closure deposit fund regulations were therefore evaluated for their potential application to estimating RCRA closure deposit costs. Figure V-2 illustrates the closure fund requirements for the Commonwealth of Pennsylvania, where there is a minimum closure fund of $1,000 per acre for mines up to 60 acres, and an increasing rate per acre thereafter. Landfills are generally smaller in area than strip mines and usually represent shallower excursions into the ground (i.e., smaller volume displaced).

Extrapolating the closure schedule in Figure V-3 backward will yield a range of cost indicated by the shaded area. From this analysis, a cost of $500 per acre was selected as the closure fund size for landfills. This produces a closure fund ranging from $8,700 to $74,000 for the facility sizes[1] examined.

For other facilities which treat or store hazardous waste, a closure cost of $8,000 per facility was used, as cited in a study as the cost of closure estimated by the state of Oregon.[2]

3. Post-Closure Monitoring and Operation

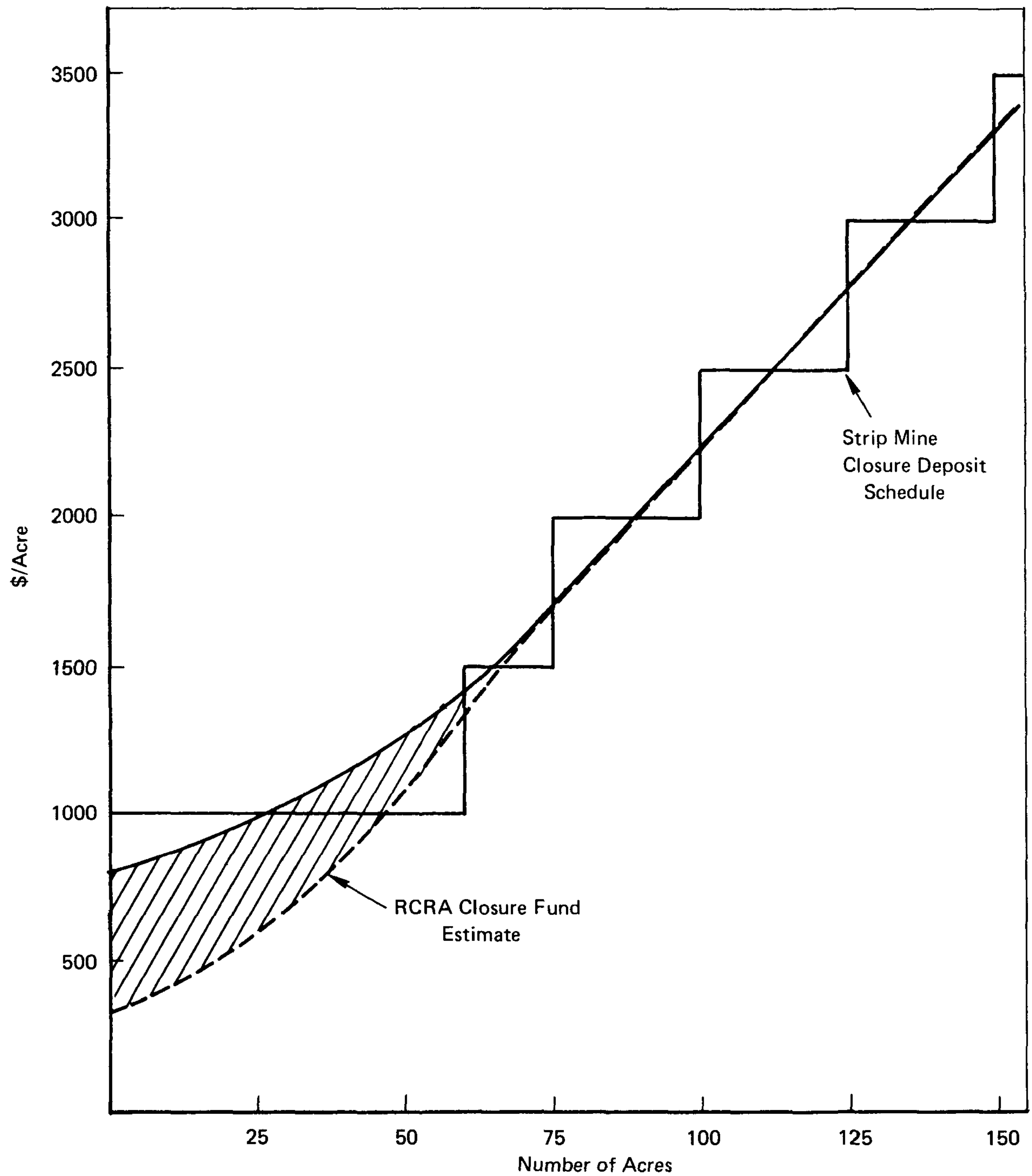
The annual costs of monitoring (Section V-D) were assumed to be the same during the active life of a landfill and after a landfill was closed under all three options studied. Also, the maintenance/inspection program will be similar during landfill life and after the landfill closes (landfills).

4. Total Financial Requirements Costs

The cost of the financial requirements of Section 3004 will vary from facility to facility under each option studied. Figure V-3 illustrates the interaction of the components of financial requirements and the factors which influence closure funds, post-closure funds and annual insurance costs.

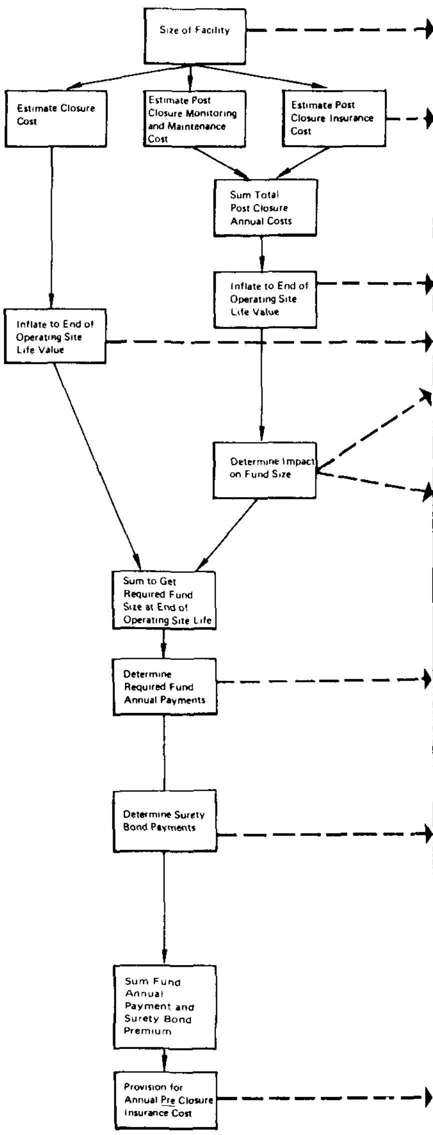
Under Option A, each disposal facility is required to set up an individual secured trust fund to provide for site closure, as well as post-closure monitoring, maintenance and financial responsibility for liability for a period of 40 years. The TSDF owner estimates the cost of closure, post-closure, financial responsibility, monitoring and maintenance and then determines fund size as indicated in Section E of Figure V-3, using a real interest of 1.852%. For example, since 40 years of post-closure care are required, the annual post-closure costs are multiplied by 28.08 and added to

1. See Table V-3 through V-5.
2. Hazardous Waste Management Issues Pertinent to Section 3004 of the Resource Conservation and Recovery Act of 1976, report to the Environmental Protection Agency by International Research and Technology Corporation, September 1977, p. II-8.



Source: Strip Mine Closure Deposit Schedule from Division of Mine Reclamation, Commonwealth of Pennsylvania; RCRA Fund Estimates – Arthur D. Little, Inc., Estimates.

FIGURE V–2 RELATIONSHIP BETWEEN CLOSURE FUND SIZE/ ACRE AND FACILITY SIZE



Reference	Impacting Elements	Levels Evaluated	Formula for Calculation	Factors
A		5 000 M^3 50 000 M^3		
B	– Facility Size – Insured Liability Level	$2M, $5M	Consult Appropriate Insurance Table	
C	Fund Coverage			
D	– Operating Site Life – Inflation Rate	10 year, 20 year, 6%	$X(1+i)^T$ Where i = Inflation Rate T = Operating Site Life	i = 06, T = 10 ⇨ 1 79 i = 06, T = 20 ⇨ 3 21
E	– Perpetual Post Closure Fund Life – Interest Rate	1 5% 1 852%	$S_T = \frac{Q}{r}$ Where S_T = Required Fund Size at End of Operating Life r = Interest Rate Q = Yearly Post Closure Expense Payments	r = 015 x 66 7 r = 01852 x 54 r = 02, + = 10 Year ⇨ 8 98
	– Finite Post Closure Monitoring and Maintenance Fund Life – Interest Rate	10 Year, 20 Year 40 Year 1 5%, 1 852%, 2 0	$S_T = Q \left[\frac{(1+r)^t - 1}{r}\right] \left[\frac{1}{(1+r)}\right]^t$ Where t = Post Closure Monitoring Life	r = 020, t = 20 year ⇨ x 16 35 r = 01852, t = 40 year ⇨ x 28 08
F	– Number of Years to Build Fund – Operating Site Life	5 Years ½ Site Life Full Site Life 10 Years, 20 Years	$A_x = S_T\left[\frac{r}{(1+r)\,[(1+r)^x - 1]}\right]\left[\frac{1}{(1+r)}\right]^{T-x}$ Where S_T = Size of Fund Required at End of Operating Site Life r = Interest Rate x = Number of Years of Payments A_x = Required Annual Payment During First x Years of Operation	X = 5, T = 10 ⇨ 173 X = 5, T = 20 ⇨ 153 X = 10, T = 10 ⇨ 090 X = 10, T = 20 ⇨ 075 X = 20, T = 20 ⇨ 041
G	– Number of Years to Build Fund	5 Years ½ Site Life, Full Site Life	$C_n = b\left[S_x \sum_{x=1}^{n} A_x(1+r)^x\right]$ Where r = Interest Rate C_n = Annual Cost of Surety Bond in Year n x = Number of Years to make Payments A_x = Required Annual Payment During First x Years of Operation b = Surety Bond Premium Expressed as a Proportion of Face Value	
H			F + G	
I	– Facility Size – Insured Liability Level	$2M, $5M	Consult Appropriate Insurance Table	

FIGURE V–3 FRAMEWORK FOR COST ANALYSIS OF FINANCIAL RESPONSIBILITY OPTIONS

the site closure cost to obtain the total size of the fund. The fund is built up over the first half of site life and thus the operator determines the annual payments as a function of site life. For example, the portion of the total fund contributed annually for a site with a 10-year life will be 17.3%. The site is required to post a surety bond for the difference between the fund size and the sum of the annual contributions made to date, as shown in Block H of Figure V-3. In addition, all TSDF operators must provide for financial responsibility during site life for $5 million per occurrence for claims arising from release of hazardous waste.

Option B differs from Option A in the following respects:

- There is no provision for post-closure financial responsibility for liability.
- Surety bonds are not required.
- Post-closure care must be provided for 20 years.
- The regulation specifies a "real" rate of interest of 2%.

Option C differs from Option A and is similar to Option B in that:

- There is no provision for post-closure financial responsibility for liability.[1]
- Surety bonds are not required.
- Post-closure care is required for 10 years.
- The regulation specifies a real interest rate of 2%.
- The liability coverage required is $2 million.

The unit and annualized costs of compliance are portrayed for selected disposal facilities in Tables V-3-V-5. Each variation in facility site life will generate a variability in annual cost: under all three options a facility with a 10-year site life will have substantially higher annual costs than a facility with a 20-year life. Therefore, an average of the 10-year and 20-year site life costs was used in the analysis.

The costs of compliance vary considerably by Option. Option A is by far the most costly at $56.13 M^3 for a small facility and $11.89 M^3 for a large facility. Whereas Option C is less costly than Option B, the differential is not nearly as large as that between Options A and B.

D. MONITORING AND TESTING COSTS

1. Introduction

Most of the testing costs will be incurred in connection with Section 3004 as part of the ongoing operations of TSD Facilities. In addition, testing may also be carried out in connection with the requirements for the identification of hazardous wastes under Section 3001. Some of the tests specified are accepted standard tests carried out routinely by commercial laboratories. Quoted prices for standard tests have been used in this report. Other tests are not widely accepted and unit costs have been estimated by Arthur D. Little, Inc., based on waste sampling and analysis.

1. Post-closure financial responsibility for liability is to be covered by legislation creating a National Trust Fund.

TABLE V-3

FINANCIAL REQUIREMENTS – UNIT COSTS

OPTION A

	5,000M³ 10-Year	5,000M³ 20-Year	50,000M³ 10-Year	50,000M³ 20-Year
Post-Closure/Closure Fund				
1. Closure Cost	8,700	17,400	87,000	174,000
2. Post-Closure Monitoring	40,600	40,600	40,600	40,600
3. Post-Closure Maintenance	10,950	10,950	10,950	10,950
4. Post-Closure Liability Insurance	20,000	20,000	85,000	85,000
5. Total Fund				
a. Closure	8,700	17,400	87,000	174,000
b. Recurring	71,550	71,550	136,550	136,550
40-Year Total	2,017,824	2,026,524	3,921,324	4,008,324
6. Annual Contribution	349,084	151,989	678,389	300,624
7. Surety Bond	10,089	10,132	19,607	20,042
8. Insurance Premium	20,000	20,000	85,000	85,000
9. Average Annual Cost	379,173	182,121	782,996	405,666
Average	$280,647		$594,331	
$/M³	$56.13		$11.89	

Source: Arthur D. Little, Inc., estimates.

TABLE V-4

FINANCIAL REQUIREMENTS – UNIT COSTS

OPTION B

	5,000M³ 10-Year	5,000M³ 20-Year	50,000M³ 10-Year	50,000M³ 20-Year
Post-Closure/Closure Fund				
1. Closure Cost	8,700	17,400	87,000	174,000
2. Post-Closure Monitoring	7,000	7,000	7,000	7,000
3. Post-Closure Maintenance	3,120	3,120	3,120	3,120
4. Post-Closure Liability Insurance	––	––	––	––
5. Total Fund				
a. Closure	8,700	17,450	87,000	174,000
b. Recurring	10,120	10,120	10,120	10,120
40-Year Total	172,846	181,546	251,146	338,146
6. Annual Contribution	15,556	7,443	22,603	13,864
7. Surety Bond	––	––	––	––
8. Insurance Premium	20,000	20,000	85,000	85,000
9. Average Annual Cost	35,556	27,443	107,603	98,864
Average	$31,501		$103,234	
$/M³	$6.30		$2.06	

Source: Arthur D. Little, Inc., estimates.

TABLE V-5

FINANCIAL REQUIREMENTS
UNIT COSTS

OPTION C

	5,000M³ 10-Year	5,000M³ 10-Year	50,000M³ 10-Year	50,000M³ 20-Year
Post-Closure/Closure Fund				
1. Closure Cost	8,700	17,400	87,000	174,000
2. Post-Closure Monitoring	6,500	6,500	6,500	6,500
3. Post-Closure Maintenance	3,120	3,120	3,120	3,120
4. Post-Closure Liability Insurance	–	–	–	–
5. Total Fund				
a. Closure	8,700	17,400	87,000	174,000
b. Recurring	9,620	9,620	9,620	9,620
– Year Total	94,800	103,500	173,100	260,100
6. Annual Contribution	8,532	4,244	15,579	10,664
7. Surety Bond	–	–	–	–
8. Insurance Premium	15,000	15,000	63,750	63,750
9. Average Annual Cost	23,532	19,244	79,329	74,414
Average	$21,388		$76,872	
$/M³	$4.27		$1.54	

Source: Arthur D. Little, Inc., estimates.

Under Section 3004, which requires an examination for hazardous contaminants in groundwater and, in some cases, in surface water and ambient air, monitoring costs will be borne by operators of TSDF's.

The following section describes the unit costs associated with each of these activities. Option B is discussed in detail, and significant differences with Options A and C are indicated.

2. Section 3001, Testing Costs

A testing protocol can be divided into three phases:

- Sampling,
- Sample preparation, and
- Analysis.

Costs for sampling and sample preparation are associated primarily with the physical characteristics of the waste, whereas the cost of analysis is determined by the chemical characteristics. Those wastes which are complex mixtures will invariably require more costly sampling and analysis.

a. Option B.

Section 3001 requires an initial determination of whether a waste is hazardous. This determination can be accomplished in several ways. If the waste is identified in the lists (Section 3001, Part 250.14[1] testing is not required unless the generator wishes to apply for an exclusion. If the waste is not listed the generator may wish to test the waste to determine whether it is hazardous on the basis of characteristics specified in the regulations. It is assumed that many generators will apply the lists and that only about 10% of the total waste generated will be subjected to testing.

The waste must be tested against one or more of the following characteristic(s), as applicable (see part 250.13):

- Ignitable
- Corrosive
- Reactive
- Toxic.

From an evaluation of the test protocol, the unit testing costs were derived as shown in Table V-6. The estimate ranges from $455 to $1,000, with an average of $750.

TABLE V-6

SECTION 3001. UNIT COSTS FOR TESTING USING THE SECTION 3001 PROTOCOL (dollars)

Test Characteristic	Option A	Option B	Option C
(a) Ignitable Waste	25-50	25-50	25-50
(b) Corrosive Waste	30-100	30-100	30-100
(c) Infectious Waste	–	–	–
(d) Reactive Waste	50-100	50-100	50-100
(e) Radioactive Waste	30-50	–	–
(f) Toxic Waste			
Sampling	50-250	50-250	–
Extraction Procedure	100-200	100-200	–
Metabolic Activation	400-1,200	–	–
Genetic Damage (bacteria)	200-300	–	–
Genetic Damage (enkaryotic organisms)	400-600	–	–
Bioaccumulation	50-100	–	–
Testing against drinking water standards	–	200-300	–
Subtotal for toxic wastes	1,200-2,650	350-750	0
Total	1,335-2,950	455-1,000	105-250
Average cost used in model calculations	1,900	750	175

b. Option A.

Unit testing costs associated with Option A are higher because additional characteristics must be determined. Tests are required for radioactivity, bioaccumulation and genetic activity

1. All quotations of section and part refer to the proposed regulations published in the *Federal Register* Part IV, Monday, December 18, 1978, p.589 et seq.

(as specified in part 250.15 and Appendices VIII, X, XI). Unit costs under Option A are estimated to range from $1,335 to $2,950, with an average of $1,900.

c. Option C.

Unit testing costs are reduced under Option C, by elimination of the testing for toxicity, to a range of $105 to $250, with an average of $175.

3. Section 3004, Testing Costs

The regulations in Option B, Part 250.43, require that all shipments of waste for disposal be tested according to a protocol which describes a *minimal* test [250.43 (h)]. In addition a *detailed* analysis is to be obtained or repeated as necessary [250.43 (g)]. The following assumptions were made as to the number and cost of testing at TSDF's (off-site disposal):

Per TSDF site:

2,000 (20 tons each) shipments per year
A detailed test for 10% of the shipments
A minimal test for 90% of the shipments
Comprehensive test, per sample, cost $200-$800, average $500
Minimal test, per sample, cost $40-$80, average $60
Therefore, total annual costs $112,000-$304,000, average $208,000.

The regulations do not differentiate between on-site and off-site disposal. In general, on-site disposers have smaller quantities for disposal; the disposal process may be continuous, and the "shipments" therefore not identifiable; and the hazardous characteristics of the waste will be better known. Unit costs for on-site disposal have been estimated on the basis of the following assumptions.

Per TSDF site:

- Three different wastes for disposal
- A comprehensive test quarterly
- A minimal test weekly
- Comprehensive test, per sample, cost $200-$800, average $500
- Minimal test, per sample, cost $20-$50, average $35
- Therefore, total annual costs $15,400-$17,100, average $11,250

a. Option A.

Option A specified a *detailed* analysis of each type of waste from each source. The testing protocol and frequency of sampling were not specified. It was assumed that the cost of a detailed analysis could range from $400 to $2,000, but would generally be close to $500.

b. Option C.

No change from Option B.

4. Section 3004, Monitoring Costs

a. Option B

Option B calls for monitoring of leachate, groundwater and in some instances air emissions and soil contamination. The unit costs are summarized in Table V-7.

TABLE V-7

AVERAGE TESTING AND MONITORING COSTS (per site) ASSOCIATED WITH SECTION 3004 (dollars)

	Option A[1]	Option B	Option C
Testing			
off-site disposal	208,000	208,000	208,000
on-site disposal	11,250	11,250	11,250
Monitoring			
Leachate (Zone of Aeration)			
Capital Cost	1,000	1,000	1,000
Annual Cost, First year	1,200	6,600	6,600
Annual Cost, Subsequent years		1,000	500
Groundwater (Zone of Saturation)			
Capital Cost	15,000	15,000	15,000
Annual Cost, First year	2,400	13,200	13,200
Annual Cost, Subsequent years		2,000	1,000
Surface Water		not required	not required
Capital Cost	6,000		
Annual Cost	33,000		
Air Monitoring			
Incinerators, Capital Cost	50,000	40,000	40,000
Incinerators, Annual Cost	8,000	6,500	6,500
Other TSD, Capital Cost	55,000	55,000	55,000
Facilities, Annual Cost	4,000	4,000	4,000
Soil Monitoring (land farms)	38,500	38,500	38,500

1. Option A has no additional first-year costs.

(1). Groundwater Monitoring (Zone of Saturation)

This regulation (250.43-8a) requires that four monitoring wells be constructed, one background well situated in an area hydraulically up-gradient from the facility and three wells hydraulically down-gradient from the facility. Each well is to be constructed to allow sample collection to detect leachate which may have penetrated the saturated zone. Each well must be able to sample from more than one depth, if necessary, and it was assumed that 2-3 wells on average will require sampling at two depths (i.e., a total of 6-7 samples per site).

Costs for installation of groundwater monitoring wells also vary with the site geology and the extent to which the geology and depth of groundwater have been previously determined. Typically, a number of exploratory wells must be dug and tested at each site in order to map the site in detail. From the results of this survey the final monitoring wells can then be located and drilled.

Data in a recent EPA study of groundwater monitoring[1] indicate that the capital costs for site exploration, drilling and installation of monitoring wells will range from about $5,000 to $25,000, with an average of $15,000.

The regulations further specify:

- A comprehensive analysis before operating facility;
- Comprehensive analysis *monthly,* first year;
- Comprehensive analysis *annually,* subsequent years; and
- Minimal analysis *quarterly,* subsequent years.

The requirements for comprehensive and minimal analysis are defined in part 250.43-8(c). Sampling costs of $25 to $100 (average $50) to collect 6-7 samples were assumed. Samples from the three down-gradient wells are then composited for a single analysis, in addition to the analysis for the background well.

Comprehensive analysis = $300 to $1,000, average $500
Minimal analysis = $50 to $150, average $100

The overall costs for groundwater monitoring (excluding capital costs) are as follows:

Per TSDF Site:

- First year, $7,800 to $26,400, average $13,200
- Subsequent years, $1,250 to $3,700, average $2,000.

It is assumed that 10% of the disposal sites will have no groundwater or will lie over a saline aquifer; therefore, only 90% of sites will require a groundwater monitoring system.

(2). Leachate Monitoring (Zone of Aeration)

Option B [part 25.43-8(b)] requires zone of aeration monitoring unless a leachate detection and removal system is installed below the disposal site.

The following assumptions were made to determine the number of sites requiring leachate monitoring in the zone of aeration:

a. Ten percent of sites have no groundwater or lie over a saline aquifer.

   Therefore, these do not require zone of aeration monitoring.

b. Ten percent of sites have either natural clay base or clay liner and synthetic liner.

   These require zone of aeration Monitoring.

c. Eighty percent of sites have clay liner with leachate collection system; these require leachate sampling. 25% (20% of *total* sites) will get leachate and require leachate sampling and analysis.

1. *"Ground-Water Monitoring,"* Geraghty & Miller, Inc., under EPA contract 68-01-3703, May 1978

Sampling of leachate by using a pressure lysimeter would be the preferred method for those sites which do not have a leachate collection system.[1] Costs incurred are related to the type and variety of the geologic formations underlying the site and the depth of the unsaturated zone. It may be impractical to provide a sample point underneath the waste and thereby require more lysimeters adjacent to the waste. It was assumed that on average such sites will require 1 to 3 pressure lysimeters installed in 6" boreholes within 30 feet of the surface. Cost of equipment and installation is estimated at $500 to $1,500 (average of $1,000) for each disposal cell. For those sites which have a leachate collection system, the capital costs are incorporated into the costs for construction of that particular design.

Analysis requirements are the same for either approach. The regulations specify monthly comprehensive analysis the first year, with quarterly minimal analysis and an annual comprehensive analysis thereafter. Assuming that a TSD site has an average of five cells and the five samples are composited for analysis, the 30% of the total sites requiring sampling and analysis have the following costs:

Per TSDF Site:

- First year, $3,900 to $13,200, average $5,500
- Subsequent years $575 to $1,900, average $1,000.

Landfarms are to be monitored by taking soil cores annually, one per acre, and analyzing the lower one-third [250.45-5(e)]. Information in a recent report[2] suggests that landfarms vary in size from 20 to 50 acres, with an average of 35 acres (i.e., 40-100 samples/year). Assuming that the toxicant extraction procedure and analysis described in Section 3001, part 250.13 (d) is applicable, the cost for each sampling and analysis is $350 to $750 and the average $550.

Per TSDF Site:

Cost for soil sampling and analysis is $14,000 to $75,000, and the average is $38,500.

(3). Air Monitoring

Incinerators are required to continuously monitor the temperature and carbon monoxide content of the exhaust emissions. The following costs were assumed:

Per TSDF Site:

- Capital costs $30,000 to $50,000, average $40,000
- Operating costs $3,000 to $10,000, average $6,500.

Some facilities (landfills, landfarms and surface impoundments) may choose to dispose of ignitable, reactive, volatile or incompatible wastes. These sites require air monitoring to ensure that the nonpoint source emissions from the facility do not contribute air emissions to the atmosphere that exceed limits prescribed in 250.45. The preamble to Section 3004 states under

1. *Ground-Water Monitoring*, Geraghty & Miller Inc., under EPA contract 68-01-3703, May 1978
2. *Land Cultivation of Industrial Wastes and Municipal Solid Wastes*, Vol. I, T. Phung, et al., SCS Engineers, August 1978, EPA-600/2-78-140a.

Air Monitoring that air sampling procedures are under development by EPA.[1] On the basis of information supplied by EPA concerning a method which measures emissions at the surface, the following assumptions were made:

Capital costs of sampling and analysis = $47,000 to $62,000, average $55,000

Cost per sample for sampling and analysis = $100 to $300, average $200. Five analyses will be done per site each quarter.

Per TSDF Site:

Sampling and analysis cost $2,000 to $6,000, average $4,000. It was assumed that about 5% of all sites will require air monitoring.

b. Option A.

The requirements for groundwater monitoring (zone of saturation) are similar to those of Option B except that the comprehensive analysis is expanded to include secondary drinking water standards and other hazardous materials in the waste. This will increase the unit cost of comprehensive analysis to about $400 to $1,000 with an average of $700. There are no specified requirements for additional monitoring during the first year.

Per TSDF Site:

Annual costs for sampling and analysis are $1,300 to $3,500, average $2,400.

Option A additionally has requirements for surface water monitoring. The details of installation and operation are not specified. The following have been assumed:

- A total of 2 to 6 stations per site, average 4
- Monitoring after major rainfall events, but at least quarterly, i.e., 4 to 20 times/year, average 10
- A total of 8-120 samples/year, average 40
- Cost of equipment and installation, per station = $1,000 to $2,000, average $1,500
- Cost of operation and maintenance = $4,000 to $6,000, average $5,000
- Cost of sampling and analysis per sample = $400 to $1,000, average $700.

Per TSDF Site:

Capital Costs = $2,000 to $12,000, average $6,000
Operating Costs = $4,000 to $6,000, average $5,000
Sampling and Analysis Costs = $3,200 to $120,000, average $28,000.

For incinerators, Option A requires monitoring of carbon dioxide and oxygen in addition to carbon monoxide. This will increase capital costs to about $35,000 to $65,000, average $50,000, and operating costs by $3,500 to $13,000, average $8,000.

1. P Zimmerman, Washington State University, Private Communication, Dec. 1978.

c. Option C

Option C limits groundwater and leachate monitoring to those facilities which can contaminate groundwater that is being used as a source of drinking water. It was assumed that this will reduce the number of sites which require monitoring to about 25% of the total sites.

Elimination of the quarterly minimum analysis requirement for groundwater and leachate will reduce the sampling and analysis cost to $650 to $2,200 (average $1,100) for groundwater monitoring and to $325 to $1,100 (average $550) for leachate monitoring.

It was assumed that the costs for testing, air monitoring and soil monitoring are the same as those for Option B.

E. RECORDKEEPING/REPORTING UNIT COSTS

Recordkeeping and reporting costs refer to those costs associated with the explicit reporting or recordkeeping requirements of RCRA, as follows:

Section 3002 (Option A) — Quarterly reporting, ID code application and notification; storage of manifests for three years.

Section 3002 (Option B) — Quarterly reporting on outstanding manifests, annual reporting, ID code application and notification, storing transfer of liability contracts, storage of manifests for three years.

Section 3002 (Option C) — ID code application and notification, storage of shipping papers/bills of lading for one year, annual reporting.

Section 3003 (Options A and B) — ID code application and notification, storage of manifests for three years.

Section 3003 (Option C) — ID code application and notification, storage of shipping papers/bills of lading for one year.

Section 3004 (Options A and B) — Quarterly reporting, storage of manifests for three years, ID code application and notification, disposal method recording, report of monitoring data.

Section 3004 (Option C) — ID code application and notification, storage of shipping papers/bills of lading for one year, quarterly reporting on shipping papers, disposal method recording, report of monitoring data.

1. Waste Generators Section (3002)

In all options, waste generators must apply for an ID code, but the format of the code differs from option to option. The ID code application requires a listing of wastes that are generated but it is assumed this listing is an activity more directly related to 3001 requirements.

Time to apply:	1 hour @ $27.50 Technical	$27.50
	1/2 hour @ 8.00 Clerical	4.00
		$31.50

The requirements for quarterly reporting also differ among the three options. In Option A, all generators who do not ship to an owned off-site facility in the same state must report quarterly on the contents of their manifests. In Option B, the reports are divided into two: a quarterly report on outstanding manifests and an annual summary report. Furthermore, the stipulation in Option B that the generator-owned off-site TSDF must be in the same state is dropped. In Option C, no quarterly reporting is required.

Option A:

8 hours Clerical	$ 64.00
3 hours Technical	82.50
4 x year	$146.50

Option B:

1-1/2 hours Clerical	$12.00
1/2 hour Technical	$13.75
4 x year	$25.75

+ annual report of $36.00 for Options B and C.

Option B also requires storage of all transfer-of-liability contracts. This storage cost was not included in the unit costs because it pertains only to the waste automotive oil industry. Although not one of the 17 generator industries studied in this report, the impact on the waste automotive oil industry, determined in a separate study, is given in the Executive Summary.

Option B also requires storage of manifests from the TSDFs for three years. This cost is small, approximately $68/year for each generator which ships off-site.

Option C requires storage of shipping papers for one year but this is also required by prior State regulation, and therefore is not an RCRA incremental cost.

2. Transporters (Section 3003)

Transporters also have an ID code application step where they must list the wastes that they haul. Inasmuch as they did not conduct a 3001 initial determination, this listing would take longer for them to complete than it would a waste generator. This step does not involve testing, only survey of the types of wastes carried by the transporter.

2 hours @ $20.60 Technical	$41.20
1 hour @ $8.00 Clerical	8.00
	$49.20

Recordkeeping for transporters in Options A and B means retaining a copy of the manifest on file for three years. Twenty-six states already have such a requirement. For the remaining 24 states, this amounts to a unit cost of:

1 hour @ $8.00 Clerical x 12	$ 96.00
$20.00 Storage	$ 20.00
	$116.00

For Option C, there is no incremental cost for recordkeeping.

3. Treatment, Storage and Disposal Facilities (Section 3004)

The notification step for a TSDF is similar to that for a generator, but differs in cost because of different wages:

1 hour @ $30.00 Technical	$30.00
1/2 hour @ $8.00 Clerical	4.00
	$34.00

- For Options A and B, the manifests must be maintained in a way similar to that for transporters and for the same three-year period.

1 hour/month @ $8.00 Clerical x 12	$ 96.00
$20.00 Storage	20.00
	$116.00

There is no cost for Option C.

- The type, quantity and method of each waste treated, stored or disposed and the location of storage or disposal must also be maintained.

2 hours/month @ $30.00 Technical x 12	$ 720.00
6 hours/month @ $8.00 Clerical x 12	576.00
$20.00 Storage	20.00
	$1,316.00

- Under Option A, every TSDF must report quarterly to the EPA regional administrator on all manifests or delivery documents. In Option B, this frequency is changed to annually. In Option C, the annual report is based on shipping papers/bills of lading.

5 hours/quarter @ $30.00 Technical x 4	$600.00
10 hours/quarter @ $8.00 Clerical x 4	320.00
$230.00 for Options B and C;	$920.00 for Option A.

- Monitoring data, such as the monitoring of wells, soil and surface water monitoring, must be reported to the regional administrator annually.

8 hours @ $30.00 Technical	$240.00
5 hours @ $ 8.00 Clerical	40.00
	$280.00

F. UNIT CONTINGENCY COSTS

Contingency costs are found in Sections 3003, 3004, and 3005. These are the unit costs of spill reporting, incident reporting, or any technical equipment used to reduce the probability of an incident. Contingency equipment includes: fire control equipment, protective clothing, and emergency communication equipment. Contingency costs do not differ among the three options.[1]

1. Section 3003

The incremental cost of reporting a spill on the part of a transporter was estimated at $50 (2 technical hours, 1 clerical). EPA previously stated that approximately 213 spills of hazardous waste material can be expected to occur in transit each year.[2]

2. Section 3004[3]

TSDF's face a $70 cost of incident reporting, which reflects the higher wage rate for TSDF technical personnel than for transport personnel.

The data for contingency plan costs, on a metric ton basis of waste managed, are:

Landfill	$0.67/ton
Landfarm	$0.10/ton
Incinerator	$3.16/ton

Relative cost estimates for the contingency items listed are given relative to 100 tpd landfills and/or a 1 tpd pyrolyzer:

1. Fire control and suppression systems, type A. As supplied by municipal system, 10,000 gallons per minute (gpm) capacity, no annual usage, $150 to $600 per month, higher if exclusive main is installed:

   7¢ to 30¢/ton, landfill

1500 gpm capacity, $30/mo. 1¢/ton, landfill
7¢/cwt, incinerator

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1. *Final Report· Hazardous Waste Management Issues Pertinent to Section 3004 of RCRA of 1976,* IR&T, 1978.

2. *Development of Standards Applicable to Transporter of Hazardous Waste,* Office of Solid Waste, U.S. Environmental Protection Agency, January, 1978.

3. *Final Report· Hazardous Waste Management Issues Pertinent to Section 3004 of RCRA of 1976,* IR&T, 1978.

Type B, pressurized or small portable systems $800 to $30,000 (Several cylinders, to truck mounted pumper):

3¢ to $1.20/ton, landfill
16¢/cwt, minimum for incinerator

(Note, the $800 is considered as annual cost, the larger amount as a capital item.)

2. Employee protective equipment $300 per year per man

$3,000 total assumed:
12¢/ton, landfill 60¢/cwt, incinerator

3. Section 3005

All facilities must include a workable contingency plan as part of their final permit application.

25 hours $30.00/hr Technical	$750.00
10 hours $ 8.00/hr Clerical	80.00
	$830.00

G. UNIT COSTS OF TRAINING

Training is required as part of Sections 3003, 3004 and 3005. The training cost estimates are: an initial cost of $9,250 plus a recurring cost of $300/employee.[1]

The number of employees that must be trained per facility, an average of 15 employees per year per on-site facility, was considered as the population eligible for training.[2] For large off-site TSDF's, the number of employees that must be trained is 25 per year.[3]

The training costs were estimated to be the same for all three options.

H. UNIT COSTS OF ADMINISTRATION

Administrative costs are complementary to recordkeeping and reporting, and often implicitly rather than explicitly associated with Subtitle C of RCRA. Some of these costs are evident in the language of the regulation, e.g., maintaining the operating log of a TSDF or having the transporter ensure that the disposer signs the manifest. Other costs are not explicit but necessary to attain compliance, e.g., the cost of documenting test results or administering the procedures associated with quarterly reporting. The estimates of time and hourly wage rates were drawn from the reports of previous contractors.

1. *Draft Report, Cost of Compliance with Hazardous Waste Management Regulations, Phase II,* February, 1978.

2. Foster D. Snell, Potential for Capacity Creation in the Hazardous Waste Management Service Industry, U.S. Environmental Protection Agency.

3. EPA, Office of Solid Waste, 1978

Systems Design, Administration and Documentation are the three broad categories into which administrative costs fall. Systems Design is the initial cost of setting up clerical and/or mechanized systems to comply with the recordkeeping or technical requirements of RCRA. These are invariably one-time costs and have been annualized over 10 years (Chapter VII). Administration is the incremental supervisory time needed to manage the activities of clerical and technical personnel. Furthermore, administrative time is needed to approve and certify the work done by other employees. Documentation is the time spent by technical and clerical personnel reviewing and writing the results of monitoring and testing procedures. Although monitoring/testing is explicitly mandated in RCRA, the consequent burden of writing the reports and supporting documentation is an implicit cost. A firm does have the option of not documenting reports, but runs the risk of not being able to provide positive proof if a violation is alleged.

Option C requirements for handling manifests are substantially different from A and B requirements. Option C uses a shipping paper/bill of lading. Since this requirement is part of Department of Transportation regulations, generators, transporters and TSDF's will avoid any RCRA-induced incremental cost.

The individual costs are presented below by Subtitle C section. All wage rates are fully burdened rates, which include overhead, pension contributions, etc.

Administrative costs fall into two categories: "annual," which are costs that require the same expenditure each year, and "initial," the one-time costs of setting up a clerical procedure, obtaining a permit and similar activities. The category into which each unit cost falls is marked in parentheses.

1. Section 3001

- (Initial) Documentation of waste inventory procedure:

2 hours @ $27.50/hr Technical	$55.00
2 hours @ $ 8.00/hr Clerical	16.00
	$71.00/facility

- (Initial) Documentation of results of criteria testing:

5 hours @ $27.50/hr Technical	$137.50
4 hours @ $ 8.00/hr Clerical	32.00
	$169.50/facility

- (Initial) Application of the EPA list of hazardous wastes against the results of the waste inventory to determine whether the facility is generating any hazardous waste:

2 hours @ $27.50/hr Technical	$55.00
2 hours @ $ 8.00/hr Clerical	16.00
	$71.00/facility

- (Initial) Supervisory/administrative time to oversee the process of waste determination:

2 hours @ $25.00/hr	$50.00/facility

- (Annual) Re-evaluation of the list to determine whether changes in the EPA list or changes in the generator's process require declaring new wastes:

1 hour @ $27.50/hr Technical	$27.50
1 hour @ $ 8.00/hr Clerical	8.00
	$35.00/facility/year

2. Section 3002

- (Initial) Options A and B: Compliance systems design-labeling and containerizing procedures, manifest and quarterly reporting systems:

23 hours @ $27.50/hr Technical	$632.50
18 hours @ $ 8.00/hr Clerical	144.00
	$776.50/facility

- (Initial) Option C: No manifest system cost:

15 hours @ $27.50/hr Technical	$412.50
10 hours @ $ 8.00/hr Clerical	80.00
	$492.50/facility

- (Initial) Options A and B: Supervision and administration associated with design of compliance systems and ID code application:

6 hours @ $25.00/hr Supervisory	$150.00/facility

- (Initial) Option C: No manifest system cost:

5 hours @ $25.00/hr Supervisory	$125.00/facility

- (Annual) Options A and B: Clerical effort needed to fill out a manifest for shipping, and filing of the generator's copy:

20 minutes @ $8.00/hr Clerical	$2.67/manifest

- (Annual) Option C: No clerical effort.

- (Annual) Options A and B: Supervisory effort for manifest handling and other compliance activities:

18 hours @ $25.00/hr Supervisory	$450.00/facility/year

- (Annual) Option C: No manifest system cost:

12 hours @ \$25.00/hr Supervisory	\$300.00/facility/ year

Although the Act requires that facilities ship only to permitted facilities and in the volumes that can be adequately handled by those facilities, EPA intends to keep a list of permitted TSDF's. This list would be available to generators, which will not have to maintain their own independent list.

3. Section 3003

- (Initial) Options A and B: Design of manifest handling system, to assure that signed manifests are carried to the TSDF and stored properly:

8 hours @ \$20.60/hr Technical	\$164.80
4 hours @ \$8.00/hr Clerical	32.00
	\$196.80/facility

- (Initial) Option C: No manifest system is required.

- (Initial) Marking of trucks — assuring that each truck is marked to meet 3003 RCRA standards:

1/4 hour @ \$20.60/hr Technical	\$5.15
1/2 hour @ \$ 8.00/hr Clerical	4.00
	\$9.15/truck
	(8 trucks/transporter)

- (Annual) Options A and B: Continuing manifest handling by driver, who must have the delivery document signed and ensure that the contents of the shipment conform with the manifest description:

Tank Truck: 5 minutes driver @ \$12.00/hr = \$1 plus
15 minutes per exception[1] @ \$12.00/hr = \$3.

- Seventy-five percent of all shipments are estimated to be in tank form; exceptions occur 15% of the time or one in six shipments. All costs are on a per shipment basis.

- (Annual) Option C: No manifest handling cost.

- (Annual) Options A and B: Ongoing supervision of incident reporting and manifest handling:

12 hours @ \$25.00/hr Supervision	\$300.00/facility/year

1. An exception is a case where the document cannot be signed promptly (personnel not available) or the manifest description differs from the actual contents.

- (Annual) Option C: No manifest handling cost:

1 hour @ $25.00/hr Supervision	$25.00/facility/year

4. Section 3004 and 3005

Section 3005 requires that 3004 standards be met, which creates ambiguity in attributing cost to a section. Furthermore, the costs of obtaining a permit range widely, up to $250,000 in one estimate. This cost depends to a large extent on the degree of public opposition to a facility throughout the process of obtaining a permit.

Permitting costs do not contain such estimates, because of the focus on pre-existing facilities rather than on new construction after the effective date of the regulation.

a. Section 3004 Requirements

- (Initial) Design and development of the financial requirements plan, including financial responsibility and post-closure plans:

40 hours @ $30.00/hr Technical	$1,200.00
30 hours @ $ 8.00/hr Clerical	240.00
	$1,440.00/facility

- (Initial) Assessment and redesign of facility, to comply with RCRA standards and results of survey:

60 hours @ $30.00/hr Technical	$1,800.00
10 hours @ $ 8.00/hr Clerical	80.00
	$1,880.00/facility

- (Initial) Options A and B: Design and development of systems: in the same manner as generators and transporters, Section 3004 implies a need for systems associated with the mandated activities. These systems for TSDF's are: recordkeeping, operating log, quarterly reporting, monitoring/testing and monitoring/reporting:

68 hours @ $30.00/hr Technical	$2,040.00
34 hours @ $ 8.00/hr Clerical	272.00
	$2,312.00/facility

- (Initial) Option C: No manifest system cost:

60 hours @ $30.00/hr Technical	$1,800.00
26 hours @ $ 8.00/hr Clerical	208.00
	$2,008.00/facility

- (Annual) Inspections: 3004 requires daily inspection of the facility. The operation log is the mechanism for recording all observations and incidents:

1 hour/day @ $30.00/hr	$10,950.00/facility/year

- For Options B and C, the frequency is changed to:

2 hours/week @ $30.00/hr	$3,120.00/facility/year

- (Annual) Options A and B: The recordkeeping system must be maintained and each shipment manifest checked and filed:

15 minutes Clerical @ $8.00/hr	$2.00/shipment

- (Annual) Option C: No manifest system cost.

b. Section 3005 Activities

- (Initial) Notification is filed that the facility intends to engage in the treatment, storage or disposal of hazardous waste:

1 hour @ $30.00/hr Technical	$30.00
1/2 hour @ $ 8.00/hr Clerical	4.00
	$34.00/facility

- (Initial) Development of appropriate technical descriptions and characterizations of the site, including contracted time of expert personnel:

80 hours @ $30.00/hr Technical	$ 2,400.00
50 hours @ $ 8.00/hr Clerical	400.00
Contracted Time	40,000.00
	$42,800.00/facility

- (Initial) Understanding of special requirements of permit, once the permit has been received. The plan must be devised to assure that the facility stays on the compliance schedule:

20 hours @ legal time $60.00/hr	$1,200.00
20 hours @ technical $30.00/hr	600.00
5 hours @ clerical $8.00/hr	40.00
	$1,840.00/facility

- (Annual) Update of systems, and tracking compliance with permit schedule:

26 hours @ $30.00/hr Technical	$780.00
12 hours @ $ 8.00/hr Clerical	96.00
	$876.00/facility/year

VI. HAZARDOUS WASTE MANAGEMENT NETWORK

A. INTRODUCTION

The available information on hazardous waste flow in the Hazardous Waste Management Network is presented in this chapter. It includes waste generation by the industry segments, waste transportation, and waste management practices. These data, plus the unit cost of compliance estimates in Chapter V, provided the basis for the total incremental cost of compliance estimates reported in Chapters VII and VIII.

For each industry segment, the hazardous waste streams have been identified and their volumes of waste estimated. The estimates are based on data in the EPA hazardous waste assessment reports and limited revisions to the data made by Arthur D. Little, Inc., as part of the economic impact analysis. In addition, the current waste management practices (Level I) and the Pathways Level III practices are identified for each waste stream. The industry segment data have been aggregated to total values for the generator industries, showing the total volumes of waste generated and the management practices for each industry.

The materials flow data used for this analysis are the best available, but there are substantial uncertainties about their accuracy and completeness. As part of the economic analysis, an effort has been made to reconcile major inconsistencies in the data.

B. CURRENT HAZARDOUS WASTE MATERIALS FLOW

In 1977, the 17 private industries covered by this report generated somewhat more than 23 million metric tons of hazardous waste. Not all waste streams from the industries have been identified, but those that have total 23 million tons and are listed by industry in Table VI-1.[1]

As previously mentioned, this study is based on waste generation data developed for 17 industries under a series of EPA-sponsored studies completed between 1973 and 1976. Other industries also generate hazardous waste, but the 17 were chosen to include the largest volume and most hazardous of the wastes. In addition, within each industry, based on a preliminary survey, each study contractor chose waste streams for detailed study so as to include those expected to be the larger and more significant in hazard level. Thus, in each industry, there may be hazardous waste streams which were not included in the original studies and are thus not included in the cost of compliance analysis. Important omissions of waste streams are most likely to be found in the organic chemicals, metals smelting and refining, electroplating, metals finishing, and electronic components industries.

Of the 23 million metric tons of hazardous waste listed in Table VI-1, 13 million tons (57%) is generated by the metals smelting and refining industry. Inorganic chemicals production accounts for the next highest portion at 3.8 million tons (16%). Captive metal finishing and electroplating operations are not included in the waste generation estimates, though some volumes may be included in other industries. The waste streams studied for the organic chemical industry are associated with a relatively small percentage of the industries' products.

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1. A more detailed listing of the volumes of waste by industry segment and waste stream is found in Table VI-6.

TABLE VI-1

HAZARDOUS WASTE GENERATION BY 17 INDUSTRIES INCLUDED IN THE ECONOMIC ANALYSIS, 1977[a]
(millions of metric tons, wet basis)

Industry	Waste Generated by the Industry Segments Studied
Electronic Components	0.064*
Electroplating and Metal Finishing (Job Shops)	0.64
Inorganic Chemicals	3.8
Leather Tanning and Finishing	0.17
Metals Smelting and Refining	12.8
Organic Chemicals	0.34
Paints and Allied Products	0.22
Petroleum Refining	1.5
Petroleum Re-refining	0.074
Pharmaceuticals	0.073
Rubber	0.05
Plastics	0.90
Special Machinery	0.075
Storage and Primary Batteries	0.15
Textiles	1.7
Explosives	0.09
Pesticides	0.7
Total	23.3
Total, excluding metals smelting and refining	10.5

a. All hazardous waste streams produced by the listed industries have not been studied and are not included in the estimates.

*Excludes reclaimable solvents.

Source: Arthur D. Little, Inc., estimates.

Eighty-two percent of the total hazardous waste generated is believed to be disposed of or reprocessed at the site of generation (Table VI-2). With the metals smelting and refining industry excluded, 64% of the waste from the remaining industries is managed on-site. Estimates of the percentage of on-site waste management at the industry segment level were unobtainable; therefore, the percentage of waste disposed of on-site for each segment was assumed to be the same as the percentage for the industry as a whole. Generally speaking, the industries with the highest volume of waste and the most toxic waste manage their wastes at the site of generation.

In the case of both on-site and off-site waste management, about 60% of the wastes are currently landfilled and 30% is lagooned (Table VI-3). The projected waste management practices for the industries under Pathways Level III are listed in Table VI-4.

Truck transport accounts for more than 90% of all hazardous waste carried away from the site of generation (Table VI-5).

TABLE VI-2

CURRENT HAZARDOUS WASTE DISPOSAL AT THE SITE OF GENERATION

Industry	Waste Managed Onsite (millions of metric tons)	Percent of Waste Generated
Electronic Components	0.010	13
Electroplating and Metal Finishing (Job Shops)	0.12	19
Inorganic Chemicals	3.3	87
Leather Tanning and Finishing	0.017	10
Metals Smelting and Refining	12.5	98
Organic Chemicals	0.29	87
Paints and Allied Products	0.009	4
Petroleum Refining	0.66	44
Petroleum Re-refining	0.009	12
Pharmaceuticals	0.028	39
Rubber	0.003	5
Plastics	0.72	80
Special Machinery	0.008	10
Storage and Primary Batteries	0.053	35
Textiles	0.83	49
Explosives	0.078	87
Pesticides	0.61	87
Total	19.2	
Total excluding metals smelting and refining	6.7	

Source: Foster D. Snell, Inc., *Potential for Capacity Creation in the Hazardous Waste Management Service Industry,* August, 1976, PB-257 187. Percentage of waste managed at the site of generation.estimated in the report.

The waste generation, transportation, and disposal data bases disaggregated to the industry segment level, shown in Tables VI-6, 7, and 8, respectively, have been used to make the compliance cost estimates. Table VI-6 lists each hazardous waste stream for each industry segment. The total volume of hazardous waste of each industry segment is shown in Table VI-7. The current and projected waste management practices are identified as well as Level I and Pathways Level III waste management costs in Table VI-8.

TABLE VI-3

HAZARDOUS WASTE MANAGEMENT METHODS (1977)
(millions of metric tons)

Industry	Total Quantity Handled	Landfill	Incineration	Landspreading	Lagoon	Deepwell Injection	Sea Disposal
1. Electronic Components	–	–	–	–	–	–	–
2. Electroplating & Metal Finishing	0.64	.064	–	–	–	–	–
3. Inorganic Chemicals	3.8	1.3	–	–	2.5	–	.001
4. Leather Tanning & Finishing	.17	.17	–	–	–	–	–
5. Metals Smelting & Refining	12.8	8.4	–	–	4.4	–	–
6. Organic Chemicals	0.34	.214	.03	–	–	.07	–
7. Paints & Allied Products	0.22	.11	.11	–	–	–	–
8. Petroleum Refining	1.5	1.3	–	.2	–	–	–
9. Petroleum Rerefining	0.074	.074	–	–	–	–	–
10. Pharmaceuticals	.073	.008	.065	–	–	–	–
11. Rubber	.05	.05	–	–	–	–	–
12. Plastics	0.90	–	.90	–	–	–	–
13. Special Machinery	.075	.075	–	–	–	–	–
14. Storage & Primary Batteries	.15	.15	–	–	–	–	–
15. Textiles	1.7	1.7	–	–	–	–	–
16. Explosives	.09	–	.09	–	–	–	–
17. Pesticides	.7	.002	.008	–	–	.678	.012
	23.2	14.3	1.2	.2	6.9	0.7	.013

Source: Arthur D. Little, Inc., estimates.

TABLE VI-4

PROJECTED HAZARDOUS WASTE MANAGEMENT PRACTICES UNDER PATHWAYS LEVEL III
(millions of metric tons)

Industry	Annual Waste Generation	Secure Landfill	Incineration	Lagoon	Landspreading	Deepwell
1. Electronic Components	.064	.039	.025	–	–	–
2. Electroplating & Metal Finishing	.64	.64	–	–	–	–
3. Inorganic Chemicals	3.8	3.8	–	–	–	–
4. Leather Tanning & Finishing	.17	.17	–	–	–	–
5. Metals Smelting & Refining	12.8	7.8	–	5.0	–	–
6. Organic Chemicals (segments analyzed)	.34	.056	.284	–	–	–
7. Paints & Allied Products	.22	0.12	0.10	–	–	–
8. Petroleum Refining	1.5	1.2	–	–	.3	–
9. Petroleum Rerefining	.074	.074	–	–	–	–
10. Pharmaceuticals	.073	.008	.065	–	–	–
11. Rubber	.050	.050	–	–	–	–
12. Plastics	.900	–	.900	–	–	–
13. Special Machinery	.075	.064	.011	–	–	–
14. Storage & Primary Batteries	.150	.150	–	–	–	–
15. Textiles	1.700	1.700	–	–	–	–
16. Explosives	.09	–	.09	–	–	–
17. Pesticides	.700	.03	–	–	–	–
	23.3	15.9	1.9	5.0	.3	0.7

Source: Arthur D. Little, Inc., estimates.

TABLE VI-5

OFFSITE TRANSPORTATION OF HAZARDOUS WASTE

Mode of Transportation	Wet Weight (million metric tons)	Percentage
Air	negligible	–
Rail	0.2	5%
Truck	3.9	94%
Waterway	0.04	1%
Pipeline	negligible	–
	4.1	100%

Source: Arthur D. Little, Inc., *Characterization of Hazardous Waste Transportation and Economic Impact Assessment of Hazardous Waste Transportation Regulations,* August 1978, report to EPA, used for estimates of percentage breakdown among transportation modes.

TABLE VI–6

DATA ON HAZARDOUS WASTE GENERATION, MANAGEMENT COST AND PERCENT OF PLANTS AT LEVEL I MANAGEMENT

Metric Tons – Wet Weight

SIC Code	Industry and Waste Stream Designation	Estimated Annual Amount of Waste Generated, 1977 Wet Weight MT	Hazardous Waste Management Methods – Level I	Hazardous Waste Management Methods Pathways – Level III	Unit Cost ($/MT) Hazardous Waste Management		% Plants At Level I
					Level I	Level III	
367	Electronic Components Manufacturing						
	Halogenated Solvents	5,540*	–on- and off-site	incineration	60	200	90
	Nonhalogenated Solvents	16,630**	–on- and off-site	incineration	60	100	82
	Wastewater Treatment Sludges	38,810	–landfill	secure landfill	24	15–55	82
	Oils	2,310	–off-site landfill	incineration	24	100	67
	Paint Wastes	246	–off-site landfill	incineration	11	100	94
3471	Electroplating and Metal Finishing (Job Shops)						
	Water Pollution Control Sludge	565,485	–landfill	secure landfill	53	15–55	70
	Process Waste Materials	42,140	–simple landfill	secure landfill	73	15–55	70
	Degreaser Sludges	5,445	–simple landfill	secure landfill	205	15–55	70
	Salt Precipitates from Electroless Nickel Bath Regeneration	22,930	–simple landfill	secure landfill	74	15–55	70

*Excludes 8,320 MT of reclaimable wastes.
**Excludes 1,850 MT of reclaimable wastes.

TABLE VI–6 (Continued)

SIC Code	Industry and Waste Stream Designation	Estimated Annual Amount of Waste Generated, 1977 Wet Weight MT	Hazardous Waste Management Methods – Level I	Hazardous Waste Management Methods Pathways – Level III	Unit Cost ($/MT) Hazardous Waste Management Level I	Level III	% Plants At Level I
281	Inorganic Chemicals						
2812	Chlor-alkali production: mercury cell process, brine muds	121,000	–landfill	secure landfill	29	15–49	71
2812	Down's cell process: metallic sodium and calcium filter cake	1,500	–sea disposal	sea disposal	–	455	0
2812	chlor-alkali production: diaphragm cell process, asbestos separator wastes, lead containing wastes and chlorinated hydrocarbons	16,900	–landfill	secure landfill	5	15–55	50
2816	titanium dioxide production: sludges from wastewater treatment, chloride process	880,000	–landfill	secure landfill	0.9	15	73
2816	chrome color and inorganic pigment production: sludges from wastewater treatment	11,800	–landfill	secure landfill	19	15–55	60
2816	hydrofluoric acid production: fluoride-containing gypsum wastes – no longer considered hazardous	2,000,000	–ponding and landfill	secure landfill	2.50	15	100
28194	boric acid production: arsenic-containing sludges	6,125	–secure landfill	secure landfill	–	38	N/A

TABLE VI–6 (Continued)

SIC Code	Industry and Waste Stream Designation	Estimated Annual Amount of Waste Generated, 1977 Wet Weight MT	Hazardous Waste Management Methods – Level I	Hazardous Waste Management Methods Pathways – Level III	Unit Cost ($/MT) Hazardous Waste Management		% Plants At Level I
					Level I	Level III	
	Inorganic Chemicals (Cont'd)						
28196	aluminum fluoride production: fluoride-containing waste-water treatment sludge	46,800	–landfill	secure landfill	1.40	15–32	84
2819	chromate production: chromate contaminated wastes	240,000	–unlined pond plus landfill	secure landfill	8.30	15	67
2819	nickel sulfate production: nickel wastes from wastewater treatment – no longer considered hazardous	1,200	–landfill on-site	secure landfill	14	15–55	75
2819	phosphorus pentasulfide production: arsenic and phosphorus wastes	120	–drummed and buried in landfill	secure landfill	28	25–65	100

TABLE VI–6 (Continued)

SIC Code	Industry by Waste Stream Designation	Estimated Annual Amount of Waste Generated, 1977 Wet Weight MT	Hazardous Waste Management Methods – Level I	Hazardous Waste Management Methods Pathways – Level III	Unit Cost ($/MT) Hazardous Waste Management Level I	Unit Cost ($/MT) Hazardous Waste Management Level III	% Plants At Level I
	Inorganic Chemicals (Cont'd)						
2819	phosphorus production, furnace process: fluoride bearing sludge and phossy water	440,000	–pond storage and landfill	secure landfill	3.50	15–45	100
2819	phosphorus trichloride: arsenic trichloride waste	67	–drummed and buried in landfill	secure landfill	235	65	100
3111	Leather Tanning and Finishing		–on-site and off-site landfill	secure landfill	18	15–55	85
	Chrome tanning wastes	170,000	–open dumping				

TABLE VI–6 (Continued)

SIC Code	Industry and Waste Stream Designation	Estimated Annual Amount of Waste Generated, 1977 Wet Weight MT	Hazardous Waste Management Methods– Level I	Hazardous Waste Management Methods Pathways – Level III	Unit Cost ($/MT) Hazardous Waste Management Level I	Level III	% Plants At Level I
2879	Pesticides						
	Liquid process waste (Malathion)	16,500	–ocean dumping	resin absorption recovery	16	–0.38 (credit)	100
	Spent activated carbon (Triduralin)	2,217	–storage in plastic-lined steel drums	secure landfill	248	15–55	100
	Filter cake (Malathion)	2,087	–approved landfill after sodium hydrozide detoxication	secure landfill	–	55	
	Sulfur sludge (Parathion)	10,400	–uncontrolled incineration	secure landfill	56	55	100
	Spent alkali scrubbing solution (Atrazine)	670,000	–deepwell injection	deepwell injection	0.74	26.40	100
286	Organic Chemical						
28612	Nitrobenzene: Heavy ends from purification column	974	–on-site landfill; lined steel drums	incineration	307	100	70
28651	Toluene Diisocyanate: Centrifuge residue sludges	7,245	–on-site landfill in drums	incineration	85	231	100
28692	chlorobenzene: heavy ends	11,352	–sanitary landfill	incineration	17	97	100
28651	furfural: heavy ends,	50,000	–sanitary landfill	secure landfill	8	15–31	100
	filter solids	490	–sanitary landfill	secure landfill	28	15–55	100
28651	benzylchloride: still bottoms	41	–sanitary landfill	secure landfill	8	15–55	100

TABLE VI–6 (Continued)

SIC Code	Industry and Waste Stream Designation	Estimated Annual Amount of Waste Generated, 1977 Wet Weight MT	Hazardous Waste Management Methods – Level I	Hazardous Waste Management Methods Pathways – Level III	Unit Cost ($/MT) Hazardous Waste Management Level I	Level III	% Plants At Level I
	Organic Chemicals (Cont'd)						
28692	Perchloroethylene: *Heavy ends*	140,000	–deep well injection and landfill	incineration	21	45	100
28692	Chloromethane: Solids tails from solvent recovery	7,620	–off-site landfill	incineration	100	288	100
28692	Epichlorohydrin: Heavy ends from fractionator	10,000	–on-site landfill	incineration	65	84	100
28692	Vinyl Chloride Monomer: Heavy ends	28,870	–landfill (some drummed)	incineration	87	208	100
28692	Methyl Methacrylate: Heavy ends	28,870	–landfill (20% in steel drums)	incineration	22	30	100
28692	Acrylonitrile: Heavy ends from purification column	1,288	–landfill (50% in steel drums)	incineration	127	350	100
28692	Maleic anhydride: Still bottoms	4,742	–landfill	secure landfill	72	15–55	100
28692	Lead Alkyls: Lead sludge from setting basin	32,800	–uncontrolled incineration w/ lead recovery as slag	incineration Pb recovery	24	25	100
28692	Ethanolamines: Heavy ends	12,000	–landfill (sealed)	incineration	99	120	100
28692	Fluorocarbons: Spent reactor catalyst	104	–sanitary landfill	secure landfill	98	55	100

TABLE VI–6 (Continued)

SIC Code	Industry and Waste Stream Designation	Estimated Annual Amount of Waste Generated, 1977 Wet Weight MT	Hazardous Waste Management Methods – Level I	Hazardous Waste Management Methods Pathways – Level III	Unit Cost ($/MT) Hazardous Waste Management Level I	Level III	% Plants At Level I
2892	Explosives	87,000					
	Activated carbon containing nitro compounds	3,500	–open burning	incineration	287	873	100
	Red water	15,000	–incineration	Tampella process	–	268	0
	Scrap explosives and explosive contaminated inert wastes	68,300	–open burning	incineration	287	1105	100
2851	Paints and Allied Products						
	Cleaning wastes-wastewater	30,760	–off-site landfill	secure landfill	55	55	76
	Still bottoms or sludge	73,000	–incineration w/ ash disposal in landfill	controlled incineration	36	100	99
	Air Pollution Control Residues	1,790	–landfill	secure landfill	6.55	65	83
	Spills and Spoiled Batches	10,800	–landfill	incineration	6.55	100	100
	Solvent Cleaning Wastes	65,000	–landfill	incineration	55	100	95
	Raw Materials Packaging	38,000	–incineration; landfill	incineration	22	35	100

TABLE VI–6 (Continued)

SIC Code	Industry and Waste Stream Designation	Estimated Annual Amount of Waste Generated, 1977 Wet Weight MT	Hazardous Waste Management Methods – Level I	Hazardous Waste Management Methods Pathways – Level III	Unit Cost ($/MT) Hazardous Waste Management		% Plants At Level I
					Level I	Level III	
2911	Petroleum Refining						
	Once-through cooling water sludge	41,279	–landfill	secure landfill	26	15–38	11
	Spent lime boiler feedwater	782,927	–landfill	secure landfill	24	15–36	42
	Exchange bundle cleaning sludge	1,490	–landfill	secure landfill	5.60	15–36	34
	API separator sludge	109,968	–landfill	secure landfill	24	15–36	53
	Kerosene filter clays	4,516	–secure landfill	secure landfill	20	15–36	9
	Neutralized HF alkylation sludge	17,956	–landfill	secure landfill	3.90	15–36	15
	Silt from storm water runoff	30,780	–landfill	secure landfill	24	15–36	24
	Fluid catalytic cracker	54,250	–conveyed to landfill in closed refuse container	secure landfill	24	15–36	30
	Coke fines	3,470	–off-site landfill	secure landfill	24	15–36	19
	Lube oil filter clays	96,436	–landfill	secure landfill	24	15–36	7
	Cooling tower sludge	401	–landfill	secure landfill	24	15–36	81
	Slop oil emulsion solids	36,506	–landfill	landspreading	5.80	6.75	36

TABLE VI–6 (Continued)

SIC Code	Industry and Waste Stream Designation	Estimated Annual Amount of Waste Generated, 1977 Wet Weight MT	Hazardous Waste Management Methods – Level I	Hazardous Waste Management Methods Pathways – Level III	Unit Cost ($/MT) Hazardous Waste Management Level I	Level III	% Plants At Level I
2911 Cont'd.	Dissolved air floatation skimmings	84,417	–landfill	landspreading	36	25	11
	Crude tank bottoms	864	–landfill	landspreading	5	6.65	37
	Lead tank bottoms	1,511	–landfill	landspreading	4.20	2.25	61
	Non-leaded tank bottoms	115,836	–landfill	landspreading	24	6.30	80
	Waste bio sludge	81,293	–landspreading	landspreading	5.30	6.35	25
2992	Petroleum Rerefining						
	Acid sludge	38,700	–landfill	secure landfill	9	15–55	59
	Caustic sludge	15,400	–landfill	secure landfill	9	15–55	8
	Spent clay	20,200	–landfill	secure landfill	9	15–55	13
30	Rubber Products						
	Floor sweeping powder dust from air pollution equipment	52,210	–off-site general landfill	secure landfill	40	15–55	92

TABLE VI–6 *(Continued)*

SIC Code	Industry and Waste Stream Designation	Estimated Annual Amount of Waste Generated, 1977 Wet Weight MT	Hazardous Waste Management Methods – Level I	Hazardous Waste Management Methods Pathways – Level III	Unit Cost ($/MT) Hazardous Waste Management Level I	Level III	% Plants At Level I
331, 332 333, 334	Metals Smelting & Refining						
3312	Primary Iron & Steel						
	combined dusts & sludges from iron & steel production	3,220,000	open dumping	lined lagoon	2.00	10.00	100
	continuous casting & primary milling sludges	2,930,000	open dumping	lined lagoon	2.00	10.00	100
	hot rolling mill scale & water pollution sludge	1,790,000	open dumping	lined lagoon	2.00	10.00	100
	cold rolling mill scale & water pollution sludge & pickling liquor	680,000	open dumping neutralization & lagoon(1)	lined lagoon	2.65	10.00	100
	tin plating sludge	23,000	open dumping	lined lagoon	2.00	10.00	100
	galvanizing sludge & *pickling sludge*	503,000	open dumping neutralization & lagoon(2)	lined lagoon	2.4	10.00	100
	ammonia still lime & sludge	30,000	open dumping	lined lagoon	2.00	10.00	100
	decanter tank tar	200,000	open dumping	lined lagoon	2.00	10.00	100
	dephenolizer sludge	4,000	(1)	lined lagoon	2.00	10.00(3)	(1)
	miscellaneous solid wastes from coke ovens	150,000	open dumping	(1)	2.00	10.00(3)	(1)

TABLE VI–6 (Continued)

SIC Code	Industry and Waste Stream Designation	Estimated Annual Amount of Waste Generated, 1977 Wet Weight MT	Hazardous Waste Management Methods – Level I	Hazardous Waste Management Methods Pathways – Level III	Unit Cost ($/MT) Hazardous Waste Management		% Plants At Level I
					Level I	Level III	
3313	Ferroalloy Smelting						
	Ferromanganese and silicomanganese APC dusts and sludges	295,493	–unlined lagoons; open dumps	lined lagoon	1.10	8.57	100
	Ferrochrome APC dusts and sludges	85,370	–unlined lagoons; open dumps	lined lagoon	1.60	12.20	100
332	Ferrous Foundries						
	Furnace dust and waste sand	12,000	–open dumping	lined lagoon	2.00	10.00	100

(1)Could not be determined.

(2)Pickling liquors are neutralized with lime prior to dumping.

(3)Assuming open dumping.

TABLE VI–6 (Continued)

SIC Code	Industry and Waste Stream Designation	Estimated Annual Amount of Waste Generated, 1977 Wet Weight MT	Hazardous Waste Management Methods – Level I	Hazardous Waste Management Methods Pathways – Level III	Unit Cost ($/MT) Hazardous Waste Management Level I	Level III	% Plants At Level I
3339	Mercury: condenser wastewater slurry	47,429	–spray on open dump or in unlined lagoon	lined lagoon	2	5	100
3339	Tungsten (APT): digestion residue	310	–land storage	store in drums	0	31	75
	filtration wastewater sludge	26,800	–unlined laggon	chemical filtration solids disposed in open dump	17.6	60	75
3333	Primary sinc: electrolytic sludge;	48,700	–land disposal (storage)	lined lagoon	.4	1.2	100
	primary pyrometallurgical sludge	128,400	–unlined lagoon, open dump (storage)	lined lagoon	1.2	9.0	75
33412	Secondary copper: blast furnace stage	106,000	–open dump	secure landfill	2.50	5.49	100
33413	Secondary lead: SO_2 scrubber sludge	49,450	–unlined lagoon	lined lagoon	3.32	8.43	100
33417	Secondary aluminum: scrubber sludge	160,750	–unlined lagoon	lined lagoon	1.42	4.28	99
	dross processing residue and high salt slag	535,000	–open dump	secure landfill	4.60	9.85	100
3332	Primary lead smelter sludge	146,500	–land disposal	lined pits and recycling	.65	2.10	73
3339	Primary antimony blast furnace slag	4,540	–on-site open dump	secure landfill	2.05	4.46	100
	primary electrolytic sludge	280	–unlined lagoon	lined lagoon	0	11.18	100

TABLE VI–6 (Continued)

SIC Code	Industry and Waste Stream Designation	Estimated Annual Amount of Waste Generated, 1977 Wet Weight MT	Hazardous Waste Management Methods – Level I	Hazardous Waste Management Methods Pathways – Level III	Unit Cost ($/MT) Hazardous Waste Management Level I	Unit Cost ($/MT) Hazardous Waste Management Level III	% Plants At Level I
3339	Primary titanium: chlorinator and condenser sludge	9,950	–landfill off-site	lined lagoon	1.55	7.89	100
3339	Primary tin: smelting slag	5,033	–open dump	secure landfill	2.20	5.24	100
3331	Primary copper: smelter acid plant sludge	66,235	–open dump, unlined lagoon	lined lagoon	3.20	15.0	100
3334	Primary aluminum:						
	potliners and skimmings	240,850	–storage	immediate recycling	.66	2.39	100
	smelter air pollution control sludge	1,281,210	–open dump	lined lagoon	1.73	2.42	100
	cast house and shot blast dust	30,878	–open dump	secure landfill	2.26	5.22	100

TABLE VI–6 (Continued)

SIC Code	Industry and Waste Stream Designation	Estimated Annual Amount of Waste Generated, 1977 Wet Weight MT	Hazardous Waste Management Methods – Level I	Hazardous Waste Management Methods Pathways – Level III	Unit Cost ($/MT) Hazardous Waste Management Level I	Level III	% Plants At Level I
355, 357	Special Machinery Manufacturing						
	Machine shop wastes	27,440	–off-site sanitary landfill	secure landfill	20	15–55	70
	Heat treating wastes	14,500	–off-site sanitary landfill	secure landfill	20	15–55	75
	Electroplating wastes-wastewater treatment sludges and solvent sludges	22,430	–off-site sanitary landfill	secure landfill	17	15–55	70
	Paint waste	11,145	–off-site sanitary landfill	incineration	11	100	85
	Electroplating wastes	–	–(not currently disposed on land)				
369	Batteries						
3692	Primary Batteries:						
	Wastewater treatment sludge	164	–on-site landfill	secure landfill	144	15–55	23
	Manufacturing scrap metals	1,310	–on-site landfill	secure landfill	121	15–55	90
3691	Storage Batteries:						
	Wastewater treatment sludge	150,000	–on-site landfill	secure landfill	1.70	15–55	20
	Wastewater treatment sludge	515	–on-site landfill	secure landfill	343	15–55	10
283	Pharmaceuticals Industry						
2831 & 2833	Medicinals and botanicals, halogenated waste solvents	3,870	–incineration on-site or by contractor w/ HCl scrubbers	secure landfill		200	N/A

TABLE VI–6 (Continued)

SIC Code	Industry and Waste Stream Designation	Estimated Annual Amount of Waste Generated, 1977 Wet Weight MT	Hazardous Waste Management Methods – Level I	Hazardous Waste Management Methods Pathways – Level III	Unit Cost ($/MT) Hazardous Waste Management Level I	Level III	% Plants At Level I
2831 &	Organic chemical residue	15,300	–landfill	incineration	2	100	20
2833	Heavy metal wastes	3,252	–secured chemical landfill	incineration		15–55	80
Cont'd	High inert content wastes (flammable)	950	–lined chemical landfill	incineration	34	100	50
	High inert content wastes	950	–landfill	secure landfill	15	15–55	40
	Nonhalogenated waste solvents	44,601	–incineration on-site or by contractor	incineration	88	100	39
2834	Pharmaceutical Preparations						
	Returned goods, and reject material	600	–sanitary landfill	incineration	36	100	60
22 2299	Textile Industry Wool Scouring	150,060	–unlined lagoon –sewer	lined lagoon	2.50	15–55	78
2231	Wool fabric dyeing and finishing	743	–landfill	secure landfill	16	15–55	29
2261, 2262;	Woven fabric dyeing and finishing	1,202,640	–sewer	lined lagoon	2.50	15–55	90
2251, 2254, 2257, 2259;	Knit fabric dyeing and finishing	302,464	–sewer	lined lagoon	2.50	15–55	50
2272	Carpet dyeing and finishing	1,426	–landfill	secure landfill	16	15–55	29
2269	Yarn and stock dyeing and finishing	610	–landfill	secure landfill	16	15–55	29

Source: Battelle Columbus Laboratories, *Cost of Complying with Hazardous Waste Management Regulations,* October 12, 1977, report to EPA. Selected values have been revised by Arthur D. Little, Inc., based upon more recent information.

TABLE VI-7

TOTAL HAZARDOUS WASTE GENERATION BY INDUSTRY SEGMENT, 1977

Industry Segment SIC Code		Number of Plants		Volume of Hazardous Wastes (1,000 metric tons)		Number of Hazardous Wastes
		Options A and B†	Option C††	Options A and B†	Option C††	
Special Machinery	(a)*	1,720	720	15	9	4
355	(b)**	2,280	1,280	35	28	
Office, Computing, and	(a)*	420	280	12	11	4
Accounting Machines 357	(b)**	580	440	13	12	
Explosives	(a)*	24	24	39	39	3
2892	(b)**	32	32	48	48	
Pesticides	(a)*	80	80	435	435	1
2879	(b)**	105	105	462	462	
Cattlehide Chrome	(a)*	41	41	23	23	2
3111	(b)**	64	64	37	37	
Cattlehide Thru to Blue	(a)*	1	1	30	30	2
3111	(b)**	2	2	60	60	
Cattlehide Splits	(a)*	6	6	5	5	2
3111	(b)**	9	9	9	9	
Sheepskins	(a)*	16	16	2	2	2
3111	(b)**	16	16	2	2	
Leather Finishers	(a)*	37	37	1	1	1
3111	(b)**	23	23	1	1	
Chlorine (Mercury Cell)	(a)*	5	5	12	12	1
2812	(b)**	22	22	109	109	
Chlorine (Downs and	(a)*	28	28	14	14	1
Diaghragm Cell) 2812	(b)**	12	12	3	3	
Titanium Dioxide	(a)*	3	3	62	62	1
2816	(b)**	10	10	818	818	
Chrome Pigments	(a)*	9	9	7	7	1
2816	(b)**	6	6	5	5	
Hydrofluoric Acid	(a)*	0	0	0	0	1
2816	(b)**	0	0	0	0	

*(a) indicates covered under existing state regulations.
**(b) indicates no prior state regulations.
†Regulatory Options A, B (waste generation of a minimum of 100 kg/month).
††Regulatory Option C (waste generation of a minimum of 1000 kg/month).

TABLE VI-7 (Continued)

Industry Segment SIC Code		Number of Plants: Options A and B†	Number of Plants: Option C††	Volume of Hazardous Wastes (1,000 metric tons): Options A and B†	Volume of Hazardous Wastes (1,000 metric tons): Option C††	Number of Hazardous Wastes
Aluminum Fluoride	(a)*	3	3	24	24	1
28196	(b)**	2	2	23	23	
Nickel Sulfate	(a)*	0	0	0	0	1
2819	(b)**	0	0	0	0	
Phosphorus Pentasulfide	(a)*	2	2	0.03	0.03	1
2819	(b)**	5	3	0.09	0.08	
Phosphorus	(a)*	0	0	0	0	
2819	(b)**	8	8	440	440	2
Phosphorus Trichloride	(a)*	2	2	0.02	0.02	1
2819	(b)**	5	0	0.05	0	
Sodium Chromates	(a)*	1	1	34	34	1
2819	(b)**	2	2	206	206	
Boric Acid	(a)*	2	2	4	4	1
28194	(b)**	1	1	2	2	
Electroplating &	(a)*	1,900	1,900	333	333	4
Metal Finishing 3471	(b)**	1,100	1,100	307	307	
Paints and Allied Products	(a)*	765	765	80	80	5
2851	(b)**	735	735	67	67	
Pharmaceuticals – Active	(a)*	55	55	22	22	6
Ingredients 2831 & 2833	(b)**	106	106	50	50	
Pharmaceuticals Formulations	(a)*	206	0	0.3	0	1
& Packaging 2834	(b)**	262	0	0.3	0	
Plastics	(a)*	209	209	540	540	1
282	(b)**	372	372	360	360	
Tires & Inner Tubes	(a)*	47	47	11	11	1
3011	(b)**	73	73	9	9	
Other Rubber Products	(a)*	377	377	18	18	1
3021	(b)**	543	543	12	12	
Petroleum Rerefining	(a)*	18	18	41	41	3
2992	(b)**	15	15	33	33	
Storage Batteries	(a)*	80	80	70	70	2
3691	(b)**	150	150	88	88	
Primary Batteries	(a)*	12	12	0.9	0.9	2
3692	(b)**	8	8	0.6	0.6	

TABLE VI-7 (Continued)

Industry Segment SIC Code		Number of Plants		Volume of Hazardous Wastes (1,000 metric tons)		Number of Hazardous Wastes
		Options A and B†	Option C††	Options A and B†	Option C††	
Petroleum Refining	(a)*	133	133	980	980	17
2911	(b)**	133	133	420	420	
Electronic Components	(a)*	1,530	1,030	39	36	5
367	(b)**	1,470	970	25	23	
Perchloroethylene	(a)*	8	8	125	125	1
28692	(b)**	2	2	15	15	
Nitrobenzene	(a)*	2	2	0.3	0.3	1
28612	(b)**	4	4	0.7	0.7	
Chloromethane	(a)*	9	9	6	6	1
28692	(b)**	10	10	2	2	
Epichlorohydrin	(a)*	2	2	9	9	1
28692	(b)**	1	1	1	1	
Toluene Diisocyanate	(a)*	5	5	4	4	1
28651	(b)**	5	5	3	3	
Vinyl Chloride Monomer	(a)*	13	13	23	23	1
28692	(b)**	2	2	6	6	
Methyl Methacrylate	(a)*	2	2	21	21	1
28692	(b)**	2	2	8	8	
Acrylonitrile	(a)*	3	3	0.6	0.6	1
28692	(b)**	2	2	0.6	0.6	
Maleic Anhydride	(a)*	3	3	2	2	1
28692	(b)**	4	4	3	3	
Lead Alkyls	(a)*	3	3	28	28	1
28692	(b)**	1	1	5	5	
Chlorobenzene	(a)*	3	3	3	3	1
28651	(b)**	7	7	8	8	
Ethanolamines	(a)*	3	3	10	10	1
28692	(b)**	2	2	2	2	
Furfural	(a)*	2	2	15	15	2
28651	(b)**	2	2	35	35	
Benzylchloride	(a)*	0	0	0	0	1
28651	(b)**	3	1	0.04	0.03	
Fluorocarbons	(a)*	2	2	0.03	0.03	1
28692	(b)**	4	4	0.07	0.07	

TABLE VI-7 (Continued)

Industry Segment SIC Code		Number of Plants		Volume of Hazardous Wastes (1,000 metric tons)		Number of Hazardous Wastes
		Options A and B†	Option C††	Options A and B†	Option C††	
Wool Scouring	(a)*	4	4	33	33	1
2299	(b)**	11	11	117	117	
Wool Fabric Dyeing &	(a)*	21	21	0.1	0.1	2
Finishing 2231	(b)**	89	89	0.6	0.6	
Woven Fabric Dyeing &	(a)*	95	95	120	120	2
Finishing 2261	(b)**	355	355	1,083	1,083	
Knit Fabric Dyeing &	(a)*	87	87	42	42	2
Finishing 2251	(b)**	490	490	260	260	
Carpet Dyeing &	(a)*	1	1	0.2	0	2
Finishing 2272	(b)**	0	0	1.2	0	
Yarn & Stock Dyeing &	(a)*	34	34	0.1	0.1	2
Finishing 2269	(b)**	166	166	0.5	0.5	
Tungsten (APT)	(a)*	3	3	23	23	2
3339	(b)**	1	1	4	4	
Mercury	(a)*	3	3	18	18	1
3339	(b)**	1	1	30	30	
Primary Copper Smelting	(a)*	1	1	5	5	1
3331	(b)**	15	15	61	61	
Primary Lead Smelting	(a)*	1	1	14	14	1
3332	(b)**	6	6	132	132	
Primary Zinc Smelting	(a)*	2	2	28	28	1
3333	(b)**	4	4	149	149	
Primary Aluminum	(a)*	11	11	521	521	2
Smelting 3334	(b)**	20	20	1,032	1,032	
Primary Antimony Smelting	(a)*	1	1	4	4	1
3339	(b)**	2	2	0.8	0.8	
Primary Titanium Smelting	(a)*	2	2	5	5	1
3339	(b)**	1	1	5	5	
Primary Tin Smelting	(a)*	1	1	5	5	1
3339	(b)**	0	0	0	0	
Secondary Copper Smelting	(a)*	40	40	57	57	1
3341	(b)**	40	40	49	49	
Secondary Lead Smelting	(a)*	40	40	28	28	1
3341	(b)**	42	42	22	22	

TABLE VI-7 (Continued)

Industry Segment SIC Code		Number of Plants		Volume of Hazardous Wastes (1,000 metric tons)		Number of Hazardous Wastes
		Options A and B†	Option C††	Options A and B†	Option C††	
Secondary Aluminum	(a)*	60	60	533	533	1
Smelting 3341	(b)**	37	37	163	163	
Iron and Steel	(a)*	60	60	4,100	4,100	7
331	(b)**	95	95	5,400	5,400	
Ferrous Foundries	(a)*	593	593	4	4	2
332	(b)**	1,171	1,171	8	8	
Ferroalloys	(a)*	10	10	247	427	2
3312	(b)**	12	12	133	133	

Sources: U.S. Department of Commerce, Economic Information System, Inc., Battelle Columbus Laboratories and Arthur D. Little, Inc., estimates.

TABLE VI-8

COST OF HAZARDOUS WASTE MANAGEMENT FOR GENERATOR INDUSTRY SEGMENTS, 1977

SIC — Industrial Segment	Current Disposal Method[a]	Future Disposal Method[a]	Cost Level I $/Ton	Cost Level III $/Ton	% Plants at Level I	% of Waste Disposed On-Site
355 — Special Machinery	1	1	20	15-55	70	10
357 — Office, Computing, & Acctg. Mchs.	1	1	20	15-55	70	10
2892 — Explosives	2	2	287	1000	100	87
2879 — Pesticides	1	1	1	15-30	100	87
3111 — Cattlehide Chrome	1	1	18	15-55	85	10
3111 — Cattlehide Thru to Blue	1	1	18	15-42	85	10
3111 — Cattlehide Splits	1	1	18	15-55	85	10
3111 — Sheepskins	1	1	18	15-55	85	10
3111 — Leather Finishers	1	1	18	15-55	85	10
2812 — Chlorine (Mercury Cell)	1	1	29	15-49	71	87
2812 — Chlorine (Diaphragm and downs cell)	1	1	5	15-55	50	87
2816 — Titanium Dioxide	1	1	1	15	73	87
2816 — Chrome Pigments	1	1	19	15-55	60	87
2816 — Hydrofluoric Acid	1	1	3	15	100	87
28196 — Aluminum Fluoride	1	1	1	15-32	84	87
2819 — Nickel Sulfate	1	1	14	15-55	75	87
2819 — Phosphorus Pentasulfide	1	1	28	25-65	100	87
2819 — Phosphorus	4	4	4	8.60	75	87
2819 — Phosphorus Trichloride	1	1	235	25-65	100	87
2819 — Sodium Chromates	1	1	8	15	67	87
28194 — Boric Acid	1	1	1	15-38	50	87
3471 — Electroplating & Metal Finishing	1	1	53	15-55	70	19
2851 — Paints and Allied Products	1	2	36	100	99	4
2831 — Pharmaceuticals — Active Ingredients	2	2	88	100	39	39
2834 — Pharmaceuticals — Formed & Packaged	1	2	36	100	60	39
282 — Plastics	2	2	100	100	0	80
3011 — Tires & Inner Tubes	1	1	40	15-55	92	5
3012 — Other Rubber Products	1	1	40	15-55	92	5
2992 — Petroleum Rerefining	1	1	9	15-55	40	12

TABLE VI-8 (Continued)

SIC – Industrial Segment	Current Disposal Method[a]	Future Disposal Method[a]	Cost Level I $/Ton	Cost Level III $/Ton	% Plants at Level I	% of Waste Disposed On-Site
3691 – Storage Batteries	1	1	2	15-55	20	35
3692 – Primary Batteries	1	1	120	15-55	90	35
2911 – Petroleum Refining	1 & 3	1 & 3	15-36	15-36	40	44
367 – Electronic Components	1	2	40	125	85	13
28692 – Perchloroethylene	1	2	21	45	100	87
28612 – Nitrobenzene	1	2	307	100	70	87
28692 – Chloromethane	1	2	100	288	100	87
28692 – Epichlorohydrin	1	2	65	84	100	87
28651 – Toluene Diisocyanate	1	2	85	231	100	87
28692 – Vinyl Chloride Monomer	1	2	87	208	100	87
28692 – Methyl Methacrylate	1	2	22	30	100	87
28692 – Acrylonitrile	1	2	127	350	100	87
28692 – Maleic Anhydride	1	1	72	15-55	100	87
28692 – Lead Alkyls	2	2	24	25	100	87
28651 – Chlorobenzene	1	2	17	97	83	87
28692 – Ethanolamines	1	2	99	120	100	87
28651 – Furfural	1	1	8	35	100	87
28651 – Benzylchloride	1	1	28	15-55	100	87
28692 – Fluorocarbons	1	1	98	15-55	100	87
2299 – Wool Scouring	4	4	3	8.60	78	49
2231 – Wool Fabric Dyeing & Finishing	1	1	16	15-55	29	49
2261 – Woven Fabric Dyeing & Finishing	4	4	3	3.50	90	49
2251 – Knit Fabric Dyeing & Finishing	4	4	3	5.40	50	49
2272 – Carpet Dyeing & Finishing	1	1	16	15-55	29	49
2269 – Yarn & Stock Dyeing & Finishing	1	1	16	15-55	29	49
3339 – Tungsten (APT)	1	1	17	60	75	98
3339 – Mercury	1	1	2	5	100	98
3331 – Primary Copper Smelting	1	1	3	15	100	98
3332 – Primary Lead Smelting	1	1	1	3	73	98
3333 – Primary Zinc Smelting	1	1	1	7	83	98

TABLE VI-8 (Continued)

SIC – Industrial Segment	Current Disposal Method[a]	Future Disposal Method[a]	Cost Level I $/Ton	Cost Level III $/Ton	% Plants at Level I	% of Waste Disposed On-Site
3334 – Primary Aluminum Smelting	1	1	1.50	2.50	100	98
3339 – Primary Antimony Smelting	1	1	2	5.00	100	98
3339 – Primary Titanium Smelting	1	1	2	8	100	79
3339 – Primary Tin Smelting	1	1	2	5	100	98
3341 – Secondary Copper Smelting	1	1	3	6	100	98
3341 – Secondary Lead Smelting	1	1	3	8	100	98
3341 – Secondary Aluminum Smelting	1	1	4	9	100	98
331 – Iron & Steel	1	1	2	10	100	98
332 – Ferrous Foundries	1	1	2	10	100	95
3312 – Ferroalloys	1	1	2	10	100	98

[a] 1 = landfill
2 = incineration
3 = landfarm
4 = lagoon storage

Source: Derived from Table VI-6.

VII. TOTAL COST OF COMPLIANCE

A. INTRODUCTION

Four presentations of the total incremental costs of compliance with RCRA Subtitle C are given in this chapter:

- costs by compliance activity;
- startup and recurring costs;
- costs by regulation section; and
- costs by hazardous waste management network activity.

These are the incremental costs which will be borne by the generator industries over and above current expenditures for hazardous waste management in order to come into compliance with RCRA Subtitle C. The incremental cost is derived from the difference between the Pathways Level III practice and the Level I practice for each waste stream.

The estimated incremental compliance costs cover only the identified waste streams of the 17 generator industries included in this report. Consequently, the estimates understate the actual cost of compliance to these industries and in particular are not a cost estimate for all industry.

B. COST OF COMPLIANCE ACTIVITIES

The total annual incremental cost of compliance with Option A is estimated to be $1.8 billion. Table VII-1 lists the compliance activity components of the cost estimate. Financial responsibility requirements form the largest component at $1.1 billion annually, or 60% of the total. The total annual incremental cost of compliance with Option B (the proposed regulations) is estimated to be $630 million. (See Table VII-2.) Financial requirement costs are reduced to $120 million in Option B, in large measure because a National Hazardous Waste Liability Fund for postclosure liability is assumed. The cost of the Fund has not been estimated because it will require separate enabling legislation. The incremental cost of monitoring and testing declines from $260 million in Option A to $100 million in Option B, accounting for 17% of Option B's annual cost.

The total annual incremental cost of hazardous waste management is estimated to be $500 million for Option C, under which generators below 1,000 kg per year would be excluded (Table VII-3). Important reductions in the reporting and financial requirements are also part of Option C. The small volume exclusion in Options A and B is 100 kg per year. The cost of compliance with the technical requirements is about the same in each of the three options. The cost of the Financial Requirements falls to $65 million in Option C and the monitoring and testing costs are $75 million.

The number of facilities for which compliance costs are estimated for Option C is 15,700, as compared with 19,900 for Options A and B. The assessment reports from which the facility counts were developed in many cases provided only partial coverage for small generators, and the 19,900 figure is probably an understatement of the actual number of generators covered in the 17

TABLE VII-1

TOTAL ANNUAL INCREMENTAL COST OF
HAZARDOUS WASTE MANAGEMENT, OPTION A[a]
($MM)

Activity	Annual Cost	Low	High
Technical Requirements	264	149	597
Financial Requirements	1,060	511	1,576
Recordkeeping/Reporting	41	39	77
Monitoring/Testing	261	170	516
Administration	97	96	187
Training	32	22	55
Contingency Planning	31	18	50
Total	1,786	1,005	3,058
		-44%	+71%

a. Costs for selected waste streams of 17 industries generating hazardous waste.

Source: Arthur D. Little, Inc., estimates.

TABLE VII-2

TOTAL ANNUAL INCREMENTAL COST OF
HAZARDOUS WASTE MANAGEMENT, OPTION B[a]
($MM)

Activity	Annual Cost	Low	High
Technical Requirements	258	145	581
Financial Requirements	121	92	153
Recordkeeping/Reporting	14	13	26
Monitoring/Testing	104	68	206
Administration	70	69	135
Training	32	22	55
Contingency Planning	31	18	50
Total	630	427	1,206
		–32%	91%

a. Costs for selected waste streams of 17 industries generating hazardous waste.

Source: Arthur D. Little, Inc., estimates.

TABLE VII-3

TOTAL ANNUAL INCREMENTAL COST OF HAZARDOUS WASTE MANAGEMENT, OPTION C[a] ($MM)

Activity	Annual Cost	Low	High
Technical Requirements	249	139	562
Financial Requirements	65	56	76
Recordkeeping/Reporting	8	7	13
Monitoring/Testing	75	49	149
Administration	53	52	102
Training	26	18	45
Contingency Planning	24	15	40
Total	501	336	987
		- 32%	100%

a. Costs for selected waste streams of 17 industries generating hazardous waste.

Source: Arthur D. Little, Inc., estimates.

industries at a 100 kg cutoff. A larger number of generators implies a higher cost of compliance. Those costs for compliance activities related primarily to the number of waste generators (e.g., recordkeeping and reporting) are reduced in Option C as compared with Option B. However, the Technical Requirement Costs (operation of secure landfills and incinerators) are not reduced appreciably because there is little change in the total volume of waste encompassed by the regulation.

C. STARTUP AND RECURRING COSTS

The annualized cost of compliance is divided into one-time startup costs and recurring or annual costs. Tables VII-4 and VII-5 show the startup and recurring costs for Option A and Option B, respectively. Startup costs are the expenditures for system development, initial waste determinations, land acquisition and development, surveys and equipment. Although most firms would capitalize such initial costs and spread them over a period of years, they also represent a sudden capital demand, which in itself could have an important economic impact. The methodology by which costs were converted to annual figures is explained in Chapter IV.

The startup costs would total $590 and $550 million for Options A and B and $435 million for Option C (Table VII-6). The costs are similar because the technical requirements are the same under each option for treatment, storage, and disposal facilities. The startup administration costs are comparable to the technical requirements costs for each of the options.

The recurring annual costs are $1.7 billion for Option A, $540 million for Option B, and $420 million for Option C. The largest difference in recurring costs among the options is in the financial requirement costs, which drop from $1.1 billion in Option A to $120 million in Option B and $65 million in Option C.

TABLE VII-4

TOTAL INCREMENTAL COMPLIANCE COST DIVIDED INTO START-UP AND RECURRING COSTS, OPTION A ($MM)

Activity	Start-Up Cost	Recurring Cost
Technical Requirements	306	214
Financial Requirements	X	1,060
Recordkeeping/Reporting	.4	41
Monitoring/Testing	X	261
Administration	237	58
Training	40	25
Contingency	2	31
Total	585	1,690

Source: Arthur D. Little, Inc., estimates.

TABLE VII-5

TOTAL INCREMENTAL COMPLIANCE COST DIVIDED INTO START-UP AND RECURRING COSTS, OPTION B ($MM)

Activity	Start-Up Cost	Recurring Cost
Technical Requirements	269	214
Financial Requirements	X	121
Recordkeeping/Reporting	.4	14
Monitoring/Testing	X	104
Administration	237	32
Training	40	25
Contingency	2	31
Total	548	541

Source: Arthur D. Little, Inc., estimates.

TABLE VII-6

TOTAL INCREMENTAL COMPLIANCE COST DIVIDED INTO START-UP AND RECURRING COSTS, OPTION C
($MM)

Activity	Start-Up Cost	Recurring Cost
Technical Requirements	217	214
Financial Requirements	X	65
Recordkeeping/Reporting	.3	8
Monitoring/Testing	X	75
Administration	184	23
Training	32	21
Contingency Planning	2	24
Total	435	430

Source: Arthur D. Little, Inc., estimates.

D. COSTS RELATED TO SUBTITLE C SECTIONS

The compliance costs can be directly attributed to the sections of Subtitle C: 3001, 3002, 3003, 3004, and 3005. Tables VII-7, VII-8, and VII-9 list the costs as they arise from each section. Under all three options, the major share of the compliance costs are attributable to Section 3004, which regulates treatment, storage, and disposal facilities (TSDF). The annual cost of compliance with Section 3004 is $1.7 billion for Option A, $570 million for Option B, and $460 million for Option C. All of the Financial Requirements costs are attributed to 3004 and account for $1.1 billion of the $1.7 billion of cost for Option A. This component drops to $120 million for Option B and $65 million for Option C. The technical requirements account for about half of the total cost for Section 3004 under Options B and C.

The administrative and training requirements applicable to TSD facilities under Section 3005 result in about $40 million of annual compliance cost for Options A and B and $33 million for Option C. The requirements of Sections 3001 and 3002 having to do with the determination of what waste is hazardous and recordkeeping by generators together result in $43 million in additional expenditures under Option A, $19 million under Option B, and $11 million under Option C. The regulation of waste transportation under Section 3003 will impose very little additional cost on transporters because the existing Department of Transportation regulations are adopted in the section.

E. COST FOR WASTE GENERATION, TRANSPORTATION AND TREATMENT/STORAGE/DISPOSAL

The compliance costs can be attributed to the major activities of the Hazardous Waste Management Network. Sections 3001 and 3002 are applicable to waste generators. Section 3003 is applicable to waste transporters and Sections 3004 and 3005 are applicable to waste TSD facilities. Table VII-10 shows the annual compliance cost for these three activities for each option. The costs attributable to TSD dominate the total cost estimates. For all of the regulatory options, about 98% of the annual cost of compliance is associated with treatment, storage, or disposal of hazardous waste.

TABLE VII-7

TOTAL, ANNUAL, INCREMENTAL COSTS OF
HAZARDOUS WASTE MANAGEMENT BY SUBTITLE C SECTION, OPTION A
($MM)

Activity	3001	3002	3003	3004	3005
Technical Requirements	X	X	X	264	X
Financial Requirements	X	X	X	1,060	X
Recordkeeping/Reporting	X	29.6	.2	11	X
Monitoring/Testing	X	X	X	261	X
Administration	2.6	10.6	.9	50	33.7
Training	X	X	X	32	6.6
Contingency	X	X	X	31	.4
Total	2.6	40.2	1.1	1,709	40.7

Source: Arthur D. Little, Inc., estimates.

TABLE VII-8

TOTAL, ANNUAL, INCREMENTAL COST OF
HAZARDOUS WASTE MANAGEMENT BY
SUBTITLE C SECTION, OPTION B
($MM)

Activity	3001	3002	3003	3004	3005
Technical Requirements	X	X	X	258	X
Financial Requirements	X	X	X	121	X
Recordkeeping/Reporting	X	5.6	.2	8	X
Monitoring/Testing	X	X	X	104	X
Adminstration	2.6	10.6	.9	22.7	32.1
Training	X	X	X	26	7
Contingency	X	X	X	30.6	.4
Total	2.6	16.2	1.1	570	39.5

Source: Arthur D. Little, Inc., estimates.

TABLE VII-9

TOTAL, ANNUAL, INCREMENTAL COST OF HAZARDOUS WASTE MANAGEMENT BY SUBTITLE C SECTION, OPTION C ($MM)

Activity	3001	3002	3003	3004	3005
Technical Requirements	X	X	X	249	X
Financial Requirements	X	X	X	65	X
Recordkeeping/Reporting	X	1.8	X	6	X
Monitoring/Testing	X	X	X	75	X
Administration	2.0	7.2	.1	16	27.1
Training	X	X	X	21	5.3
Contingency Planning	X	X	X	24	.3
Total	2.0	9.0	.1	456	32.7

Source: Arthur D. Little, Inc., estimates.

TABLE VII-10

ANNUAL COMPLIANCE COST RESULTING FROM WASTE MANAGEMENT ACTIVITY ($MM)

Waste Management Activity	Option A	Option B	Option C
Generation[a]	42.8	18.8	11
Transportation[b]	1.1	1.1	0.1
Treatment, Storage, and Disposal[c]	1,750	610	489
Total	1,786	629	501

a. Section 3001 and 3002
b. Section 3003
c. Section 3004 and 3005

Source: Arthur D. Little, Inc., estimates.

F. SENSITIVITY ANALYSIS

The compliance cost estimates are based on the assumption that the current division between on-site and off-site waste management will remain unchanged. In practice, the costs of on-site waste management for a small-volume generator will probably be higher than if the wastes were shipped off-site. The magnitude of a shift from on-site to off-site waste management has not been analyzed. To put boundaries on the compliance cost implications of such a shift, the costs were estimated assuming that all but a small quantity of waste would be managed off-site.

For the cost scenarios presented in Tables VII-11, VII-12, and VII-13, the estimated amount of waste sent off-site was as high as possible. For all industries where the off-site cost of hazardous waste management was less than the on-site cost, all waste was shipped off-site. Under this assumption, all but 13,000 tons of the total 23 million tons of hazardous waste would be shipped to large-scale off-site TSD facilities located within 125 miles of the generator site. The incremental transport costs were assumed to be $30/ton or 12¢/ton/mile with a 250 mile round-trip to the TSDF. The magnitude of the assumed shift of waste off-site is an extreme assumption intended to establish the lower bound of the compliance cost estimated.

Under the off-site waste management assumption, the total cost of compliance decreases by approximately 33% for Options B and C and 44% for Option A. The cost reductions are primarily a result of economies of scale and a reduction in the number of waste management facilities. The costs of financial responsibility, monitoring/testing, administration, training, and contingency decrease 50%-60%. These costs reflect the assumption that the number of disposal facilities is proportional to the quantity of waste managed on-site, and as a result, fall sharply when waste is shifted off-site. The technical costs of waste management decrease by only 17%. Technical costs decline by a lesser degree than the other six activities because increased transportation costs are included under this catetory.

Constraints on the availability of off-site waste management capacity have not been considered in this analysis.

In addition to testing the sensitivity of the compliance cost estimates to the assumption of on-site versus off-site waste management, the analysis tested variations in the unit cost estimates, (Chapter V). The range of cost estimates resulted in a percentage uncertainty band for each compliance activity. The uncertainties are listed on Table VII-14. The high and low compliance cost estimates resulting from the uncertainties are included on Tables VII-1, 2, and 3. Option B has an uncertainty range of -31% to +94% around the incremental annual cost of compliance. The uncertainty range for Option C is about the same, whereas the range for Option A is -44% to +71%.

TABLE VII-11

TOTAL, ANNUAL, INCREMENTAL COST OF
WASTE MANAGEMENT – OFF-SITE, OPTION A[a]
($MM)

Activity	Current % Offsite TSD	Offsite TSD	% Difference
Technical Requirements	264	212	-17
Financial Requirements	1,060	543	-49
Recordkeeping/Reporting	41	25	-38
Monitoring/Reporting	261	145	-45
Administration	97	48	-51
Training	32	13	-58
Contingency	31	12	-61
Total	1,786	998	-44

a. Assumes almost all waste is treated, stored, and disposed of offsite.

Source: Arthur D. Little, Inc., estimates.

TABLE VII-12

TOTAL, ANNUAL, INCREMENTAL COST OF
WASTE MANAGEMENT – OFF-SITE, OPTION B[a]
($MM)

Activity	Current % Offsite TSD	Offsite TSD	% Difference
Technical Requirements	258	206	-17
Financial Requirements	121	62	-49
Recordkeeping/Reporting	14	9	-35
Monitoring/Testing	104	83	-45
Administration	70	34	-51
Training	32	13	-58
Contingency	31	12	-61
Total	630	419	-33

a. Assumes almost all waste is treated, stored and disposed of offsite.

Source: Arthur D. Little, Inc., estimates.

TABLE VII-13

TOTAL, ANNUAL, INCREMENTAL COST OF WASTE MANAGEMENT – OFF-SITE, OPTION C[a]

Activity	Current % Offsite TSD	Offsite TSD	% Difference
Technical Requirements	249	199	– 17
Financial Requirements	65	34	– 49
Recordkeeping/Reporting	8	5	– 33
Monitoring/Testing	75	42	– 45
Administration	53	26	– 51
Training	26	11	– 58
Contingency	24	10	– 61
	501	327	– 34%

a. Assumes almost all waste is treated, stored, and disposed offsite.

Source: Arthur D. Little, Inc., estimates.

TABLE VII-14

UNCERTAINTY PERCENTAGES USED IN CALCULATING COST OF COMPLIANCE

Activity	Option A	Option B	Option C
Technical Requirements	+130%, –42%	+130%, –42%	+130%, –42%
Financial Requirements	± 48%	± 25%	± 23%
Recordkeeping/Reporting	+88%, –15%	+88%, – 15%	+88%, – 15%
Monitoring/Testing	+96%, –35%	+96%, – 35%	+96%, – 35%
Administration	+93%, –1%	+93%, – 1%	+93%, – 1%
Training	+72%, –31%	+72%, – 31%	+72%, – 31%
Contingency	+61%, –42%	+61%, – 42%	+61%, – 42%

Source: Arthur D. Little, Inc., estimates.

VIII. CHARACTERIZATION AND IMPACT ON 17 GENERATOR INDUSTRIES

A. INTRODUCTION

This chapter characterizes each of the 17 generator industries in terms of structure, supply and demand balance, profitability, and capital expenditures. Following the characterization of each industry, the economic impact of three hazardous waste management regulatory options is presented. The impact of each option is divided into two parts: cost of compliance; and potential adverse economic impact expressed in terms of plant closures, job losses, production cutbacks, and balance of payments effects. Option B, the proposed regulatory approach, is presented first, followed by Option A and Option C.

A qualitative assessment has been made of the potential economic impacts on the waste generating industries as a result of having to bear the projected compliance costs. The probability of a negative change in the individual impact measures, for example plant closures, has been classified as either likely, probable, possible, unlikely, negligible, or none. Likely means there is a probability of more than 75% that some plants in the industry segment under consideration will close because of the added cost of the regulatory option being evaluated. A probable assessment means that there is a 51% to 75% probability that some of the plants in the industry segment under consideration will close; possibly means the probability is between 26% and 50%; unlikely means the probability is between 11% and 25%; negligible means the probability is between 0.5% and 10% that some of the plants will close; and, none means no plant closures are expected.

The probability of change in the economic impact measure has only been applied to negative changes greater than 0.5% of the measure under consideration. For example, if there is a high probability of production curtailments of 0.1%, this is said to be a negligible impact. With a 60% probability of a 1% production curtailment, the impact is said to be probable for that impact measure. This approach has been used so as to apply the impact assessment only to non-trivial changes in the measures of impact.

The impact assessment is carried out for each of the economic impact criteria (i.e., job losses, production cutbacks, price increases, the balance of payments effects). The results for each of the 17 industries and their 69 attendant segments are described and tabulated in the following sections. The plastics and explosives industries are discussed together in one section.

B. TEXTILE MILL PRODUCTS

1. Characterization of Textile Mill Products

a. Industry Description

The textile mill products industry is extremely diversified and highly fragmented, supporting about 6,500 plants and about 800,000 employees. The basic purpose of this industry is to convert fibrous raw materials (both synthetic and natural fibers) into fabrics (both woven and knit) and a multitude of other end use products (e.g., carpets, felts, non-wovens, cordage and twine, etc.). Production in 1976 included about 10 billion square yards of woven fabrics, 7 billion square yards of knit fabrics, and 920 million square yards of carpets. The total value of shipments in this industry was $36.4 billion.

The major customer of this industry is the domestic apparel industry, which consumed about 40% of the annual output in 1976. Other major consuming industries are domestic home furnishings (draperies, carpets, blankets, sheets, towels, etc.) and the furniture and automotive industry (upholstery, fabrics, carpetings, interlinings, etc.). Producers operate facilities ranging from highly integrated manufacturing units (integrated from basic fiber processing to apparel and home furnishings product production) to small, non-integrated contract plants (commission finishers) that process goods owned by other plants. Most producers are non-integrated, regionally oriented firms, although there has been a trend to greater integration within this industry over the past ten years.

In recent decades, the industry has been concentrating in the Southeast, principally in North and South Carolina, Georgia, and Alabama, and this trend is expected to continue. Nearly 40% of the textile industry is concentrated in the Southeast and over 90% is located on the Eastern seaboard. The remainder is scattered throughout the United States.

b. Segmentation.

According to the standard SIC classification scheme, the textile mill products industry contains ten major SIC classifications and 30 subclassifications. The focus of this classification scheme is around major producing groups rather than around important production processes. To assess the impact of hazardous waste management costs, a production process segmentation scheme has been used, defining six major process technologies which are likely to generate or handle hazardous waste: wool scouring, wool fabric dyeing and finishing, woven fabric dyeing and finishing, knit fabric dyeing and finishing, carpet dyeing and finishing, and yarn and stock dyeing and finishing.

c. Structure.

Wool scouring is a declining business in the United States and supports only 11 producers operating 15 plants (Table VIII-1). Four of the 11 producers account for 73% of the shipment value. This high concentration is expected to continue even in the absence of hazardous waste management regulations.

Wool fabric dyeing and finishing is also a declining business in the United States and supports only 60 producers operating about 110 plants (Table VIII-1). Production in 1976 was estimated to be about 155,000 metric tons. While there has been a 30% reduction in the number of plants operating in this industry since 1972, not all of these plants have closed but instead have shifted to finishing synthetic and cotton woven fabrics.

Woven fabric dyeing and finishing in the United States is a mature business which supports about 200 producers and 450 plants. Most of the producers are single plant operations serving regional customers either on a contract basis or as a commission finisher (i.e., providing only the finishing service for the fabric owner). The top four firms account for 48% of the shipment value.

TABLE VIII-1

CHARACTERIZATION OF THE TEXTILE MILL PRODUCTS INDUSTRY

	1976 Production 1,000's Metric Tons	Number of Producers	Number of Plants	Four Firm Concentration Ratio	Unit Demand Growth %/Year 1976-81	Price-Elasticity of Demand	Product Substitution	Import Competition	Capacity Utilization
Wool Scouring	45	11	15	73	−4	Moderate	High	Moderate	40
Wool Fabric Dyeing and Finishing	155	60	110	38	−7	High	Moderate	High	50
Woven Fabric Dyeing and Finishing	1200	200	450	48	4	Moderate	Low-Moderate	Moderate	75
Knit Fabric Dyeing and Finishing	770	500	577	20	5	Moderate	Low-Moderate	Moderate	65
Carpet Dyeing and Finishing	495	200	254	25	3	Low-Moderate	Low-Moderate	Moderate	75
Yarn and Stock Dyeing and Finishing	226	110	200	24	5	Moderate	Low	Moderate	75

Source: Arthur D. Little, Inc., estimates.

Knit fabric dyeing and finishing in the United States has matured rather recently. It supports about 577 plants. Most producers are single plant operations, although some knitting mills are attached to the large integrated textile producers.

Carpet dyeing and finishing in the United States is a growing business supporting roughly 254 plants. A larger percentage of these producers are manufacturing carpet on a relatively large scale and many of them are connected with major integrated textile firms.

Yarn and stock dyeing and finishing is a small specialized business in the textile industry producing pre-dyed yarns for striped and patterned fabric production. It currently supports about 110 producers operating 200 plants. The estimated production in 1976 was 226,000 metric tons, most of which was consumed by woven fabric manufacturers.

d. Supply and Demand.

In all segments of the textile industry, capacity and supply are more than adequate to meet future demand over the next five years (Table VIII-1). Capacity is quite flexible in this industry and can be expanded and contracted rapidly by increasing or reducing the number of shifts operated or the length of the work week.

In the absence of hazardous waste management requirements, higher prices and increasing competition from imports are expected to result in a 4% per year reduction in demand for scoured wool through 1981. Production in 1976 was estimated at only 45,000 metric tons, down from 69,000 metric tons in 1972. Higher prices, as well as significant competition from imported wool, wool fabrics and apparel, and other synthetic fibers, have contributed significantly to this decline in demand.

Higher prices for wool and synthetic fibers plus competition from wool fabric imports will result in a significant decline in demand for wool fabric dyeing and finishing through 1981.

The demand for woven fabrics, knit fabrics and carpets is expected to increase 3% to 5% per year through 1981.

The demand elasticity for all of the above segments of the textile industry is moderately high, because there is competition from substitute products and imports at the final retail level and consumer shifts are quickly felt throughout the textile industry.

The projected five-year demand growth for pre-dyed and finished yarn and stock (5% per year) will be slightly above the industry average because, at present, this is the best practical route to striped, patterned, or fancy woven or knit fabric production. Over the long term, competition from high-quality printed fabrics will be felt but the impact will be primarily to retard growth rather than reverse it.

e. Profitability.

The textile mill products industry is highly cyclical and marginally profitable (Table VIII-2). Profit margins, even in good years, rarely average above 3% after taxes. An acceptable return on equity is achieved only by carrying high debt loads, which average about 40%-50%.

TABLE VIII-2

FINANCIAL PROFILE OF THE TEXTILE MILL PRODUCTS INDUSTRY

Total Industry (SIC 22)	**1976**	**1975**	**1974**	**1973**	**1972**
Profitability[1]					
• Net Income after Taxes/Sales (%)	2.4	1.5	2.5	2.8	2.6
• Net Income after Taxes/Net Worth (%)	8.1	4.2	7.8	9.0	7.5
Revenues[2]					
• Value of Shipments (MM$)	36,389.2	31,063.6	32,892.2	31,072.7	28,071.5
• Value Added/Shipments (%)	39.8	38.8	40.1	41.9	41.7
New Capital Expenditures (MM$)	1,087.4	996.7	1,169.9	1,120.9	1,127.5

Sources: 1. U.S. Federal Trade Commission, *Quarterly Financial Report for Manufacturing Mining & Trade Corporations* 1972-1977
2. U.S. Department of Commerce, *Census of Manufacturers* 1972 and *Annual Survey of Manufacturers* 1973-1976

During recession years such as 1975, the return on equity falls at a faster rate than profitability and forces many small firms into bankruptcy because additional financing cannot be easily obtained. A moderate to high degree of price elasticity and competition from imported goods keeps prices depressed and the industry profitability low.

f. Capital Investment.

The textile mill products industry is fairly capital intensive, requiring about one dollar of investment for each dollar of shipment value. Most of the capital investment in this industry is old and largely depreciated and new capital investment is infrequently added. The data for new capital expenditures (Table VIII-2) include both replacement of productive equipment and non-productive equipment related to environmental control. Because capital investment in place is largely depreciated and profit margins are typically low, the industry's cash flow position is not strong. This, coupled with the existing high levels of long-term debt, makes it very difficult to raise new capital for investment.

2. Economic Impact on Textile Mill Products

a. Cost of Compliance and Economic Impact of Option B.

The estimated incremental annual cost of compliance under Option B to go from Level I to Pathways Level III is shown in Table VIII-3. The hazardous waste treatment, storage, and disposal activities associated with 3004 and 3005 constitute the largest component of these costs.

The cost of compliance as a percent of production value for the textile mill products industry ranges from a low of .2% for woven fabric dyeing and finishing, and carpet dyeing and finishing to a high of 1.0% for wool fabric dyeing and finishing. The range of error in these estimates runs from -32% to +93%, see Table VIII-3.

Adverse economic effects such as plant closures and job losses are considered probable for wool fabric dyeing and finishing. This means that the probability is between 51% and 75% that more than 0.5% of the plants in this segment may close due to regulatory Option B (Table VIII-4). In knit fabric dyeing and finishing, plant closures are considered unlikely (probability between 11% and 25%). In wool scouring, plant closures, job losses, etc., are also considered unlikely (i.e., 11% to 25% probability). The probability of more than 0.5% woven fabric dyeing and finishing or yarn/stock dyeing and finishing being adversely affected is negligible (probability between .5% and 10%). No adverse economic effects are expected in carpet dyeing and finishing. Across the textile industry, price increases due to Option B are expected to be small.

b. Cost of Compliance and Economic Impact of Option A.

The estimated incremental annual cost of compliance under regulatory Option A to go from Level I to Pathways Level III is shown in Table VIII-5. The cost of compliance as a percent of production value for the six segments of the textile industry ranges from a low of .4% for woven fabric dyeing and finishing to a high of 4.1% for wool fabric dyeing and finishing. The range of error in these estimates runs from -42% to +78%.

TABLE VIII-3

OPTION B
TEXTILE MILL PRODUCTS

ESTIMATED INCREMENTAL ANNUAL COST OF HAZARDOUS WASTE MANAGEMENT ACTIVITIES
(The cost of going from Level I to Pathways Level III)

Industry Segments	Estimated 1977 Production Value	1977 Incremental Annual Cost					Incremental Hazardous Waste Management Cost as a Percent of Production Value
		Generation	Transportation	HW Treatment, Storage & Disposal	Total	Range	
	$MM	$MM	$MM	$MM	$MM	%	%
Wool Scouring	165.0	0.015	0.029	0.965	1.009	-32, +93	0.6
Wool Fabric Dyeing & Finishing	515.0	0.105	0.000	4.808	4.913	-25, +61	1.0
Woven Fabric Dyeing & Finishing	7425.0	0.467	0.266	15.650	16.383	-26, +73	0.2
Knit Fabric Dyeing & Finishing	3480.0	0.581	0.063	19.006	19.650	-26, +74	0.6
Carpet Dyeing & Finishing	6675.0	0.256	0.000	11.200	11.456	-25, +60	0.2
Yarn/Stock Dyeing & Finishing	3175.0	0.195	0.000	8.806	9.001	-25, +60	0.3

Source: Arthur D. Little, Inc., estimates.

TABLE VIII-4

OPTION B
ECONOMIC IMPACT ON TEXTILE MILL PRODUCTS

Industry Segments	Number of Existing Plants in 1976	Plant Closures	Job Losses	U.S. Production Cutbacks	Price Increases	U.S. Demand Reduction	Balance of Payments Effects
Wool Scouring	15	unlikely	unlikely	unlikely	small	unlikely	possibly
Wool Fabric Dyeing and Finishing	110	probably	probably	probably	small	possibly	probably
Woven Fabric Dyeing and Finishing	450	negligible	negligible	negligible	slight	negligible	negligible
Knit Fabric Dyeing and Finishing	577	unlikely	unlikely	unlikely	small	unlikely	possibly
Carpet Dyeing and Finishing	254	none	none	none	small	none	none
Yarn/Stock Dyeing and Finishing	200	negligible	negligible	negligible	small	negligible	none

Source: Arthur D. Little, Inc., estimates.

TABLE VIII-5

OPTION A
TEXTILE MILL PRODUCTS

ESTIMATED INCREMENTAL ANNUAL COST OF HAZARDOUS WASTE MANAGEMENT ACTIVITIES
(The cost of going from Level I to Pathways Level III)

Industry Segments	Estimated 1977 Production Value	1977 Incremental Annual Cost: Generation	Transportation	HW Treatment, Storage & Disposal	Total	Range	Incremental Hazardous Waste Management Cost as a Percent of Production Value
	$MM	$MM	$MM	$MM	$MM	%	%
Wool Scouring	165.0	0.021	0.029	1.233	1.283	-39, +78	0.8
Wool Fabric Dyeing & Finishing	515.0	0.200	0.000	20.714	20.914	-42, +59	4.1
Woven Fabric Dyeing & Finishing	7425.0	0.849	0.266	25,584	26,699	-37, +61	0.4
Knit Fabric Dyeing & Finishing	3480.0	1.087	0.063	30.451	31.601	-37, +61	0.9
Carpet Dyeing & Finishing	6675.0	0.484	0.000	48.252	48.736	-42, +59	0.7
Yarn/Stock Dyeing &Finishing	3175.0	0.368	0.000	47.947	38.315	-42, +59	1.2

Source: Arthur D. Little, Inc., estimates.

Plant closures and other adverse impacts are considered a possibility for wool scouring, knit fabric dyeing and finishing, and yarn/stock dyeing and finishing. That is, the probability ranges between 26% and 50% that more than 0.5% of the segment will be adversely affected. At the same time, adverse impacts are considered likely (probability greater than 75%) for wool fabric dyeing and finishing (Table VIII-6). Adverse consequences are considered unlikely for woven fabric dyeing and finishing, and negligible for carpet dyeing and finishing. Under this regulatory option, an increase in imports is more likely to take place and could keep the producers of wool fabrics from raising their prices enough to cover the full increase in their incremental costs.

c. *Cost of Compliance and Economic Impact of Option C.*

The estimated incremental annual cost of compliance under regulatory Option C to go from Level I to Pathways Level III is shown in Table VIII-7. The cost of compliance as a percent of production value ranges from a low of 0% for carpet dyeing and finishing to a high of 0.8% for wool fabric dyeing and finishing. The range of error in these estimates runs from -25% to +74%.

Under regulatory Option C, plant closures and other adverse impacts are considered probable (i.e., the probability ranges between 51% and 75% that more than 0.5% of the segment will be adversely affected) for wool fabric dyeing and finishing (Table VIII-8). It is considered unlikely (probability of between 11% and 25%) that wool scouring or knit fabric dyeing and finishing will be adversely affected. Negligible economic impacts (probability of between 0.5% and 10%) are expected in woven fabric dyeing and finishing and yarn/stock dyeing and finishing, while no impact is expected in carpet dyeing and finishing. Under this regulatory option, imports are expected to increase even though, in most cases, the required price increases are lower for this option than for the previous two options.

C. INORGANIC CHEMICALS

1. Characterization of Inorganic Chemicals

a. *Industry Description.*

Inorganic chemicals are most often produced from metallic or nonmetallic minerals. In general, they are solid, noncombustible, and often soluble in water. Although some inorganics are used to manufacture other chemicals, they are used less as building blocks than as processing aids in the manufacture of both chemical and non-chemical products. They most often do not appear in the final product.

Inorganic chemicals are characterized both by a smaller number of producers than organic chemicals and a higher concentration of sales among the larger producers. The inorganic segment of the chemical industry, already well established by the end of World War II, did not attract the large number of new entrants that the organic chemicals sector did.

In 1976, the inorganic chemicals industry shipped products valued at nearly $12 billion. Historically, the industry has grown faster than GNP. However, through 1981, the growth rate is only expected to match GNP. Between 1972 and 1976, after-tax profitability averaged 5% of sales and 14% of net worth. Approximately 100,000 persons are employed by this segment of the chemical industry. The structure of the inorganic chemicals business is generally oligopolistic, mainly because of the capital intensive nature of the business and its attendant economies of scale.

TABLE VIII-6

OPTION A
ECONOMIC IMPACT ON TEXTILE MILL PRODUCTS

Industry Segments	Number of Existing Plants in 1976	Plant Closures	Job Losses	U.S. Production Cutbacks	Price Increases	U.S. Demand Reduction	Balance of Payments Effects
Wool Scouring	15	possibly	possibly	possibly	small	possibly	possibly
Wool Fabric Dyeing and Finishing	110	likely	likely	likely	small	probably	likely
Woven Fabric Dyeing and Finishing	450	unlikely	unlikely	unlikely	small	unlikely	unlikely
Knit Fabric Dyeing and Finishing	577	possibly	possibly	possibly	small	possibly	probably
Carpet Dyeing and Finishing	254	negligible	negligible	negligible	small	negligible	none
Yarn/Stock Dyeing and Finishing	200	possibly	possibly	possibly	small	unlikely	possibly

Source: Arthur D. Little, Inc., estimates.

TABLE VIII-7

OPTION C
TEXTILE MILL PRODUCTS

ESTIMATED INCREMENTAL ANNUAL COST OF HAZARDOUS WASTE MANAGEMENT ACTIVITIES
(The cost of going from Level I to Pathways Level III)

Industry Segments	Estimated 1977 Production Value	1977 Incremental Annual Cost					Incremental Hazardous Waste Management Cost as a Percent of Production Value
		Generation	Transportation	HW Treatment, Storage & Disposal	Total	Range	
	$MM	$MM	$MM	$MM	$MM	%	%
Wool Scouring	165.0	0.008	0.001	0.768	0.777	-16, +44	0.5
Wool Fabric Dying & Finishing	515.0	0.082	0.000	4.166	4.248	-25, +64	0.8
Woven Fabric Dyeing & Finishing	7425.0	0.338	0.011	14.450	14.799	-25, +73	0.2
Knit Fabric Dyeing & Finishing	3480.0	0.448	0.002	17.776	18.226	-25, +74	0.5
Carpet Dyeing & Finishing	6675.0	0.000	0.000	0.000	0.000	0.0, 0.0	0.0
Yarn/Stock Dyeing & Finishing	3175.0	0.153	0.000	7.630	7.783	-25, +64	0.2

Source: Arthur D. Little, Inc., estimates.

TABLE VIII-8

OPTION C
ECONOMIC IMPACT ON TEXTILE MILL PRODUCTS

Industry Segments	Number of Existing Plants in 1976	Plant Closures	Job Losses	U.S. Production Cutbacks	Price Increases	U.S. Demand Reduction	Balance of Payments Effects
Wool Scouring	15	unlikely	unlikely	unlikely	small	unlikely	possibly
Wool Fabric Dyeing and Finishing	110	probably	probably	probably	small	possibly	probably
Woven Fabric Dyeing and Finishing	450	negligible	negligible	negligible	slight	negligible	negligible
Knit Fabric Dyeing and Finishing	577	unlikely	unlikely	unlikely	small	unlikely	possibly
Carpet Dyeing and Finishing	254	none	none	none	small	none	none
Yarn/Stock Dyeing and Finishing	200	negligible	negligible	negligible	small	negligible	none

Source: Arthur D. Little, Inc., estimates.

b. Segmentation.

Not all segments of the inorganic chemicals industry generate hazardous waste. Thus, the segments analyzed in this report do not cover the whole industry, but only those segments which previous analysis has indicated generate hazardous waste: i.e., chlorine (mercury cell process), chlorine (downs and diaphragm cell process), titanium dioxide, chrome pigments, aluminum fluoride, phosphorus pentasulfide, phosphorus, phosphorus trifluoride, sodium chromates, and boric acid.

c. Structure.

With the exception of chlorine and chrome pigments, the products of the inorganic chemical industry studied are manufactured by relatively few producers; hence, the four-firm concentration ratios are high, running 80% or more (Table VIII-9). The concentration ratios for the two more-widely produced products range from 65% to 70%.

d. Supply and Demand.

Through 1981, with the exception of phosphorus pentasulfide, phosphorus trichloride, and titanium dioxide, the growth in unit demand for the chemicals under study is expected to be less than that for the inorganic chemicals industry as a whole (Table VIII-9). Currently, capacity utilization is reasonably good in most segments. Existing conditions indicate no significant supply constraints over the near term, with the possible exception of boric acid.

Most of the chemicals face a moderate amount of product substitution and generally have a moderate price elasticity of demand. Import competition is expected to become an increasing problem.

e. Profitability.

For the inorganic chemicals industry as a whole (the data are not available for individual segments), after-tax profitability, both in terms of the return on sales and the return on net worth, has fluctuated with the state of the economy (Table VIII-10). Although the rate of profit for the average company in the industry is reasonably favorable, the rates of return on sales and net worth after taxes for companies in the bottom half of the industry are quite low. Companies operating at the lower levels of profitablilty are most likely to be adversely affected by the proposed hazardous waste management regulations if they produce the highly impacted chemicals.

f. Capital Investment.

The level of new capital investment in the inorganic chemicals industry more than doubled between 1972 and 1976 (Table VIII-10). The data include productive investment which permits increases in sales and profits and non-productive investment related to pollution control and energy conservation.

TABLE VIII-9

CHARACTERIZATION OF INORGANIC CHEMICALS

Industry Segments	1976 Production 1,000's Metric Tons	Number of Producers	Number of Plants	Four-Firm Concentration Ratio	Unit Demand Growth %/Year 1976-81	Price Elasticity of Demand	Product Substitution	Import Competition	Capacity Utilization %
Chlorine (Mercury Cell)	2021	15	27	70	0	low	*	low	75
Chlorine (Downs & Diaphragm Cell)	7423	20	40	65	4	low	moderate	low	85
Titanium Dioxide	649	6	13	85	5	low	low	increasing	75
Chrome Pigments	64	11	15	70	3	moderate	moderate	moderate	85
Hydrofluoric Acid	262	8	12	80	-2	moderate	moderate	increasing	75
Aluminum Fluoride	120	4	5	100	3	moderate	moderate	low	80
Nickel Sulfate	7	4	4	100	-4	moderate	moderate	low	90
Phosphorous Pentasulfide	59	3	7	100	6	low	moderate	low	75
Phosphorous	397	6	9	95	-2	moderate	moderate	low	75
Phosphorus Trichloride	75	5	7	90	5	moderate	moderate	low	70
Sodium Chromates	140	3	3	100	2	low	low	low	85
Boric Acid	125	3	3	100	2	moderate	moderate	increasing	85

*High process substitution-industry switching from mercury cell to diaphragm cell process.

Sources: Arthur D. Little, Inc. estimates based on our 1976 report entitled *Economic Assessment of Potential Hazardous Waste Control Guidelines for the Inorganic Chemicals Industry*, prepared for the U.S. Environmental Protection Agency, Office of Solid Waste Management.

TABLE VIII-10

FINANCIAL PROFILE OF INORGANIC CHEMICALS

Total Industry (SIC 281)		1976	1975	1974	1973	1972
Profitability[1]						
Net Income After Taxes/Sales (%)	upper quartile	8.3	8.0	8.7	6.8	6.3
	median	5.6	5.0	6.2	5.3	3.8
	lower quartile	3.2	1.9	3.4	3.4	1.2
Net Income After Taxes/Net Worth (%)	upper quartile	21.7	25.3	22.0	18.0	14.4
	median	16.4	15.6	16.5	12.3	9.7
	lower quartile	8.8	7.5	11.0	8.2	5.4
Revenues[2]						
Value of Shipments (MM$)		11,610.8	9,660.8	8,849.1	6,773.4	6,132.7
Value Added/Shipments (%)		53.1	54.0	53.5	55.1	54.5
New Capital Expenditures (MM$)		813.2	721.0	669.0	372.6	280.4

Sources: 1. Dun and Bradstreet, *Ratios of Manufacturing* 1973-1976
2. U.S. Department of Commerce, *Census of Manufactures* 1972 and *Annual Survey of Manufacturers* 1973-1976

2. Economic Impact on Inorganic Chemicals

a. Cost of Compliance and Economic Impact of Option B.

The estimated incremental annual cost of compliance under Option B to go from Level I to Pathways Level III is shown in Table VIII-11. The cost of compliance as a percent of production value for the inorganic chemicals industry ranges from a low of 0.4% for downs and diaphragm cell chlorine to a high of 2.4% for aluminum fluoride (Table VIII-11). The range of error is from −39% to +121%.

Adverse economic effects such as plant closures and job losses are considered probable for mercury cell chlorine. This means that the probability is between 51% and 75% that more 0.5% of the plants in this segment may close due to regulatory Option B (Table VIII-12). Job losses are considered possible (probability of between 25% and 50%) for chrome pigments. Adverse economic affects are considered negligible (probability of 0.5% to 10%) for titanium dioxide, aluminum fluoride, phosphorus pentasulfide, phosphorus trichloride, and sodium chromates. No impacts are expected for downs and diaphragm cell chlorine, hydrofluoric acid, nickel sulfate, phosphorus, and boric acid. There will be no economic impact on hydrofluoric acid and nickel sulfate, because more extensive, recent tests have revealed that the wastes generated by these processes are not hazardous.

b. Cost of Compliance and Economic Impact of Option A.

The estimated incremental annual cost of compliance under regulatory Option A to go from Level I to Pathways Level III is shown in Table VIII-13. The cost of compliance as a percent of production value for the segments of the inorganic chemicals industry range from 0.5% for phosphorus to 4.7% for mercury cell chlorine (Table VIII-13). The range of error is from -42% to +104%.

Under regulatory Option A, plant closures and other adverse economic impacts are considered likely for mercury cell chlorine. This means there is a probability of more than 75% that more than 0.5% of this segment will experience adverse economic impacts (Table VIII-14). At the same time, job losses are considered probable for chrome pigments (that is, a probability of from 51% to 75%). Adverse economic impacts are considered unlikely for titanium dioxide, aluminum fluoride, phosphorus pentasulfide, phosphorus trichloride, and sodium chromates. This means there is a probability of between 11% and 25% that more than 0.5% of these segments will experience adverse economic effects. Negligible economic impacts (probability of from 0.5% to 10%) are expected for downs and diaphragm cell chlorine, phosphorus, and boric acid. In several of the above cases, U.S. production cutbacks are considered more likely than job losses or plant closures. This is because the necessary annual price increases under Option A are in the moderate range (between 2% and 5%) for several products which also have moderate product substitution effects such as chrome pigments, aluminum fluoride, phosphorus pentasulfide, and phosphorus trichloride.

c. Cost of Compliance and Economic Impact of Option C.

The estimated incremental cost of compliance under regulatory Option C to go from Level I to Pathways Level III is shown in Table VIII-15. The cost of compliance as a percent of production

TABLE VIII-11

OPTION B
INORGANIC CHEMICALS

ESTIMATED INCREMENTAL ANNUAL COST OF HAZARDOUS WASTE MANAGEMENT ACTIVITIES
(The cost of going from Level I to Pathways Level III)

Industry Segments	Estimated 1977 Production Value	1977 Incremental Annual Cost					Incremental Hazardous Waste Management Cost as a Percent of Production Value
		Generation	Transportation	HW Treatment Storage & Disposal	Total	Range	
	$MM	$MM	$MM	$MM	$MM	%	%
Chlorine (Mercury Cell)	225.0	0.022	0.004	3.485	3.511	-32, +87	1.6
Chlorine (Downs & Diaphragm Cell)	800.0	0.022	0.000	3.342	3.364	-27, +68	0.4
Titanium Dioxide	625.0	0.011	0.051	10.259	10.321	-39, +121	1.7
Chrome Pigments	110.0	0.008	0.000	1.264	1.272	-28, +73	1.2
Hydrofluoric Acid	200.0	0.000	0.000	0.000	0.000	0, 0	0.0
Aluminum Fluoride	55.0	0.002	0.000	1.317	1.319	-38, +117	2.4
Nickel Sulfate	10.0	0.000	0.000	0.000	0.000	0, 0	0.0
Phosphorus Pentasulfide	45.0	0.004	0.000	0.452	0.456	-26, +62	1.0
Phosphrous	420.0	0.007	0.026	1.905	1.938	-36, +116	0.5
Phosphorus Trichloride	60.0	0.004	0.000	0.449	0.453	-26, +61	0.8
Sodium Chromates	85.0	0.001	0.012	1.467	1.480	-39, +117	1.7
Boric Acid	25.0	0.001	0.000	0.172	0.173	-34, +101	0.7

Source: Arthur D. Little, Inc., estimates.

TABLE VIII-12

OPTION B
ECONOMIC IMPACT ON INORGANIC CHEMICALS

Industry Segments	Number of Existing Plants in 1976	Plant Closures	Job Losses	U.S. Production Cutbacks	Price Increases	U.S. Demand Reduction	Balance of Payments Effects
Chlorine (Mercury Cell)	27	probably	probably	likely	small	probably	negligible
Chlorine (Downs and Diaphragm Cell)	40	none	none	none	small	none	none
Titanium Dioxide	13	negligible	negligible	unlikely	small	negligible	negligible
Chrome Pigments	15	unlikely	possibly	probably	small	unlikely	unlikely
Hydrofluoric Acid	12	none	none	none	none	none	none
Aluminum Fluoride	5	negligible	negligible	unlikely	small	none	negligible
Nickel Sulfate	4	none	none	none	none	none	none
Phosphorus Pentasulfide	7	negligible	negligible	unlikely	small	none	negligible
Phosphorus	9	none	none	none	small	none	none
Phosphorus Trichloride	7	negligible	negligible	unlikely	small	negligible	negligible
Sodium Chromates	3	negligible	negligible	negligible	small	negligible	negligible
Boric Acid	3	none	none	negligible	small	none	negligible

Source: Arthur D. Little, Inc., estimates.

TABLE VIII-13

OPTION A
INORGANIC CHEMICALS

ESTIMATED INCREMENTAL ANNUAL COST OF HAZARDOUS WASTE MANAGEMENT ACTIVITIES
(The cost of going from Level I to Pathways Level III)

Industry Segments	Estimated 1977 Production Value	1977 Incremental Annual Cost					Incremental Hazardous Waste Management Cost as a Percent of Production Value
		Generation	Transportation	HW Treatment, Storage & Disposal	Total	Range	
	$MM	$MM	$MM	$MM	$MM	%	%
Chlorine (Mercury Cell)	225.0	0.033	0.004	10.469	10.506	-42. +68	4.7
Chlorine (Downs & Diaphragm Cell)	800.0	0.033	0.000	13.301	13.334	-42, +61	1.7
Titanium Dioxide	625.0	0.016	0.049	13.812	13.877	-42, +102	2.2
Chrome Pigments	110.0	0.013	0.000	4.809	4.822	-42, +62	4.4
Hydrofluoric Acid	200.0	0.000	0.000	0.000	0.000	0, 0	0.0
Aluminum Fluoride	55.0	0.004	0.000	2.220	2.224	-42, +92	4.0
Nickel Sulfate	10.0	0.000	0.000	0.000	0.000	0,0	0.0
Phosphorus Pentasulfide	45.0	0.007	0.000	1.953	1.960	-42, +60	4.4
Phosphorus	420.0	0.016	0.024	2.172	2.212	-40, +104	0.5
Phosphorus Trichloride	60.0	0.007	0.000	1.950	1.957	-42, +59	3.3
Sodium Chromates	85.0	0.002	0.011	1.937	1.950	-42, +98	2.3
Boric Acid	25.0	0.002	0.000	0.468	0.470	-42, +74	1.9

Source: Arthur D. Little, Inc., estimates.

TABLE VIII-14

OPTION A
ECONOMIC IMPACT ON INORGANIC CHEMICALS

Industry Segments	Number of Existing Plants in 1976	Plant Closures	Job Losses	U.S. Production Cutbacks	Price Increases	U.S. Demand Reduction	Balance of Payments Effects
Chlorine (Mercury Cell)	27	likely	likely	likely	moderate	likely	negligible
Chlorine (Downs and Diaphragm Cell)	40	negligible	negligible	unlikely	small	unlikely	negligible
Titanium Dioxide	13	unlikely	unlikely	possibly	small	unlikely	unlikely
Chrome Pigments	15	possibly	probably	likely	moderate	possibly	probably
Hydrofluoric Acid	12	none	none	none	none	none	none
Aluminum Fluoride	5	unlikely	unlikely	possibly	moderate	negligible	possibly
Nickel Sulfate	4	none	none	none	none	none	none
Phosphorus Pentasulfide	7	unlikely	unlikely	possibly	moderate	negligible	negligible-none
Phosphorus	9	negligible	negligible	negligible	small	negligible	negligible
Phosphorus Trichloride	7	unlikely	unlikely	possibly	moderate	unlikely	negligible-none
Sodium Chromates	3	unlikely	unlikely	unlikely	small	negligible	negligible
Boric Acid	3	negligible	negligible	unlikely	small	negligible	unlikely

Source: Arthur D. Little, Inc., estimates.

TABLE VIII-15

OPTION C
INORGANIC CHEMICALS

ESTIMATED INCREMENTAL ANNUAL COST OF HAZARDOUS WASTE MANAGEMENT ACTIVITIES
(The cost of going from Level I to Pathways Level III)

Industry Segments	Estimated 1977 Production Value	1977 Incremental Annual Cost					Incremental Hazardous Waste Management Cost as a Percent of Production Value
		Generation	Transportation	HW Treatment, Storage & Disposal	Total	Range	
	$MM	$MM	$MM	$MM	$MM	%	%
Chloride (Mercury Cell)	225.0	0.018	0.000	3.074	3.092	-16, +40	1.4
Chlorine (Downs & Diaphragm Cell)	800.0	0.018	0.000	2.938	2.956	-22, +57	0.4
Titanium Dioxide	625.0	0.007	0.002	9.154	9.163	-4, +10	1.5
Chrome Pigments	110.0	0.006	0.000	1.118	1.124	-21, +54	1.0
Hydrofluoric Acid	200.0	0.000	0.000	0.000	0.000	0,0	0.0
Aluminum Fluoride	55.0	0.001	0.000	1.228	1.228	-6, +14	2.2
Nickel Sulfate	10.0	0.000	0.000	0.000	0.000	0,0	0.0
Phosphorus Pentasulfide	41.0	0.003	0.000	0.391	0.394	-25, +65	1.0
Phosphorus	420.0	0.005	0.001	1.755	1.761	-7, +19	0.4
Phosphorus Trichloride	60.0	0.003	0.000	0.388	0.391	-26, +65	0.7
Sodium Chromates	85.0	0.001	0.000	1.204	1.205	-6, +13	1.4
Boric Acid	25.0	0.001	0.000	0.159	0.160	-12, +33	0.6

Source: Arthur D. Little, Inc., estimates.

value ranges from a low of 0.4% for phosphorus and downs and diaphragm cell chlorine to a high of 2.2% for aluminum fluoride. The range of error on these estimates runs from −26% to +65%.

Under regulatory Option C, the adverse economic effects such as plant closures and job losses are considered probable for mercury cell chlorine. This means that the probability is between 51% and 75% that more than 0.5% of the plants in this segment will close due to regulatory Option C (Table VIII-16). Job losses are considered possible (probability of between 26% and 50%) for chrome pigments. Adverse economic affects are considered negligible (probability of 0.5% to 10%) for titanium dioxide, aluminum fluoride, phosphorus pentasulfide, phosphorus trichloride, and sodium chromates. No impacts are expected for downs and diaphragm cell chlorine, hydrofluoric acid, nickel sulfate, phosphorus, and boric acid. There will be no economic impact on hydrofluoric acid and nickel sulfate, because more extensive, recent tests have revealed that the wastes generated by these processes are not hazardous.

The relatively low economic impact of the hazardous waste management regulations on the inorganic chemicals industry is predicated on the assumption that, given the industry's oligopolistic structure, the firms in the impacted segments will be able to raise their prices to cover the increased costs. Should price controls be instituted, thus inhibiting pricing flexibility, more plants would be expected to close and a larger number of jobs would be lost as a result of the regulations.

D. PLASTIC MATERIALS AND SYNTHETIC FIBERS

1. Characterization of Plastic Materials and Synthetic Fibers

a. Industry Description.

The plastics industry contains four distinct sub-industries: plastics materials and resins (SIC 2821); synthetic rubber (SIC 2822); man-made cellulosic fibers (SIC 2823); and man-made non-cellulosic fibers (SIC 2824). These industries manufacture plastics for use by the packaging, building/construction, transportation, apparel, and automotive industries. Petroleum feedstocks and natural gas are the basic raw materials for this industry. Thus, the availability and price of these starting materials are of key importance. Plants in this industry are spread throughout the United States. They employ an estimated 160,000 persons.

b. Segmentation.

For purposes of assessing economic impact, the plastics industry was analyzed as a single entity.

c. Structure.

The plastics industry varies in its degree of concentration. While only 27% of industry capacity is accounted for by the top four producers in the plastics materials sector, 96% of industry capacity is accounted for by the top four producers in the cellulosic man-made fibers sector.

TABLE VIII-16

OPTION C
ECONOMIC IMPACT ON INORGANIC CHEMICALS

Industry Segments	Number of Existing Plants in 1976	Plant Closures	Job Losses	U.S. Production Cutbacks	Price Increases	U.S. Demand Reduction	Balance of Payments Effects
Chlorine (Mercury Cell)	27	probably	probably	likely	small	probably	negligible
Chlorine (Downs and Diaphragm Cell)	40	none	none	none	small	none	none
Titanium Dioxide	13	negligible	negligible	unlikely	small	negligible	negligible
Chrome Pigments	15	unlikely	possibly	probably	small	unlikely	unlikely
Hydrofluoric Acid	12	none	none	none	none	none	none
Aluminum Fluoride	5	negligible	negligible	unlikely	small	none	negligible
Nickel Sulfate	4	none	none	none	none	none	none
Phosphorus Pentasulfide	7	negligible	negligible	unlikely	small	none	negligible
Phosphorus	9	none	none	none	small	none	none
Phosphorus Trichloride	7	negligible	negligible	unlikely	small	negligible	negligible
Sodium Chromates	3	negligible	negligible	negligible	small	negligible	negligible
Boric Acid	3	none	none	negligible	small	none	negligible

Source: Arthur D. Little, Inc., estimates.

d. Supply and Demand.

Historically, the plastics industry has grown at a faster pace than most other manufacturing sectors. Given the availability of raw materials at a reasonable price, unit demand growth is expected to continue at 7% to 9% per year through 1981 because of the continued inroads being made by plastics into a wide range of product lines including containers, automobiles, etc. The elasticity of demand is generally moderate, although product substitution ranges from low to high depending on the product (Table VIII-17).

e. Profitability.

Profit margins have declined since the 1973-1974 period when the oil embargo occurred (Table VIII-18).

f. Capital Investment.

The plastics industry is relatively capital intensive. New capital expenditures more than doubled between 1972 and 1976, when the annual rate of expenditures in this industry approached roughly $1.5 billion (Table VIII-18).

2. Economic Impact on Plastics Materials and Synthetic Fibers

a. Cost of Compliance and Economic Impact of Option B.

The estimated incremental annual cost of compliance under regulatory Option B to go from Level I to Pathways Level III is shown in Table VIII-19. The cost of compliance as a percent of production value for plastics is 0.3%. The range of error is -28% to +60%.

Under regulatory Option B, no plant closures are expected. Job losses and other adverse economic impacts will probably be negligible (probability of 0.5% to 10% of occurrence). (See Table VIII-20.)

b. Cost of Compliance and Economic Impact of Option A.

The estimated incremental annual cost of compliance under regulatory Option A to go from Level I to Pathways Level III is shown in Table VIII-21. This cost as a percent of production value is 1.1%. The range of error is -42% to +60%.

Even under this higher cost option, no plant closures are expected and other adverse economic impacts are considered unlikely (probability of 11% to 25%) in the plastics materials and synthetic fibers industry (Table VIII-22).

c. Cost of Compliance and Economic Impact of Option C.

The estimated incremental annual cost of compliance under regulatory Option C to go from Level I to Pathways Level III is shown in Table VIII-23. This cost as a percent of production value is 0.2%. The range of error is -27%, to +63%.

TABLE VIII-17

CHARACTERIZATION OF THE PLASTICS INDUSTRY

Industry Segment	1976 Production 1,000's Metric Tons	Number of Producers	Number of Plants	Four-Firm Concentration Ratio	Unit Demand Growth %/Year 1976-81	Price Elasticity of Demand	Product Substitution	Import Competition	Capacity Utilization %
Plastics (SIC 282)	37	310	581	27-96	7-9	moderate	low-high	low	89

Source: Arthur D. Little, Inc., estimates.

TABLE VIII-18

FINANCIAL PROFILE OF PLASTICS INDUSTRY

Total Industry (SIC 282)		**1976**	**1975**	**1974**	**1973**	**1972**
Profitability[1]						
Net Income After Taxes/Net Sales	upper quartile	4.28	4.58	6.89	6.31	6.40
	median	3.25	2.80	5.27	3.80	4.14
	lower quartile	1.69	1.21	2.18	2.36	2.54
(Net Profits on Net Sales)						
Net Income After Taxes/Net Worth (%)	upper quartile	11.30	15.60	21.66	16.50	18.17
	median	8.81	7.81	13.92	11.89	11.30
	lower quartile	5.46	3.64	8.52	4.75	6.36
(Net Profits on Tangible Net Worth)						
Revenues[2]						
Value of Shipments (MM$)		17,155.5	14,348.6	15,108.1	11,719.6	9,796.9
Value Added/Shipments (%)		38.7	38.4	46.9	51.8	50.4
New Capital Expenditures (MM$)		1,368.6	1,439.4	1,276.6	829.8	686.4

Sources: 1. Dun and Bradstreet, *Ratios of Manufacturing,* 1973-1976.
2. U.S. Department of Commerce, *Census of Manufacturers* 1972 and *Annual Survey of Manufacturers* 1973-1976.

TABLE VIII-19

OPTION B
PLASTICS MATERIALS & SYNTHETIC FIBERS

ESTIMATED INCREMENTAL ANNUAL COST OF HAZARDOUS WASTE MANAGEMENT ACTIVITIES
(The cost of going from Level I to Pathways Level III)

Industry Segment	Estimated 1977 Production Value	1977 Incremental Annual Cost					Incremental Hazardous Waste Management Cost as a Percent of Production Value
		Generation	Transportation	HW Treatment, Storage & Disposal	Total	Range	
	$MM	$MM	$MM	$MM	$MM	%	%
Plastics Materials and Synthetic Fibers	18,000.0	0.442	0.047	48.741	49.230	-28, +60	0.3

Source: Arthur D. Little, Inc., estimates.

TABLE VIII-20

OPTION B
ECONOMIC IMPACT ON PLASTICS MATERIALS AND SYNTHETIC FIBERS

Industry Segment	Number of Existing Plants in 1976	Plant Closures	Job Losses	U.S. Production Cutbacks	Price Increases	U.S. Demand Reduction	Balance of Payments Effects
Plastics Materials and Synthetic Fibers	581	none	negligible	negligible	small	negligible	negligible

Source: Arthur D. Little, Inc., estimates.

TABLE VIII-21

OPTION A
PLASTICS MATERIALS AND SYNTHETIC FIBERS
ESTIMATED INCREMENTAL ANNUAL COST OF HAZARDOUS WASTE MANAGEMENT ACTIVITIES
(The cost of going from Level I to Pathways Level III)

Industry Segment	Estimated 1977 Production Value $MM	1977 Incremental Annual Cost					Incremental Hazardous Waste Management Cost as a Percent of Production Value %
		Generation $MM	Transportation $MM	HW Treatment, Storage & Disposal $MM	Total $MM	Range %	
Plastics Materials and Synthetic Fibers	18,000.0	0.663	0.047	190.101	190.811	-42, +60	1.1

Source: Arthur D. Little, Inc., estimates.

TABLE VIII-22

OPTION A
ECONOMIC IMPACT ON PLASTICS MATERIALS AND SYNTHETIC FIBERS

Industry Segment	Number of Existing Plants in 1976	Plant Closures	Job Losses	U.S. Production Cutbacks	Price Increases	U.S. Demand Reduction	Balance of Payments Effects
Plastics Materials and Synthetic Fibers	581	none	unlikely	unlikely	small	unlikely	unlikely

Source: Arthur D. Little, Inc., estimates.

TABLE VIII-23

OPTION C
PLASTICS MATERIALS & SYNTHETIC FIBERS

ESTIMATED INCREMENTAL ANNUAL COST OF HAZARDOUS WASTE MANAGEMENT ACTIVITIES
(The cost of going from Level I to Pathways Level III)

Industry Segment	Estimated 1977 Production Value	1977 Incremental Annual Cost					Incremental Hazardous Waste Management Cost as a Percent of Production Value
		Generation	Transportation	HW Treatment, Storage & Disposal	Total	Range	
	$MM	$MM	$MM	$MM	$MM	%	%
Plastics Mterials & Synthetic Fibers	18,000.0	0.375	0.001	42.722	43.098	-27, +63	0.2

Source: Arthur D. Little, Inc., estimates

Under regulatory Option C, no plant closures are expected. Job losses and other adverse economic impacts will probably be negligible (probability of 0.5% to 10% of occurrence). (See Table VIII-24.)

E. PHARMACEUTICALS

1. Characterization of Pharmaceuticals

a. Industry Description.

The pharmaceuticals industry can be divided into two basic parts: the production of active ingredients and the production of pharmaceutical preparations (formulations and packaging). In 1976, the industry shipped products valued at roughly $13 billion. Through 1981, a real growth of 7% to 9% is expected for the active ingredients sector, and 6% to 8% per year for the formulations and packaging sector. The industry employs approximately 151,000 persons.

The production of active ingredients involves the manufacture of bulk organic and inorganic medicinal chemicals and their derivatives as well as the production of biological products such as vaccines, toxoids, and serums. The bulk drugs are formulated into tablets, ointments, syrups, and injectable solutions in dispensable dosages by the formulation and packaging sector.

b. Segmentation.

For purposes of this analysis, the industry has been divided into its two basic components: the production of active ingredients and the production of pharmaceutical preparations (i.e., formulations and packaging).

c. Structure.

Approximately 160 plants produce active ingredients and 470 plants engage in formulations and packaging (Table VIII-25). Most of the large pharmaceutical houses producing active ingredients are integrated forward to the formulations and packaging stage. However, many small firms concentrate on formulations and packaging alone.

d. Supply and Demand.

Although a growth of greater than 6% per year is expected through 1981 for both segments of the pharmaceutical industry, the required capital expenditures are expected to be forthcoming and no supply constraints are anticipated.

Because the active ingredients are highly application-specific, there is little product substitution at this level in the pharmaceutical industry and import competition is insignificant. Thus, price elasticity of demand is low. On the other hand, product substitutes are frequently available at the formulations and packaging level. Also, some import competition is encountered. Thus, price elasticity of demand for this segment of the pharmaceutical industry is moderate.

TABLE VIII-24

OPTION C
ECONOMIC IMPACT ON PLASTICS MATERIALS AND SYNTHETIC FIBERS

Industry Segment	Number of Existing Plants in 1976	Plant Closures	Job Losses	U.S. Production Cutbacks	Price Increases	U.S. Demand Reduction	Balance of Payments Effects
Plastics Materials and Synthetic Fibers	581	none	negligible	negligible	small	negligible	negligible

Source: Arthur D. Little, Inc., estimates.

TABLE VIII-25

CHARACTERIZATION OF THE PHARMACEUTICAL INDUSTRY

Industry Segments	1976 Production 1,000's Metric Tons	Number of Producers	Number of Plants	Four-Firm Concentration Ratio	Unit Demand Growth %/Year 1976-81	Price Elasticity of Demand	Product Substitution	Import Competition	Capacity Utilization (%)
Production of Active Ingredients (SIC 2831, 2833)	45.0	100	161	49	7-9	low	low	low	80
Formulation and Packaging (Pharmaceutical Preparations) (SIC 2834)	N.A.	400	468	26	6-8	moderate	moderate	moderate	80

Source: Arthur D. Little, Inc., estimates.

e. *Profitability.*

Profitability varies significantly between companies (Table VIII-26). In general, profits as a percent of sales have been relatively stable from 1972 to 1976 at a median level of about 6% after taxes. On the other hand, after-tax profit as a percent of net worth peaked at 16% in 1974 and, as of 1976, had dropped to roughly 14% for the average firm in the industry. Even though these rates of return appear to be good, in 1976 profitabilities of companies in the bottom half of the industry were quite low, less than 3% of sales and just over 3% of net worth in 1976. Firms operating at these lower levels of profitability will be most heavily impacted by the proposed hazardous waste management regulations.

f. *Capital Investment.*

New capital expenditures for the pharmaceutical industry grew very significantly between 1972 and 1975 from $250 million to $475 million. However, in 1976, they leveled off at roughly $470 million (Table VIII-26).

2. Economic Impact on Pharmaceuticals

a. *Cost of Compliance and Economic Impacts of Option B.*

The estimated incremental annual cost of compliance under regulatory Option B to go from Level I to Pathways Level III is shown in Table VIII-27. The cost of compliance as a percent of production value for the two segments of the pharmaceutical industry is 0.3% for active ingredients and 0.2% for formulations and packaging. The range of possible error is -27% to +61%.

Under this regulatory option, no plant closures are expected and other adverse economic impacts are considered negligible for both these segments (Table VIII-28). That means that the probability is between 0.5% and 10% that more than 0.5% of the industry will be affected adversely by the adoption of Option B.

b. *Cost of Compliance and Economic Impact of Option A.*

The estimated incremental annual cost of compliance under regulatory Option A to go from Level I to Pathways Level III is shown in Table VIII-29. The cost of compliance as a percent of production value for the two segments of the pharmaceutical industry is 0.9% for active ingredients and 0.7% for formulations and packaging. The range of error is -42% to +59%.

Even under this higher-cost regulatory option, plant closures and other adverse economic impacts are considered unlikely for the formulations and packaging segment (Table VIII-30). This means that the probability is between 11% and 25% that more than 0.5% of the industry will be adversely affected. No plant closures are expected in the active ingredients sector.

c. *Cost of Compliance and Economic Impact of Option C.*

The estimated incremental annual cost of compliance under regulatory Option C to go from Level I to Pathways Level III is shown in Table VIII-31. The cost of compliance as a percent of production value for the two segments of the pharmaceutical industry is 0.2% for active ingredients and 0% for formulations and packaging. The range of probable error is from −26% to +61%.

TABLE VIII-26

FINANCIAL PROFILE OF PHARMACEUTICALS

Total Industry (SIC 283)		1976	1975	1974	1973	1972
Profitability[1]						
Net Income After Taxes/Sales (%)	upper quartile	10.54	10.16	11.01	9.41	9.31
	median	6.62	6.15	6.73	6.05	6.10
	lower quartile	2.84	3.27	3.30	2.51	2.48
Net Income After Taxes/Net Worth (%)	upper quartile	18.76	18.86	21.42	21.36	20.54
	median	13.71	14.37	16.29	13.40	12.76
	lower quartile	3.43	7.46	9.80	6.87	4.46
Revenues[2]						
Value of Shipments (MM$)		13,016.3	11,232.1	9,897.3	8,749.5	8,018.5
Value Added/Shipments (%)		71.6	71.4	73.4	75.7	76.4
New Capital Expenditures (MM$)		471.2	475.0	400.2	259.1	245.3

Sources: 1. Dun and Bradstreet, *Ratios of Manufacturing.*
2. *Annual Survey of Manufacturers.*

TABLE VIII-27

OPTION B
PHARMACEUTICALS

ESTIMATED INCREMENTAL ANNUAL COST OF HAZARDOUS WASTE MANAGEMENT ACTIVITIES
(The cost of going from Level I to Pathways Level III)

Industry Segments	Estimated 1977 Production Value	1977 Incremental Annual Cost					Incremental Hazardous Waste Management Cost as a Percent of Production Value
		Generation	Transportation	HW Treatment Storage & Disposal	Total	Range	
	$MM	$MM	$MM	$MM	$MM	%	%
Active Ingredients	3,000.0	0.212	0.016	7.678	7.906	-27, +61	0.3
Formulations & Packaging	11,000.0	0.340	0.000	18.553	18.893	-27, +60	0.2

Source: Arthur D. Little, Inc., estimates.

TABLE VIII-28

OPTION B
ECONOMIC IMPACT ON PHARMACEUTICALS

Industry Segments	Number of Existing Plants in 1976	Plant Closures	Job Losses	U.S. Production Cutbacks	Price Increases	U.S. Demand Reduction	Balance of Payments Effects
Active Ingredients	161	none	negligible	negligible	small	negligible	negligible
Formulations and Packaging	468	none	negligible	negligible	small	negligible	negligible

Source: Arthur D. Little, Inc., estimates.

TABLE VIII-29

OPTION A
PHARMACUETICALS

ESTIMATED INCREMENTAL ANNUAL COST OF HAZARDOUS WASTE MANAGEMENT ACTIVITIES
(The cost of going from Level I to Pathways Level III)

Industry Segments	Estimated 1977 Production Value	1977 Incremental Annual Cost					Incremental Hazardous Waste Management Cost as a Percent of Production Value
		Generation	Transportation	HW Treatment, Storage & Disposal	Total	Range	
	$MM	$MM	$MM	$MM	$MM	%	%
Active Ingredients	3,000.0	0.585	0.013	25.918	26.516	–41, +59	0.9
Formulations & Packaging	11,000.0	0.510	0.000	73.031	73.541	–42, +59	0.7

Source: Arthur D. Little, Inc., estimates.

TABLE VIII-30

OPTION A
ECONOMIC IMPACT ON PHARMACEUTICALS

Industry Segments	Number of Existing Plants in 1976	Plant Closures	Job Losses	U.S. Production Cutbacks	Price Increases	U.S. Demand Reduction	Balance of Payments Effects
Active Ingredients	161	none	unlikely	unlikely	small	unlikely	unlikely
Formulations and Packaging	468	unlikely	unlikely	unlikely	small	unlikely	unlikely

Source: Arthur D. Little, Inc., estimates.

TABLE VIII-31

OPTION C
PHARMACEUTICALS

ESTIMATED INCREMENTAL ANNUAL COST OF HAZARDOUS WASTE MANAGEMENT ACTIVITIES
(The cost of going from Level I to Pathways Level III)

Industry Segments	Estimated 1977 Production Value	1977 Incremental Annual Cost					Incremental Hazardous Waste Management Cost as a Percent of Production Value
		Generation	Transportation	HW Treatment, Storage & Disposal	Total	Range	
	$MM	$MM	$MM	$MM	$MM	%	%
Active Ingredients	3000.0	0.130	0.000	5.933	6.063	-26, +61	0.2
Formulations & Packaging	11,000.0	0.000	0.000	0.000	0.000	0.0, 0.0	0.0

Source: Arthur D. Little, Inc., estimates.

Under this regulatory option, no plant closures are expected and other adverse economic impacts are considered negligible for the active ingredients sector. No impacts are expected on the formulations and packaging sector (Table VIII-32). Negligible impact means that the probability is between 0.5% and 10% that more than 0.5% of the industry will be affected adversely by the adoption of Option C.

F. PAINTS AND ALLIED PRODUCTS

1. Characterization of Paints and Allied Products

a. Industry Description.

The paints and allied products industry consists of about 700 producers operating 743 plants. In 1976, the industry shipped product valued at approximately $6 billion. Through 1981, a real growth of about 4% per year is expected.

The industry can be divided into two segments: trade sales paints and industrial sales paints. Trade sales paints are those products which are sold through wholesalers and retailers to the general public and to professional painters. Producers in this segment manufacture both exterior and interior products which are available in either oil- or water-base formulations. Most plants manufacture a limited number of standard colors along with tinting bases which can be used with the standard colors to produce a wide variety of shades or hues in response to customer demand. The industrial finishes sector produces products such as automotive and appliance finishes and industrial maintenance coatings.

Large plants represent about 60% of total annual sales and employ about 65% of the workers in the industry. Medium-sized plants represent 30% of annual sales and 20% of employment. Small plants account for the remaining 10% of annual sales and 15% of total employment in the industry. These small plants generally act as wholesalers only and do not manufacture paints. Therefore, they have been excluded from the analysis.

b. Segmentation.

For purposes of this study, producers of both trade sales paints and industrial paints have been analyzed together.

c. Structure.

The four-firm concentration ratio for the paints and allied products industry is a relatively low 22% because there are a large number of small and medium-sized firms in this industry (Table VIII-33).

d. Supply and Demand.

Unit demand growth for paints and allied products is expected to be around 4% per year through 1981. Although capacity utilization is a moderately high 85%, no supply constraints are anticipated over the next five years (Table VIII-33).

TABLE VIII-32

OPTION C
ECONOMIC IMPACT ON PHARMACEUTICALS

Industry Segments	Number of Existing Plants in 1976	Plant Closures	Job Losses	U.S. Production Cutbacks	Price Increases	U.S. Demand Reduction	Balance of Payments Effects
Active Ingredients	161	none	negligible	negligible	small	negligible	negligible
Formulations and Packaging	468	none	none	none	none	none	none

Source: Arthur D. Little, Inc., estimates.

TABLE VIII-33

CHARACTERIZATION OF PAINTS AND ALLIED PRODUCTS

Industry Segments	1976 Production 1,000's Metric Tons	Number of Producers	Number of Plants	Four-Firm Concentration Ratio	Unit Demand Growth %/Year 1976-81	Price Elasticity of Demand	Product Substitution	Import Competition	Capacity Utilization (%)
Paints & Allied Products (SIC 2851)	965,650.0	700	743	22	4	high	high	low	85

Source: Arthur D. Little, Inc., estimates.

Product substitution is relatively high in the paint industry, whereas imports are low. The high degree of product substitution results in a high elasticity of demand. This, in turn, makes it difficult for firms in the industry to pass cost increases on through price increases.

e. Profitability.

Profitability measured in terms of net income after taxes as a percent of net sales remained relatively stable at just over 2.5% from 1972 to 1976, while profitability measured in terms of after-tax income as a percent of net worth was around 9% over the same period for the average company in this industry. After-tax profits are particularly low for companies operating in the bottom quartile (Table VIII-34). The latter group will be most adversely affected by the proposed hazardous waste management regulations.

f. Capital Investments.

Capital investment in the paints industry has been growing slowly but steadily over the past five years. As of 1976, it approached $1.5 billion (Table VIII-34).

2. Economic Impact on Paints and Allied Products

a. Cost of Compliance and Economic Impact of Option B

The estimated incremental annual cost of compliance under regulatory Option B to go from Level I to Pathways Level III is shown in Table VIII-35. The cost of compliance as a percent of production value for the paints industry is 0.3%. The range of error is −24% to + 54%.

Under this regulatory option, plant closures and other adverse impacts are considered negligible. This means the probability is between 0.5% and 10% more than 0.5% of the industry would be affected adversely (Table VIII-36).

b. Cost of Compliance and Economic Impact of Option A

The estimated incremental annual cost of compliance under regulatory Option A to go from Level I to Pathways Level III is shown in Table VIII-37. The cost of compliance as a percent of production value for the paint industry is 0.5%. The range of error is −36% to +53%.

Even under this higher-cost regulatory option, the probability of plant closures is considered negligible (0.5% to 10% chance of occurrence). Other adverse impacts are considered unlikely (26% to 50% probability) Table VIII-38.

c. Cost of Compliance and Economic Impact of Option C

The estimated incremental annual cost of compliance under regulatory Option C to go from Level I to Pathways Level III is shown in Table VIII-39. The cost of compliance as a percent of production value for the paint industry is 0.1%. The range of error is −23% to +52%.

Under this regulatory option, plant closures and other adverse economic impacts are considered negligible. This means the probability is between 0.5% and 10% that more than 0.5% of the industry would be affected adversely, see Table VIII-40.

TABLE VIII-34

FINANCIAL PROFILE OF PAINTS AND ALLIED PRODUCTS

Total Industry (SIC 2851)		1976	1975	1974	1973	1972
Profitability[1]						
Net Income After Taxes/Net Sales (%)	upper quartile	4.36	4.66	4.58	3.64	3.96
	median	2.80	2.71	2.52	2.61	2.61
	lower quartile	1.26	1.46	1.29	1.52	1.50
Net Income After Taxes/Net Worth (%)	upper quartile	16.61	13.13	14.66	11.86	12.91
	median	8.96	9.05	9.00	8.49	8.87
	lower quartile	4.12	3.82	4.38	4.19	5.39
Revenues[2]						
Value of Shipments (MM$)		5,931.3	5,149.0	5,007.0	4,268.3	3,824.3
Value Added/Shipments		43.19	41.29	44.48	45.91	46.86
New Capital Expenditures (MM$)		1,443.5	1,321.0	1,199.4	1,080.3	1,006.8

Sources: 1. Dun and Bradstreet, *Ratios of Manufacturers*
2. Annual Survey of Manufacturers.

TABLE VIII-35

OPTION B
PAINTS & ALLIED PRODUCTS

ESTIMATED INCREMENTAL ANNUAL COST OF HAZARDOUS WASTE MANAGEMENT ACTIVITIES
(The cost of going from Level I to Pathways Level III)

Industry Segment	Estimated 1977 Production Value	1977 Incremental Annual Cost					Incremental Hazardous Waste Management Cost as a Percent of Production Value
		Generation	Transportation	HW Treatment Storage & Disposal	Total	Range	
	$MM	$MM	$MM	$MM	$MM	%	%
Paints & Allied Products	6,000.0	1.709	0.060	18.727	20.496	-24, +54	0.3

Source: Arthur D. Little, Inc., estimates.

TABLE VIII-36

OPTION B
ECONOMIC IMPACT ON PAINTS AND ALLIED PRODUCTS

Industry Segment	Number of Existing Plants in 1976	Plant Closures	Job Losses	U.S. Production Cutbacks	Price Increases	U.S. Demand Reduction	Balance of Payments Effects
Paints and Allied Products	743	negligible	negligible	negligible	small	negligible	none

Source: Arthur D. Little, Inc., estimates.

TABLE VIII-37

OPTION A
PAINTS & ALLIED PRODUCTS

ESTIMATED INCREMENTAL ANNUAL COST OF HAZARDOUS WASTE MANAGEMENT ACTIVITIES
(The cost of going from Level I to Pathways Level III)

Industry Segment	Estimated 1977 Production Value	1977 Incremental Annual Cost					Incremental Hazardous Waste Management Cost as a Percent of Production Value
		Generation	Transportation	HW Treatment Storage & Disposal	Total	Range	
	$MM	$MM	$MM	$MM	$MM	%	%
Paints & Allied Products	6000.0	4.251	0.039	26.465	30.755	−36, +53	0.5

Source: Arthur D. Little, Inc., estimates.

TABLE VIII-38

OPTION A
ECONOMIC IMPACT ON PAINTS AND ALLIED PRODUCTS

Industry Segment	Number of Existing Plants in 1976	Plant Closures	Job Losses	U.S. Production Cutbacks	Price Increases	U.S. Demand Reduction	Balance of Payments Effects
Paints and Allied Products	743	negligible	unlikely	unlikely	small	unlikely	none

Source: Arthur D. Little, Inc., estimates.

TABLE VIII-39

OPTION C
PAINTS & ALLIED PRODUCTS

ESTIMATED INCREMENTAL ANNUAL COST OF HAZARDOUS WASTE MANAGEMENT ACTIVITIES
(The cost of going from Level I to Pathways Level III)

Industry Segment	Estimated 1977 Production Value	1977 Incremental Annual Cost					Incremental Hazardous Waste Management Cost as a Percent of Production Value
		Generation	Transportation	HW Treatment, Storage & Disposal	Total	Range	
	$MM	$MM	$MM	$MM	$MM	%	%
Paints & Allied Products	6000.0	1.029	0.001	6.299	7.329	-23, +52	0.1

Source: Arthur D. Little, Inc., estimates.

TABLE VIII-40

OPTION C
ECONOMIC IMPACT ON PAINTS AND ALLIED PRODUCTS

Industry Segment	Number of Existing Plants in 1976	Plant Closures	Job Losses	U.S. Production Cutbacks	Price Increases	U.S. Demand Reduction	Balance of Payments Effects
Paints and Allied Products	743	negligible	negligible	negligible	small	negligible	none

Source: Arthur D. Little, Inc., estimates.

G. ORGANIC CHEMICALS

1. Characterization of the Organic Chemicals Industry

a. Industry Description

Organic chemicals contain carbon in a form similar to that of plants and animals. They are generally combustible, frequently insoluble in water, and usually either liquids or low-melting solids. Commercially, there are three important types: (1) basic organics obtained directly from the primary raw material — petroleum, natural gas, or coal tar; (2) intermediates manufactured from basic chemicals, but used in turn as raw materials for the synthesis of still other chemicals; and, (3) end products which are not further altered chemically, but are often either formulated with other materials for a specific industrial or commercial application or used by other industries for fabricating their products. Basic and intermediate organic chemicals are largely commodity products produced in relatively large volumes and sold at lower prices than most end product chemicals.

Basic and intermediate organics, because they are the raw materials for all other organic chemicals, are made by most chemical companies. Hence, the concentration ratios for the largest volume commodity products are not high with 25 or more producers in some cases. On the other hand, several important organic and intermediate products are produced by only half a dozen, or even fewer, companies.

In 1976, the organic chemicals industry shipped product valued at roughly $25 billion. Historically, the industry has grown significantly faster than the GNP. However, through 1981, growth is expected to be only slightly better than the growth of the economy as a whole. In 1976, after-tax profitability was 5% of sales and 16% of net worth. Barring a major recession, these levels are expected to remain basically unchanged through 1981. About 150,000 persons are employed by this segment of the chemical industry. The structure of the organic chemicals business is generally oligopolistic, mainly because of the capital-intensive nature of the business and its economies of scale.

b. Segmentation

Previous analyses of hazardous waste volume in the chemicals industry have demonstrated that not all segments of that industry produce hazardous waste. Therefore, the analysis of the industry for purposes of assessing the economic impact of the proposed hazardous waste management regulations has focused on the following segments which are known to be generators of hazardous waste: perchloroethylene, nitrobenzene, chloromethanes, epichlorohydrin, toluene diisocyanate, vinyl chloride monomer, methyl methacrylate, acrylonitrile, maleic anhydride, lead alkyls, chlorobenzene, ethanolamines, furfural, benzylchloride, and fluorocarbons.

c. Structure

Several of the above segments of the organic chemicals industry have four-firm concentration ratios of 100%, i.e., epichlorohydrin, ethanolamines, furfural, acrylonitrile, benzylchloride, lead alkyls and methyl methacrylate. The other segments under study are produced by slightly larger numbers of firms. Their concentration ratios range from 70% to 90%.

d. *Supply and Demand*

Through 1981, the growth in unit demand for the organic chemicals under study will, on the average, almost equal the growth of the industry as a whole. However, declines are expected for several segments, notably, perchloroethylene, lead alkyls, and fluorocarbons (Table VIII-41). Capacity utilization is at the low end of the preferred range (i.e., 70% to 80%) for most of the segments. The exceptions on the high side are furfural, epichlorohydrin, chloromethanes and benzylchloride. The exceptions on the low side are chlorobenzene, perchloroethylene and fluorocarbons. Given current market conditions, and the industry structure, no supply constraints are anticipated over the next five years.

All of the organic chemicals under study, except lead alkyls and nitrobenzene, encounter a moderate to high degree of product substitution. At the present time, only three products, furfural, perchloroethylene, and acrylonitrile, face import competition. However, imports are likely to become an increasing problem.

e. *Profitability*

Both in terms of return on sales and return on net worth, profitability after taxes in the organic chemicals industry fluctuated with the state of the economy between 1972 and 1976 (Table VIII-42). The average during those years was roughly 4.5% of sales and 14% of net worth.

f. *Capital Investment*

The level of new capital investment in the organic chemicals industry has more than tripled over the last five years, (Table VIII-42). The capital expenditure statistics include both productive investments which lead to the capacity to produce more products and non-productive investments for purposes of pollution control and energy conservation.

2. Economic Impact on Organic Chemicals

a. *Cost of Compliance and Economic Impact of Option B*

The estimated incremental cost of compliance under regulatory Option B to go from Level I to Pathways Level III is shown in Table VIII-43. The cost of compliance as a percent of production value for the organic chemicals industry ranges from 0.1% for acrylonitrile, lead alkyls, and fluorocarbons to a high of 3.6% for perchloroethylene. The range of error in these estimates extends from −40% to +123%.

Under this regulatory option, plant closures are considered unlikely for chlorobenzene and perchloroethylene (i.e., an 11% to 25% chance of occurrence). (See Table VIII-44.) The probabilities of plant closures for all of the other segments of the organic chemicals industry are considered to be negligible or none. With regard to job losses, this adverse occurrence could take place in the perchloroethylene segment (i.e., 26% to 50% chance of occurrence). The probabilities of job losses for all the other segments of the organic chemicals industry are considered unlikely, negligible, or none. With regard to U.S. production cutbacks, this adverse affect is considered probable for perchloroethylene (a 51% to 75% chance of occurrence). All the other segments are unlikely to be significantly affected. Price increases are likely to be moderate only in perchloroethylene and small to none in the other segments. Imports are also likely to be significantly affected only in the case of perchloroethylene.

TABLE VIII-41

CHARACTERIZATION OF ORGANIC CHEMICALS

Industry Segments	1976 Production 1,000's Metric Tons	Number of Producers	Number of Plants	Four-Firm Concentration Ratio	Unit Demand Growth %/Year 1976–81	Price Elasticity of Demand	Product Substitution	Import Competition	Capacity Utilization %
Perchloroethylene	305	7	10	75	-1	moderate	moderate	moderate	60
Nitrobenzene	185	5	6	90	5	low	low	low	80
Chloromethanes	940	12	19	70	4	moderate	moderate	low	60
Epichlorohydrin	180	2	3	100	2	some	moderate	low	85
Toluene Diisocyanate	275	8	10	80	5	moderate	moderate	low	75
Vinyl Chloride Monomer	2580	10	15	70	3	some	some	low	80
Methyl Methacrylate	320	3	4	100	6	moderate	moderate	low	80
Acrylonitrile	690	4	5	100	5	moderate	moderate	some	70
Maleic Anhydride	120	6	7	80	5	moderate	moderate	low	80
Lead Alkyls	295	4	4	100	- 10	low	low	low	75
Chlorobenzene	150	9	10	80	3	moderate	moderate	low	50
Ethanolamines	130	4	5	100	2	moderate	moderate	low	70
Furfural	75	1	4	100	3	high	high	moderate	90
Benzylchloride	40	3	3	100	6	moderate	moderate	low	85
Fluorocarbons	400	6	15	90	-5	moderate	moderate	low	60

Sources: Arthur D. Little, Inc. estimates based on *Economic Impact Analysis of Anticipated Hazardous Waste Regulations on the Industrial Organic Chemicals, Pesticides, and Explosives Industries* by Energy Resources Company, Inc. prepared for the U.S. Environmental Protection Agency, Office of Solid Waste Management.

TABLE VIII-42

FINANCIAL PROFILE OF ORGANIC CHEMICALS

Total Industry (SIC 286)	**1976**	**1975**	**1974**	**1973**	**1972**
Profitability[1]					
Net Income After Taxes/Sales (%)	5.0	4.6	4.9	4.1	3.0
Net Income After Taxes/Net Worth (%)	16.0	15.0	18.0	12.0	8.0
Revenues[2]					
Value of Shipments (MM$)	25,685.1	21,056.7	19,355.5	13,477.8	11,605.4
Value Added/Shipments (%)	44.2	45.2	48.2	51.3	52.3
New Capital Expenditures (MM$)	2,684.4	2,119.7	1,589.4	1,005.6	831.6

Sources: 1. Arthur D. Little, Inc., estimates based on Robert Morris, *Annual Statement Studies,* 1973-1977.
2. U. S. Department of Commerce, *Census of Manufactures,* 1972 and *Annual Survey of Manufacturers,* 1973-1976

TABLE VIII-43

OPTION B
ORGANIC CHEMICALS
ESTIMATED INCREMENTAL ANNUAL COST OF HAZARDOUS WASTE MANAGEMENT ACTIVITIES
(The cost of going from Level I to Pathways Level III Technology)

Industry & Segments	Estimated 1977 Production Value $MM	1977 Incremental Annual Cost					Incremental Hazardous Waste Management Cost as a Percent of Production Value %
		Generation $MM	Transportation $MM	HW Treatment, Storage & Disposal $MM	Total $MM	Range %	
Perchloroethylene	125.0	0.003	0.001	4.533	4.537	-39, +118	3.6
Nitrobenzene	100.0	0.003	0.000	0.408	0.411	-28, +61	0.4
Chloromethanes	330.0	0.011	0.000	2.842	2.853	-34, +94	0.9
Epichlorohydrin	110.0	0.001	0.000	0.327	0.328	-37, +106	0.3
Toluene Diisocyanate	335.0	0.005	0.000	1.678	1.683	-35, +98	0.5
Vinyl Chloride Monomer	720.0	0.006	0.000	4.151	4.157	-38, +112	0.6
Methyl Methacrylate	290.0	0.001	0.000	0.611	0.612	-35, +97	0.2
Acrylonitrile	410.0	0.001	0.000	0.525	0.526	-34, +93	0.1
Maleic Anhydride	95.0	0.004	0.000	0.450	0.454	-26, +62	0.5
Lead Alkyls	425.0	0.001	0.000	0.252	0.253	-30, +71	0.1
Chlorobenzene	65.0	0.007	0.000	1.456	1.463	-34, +92	2.3
Ethanolomines	120.0	0.002	0.000	0.597	0.599	-34, +91	0.5
Furfural	85.0	0.001	0.001	1.433	1.435	-40, +123	1.7
Benzylchloride	30.0	0.001	0.000	0.178	0.179	-27, +64	0.6
Fluorocarbons	400.0	0.003	0.000	0.357	0.360	-26, +62	0.1

Source: Arthur D. Little, Inc., estimates.

TABLE VIII-44

OPTION B
ECONOMIC IMPACT ON ORGANIC CHEMICALS

Industry Segments	Number of Existing Plants in 1976	Plant Closures	Job Losses	U.S. Production Cutbacks	Price Increases	U.S. Demand Reduction	Balance of Payments Effects
Perchloroethylene	10	unlikely	possibly	probably	moderate	unlikely	possibly
Nitrobenzene	6	none	none	negligible	small	none	negligible
Chloromethanes	19	negligible	negligible	unlikely	small	negligible	unlikely
Epichlorohydrin	3	none	none	none	none	none	none
Toluene Diisocyanate	10	none	none	negligible	small	none	negligible
Vinyl Chloride Monomer	15	none	none	negligible	small	none	negligible
Methyl Methacrylate	4	none	none	none	none	none	none
Acrylonitrile	5	none	none	none	none	none	none
Maleic Anhydride	7	negligible	negligible	negligible	small	negligible	negligible
Lead Alkyls	4	none	none	none	none	none	none
Chlorobenzene	10	unlikely	unlikely	unlikely	small	unlikely	negligible
Ethanolamines	5	none	none	negligible	small	none	negligible
Furfural	4	negligible	negligible	unlikely	small	negligible	unlikely
Benzylchloride	3	negligible	negligible	negligible	small	negligible	negligible
Fluorocarbons	6	none	none	none	none	none	none

Source: Arthur D. Little, Inc., estimates.

b. Cost of Compliance and Economic Impact of Option A

The estimated incremental annual costs of compliance under regulatory Option A to go from Level I to Pathways Level III are shown in Table VIII-45. The costs of compliance as a percent of production value for the organic chemicals industry range from 0.2% for lead alkyls to 6% for chlorobenzene. The range of error for Option A extends from −43% to +102%.

Under this regulatory option, plant closures are considered probable for chlorobenzene (a 51% to 75% chance of occurrence) and possible for perchloroethylene (a 26% to 50% chance of occurrence). (See Table VIII-46.) Such adverse economic effects are considered unlikely or negligible for the rest of the organic chemicals industry under study. Production cutbacks are considered likely for perchloroethylene (greater than 75% chance of occurrence), whereas production cutbacks are considered probable for chlorobenzene (a 51% to 75% chance of occurrence) and possible for chloromethanes and furfural (a 26% to 50% chance of occurrence). For the other segments, production cutbacks are considered to be unlikely, negligible or none. Price increases for perchloroethylene and chlorobenzene are expected to be moderate (i.e., between 3% and 5%). Increases in price are expected to be small for the other segments. Increased imports are considered probable for perchloroethylene, possible for chloromethane, furfural, and chlorobenzene, but unlikely or none for the other segments.

c. Cost of Compliance and Economic Impacts of Option C

The estimated incremental annual cost of compliance under regulatory Option C to go from Level I to Pathways Level III is shown in Table VIII-47. The cost of compliance as a percent of production value for the organic chemicals industry ranges from 0% for benzylchloride to 2.8% for perchloroethylene. The range of error is from −28% to +65%.

Under this regulatory option, plant closures for chlorobenzene and perchloroethylene are considered unlikely (i.e., an 11% to 25% chance of occurrence). (See Table VIII-48.) The probabilities for all of the other segments of the organic chemicals industry of plant closures are considered to be negligible or none. Job losses could take place in the perchloroethylene segment (i.e., 26% to 50% chance of occurrence). The probability of job losses for all the other segments in the organic chemicals industry is considered unlikely, negligible, or none. With regard to U.S. production cutbacks, this adverse affect is considered probable for perchloroethylene (a 51% to 75% chance of occurrence). All the other segments are unlikely to be significantly affected. Price increases are likely to be moderate only in perchloroethylene and small to none in the other segments. Imports are also likely to be significantly affected only in the case of perchloroethylene.

The relatively low economic impact of the proposed regulations is predicated on the assumption that the firms in the impacted segments will be able to raise their prices to cover the increased costs. Should price controls be instituted, more plants would be expected to close and a larger number of jobs would be lost as a result of regulations.

TABLE VIII-45

OPTION A
ORGANIC CHEMICALS

ESTIMATED INCREMENTAL ANNUAL COST OF HAZARDOUS WASTE MANAGEMENT ACTIVITIES
(The cost of going from Level I to Pathways Level III)

Industry Segments	Estimated 1977 Production Value	1977 Incremental Annual Cost: Generation	Transportation	HW Treatment, Storage & Disposal	Total	Range	Incremental Hazardous Waste Management Cost as a Percent of Production Value
	$MM	$MM	$MM	$MM	$MM	%	%
Perchloroethylene	125.0	0.007	0.001	5.858	5.866	-42, +95	4.7
Nitrobenzene	100.0	0.005	0.000	1.619	1.624	-42, +60	1.6
Chloromethanes	330.0	0.019	0.000	7.283	7.302	-42, +73	2.2
Epichlorohydrin	110.0	0.002	0.000	0.567	0.569	-42, +80	0.5
Toluene Diisocyanate	335.0	0.009	0.000	4.075	4.084	-42, +76	1.2
Vinyl Chloride Monomer	720.0	0.009	0.000	7.694	7.703	-42, +88	1.1
Methyl Methacrylate	290.0	0.002	0.000	1.056	1.058	-42, +74	0.4
Acrylonitrile	410.0	0.003	0.000	1.413	1.416	-42, +72	0.3
Maleic Anhydride	95.0	0.007	0.000	1.940	1.947	-42, +60	2.0
Lead Alkyls	425.0	0.002	0.000	0.878	0.880	-42, +63	0.2
Chlorobenzene	65.0	0.011	0.000	3.888	3.899	-42, +72	6.0
Ethanolamines	120.0	0.004	0.000	1.422	1.426	-42, +71	1.2
Furfural	85.0	0.005	0.001	2.041	2.047	-42, +102	2.4
Benzylchloride	30.0	0.002	0.000	0.785	0.787	-43, +60	2.6
Fluorocarbons	400.0	0.005	0.000	1.554	1.559	-42, +59	0.4

Source: Arthur D. Little, Inc., estimates.

TABLE VIII-46

OPTION A
ECONOMIC IMPACT ON ORGANIC CHEMICALS

Industry Segments	Number of Existing Plants in 1976	Plant Closures	Job Losses	U.S. Production Cutbacks	Price Increases	U.S. Demand Reduction	Balance of Payments Effects
Perchloroethylene	10	possibly	probably	likely	moderate	possibly	probably
Nitrobenzene	6	negligible	negligible	unlikely	small	negligible	unlikely
Chloromethanes	19	unlikely	unlikely	possibly	small	unlikely	possibly
Epichlorohydrin	3	none	none	none	small	none	none
Toluene Diisocyanate	10	negligible	negligible	unlikely	small	negligible	unlikely
Vinyl Chloride Monomer	15	negligible	negligible	unlikely	small	negligible	unlikely
Methyl Methacrylate	4	none	none	none	small	none	none
Acrylonitrile	5	none	none	none	small	none	none
Maleic Anhydride	7	unlikely	unlikely	unlikely	small	unlikely	unlikely
Lead Alkyls	4	none	none	none	small	none	none
Chlorobenzene	10	probably	probably	probably	moderate	probably	possibly
Ethanolamines	5	negligible	negligible	unlikely	small	negligible	unlikely
Furfural	4	unlikely	unlikely	possibly	small	unlikely	possibly
Benzylchloride	3	unlikely	unlikely	unlikely	small	unlikely	unlikely
Fluorocarbons	6	negligible	negligible	negligible	small	unlikely	unlikely

Source: Arthur D. Little, Inc., estimates.

TABLE VIII-47

OPTION C
ORGANIC CHEMICALS

ESTIMATED INCREMENTAL ANNUAL COST OF HAZARDOUS WASTE MANAGEMENT ACTIVITIES
(The cost of going from Level I to Pathways Level III)

Industry Segments	Estimated 1977 Production Value	1977 Incremental Annual Cost					Incremental Hazardous Waste Management Cost as a Percent of Production Value
		Generation	Transportation	HW Treatment, Storage & Disposal	Total	Range	
	$MM	$MM	$MM	$MM	$MM	%	%
Perchloroethylene	125.0	0.003	0.000	3.488	3.491	-6, +13	2.8
Nitrobenzene	100.0	0.002	0.000	0.360	0.362	-28, +64	0.4
Chloromethanes	330.0	0.010	0.000	2.608	2.618	-14, +33	0.8
Epichlorohydrin	110.0	0.001	0.000	0.246	0.247	-10, +24	0.2
Toluene Diisocyanate	335.0	0.004	0.000	1.581	1.585	-12, +29	0.5
Vinyl Chloride Monomer	720.0	0.004	0.000	4.001	4.005	-7, +17	0.6
Methyl Methacrylate	290.0	0.001	0.000	0.386	0.387	-14, +32	0.1
Acrylonitrile	410.0	0.001	0.000	0.490	0.491	-15, +34	0.1
Maleic Anhydride	95.0	0.003	0.000	0.387	0.390	-26, +65	0.4
Lead Alkyls	425.0	0.001	0.000	0.216	0.217	-24, +58	0.1
Chlorobenzene	65.0	0.005	0.000	1.356	1.361	-15, +34	2.1
Ethanolamines	120.0	0.001	0.000	0.479	0.480	-15, +36	0.4
Furfural	85.0	0.001	0.000	1.339	1.340	-4, +9	1.6
Benzylchloride	23.0	0.000	0.000	0.000	0.000	0.0, 0.0	0.0
Fluorocarbons	400.0	0.002	0.000	0.310	0.312	-26, +66	0.1

Source: Arthur D. Little, Inc., estimates.

OPTION C
ECONOMIC IMPACT ON ORGANIC CHEMICALS

Industry Segments	Number of Existing Plants in 1976	Plant Closures	Job Losses	U.S. Production Cutbacks	Price Increases	U.S. Demand Reduction	Balance of Payments Effects
Perchloroethylene	10	unlikely	possibly	probably	moderate	unlikely	possibly
Nitrobenzene	6	none	none	negligible	small	none	negligible
Chloromethanes	19	negligible	negligible	unlikely	small	neglible	unlikely
Epichlorohydrin	3	none	none	none	none	none	none
Toluene Diisocyanate	10	none	none	negligible	small	none	negligible
Vinyl Chloride Monomer	15	none	none	negligible	small	none	negligible
Methyl Methacrylate	4	none	none	none	none	none	none
Acrylonitrile	5	none	none	none	none	none	none
Maleic Anhydride	7	negligible	negligible	negligible	small	negligible	negligible
Lead Alkyls	4	none	none	none	none	none	none
Chlorobenzene	10	unlikely	unlikely	unlikely	small	unlikely	negligible
Ethanolamines	5	none	none	negligible	small	none	negligible
Furfural	4	negligible	negligible	unlikely	small	negligible	unlikely
Benzylchloride	3	negligible	negligible	negligible	small	negligible	negligible
Fluorocarbons	6	none	none	none	none	none	none

Source: Arthur D. Little, Inc., estimates.

H. EXPLOSIVES AND PESTICIDES

1. Characterization of Explosives and Pesticides

a. Industry Description

Most of the manufacturers of explosives operate their plants under government contract. In 1976, the industry shipped products valued at about $600 million. A real growth of about 3% per year is expected for explosives through 1981. The industry employs almost 12,000 persons.

Pesticides are chemicals capable of destroying or repelling leaves, fungi, nematodes, insects, rodents, and other undesirable plants and animals that interfere with the growth and storage of crops and livestock. There are three major types: (1) herbicides, used to kill weeds; (2) insecticides; and (3) fungicides. Pesticide production is a two-tier business encompassing the companies producing the basic toxicants and formulators. The producers of toxicants generate most of the hazardous waste. The producers of the basic toxicants, who are increasingly integrating forward by acquiring independent formulators are, for the most part, large chemical companies with resources for relatively high investment in research and development. Prices and profits are quite variable in the pesticides industry, depending upon the proprietary position of the product. Profitability for patented highly specific products is generally good. However, many older products without patent protection have degenerated to the status of commodities. Also, even though a pesticide is patented, chemically related products can sometimes be developed that fall outside the original patent. Competition between similar products thus forces prices and profits down.

The formulators mix the toxicants with other materials for specific applications. Relatively little hazardous waste is created during this process.

In 1976, the pesticide industry shipped products valued at about $2.8 billion. Over the next five years, real growth is expected to be about 5% per year. More than 15,000 persons are employed by this segment of the chemical industry.

b. Segmentation

For purposes of this study, both the explosives and pesticides industries were analyzed as whole entities.

c. Structure

The four-firm concentration ratio is considerably higher for explosives (67%) than it is for pesticides (39%) due to the smaller number of producers in the explosives industry (Table VIII-49).

d. Supply and Demand

The growth in unit demand through 1981 for explosives and pesticides is expected to be 3% and 5%, respectively. Capacity utilization is at the low end of the preferred range in both industries (Table VIII-49). No supply constraints are expected over the next several years.

TABLE VIII-49

CHARACTERIZATION OF EXPLOSIVES AND PESTICIDES

Industry Segments	1976 Production 1,000's Metric Tons	Number of Producers	Number of Plants	Four-Firm Concentration Ratio	Unit Demand Growth %/Year 1976-81	Price Elasticity of Demand	Product Substitution	Import Competition	Capacity Utilization %
Explosives (SIC 2892)	1513	24	56	67	3	low to moderate*	low to moderate*	low	80
Pesticides (SIC 2879)	825	82	185	39	5	low to moderate*	low to moderate*	low	80

*Depends on proprietary position of product and/or the specificity of its end use.

Source: Arthur D. Little, Inc., estimates, and Economic Impact Analysis of Anticipated Hazardous Waste Regulations on the Industrial Organic Chemicals, Pesticides, and Explosives Industry, Energy Resources Co., Inc.

The elasticity of demand and degree of product substitution vary in both industries from low to moderate, depending on the proprietary position of the product and/or the specificity of its end use. Imports are insignificant.

e. Profitability

Profitability data are not available for the explosives industry because most of the plants are operated under contract for the federal government.

Pesticide manufacturers' profitability, both in terms of the return on sales and the return on net worth after taxes, fluctuated around a flat trend line between 1972 and 1976 (Table VIII-50). Even though the profitability of the average company appears to be reasonably favorable, the rates of return on sales and net worth after taxes for companies in the bottom half of the industry are quite low. Companies operating at these lower levels of profitability will have the most difficulty absorbing the incremental costs of the hazardous waste management regulations.

f. Capital Investment

New capital expenditures for explosives fluctuated around a flat trend line between 1972 and 1976, while pesticide producers' capital expenditures increased significantly through 1975 and moved slightly lower, to roughly $190 million in 1976 (Table VIII-50).

2. Economic Impact on Explosives and Pesticides

a. Cost of Compliance and Economic Impact of Option B

The estimated incremental annual cost of compliance under regulatory Option B to go from Level I to Pathways Level III is shown in Table VIII-51. The cost of compliance as a percent of production value for the explosives industry is 9.0%, whereas for the pesticides industry, it is 1.2%. The range of error is −41% to +128%. The hazardous waste treatment, storage, and disposal activity associated with 3004 and 3005 constitutes the largest percentage of these costs.

Under this regulatory option, plant closures and other adverse impacts are considered unlikely for the explosives industry (Table VIII-52). Unlikely means that the probability is between 11% and 25% that more than 0.5% of the industry would be adversely affected by the proposed regulation. This is attributable to the fact that explosives plants are operated under government contract and are expected to be permitted to raise their prices enough to cover the incremental cost of this regulatory option.

Plant closures in the pesticides industry are also considered unlikely but job losses, U.S. production cutbacks and demand reduction are considered possible (i.e., 26% to 50% chance of occurrence).

b. Cost of Compliance and Economic Impact of Option A

The estimated incremental annual cost of compliance under regulatory Option A to go from Level I to Pathways Level III is shown in Table VIII-53. The cost of compliance as a percent of production value for the explosives industry is 11.1% and for the pesticides industry, 2.8%. The range of error is −42% to +114%.

TABLE VIII-50

FINANCIAL PROFILE OF EXPLOSIVES AND PESTICIDES

Explosives (SIC 2892)		**1976**	**1975**	**1974**	**1973**	**1972**
Profitability						
Net Income After Taxes/Sales (%)	N.A. many plants operated for the Federal Goverment					
Net Income After Taxes/Net Worth (%)						
Revenues[1]						
Value of Shipments (MM$)		602.6	613.0	548.2	429.4	408.7
Value Added/Shipments (%)		61.5	58.9	68.4	70.3	69.8
New Capital Expenditures (MM$)		17.5	22.4	20.6	12.5	14.9
Pesticides (SIC 2879)						
Profitability[2]						
Net Income After Taxes/Sales (%)	upper quartile	6.0	10.1	8.3	5.8	4.2
	median	3.5	6.6	5.2	3.7	2.5
	lower quartile	1.8	4.4	2.1	2.6	1.7
Net Income After Taxes/Net Worth (%)	upper quartile	18.8	26.2	28.4	20.9	11.1
	median	13.1	21.6	18.5	16.2	6.8
	lower quartile	5.9	15.4	11.7	9.1	4.5
Revenues[1]						
Value of Shipments (MM$)		2,755.2	2,290.9	1,974.8	1,325.9	1,150.8
Value Added/Shipments (%)		50.3	54.1	57.9	55.8	52.0
New Capital Expenditures (MM$)		188.4	207.2	96.9	54.2	39.5

Sources: 1. U.S. Department of Commerce, *Census of Manufacturers,* 1972 and *Annual Survey of Manufacturers* 1973-1976
2. Dun and Bradstreet, *Ratios of Manufacturing* 1973-1976

TABLE VIII-51

OPTION B
EXPLOSIVES & PESTICIDES

ESTIMATED INCREMENTAL ANNUAL COST OF HAZARDOUS WASTE MANAGEMENT ACTIVITIES
(The cost of going from Level I to Pathways Level III)

Industry Segments	Estimated 1977 Production Value	1977 Incremental Annual Cost: Generation	Transportation	HW Treatment, Storage & Disposal	Total	Range	Incremental Hazardous Waste Management Cost as a Percent of Production Value
	$MM	$MM	$MM	$MM	$MM	%	%
Explosives	650.0	0.048	0.001	58.211	58.260	-41, +128	9.0
Pesticides	3000.0	0.132	0.034	35.779	35.945	-35, +103	1.2

Source: Arthur D. Little, Inc., estimates.

TABLE VIII-52

OPTION B
ECONOMIC IMPACT ON EXPLOSIVES AND PESTICIDES

Industry Segments	Number of Existing Plants in 1976	Plant Closures	Job Losses	U.S. Production Cutbacks	Price Increases	U.S. Demand Reduction	Balance of Payments Effects
Explosives	56	unlikely	unlikely	unlikely	large	unlikely	none
Pesticides	185	unlikely	possibly	possibly	small	possibly	none

Source: Arthur D. Little, Inc., estimates.

TABLE VIII-53

OPTION A
EXPLOSIVES & PESTICIDES

ESTIMATED INCREMENTAL ANNUAL COST OF HAZARDOUS WASTER MANAGEMENT ACTIVITIES
(The cost of going from Level I to Pathways Level III)

Industry Segments	Estimated 1977 Production Value	1977 Incremental Annual Cost					Incremental Hazardous Waste Management Cost as a Percent of Production Value
		Generation	Transportation	HW Treatment Storage & Disposal	Total	Range	
	$MM	$MM	$MM	$MM	$MM	%	%
Explosives	650.0	0.109	0.001	71.825	71.935	-42, +114	11.1
Pesticides	3000.0	0.199	0.034	84.441	84.674	-42, +78	2.8

Source: Arthur D. Little, Inc., estimates.

Under this regulatory option, adverse impacts are considered unlikely (i.e., 11% to 25% chance of occurrence) for the explosives industry because companies are expected to be able to increase prices (Table VIII-54). On the other hand, plant closures and other adverse economic impacts are considered a possibility in the pesticides industry under Option A (Table VIII-54). This means that there is a 26% to 50% chance that more than 0.5% pesticides plants might close if Option A is promulgated.

c. *Cost of Compliance and Economic Impact of Option C*

The estimated incremental annual cost of compliance under regulatory Option C to go from Level I to Pathways Level III is shown in Table VIII-55. The cost of compliance as a percent of production value for the explosives industry is 8.8% and for the pesticides industry, 0.7%. The range of error is −2% to +5%.

Under this regulatory option, adverse impacts are considered unlikely (i.e., 11% to 25% chance of occurrence) for both segments (Table VIII-56).

I. PETROLEUM REFINING

1. Characterization of Petroleum Refining

a. *Industry Description*

The petroleum refining industry comprises of 266 refineries, ranging in capacity from less than one thousand barrels per day to over 600 thousand barrels per day. Because most refineries are located near domestic crude oil production or near ports receiving shipments of foreign crude and unfinished oils, there is a high concentration of refining capacity in the Gulf Coast, West Coast and Mid-Atlantic regions.

Refineries belong to major oil companies or to independent regional refiners. Major oil companies operate several refineries, whereas many independent refiners may operate only one. Employment in the industry exceeds 160,000.

b. *Segmentation*

For purposes of assessing economic impact, the petroleum refining industry was analyzed as a single entity.

c. *Structure*

The largest companies dominate the petroleum refining industry. The four largest refiners, all major oil companies, operate 13% of the refineries and control 31% of the industry's capacity (Table VIII-57).

d. *Supply and Demand*

Growth in unit demand is expected to average 4% during the 1976 to 1981 period (Table VIII-57). Overall growth in petroleum consumption will begin to decline by 1980 because of

TABLE VIII-54

OPTION A
ECONOMIC IMPACT ON EXPLOSIVES AND PESTICIDES

Industry Segments	Number of Existing Plants in 1976	Plant Closures	Job Losses	U.S. Production Cutbacks	Price Increases	U.S. Demand Reduction	Balance of Payments Effects
Explosives	56	unlikely	unlikely	unlikely	large	unlikely	none
Pesticides	185	possibly	possibly	possibly	moderate	possibly	none

Source: Arthur D. Little, Inc., estimates.

TABLE VIII-55

OPTION C
EXPLOSIVES & PESTICIDES

ESTIMATED INCREMENTAL ANNUAL COST OF HAZARDOUS WASTE MANAGEMENT ACTIVITIES
(The cost of going from Level I to Pathways Level III)

Industry Segments	Estimated 1977 Production Value	1977 Incremental Annual Cost					Incremental Hazardous Waste Management Cost as a Percent of Production Value
		Generation	Transportation	HW Treatment, Storage & Disposal	Total	Range	
	$MM	$MM	$MM	$MM	$MM	%	%
Explosives	650.0	0.036	0.000	57.037	57.073	-2, +5	8.8
Pesticides	3000.0	0.004	0.001	21.682	21.687	-2, +4	0.7

Source: Arthur D. Little, Inc., estimates.

TABLE VIII-56

OPTION C
ECONOMIC IMPACT ON EXPLOSIVES AND PESTICIDES

Industry Segments	Number of Existing Plants in 1976	Plant Closures	Job Losses	U.S. Production Cutbacks	Price Increases	U.S. Demand Reduction	Balance of Payments Effects
Explosives	56	unlikely	unlikely	unlikely	large	unlikely	none
Pesticides	185	negligible	unlikely	unlikely	slight	unlikely	none

Source: Arthur D. Little, Inc., estimates.

TABLE VIII-57

CHARACTERIZATION OF PETROLEUM REFINING

Industry Segment	1976 Production 1,000's Barrels Per Day	Number of Producers	Number of Plants	Four-Firm Concentration Ratio	Unit Demand Growth %/Year 1976-81	Price Elasticity of Demand	Product Substitution	Import Competition	Capacity Utilization %
Petroleum Refining (SIC 2911)	13,473	134	266	31	4	low	moderate	low	88.4

Sources:
1. Oil and Gas Journal, *Annual Refining Issue,* March 20, 1978.
2. Department of Energy, *Monthly Petroleum Statement,* 1976.
3. Arthur D. Little, Inc., estimates.

conservation of energy and a lower growth in gasoline demand. Potential government actions such as ordering the conversion to coal or imposing a crude oil equalization tax would further depress demand.

e. Profitability

Profit margins have declined since the oil embargo of 1973-1974 as imported crude prices have steadily risen (Table VIII-58). However, the federal government has protected small refiners from increasing foreign crude prices through its entitlements program. Because many refiners engage in other petroleum activities, e.g., exploration, production, transportation and marketing, the examination of the profitability of petroleum refining in isolation may not represent the true industry situation.

f. Capital Investment

Petroleum refining is very capital intensive. Significant new capital expenditures will be required as refiners comply with lead phase-down regulations and install capacity to handle sour (i.e., high sulfur), crude (Table VIII-58).

2. Economic Impact on Petroleum Refining

a. Cost of Compliance and Economic Impact of Option B

The estimated incremental annual cost of compliance under regulatory Option B to go from Level I to Pathways Level III is shown in Table VIII-59. The cost of compliance as a percent of production value for the petroleum refining industry is 0.02.

Under this regulatory option, plant closures and other adverse economic impacts are not expected to take place (Table VIII-60).

b. Cost of Compliance and Economic Impact of Option A

The estimated incremental annual cost of compliance under regulatory Option A to go from Level I to Pathways Level III is shown in Table VIII-61. The cost of compliance as a percent of production value for the petroleum industry is 0.1%.

Under this regulatory option, plant closures and other adverse economic impacts are not expected (Table VIII-62).

c. Cost of Compliance and Economic Impact of Option C

The estimated incremental annual cost of compliance under regulatory Option C to go from Level I to Pathways Level III is shown in Table VIII-63. The cost of compliance as a percent of production value for the petroleum industry is 0.02%.

Under this regulatory option, plant closures and other adverse economic impacts are not expected to take place (Table VIII-64).

TABLE VIII-58

FINANCIAL PROFILE OF PETROLEUM REFINING

Petroleum Refining Industry (SIC 2911)	**1976**	**1975**	**1974**	**1973**	**1972**
Profitability[1]					
Net Income After Taxes/Sales (%)	3.13	4.19	6.12	7.03	5.03
Net Income After Taxes/Net Worth (%)	16.94	15.10	17.53	14.37	9.86
Revenues[2]					
Value of Shipments (MM$)	77,507.3	65,254.2	54,833.8	31,845.8	25,921.1
Value Added/Shipments (%)	14.72	13.68	15.25	20.46	17.72
New Capital Expenditures (MM$)	2,656.1	2,275.2	1,716.3	1,012.5	1,061.6

Sources: 1. Dun and Bradstreet, *Ratios of Manufacturing*, 1973-1976.
2. U.S. Department of Commerce, *Census of Manufacturers*, 1972 and *Annual Survey of Manufacturers, 1973-1976.*

TABLE VIII-59

OPTION B
PETROLEUM REFINING

ESTIMATED INCREMENTAL ANNUAL COST OF HAZARDOUS WASTE MANAGEMENT ACTIVITIES
(The cost of going from Level I to Pathways Level III

Industry Segment	Estimated 1977 Production Value	1977 Incremental Annual Cost					Incremental Hazardous Waste Management Cost as a Percent of Production Value
		Generation	Transportation	HW Treatment, Storage & Disposal	Total	Range	
	$MM	$MM	$MM	$MM	$MM	%	%
Petroleum Refining	90,090.0	0.584	0.186	17.345	18.115	-28, +68	0.02

Source: Arthur D. Little, Inc., estimates.

TABLE VIII-60

OPTION B
ECONOMIC IMPACT ON PETROLEUM REFINING

Industry Segment	Number of Existing Plants in 1976	Plant Closures	Job Losses	U.S. Production Cutbacks	Price Increases	U.S. Demand Reduction	Balance of Payments Effects
Petroleum Refining	266	none	none	none	slight	none	none

Source: Arthur D. Little, Inc., estimates.

TABLE VIII-61

OPTION A
PETROLEUM REFINING

ESTIMATED INCREMENTAL ANNUAL COST OF HAZARDOUS WASTE MANAGEMENT ACTIVITIES
(The cost of going from Level I to Pathways Level III)

Industry Segment	Estimated 1977 Production Value	1977 Incremental Annual Cost: Generation	Transportation	HW Treatment, Storage & Disposal	Total	Range	Incremental Hazardous Waste Management Cost as a Percent of Production Value
	$MM	$MM	$MM	$MM	$MM	%	%
Petroleum Refining	90,090.0	2.150	0.186	59.858	62.194	-41, +60	0.1

Source: Arthur D. Little, Inc., estimates.

TABLE VIII-62

OPTION A
ECONOMIC IMPACT ON PETROLEUM REFINING

Industry Segment	Number of Existing Plants in 1976	Plant Closures	Job Losses	U.S. Production Cutbacks	Price Increases	U.S. Demand Reduction	Balance of Payments Effects
Petroleum Refining	266	none	none	none	slight	none	none

Source: Arthur D. Little, Inc., estimates.

TABLE VIII-63

OPTION C
PETROLEUM REFINING

ESTIMATED INCREMENTAL ANNUAL COST OF HAZARDOUS WASTE MANAGEMENT ACTIVITIES
(The cost of going from Level I to Pathways Level III)

Industry Segment	Estimated 1977 Production Value	1977 Incremental Annual Cost					Incremental Hazardous Waste Management Cost as a Percent of Production Value
		Generation	Transportation	HW Treatment, Storage & Disposal	Total	Range	
	$MM	$MM	$MM	$MM	$MM	%	%
Petroleum Refining	90,090.0	0.272	0.008	14.006	14.286	-24, +59	0.02

Source: Arthur D. Little, Inc., estimates.

TABLE VIII-64

OPTION C
ECONOMIC IMPACT ON PETROLEUM REFINING

Industry Segment	Number of Existing Plants in 1976	Plant Closures	Job Losses	U.S. Production Cutbacks	Price Increases	U.S. Demand Reduction	Balance of Payments Effects
Petroleum Refining	266	none	none	none	slight	none	none

Source: Arthur D. Little, Inc., estimates.

J. PETROLEUM REREFINING

1. Characterization of Petroleum Rerefining

a. Industry Description

The petroleum rerefining industry reprocesses automotive and industrial waste oils into high-quality lubricants. The industry is in a depressed economic state, primarily as a result of waste oil feedstock constraints. Most of the 33 operating rerefiners are small, old, family-run businesses, and the average plant has 12 employees. Rerefiners are expanding into non-rerefining areas because of low profits from rerefining activities.

b. Segmentation

The petroleum rerefining industry has been analyzed as a single impact segment.

c. Structure

Only 33 rerefining plants have survived from a total of more than 165 rerefiners that were operating in the early 1960's (Table VIII-65). The contraction of this industry from the 1960's has resulted from many institutional and marketing problems. The attrition has fostered a significant concentration, with the top four rerefiners marketing about 60% of the rerefined oil volume in 1976. In total, this industry rerefines 54 million gallons of oil out of a total virgin oil sales pool exceeding 2 billion gallons annually.

d. Supply and Demand

Despite past problems, the rerefining industry has tremendous growth potential because it offers the country the following dual advantages: (1) helps keep the environment clean of waste oil; and, (2) promotes the conservation of scarce hydrocarbons.

The actual growth rate of the rerefining industry is highly dependent upon future government regulatory actions to insure waste oil feedstock availability and promote the use of rerefined oil by changes in federal specifications and labeling requirements. New lubricating oil specifications which allow the utilization of rerefined oil for sales to military and government units have been established and soon will become effective. This will open new markets for rerefined oil and provide product specifications which can be used in the private sector to evaluate rerefined oil. The hazardous waste management regulations to be promulgated by the EPA are perceived by most rerefiners as being beneficial to the rerefining industry because the regulations will significantly increase feedstock availability to the rerefiners. If government efforts in this area are implemented, the demand for rerefined oil could more than double over the next five years, i.e., a 14% annual growth. Feedstock availability would be adequate for such demand growth. However, a continuation of current government impediments would result in a relatively stagnant growth for rerefined oil (i.e., about 2% per year). At the present time, the depressed market for rerefined oils has resulted in only a 50% utilization of the existing rerefining capacity in the United States (Table VIII-65).

TABLE VIII-65

CHARACTERIZATION OF PETROLEUM REREFINING INDUSTRY

Industry Segment	1976 Production MM Gallons	Number of Producers	Number of Plants	Four-Firm Concentration Ratio	Unit Demand Growth %/Year 1976-81	Price Elasticity of Demand	Product Substitution	Import Competition	Capacity Utilization %
Petroleum Rerefining (SIC 2992)	54*	26	33**	60	2-14	moderate	moderate	none	50

*MM U.S. gallons = 3,400 metric tons of waste oil.

**Only 27 active.

Source: Arthur D. Little, Inc., estimates

Rerefiners are optimistic that conditions in that industry will improve. One new rerefining plant with a capacity of about 12 to 15 million gallons per year has recently been constructed; several expansions (a total new capacity of 5 to 8 million gallons annually) have been or will soon be completed. Further, a survey of rerefiners indicates that at least one more new grassroots rerefining plant is about to be built. Most rerefiners indicate that they have "held on" through the lean years and now expect that the improving climate for rerefining will allow them to become more profitable (or to make a profit).

A further restriction in rerefined lube oil supplies would force current customers to purchase virgin lube oils. Thus, the price of rerefined oils has a moderate elasticity of demand, because the upper limit is set by the cost of virgin oils less a virgin premium of approximately 15 cents a gallon. A key problem in the rerefining industry is the ability to competitively obtain waste oil feedstock which, for the most part, is being siphoned off as a fuel oil extender at a value higher than most rerefiners can reasonably pay. Proposed EPA regulations may force more waste oil to move towards rerefiners as its use as a fuel oil extender is restricted.

There is no import competition in the rerefined oil business.

e. Profitability

When rerefining operations are viewed as separate profit centers, the average rerefiner has negative net margins with a positive cash flow only provided by a "set aside" for depreciation. The key factor here is the high price of street drainings (i.e., waste oil feedstocks) which has been bid up to 15 to 22 cents per gallon by fuel oil resellers to blend it into their 32 cents a gallon fuel oil. In many areas, rerefiners were paid five cents a gallon to cart away the unwanted waste oil only five years ago. In addition, plant labor expenses have increased significantly at a much greater rate than the rerefiners' gross margin. The key to future profitability in rerefining lies in the federal ban on burning waste oil in fuel oil as a step to curb undesirable air effluents. Table VIII-66 shows the industry's decreasing profitability since 1972, both in terms of net sales and net worth.

f. Capital Investment

The rerefining industry is not significantly capital intensive, since most of the existing facilities have been depreciated (Table VIII-66). A new grassroots rerefining plant which would treat 5 to 10 million gallons per year would probably require an investment of approximately $2.5 to $4.0 million, or about five times current average net fixed assets in most rerefining operations. A substantial part of the investment for new rerefining plants is for pollution control equipment to handle waste streams generated by the plant.

2. Economic Impact on Petroleum Rerefining

a. Cost of Compliance and Economic Impact of Option B

The estimated incremental annual cost of compliance under regulatory Option B to go from Level I to Pathways Level III is shown in Table VIII-67. The cost of compliance as a percent of production value for the petroleum rerefining industry is 2.6%. The range of error is −29% to +69%.

TABLE VIII-66

FINANCIAL PROFILE OF PETROLEUM REREFINING INDUSTRY

Petroleum Rerefining (SIC 2992)	**1977**	**1976**	**1975**	**1974**	**1973**	**1972**
Profitability						
Net Income After Taxes/Net Sales (%)	(1%)		←	decreasing		
Net Income After Taxes/Net Worth* (%)	(3%)		←	decreasing		
Sales						
Total Sales (MM$)	40.0	static				
Value Added/Sales (%)	63.0		←	decreasing		
New Capital Expenditures	insignificant expenditures on a net basis					

*Only staying in business because getting cash from depreciation.

Source: Arthur D. Little, Inc. estimates

TABLE VIII-67

OPTION B
PETROLEUM REREFINING

ESTIMATED INCREMENTAL ANNUAL COST OF HAZARDOUS WASTE MANAGEMENT ACTIVITIES
(The cost of going from Level I to Pathways Level III)

Industry Segment	Estimated 1977 Production Value	1977 Incremental Annual Cost					Incremental Hazardous Waste Management Cost as a Percent of Production Value
		Generation	Transportation	HW Treatment, Storage & Disposal	Total	Range	
	$MM	$MM	$MM	$MM	$MM	%	%
Petroleum Rerefining	40.0	0.033	0.017	0.987	1.037	-29, +69	2.6

Source: Arthur D. Little, Inc., estimates.

Under this regulatory option, plant closures and other adverse economic impacts are considered unlikely (Table VIII-68). This means that the probability is between 11% and 25% more than 0.5% of the industry would experience adverse impacts. Because of upcoming federal government policies which are expected to substantially boost demand for rerefined products, it is expected to be relatively easy for this industry to pass on the moderate price increase that will be required to overcome the cost of hazardous waste management regulations under Option B.

b. Cost of Compliance and Economic Impact of Option A

The estimated incremental annual cost of compliance under regulatory Option A to go from Level I to Pathways Level III is shown in Table VIII-69. The hazardous waste treatment, storage and disposal activities associated with 3004 and 3005 constitute the largest components of these costs. The cost of compliance as a percent of production value for petroleum rerefining is 6.1% under regulatory Option A. The range of error extends from −41% to +61%.

Under this regulatory option, plant closures and other adverse economic impacts are considered possible (Table VIII-70). This means that the probability is between 26% and 50% more than 0.5% of the industry would experience adverse economic effects. Such adverse economic effects are possible because of the large price increases that are required to overcome the incremental costs of regulatory Option A. Even the favorable federal regulatory climate for this industry may not be adequate to permit the required large price increases without adverse impact on the industry. The adverse impact would take the form of a reduced market which would mean that some plants would not be able to sell their products and would, therefore, have to close.

c. Cost of Compliance and Economic Impact of Option C

The estimated incremental annual cost of compliance under regulatory Option C to go from Level I to Pathways Level III is shown in Table VIII-71. The cost of compliance as a percent of production value for petroleum rerefining is 1.5% under regulatory Option C. The range of error extends from −26% to +62%.

Under this regulatory option, plant closures and other adverse economic impacts are considered negligible (i.e., a 0.5% to 10% chance of occurrence). (See Table VIII-72.)

K. RUBBER PRODUCTS

1. Characterization of Rubber Products

a. Industry Description

The rubber products industry comprises four separate industry segments: tires and inner tubes (SIC 3011); rubber and plastics footwear (SIC 3021); hose and belting (SIC 3041); and fabricated rubber products not elsewhere classified (SIC 3069). The tire and inner tube sector represents 57% of total production value in the industry. There is presently overcapacity for bias ply tires and intense foreign competition for radial tires within this segment.

The rubber and plastics footwear industry in the U.S. is a declining one because of its high labor intensity, which has resulted in an uncompetitive cost position relative to foreign imports. The value of production of the other two segments, i.e., hose and belting, and other rubber products, has increased almost 50% since 1972.

TABLE VIII-68

OPTION B
ECONOMIC IMPACT ON PETROLEUM REREFINING

Industry Segment	Number of Existing Plants in 1976	Plant Closures	Job Losses	U.S. Production Cutbacks	Price Increases	U.S. Demand Reduction	Balance of Payments Effects
Petroleum Rerefining	33	unlikely	unlikely	unlikely	small	unlikely	none

Source: Arthur D. Little, Inc., estimates.

TABLE VIII-69

OPTION A
PETROLEUM REREFINING

ESTIMATED INCREMENTAL ANNUAL COST OF HAZARDOUS WASTE MANAGEMENT ACTIVITIES
(The cost of going from Level I to Pathways Level III)

Industry Segment	Estimated 1977 Production Value	1977 Incremental Annual Cost					Incremental Hazardous Waste Management Cost as a Percent of Production Value
		Generation	Transportation	HW Treatment, Storage & Disposal	Total	Range	
	$MM	$MM	$MM	$MM	$MM	%	%
Petroleum Rerefining	40.0	0.067	0.017	2.354	2.438	-41, +61	6.1

Source: Arthur D. Little, Inc., estimates.

TABLE VIII-70

OPTION A
ECONOMIC IMPACT ON PETROLEUM REREFINING

Industry Segment	Number of Existing Plants in 1976	Plant Closures	Job Losses	U.S. Production Cutbacks	Price Increases	U.S. Demand Reduction	Balance of Payments Effects
Petroleum Rerefining	33	possibly	possibly	possibly	moderate	possibly	none

Source: Arthur D. Little, Inc., estimates.

TABLE VIII-71

OPTION C
PETROLEUM REREFINING

ESTIMATED INCREMENTAL ANNUAL COST OF HAZARDOUS WASTE MANAGEMENT ACTIVITIES
(The cost of going from Level I to Pathways Level III)

Industry Segment	Estimated 1977 Production Value	1977 Incremental Annual Cost					Incremental Hazardous Waste Management Cost as a Percent of Production Value
		Generation	Transportation	HW Treatment, Storage & Disposal	Total	Range	
	$MM	$MM	$MM	$MM	$MM	%	%
Petroleum Rerefining	40.0	0.019	0.000	0.585	0.604	-26, +62	1.5

Source: Arthur D. Little, Inc., estimates.

TABLE VIII-72

OPTION C
ECONOMIC IMPACT ON PETROLEUM REREFINING

Industry Segment	Number of Existing Plants in 1976	Plant Closures	Job Losses	U.S. Production Cutbacks	Price Increases	U.S. Demand Reduction	Balance of Payments Effects
Petroleum Rerefining	33	negligible	negligible	negligible	slight	negligible	none

Source: Arthur D. Little, Inc., estimates.

b. Segmentation

For purposes of assessing economic impact, the rubber products industry was analyzed as two entities: first, the tire and inner tube industry, and second, the combined industries of footwear, hose and belting, and fabricated rubber products.

c. Structure

There are approximately 75 tire and inner tube manufacturers, with the four largest companies accounting for approximately 75% of industry shipment value. The footwear segment is somewhat less concentrated, with the four largest companies accounting for 60% of industry shipment value. About 60 companies manufacture hose and belting, with the top four companies representing more than 50% of industry shipment value. Fabricated rubber products is the least concentrated of the four sectors, with the four largest companies accounting for only 16% of industry shipment value (Table VIII-73).

d. Supply and Demand

Overall growth in unit demand for tires and inner tubes will average 3.0% per year through 1981. The growth in shipment value, however, will exceed this and average 5.0% (excluding inflationary price change) because of the conversion to higher-unit-value radial tires from bias ply tires in both the passenger car and truck and bus tire market segments. Hose and belting shipment value is expected to grow at an average annual rate of 4.0% (excluding inflationary price change) because of the positive impact of automotive clean air regulations and the increasing use of agricultural irrigation systems. There is little chance that footwear will achieve any economic growth in the future, because the share of foreign imports to domestic manufactured footwear sold in the United States is expected to increase, thereby offsetting a unit demand growth of approximately 2.0% per year. Fabricated rubber products will average only 3.0% per year through 1981 because of increasing substitution of plastics products, see Table VIII-73.

e. Profitability

No published information is available on the profitability of the individual rubber products segments. On an overall basis, however, profit margins declined from a high of 5.5% of sales after taxes in 1973 to 3.8% in 1976. A general situation of overcapacity, intense foreign competition, and an uncompetitive cost position relative to foreign imports is expected to keep industry profitability low (Table VIII-74).

f. Capital Investment

New capital investment for rubber products as a whole has fluctuated widely around a flat trend line since 1972 (Table VIII-74).

2. Economic Impact on the Rubber Industry

a. Cost of Compliance and Economic Impact of Option B

The estimated incremental annual cost of compliance under regulatory Option B to go from Level I to Pathways Level III is shown in Table VIII-75. The cost of compliance as a percent of

TABLE VIII-73

CHARACTERIZATION OF THE RUBBER PRODUCTS INDUSTRY

Industry Segments	1976 Production 1000's Units	Number of Producers	Number of Plants	Four-Firm Concentration Ratio	Unit Demand Growth %/Year 1976-81	Price Elasticity of Demand	Product Substitution	Import Competition	Capacity Utilization %
Tires & Inner Tubes (SIC 3100)	187,953	75	120	75	3.0	medium	low	high	75
Footwear, Hose and Belting and Fabricated Rubber Products (SIC 3021, 3041, 3069)	N.A.	770	920	16-60	2-4	high	medium	high	70-85

Sources: 1. Standard & Poor's Industry Surveys, October 27, 1977.
2. U.S. Industrial Outlook, 1978.
3. Arthur D. Little, Inc., estimates.

TABLE VIII-74

FINANCIAL PROFILE OF RUBBER PRODUCTS

Rubber Products Industry[1] (SIC 30)	1976	1975	1974	1973	1972
Profitability[2]					
Net Income After Taxes/Sales (%)	3.80	3.06	5.01	5.46	3.96
Net Income After Taxes/Net Worth (%)	10.4	7.9	14.2	12.2	10.3
Revenues[3]					
Value of Shipments (MM$)	13,552.7	12,353.5	12,677.7	11,415.0	10,198.1
Value Added/Shipments (%)	49.6	50.4	52.8	56.8	55.2
New Capital Expenditures (MM$)	542.1	494.1	633.8	684.9	509.9

1. Includes tires and inner tubes, hose and belting, footwear and fabricated rubber products.

Sources:
2. Dun and Bradstreet, *Ratios of Manufacturing,* 1973-1976.
3. U.S. Department of Commerce, Census of Manufacturers, 1972 and Annual Survey of Manufacturers, 1973-1976.

TABLE VIII-75

OPTION B
RUBBER PRODUCTS

ESTIMATED INCREMENTAL ANNUAL COST OF HAZARDOUS WASTE MANAGEMENT ACTIVITIES
(The cost of going from Level I to Pathways Level III)

Industry Segments	Estimated 1977 Production Value	1977 Incremental Annual Cost					Incremental Hazardous Waste Management Cost as a Percent of Production Value
		Generation	Transportation	HW Treatment, Storage & Disposal	Total	Range	
	$MM	$MM	$MM	$MM	$MM	%	%
Tires & Inner Tubes	10,200.0	0.092	0.003	0.585	0.680	-23, +57	0.007
Other Rubber Products	6275.0	0.701	0.005	4.248	4.954	-23, +54	0.1

Source: Arthur D. Little, Inc., estimates.

production value for the tires and inner tubes segment of the rubber industry is 0.007% and for the other rubber products segment of the rubber industry, 0.1%. The range of error extends from −23% to +57%.

Under this regulatory option, plant closures and other adverse impacts are not expected in either segment (Table VIII-76).

b. Cost of Compliance and Economic Impact of Option A

The estimated incremental annual cost of compliance under regulatory Option A to go from Level I to Pathways Level III is shown in Table VIII-77. The cost of compliance as a percent of production value for the tires and inner tubes segment of the rubber industry is 0.02% and for the other rubber products segment of the industry, 0.3%. The range of error extends from −40% to +56%.

Under this regulatory option, as well, plant closures and other adverse impacts are not expected (Table VIII-78).

c. Cost of Compliance and Economic Impact of Option C

The estimated incremental annual cost of compliance under regulatory Option C to go from Level I to Pathways Level III is shown in Table VIII-79. The cost of compliance as a percent of production value for the tires and inner tubes segment of the rubber industry is 0.005% and for the other rubber products segment of the industry, 0.1%. The range of error is from −23% to +58%.

Under this regulatory option, plant closures and other adverse economic impacts are not expected (Table VIII-80).

L. LEATHER TANNING AND FINISHING

1. Characterization of Leather Tanning and Finishing

a. Industry Description

The leather tanning and finishing industry consists of establishments that carry out the tanning, currying, and finishing of hides and skins into leather. There is wide diversity in the size and ownership of firms, ranging from small, family operations to divisions of large conglomerates. There is also a wide range of tanning techniques for the various hides and skins that are processed. Tanneries are concentrated in the Northeast, and more than 70% of the plants are 50 or more years old. Many have been modernized, but technological changes in the last 50 years have been minimal. Shoe manufacturing consumes about ¾ of all the leather produced.

b. Segmentation

The 430 establishments in the industry include the hazardous waste-producing wet and dry tanneries, in addition to the non-hazardous waste-producing leather converters and non-production plants. The traditional industry segmentation is by type of leather manufactured, such as cattlehide, sheepskin, etc. But for purposes of assessing the impacts of hazardous waste manage-

TABLE VIII-76

OPTION B
ECONOMIC IMPACT ON RUBBER PRODUCTS

Industry Segments	Number of Existing Plants in 1976	Plant Closures	Job Losses	U.S. Production Cutbacks	Price Increases	U.S. Demand Reduction	Balance of Payments Effects
Tires and Inner Tubes	120	none	none	none	slight	none	none
Other Rubber Products	920	none	negligible	negligible	small	negligible	none

Source: Arthur D. Little, Inc., estimates.

TABLE VIII-77

OPTION A
RUBBER PRODUCTS

ESTIMATED INCREMENTAL ANNUAL COST OF HAZARDOUS WASTE MANAGEMENT ACTIVITIES
(The cost of going from Level I to Patheays Level III)

Industry Segments	Estimated 1977 Production Value	1977 Incremental Annual Cost					Incremental Hazardous Waste Management Cost as a Percent of Production Value
		Generation	Transportation	HW Treatment, Storage & Disposal	Total	Range	
	$MM	$MM	$MM	$MM	$MM	%	%
Tires & Inner Tubes	10,200.0	0.137	0.003	2.274	2.412	-40, +57	0.02
Other Rubber Products	6,275.0	1.043	0.005	17.909	18.957	-40, +56	0.3

Source: Arthur D. Little, Inc. estimates

TABLE VIII-78

OPTION A
ECONOMIC IMPACT ON RUBBER PRODUCTS

Industry Segments	Number of Existing Plants in 1976	Plant Closures	Job Losses	U.S. Production Cutbacks	Price Increases	U.S. Demand Reduction	Balance of Payments Effects
Tires and Inner Tubes	120	none	none	none	slight	none	none
Other Rubber Products	920	negligible	negligible	negligible	small	negligible	none

Source: Arthur D. Little, Inc., estimates.

TABLE VIII-79

OPTION C
RUBBER PRODUCTS

ESTIMATED INCREMENTAL ANNUAL COST OF HAZARDOUS WASTE MANAGEMENT ACTIVITIES
(The cost of going from Level I to Pathways Level III)

Industry Segments	Estimated 1977 Production Value	1977 Incremental Annual Cost: Generation	Transportation	HW Treatment, Storage & Disposal	Total	Range	Incremental Hazardous Waste Management Cost as a Percent of Production Value
	$MM	$MM	$MM	$MM	$MM	%	%
Tires & Inner Tubes	10,200.0	0.075	0.000	0.477	0.552	-23, +58	0.005
Other Rubber Products	6275.0	0.575	0.000	3.638	4.213	-22, +56	0.1

Source: Arthur D. Little, Inc. estimates

TABLE VIII-80

OPTION C
ECONOMIC IMPACT ON RUBBER PRODUCTS

Industry Segments	Number of Existing Plants in 1976	Plant Closures	Job Losses	U.S. Production Cutbacks	Price Increases	U.S. Demand Reduction	Balance of Payments Effects
Tires and Inner Tubes	120	none	none	none	slight	none	none
Other Rubber Products	920	none	negligible	negligible	small	negligible	none

Source: Arthur D. Little, Inc., estimates.

ment, the industry has been categorized into types of manufacturing processes and only those firms which engage in such processes have been included in this analysis. The five tannery categories included are: cattlehide chrome, cattlehide through to blue, cattlehide splits, sheepskins, and leather finishers.

c. *Structure*

With the exception of the cattlehide through to blue tanneries, this industry is categorized by relatively low concentration ratios, ranging from 10% to 45% (Table VIII-81). The largest and strongest segments of the industry are cattlehide chrome and the leather finishers.

d. *Supply and Demand*

From 1965 to 1974, the volume of production of the leather tanning and finishing industry trended downward, primarily due to competition from foreign tanners and the consumers' acceptance of synthetic leather substitutes. However, since 1974, the volume of production has increased as a result of an increased appreciation for natural leather products, coupled with the declining value of the dollar. For the same reasons, the unit demand growth in cattlehide chrome, cattle through to blue, and sheepskins is expected to continue increasing through 1981. On the other hand, because of increased imports, production of cattlehide splits is likely to continue to decrease. Leather finishers, as independent entities, will probably experience no growth over the next five years as tanneries increasingly integrate forward into finishing operations (Table VIII-81).

e. *Profitability*

Table VIII-82 provides financial information on the leather tanning industry as a whole. After increasing steadily from 1972 to 1975, after tax profitability on sales declined in 1976 while return on net worth leveled off.

f. *Capital Investment*

Although this is not a very capital-intensive business, new capital expenditures for the industry have generally increased since 1973 (Table VIII-82).

2. Economic Impact on Leather Tanning and Finishing

a. *Cost of Compliance and Economic Impact of Option B*

The estimated incremental annual cost of compliance under regulatory Option B to go from Level I to Pathways Level III is shown in Table VIII-83. The hazardous waste treatment, storage and disposal activities associated with 3004 and 3005 constitute the largest component of these costs. The cost of compliance as a percent of production value for the leather tanning and finishing industry ranges from a low of 0.2% for sheepskins to a high of 2.4% for the leather finishers. The range of error is from −31% to +71%.

Under this regulatory option, plant closures are considered probable in the leather finishing segment of the industry. This means there is a probability of 51% to 75% that more than 0.5% of

TABLE VIII-81

CHARACTERIZATION OF LEATHER TANNING & FINISHING INDUSTRY (SIC 3111)

Industry Segments	1976 Production 1,000 Equivalent Hides	Number of Firms	Number of Plants 1976	Four-Firm Concentration Ratio	Unit Demand Growth %/Year to 1981	Price Elasticity of Demand	Product Substitution	Import Competition	Capacity Utilization %
Cattlehide Chrome	11,180	≃90	105	10	5	high	high	high	85
Cattlehide Through to Blue	7,964	3	3	100	3	low	low	low	85
Cattlehide Splits	1,608	15	15	45	-1	moderate	high	moderate	85
Sheepskins (includes Shearling)	2,502	≃30	32	35	2	high	high	high	75
Leather Finishers	2,246	54-55	60	10	0	moderate	high	moderate	75

Source: Arthur D. Little, Inc., estimates, Personal Communication with DPRA Inc. "Economic Impact Analysis of Hazardous Waste Management Regulation in the Leather Tanning & Finishing Industry" Development Planning & Research Associates, Inc. Manhattan, Kansas – November 1977.

TABLE VIII-82

FINANCIAL PROFILE OF LEATHER TANNING & FINISHING INDUSTRY

Total Industry* (SIC 3111)	**1976**	**1975**	**1974**	**1973**	**1972**
Profitability[1]					
Net Income After Taxes/Sales (%)	2.3	3.3	3.0	1.0	1.3
Net Income After Taxes/Net Worth (%)	10.0	10.0	7.5	5.0	4.7
Revenues[2]					
Value of Shipments (MM$)	1,326.0	1,091.8	1,075.5	1,081.5	1,059.5
Value Added/Shipments (%)	39.3	40.6	37.0	31.0	34.8
New Capital Expenditures (MM$)	32.6	22.7	13.1	12.8	16.3

*Includes non-waste producing leather converters, brokers, dealers, warehousers and others.

Sources: 1. Arthur D. Little, Inc., *estimates*
2. *Census of Manufactures,* 1972 and *Annual Survey of Manufacturers,* 1972-1976

TABLE VIII-83

OPTION B
LEATHER TANNING & FINISHING

ESTIMATED INCREMENTAL ANNUAL COST OF HAZARDOUS WASTE MANAGEMENT ACTIVITIES
(The cost of going from Level I to Pathways Level III)

Industry Segments	Estimated 1977 Production Value	1977 Incremental Annual Cost					Incremental Hazardous Waste Management Cost as a Percent of Production Value
		Generation	Transportation	HW Treatment, Storage & Disposal	Total	Range	
	$MM	$MM	$MM	$MM	$MM	%	%
Cattlehide Chrome	662.0	0.098	0.017	1.679	1.794	-26, +61	0.3
Cattlehide through to Blue	271.0	0.009	0.027	1.170	1.206	-31, +71	0.4
Cattlehide Splits	21.0	0.013	0.002	0.179	0.194	-29, +67	0.9
Sheepskin	118.0	0.025	0.000	0.200	0.225	-24, +58	0.2
Leather Finishers	21.0	0.038	0.000	0.467	0.505	-24, +58	2.4

Source: Arthur D. Little, Inc. estimates

the leather finishing segment may close due to Option B (Table VIII-84). This adverse impact is anticipated because moderate price increases will be difficult for leather finishing plants to achieve because of significant import competition. As a result of having to settle for lesser price increases or a smaller market share, some leather finishing plants are expected to close. On the other hand, the probability of plant closures is considered negligible for the other four segments of the leather tanning and finishing industry: cattlehide chrome, cattle through to blue, cattlehide splits, and sheepskins. This means that the probability is between 0.5% and 10%.

b. Cost of Compliance and Economic Impact of Option A

The estimated incremental annual cost of compliance under regulatory Option A to go from Level I to Pathways Level III is shown in Table VIII-85. The cost as a percent of production value ranges from 0.6% for cattlehide through to blue, to 9.5% for leather finishing. The range of error is from −42% to +63%.

Under this regulatory option, plant closures and other adverse impacts are considered likely for the leather finishing segment of this industry (Table VIII-86). This means the probability of more than 0.5% of the segment experiencing difficulties is greater than 75%. These difficulties will probably be experienced because large price increases will be required to pay for the cost of pollution control and significant import competition is expected to make it very difficult for all producers to pass on the required price increases. Plant closures for other segments of this industry are considered unlikely, or none.

c. Cost of Compliance and Economic Impact of Option C

The estimated incremental annual cost of compliance under regulatory Option C to go from Level I to Pathways Level III is shown in Table VIII-87. The cost as a percent of production value ranges from a low of 0.1% for cattle through to blue to a high of 2% for the leather finishers. The range of error is from −32% to +71%.

Under this regulatory option, plant closures are considered a possibility for the leather finishers, but negligible to none for the other segments of the industry (Table VIII-88).

M. METAL SMELTING AND REFINING

1. Characterization of Metal Smelting and Refining

a. Industry Description

The metal smelting and refining industries, as a group, are large, interrelated, complex, and highly concentrated industries. The leading firms, although of unequal size, are large, multiplant, vertically integrated, multinational corporations. Dominant firms have long time horizons, are typically producers of numerous products, and operate in a diverse range of markets where they often face the threat of substitution from a number of key rival products. Because of the complexities characterizing these industries which condition market structure, firm behavior, market price determination, and industry financial performance, broad generalizations concerning economic impact should be viewed with caution for the industries as a group and for specific metal segments.

TABLE VIII-84

OPTION B
ECONOMIC IMPACT ON LEATHER TANNING AND FINISHING

Industry Segments	Number of Existing Plants in 1976	Plant Closures	Job Losses	U.S. Production Cutbacks	Price Increases	U.S. Demand Reduction	Balance of Payments Effects
Cattlehide Chrome	105	negligible	unlikely	unlikely	small	negligible	unlikely
Cattlehide Through to Blue	3	none	none	none	small	none	none
Cattlehide Splits	15	negligible	unlikely	unlikely	small	negligible	unlikely
Sheepskins	32	negligible	unlikely	unlikely	small	negligible	unlikely
Leather Finishers	60	probably	likely	likely	small	possibly	probably

Source: Arthur D. Little, Inc., estimates.

TABLE VIII-85

OPTION A
LEATHER TANNING & FINISHING

ESTIMATED INCREMENTAL ANNUAL COST OF HAZARDOUS WASTE MANAGEMENT ACTIVITIES
(The cost of going from Level I to Pathways Level III)

Industry Segments	Estimated 1977 Production Value	1977 Incremental Annual Cost					Incremental Hazardous Waste Management Cost as a Percent of Production Value
		Generation	Transportation	HW Treatment, Storage & Disposal	Total	Range	
	$MM	$MM	$MM	$MM	$MM	%	%
Cattlehide Chrome	662.0	0.175	0.017	4.851	5.043	-41, +58	0.8
Cattlehide through to Blue	271.0	0.012	0.026	1.474	1.512	-42, +63	0.6
Cattlehide Splits	21.0	0.025	0.002	0.227	0.254	-39, +59	1.2
Sheepskin	118.0	0.048	0.000	0.830	0.878	-40, +57	0.7
Leather Finishers	21.0	0.056	0.000	1.943	1.999	-41, +58	9.5

Source: Arthur D. Little, Inc. estimates

TABLE VIII-86

OPTION A
ECONOMIC IMPACT ON LEATHER TANNING AND FINISHING

Industry Segments	Number of Existing Plants in 1976	Plant Closures	Job Losses	U.S. Production Cutbacks	Price Increases	U.S. Demand Reduction	Balance of Payments Effects
Cattlehide Chrome	105	unlikely	possibly	possibly	small	unlikely	possibly
Cattlehide Through to Blue	3	none	negligible	negligible	small	none	none
Cattlehide Splits	15	unlikely	possibly	possibly	small	unlikely	possibly
Sheepskins	32	unlikely	possibly	possibly	small	unlikely	possibly
Leather Finishers	60	likely	likely	likely	moderate	possibly	probably

Source: Arthur D. Little, Inc., estimates.

TABLE VIII-87

OPTION C
LEATHER TANNING & FINISHING

ESTIMATED INCREMENTAL ANNUAL COST OF HAZARDOUS WASTE MANAGEMENT ACTIVITIES
(The cost of going from Level I to Pathways Level III

Industry Segments	Estimated 1977 Production Value	1977 Incremental Annual Cost					Incremental Hazardous Waste Management Cost as a Percent of Production Value
		Generation	Transportation	HW Treatment, Storage & Disposal	Total	Range	
	$MM	$MM	$MM	$MM	$MM	%	%
Cattlehide Crome	662.0	0.068	0.000	1.047	1.115	-25, +62	0.2
Cattlehide through to Blue	271.0	0.001	0.001	0.398	0.400	-31, +71	0.1
Cattlehide Splits	21.0	0.008	0.000	0.061	0.069	-32, +62	0.3
Sheepskins	118.0	0.018	0.000	0.168	0.186	-24, +60	0.2
Leather Finishers	21.0	0.030	0.000	0.389	0.419	-24, +61	2.0

Source: Arthur D. Little, Inc. estimates

TABLE VIII-88

OPTION C
ECONOMIC IMPACT ON LEATHER TANNING AND FINISHING

Industry Segments	Number of Existing Plants in 1976	Plant Closures	Job Losses	U.S. Production Cutbacks	Price Increases	U.S. Demand Reduction	Balance of Payments Effects
Cattlehide Chrome	105	negligible	unlikely	unlikely	small	negligible	negligible
Cattlehide Through to Blue	3	none	none	none	small	none	none
Cattlehide Splits	15	negligible	negligible	negligible	small	negligible	negligible
Sheepskins	32	negligible	unlikely	unlikely	small	negligible	unlikely
Leather Finishers	60	possibly	probably	probably	small	possibly	possibly

Source: Arthur D. Little, Inc., estimates.

b. Segmentation

For purposes of this study, the metal smelting and refining industry has been divided into the following product categories: the non-ferrous metals — tungsten (APT), mercury, primary copper smelting, primary lead smelting, primary zinc smelting, primary aluminum smelting, primary antimony smelting, primary titanium smelting, primary tin smelting, secondary copper smelting, secondary lead smelting, secondary aluminum smelting; and the ferrous metals — iron and steel production, ferrous foundry production, and ferroalloy production.

Each product category includes those plants primarily engaged in smelting or refining a given metal. Although significant quantities of metal may be produced as by-products or co-products at other plants, or from secondary sources, these plants were not included in the industry sector.

c. Structure

Most of the primary non-ferrous metal segments have four-firm concentration ratios of 100%. However, the concentration ratios are low for the secondary nonferrous metal sectors and the ferrous metal sectors (Table VIII-89).

d. Supply and Demand

The real growth rate projected through 1981 for the primary non-ferrous metal producers ranges from a low of less than 1% per year for mercury and tin production to a high of 6% per year for the tungsten and aluminum producers. At the same time, the secondary non-ferrous metal producers are expected to experience a growth of about 3% per year while the growth of the ferrous metal producers is expected to be about 2% per year. No significant supply constraints are anticipated in these segments through 1981. In fact, some of them have considerable excess capacity.

Product substitution ranges from low in the case of tungsten, mercury, antimony, lead, titanium and ferroalloys, to moderate in the case of iron and steel, ferrous foundries, zinc, aluminum, tin and copper.

Import competition is high for mercury, zinc, primary copper, iron and steel, and ferroalloys. It is moderate for lead, antimony, titanium, and secondary copper, whereas it is low for tungsten, ferrous foundries, aluminum, and tin.

The interaction of product substitution and import competition yields a high elasticity of demand in the case of primary copper, a moderate elasticity of demand in the cases of mercury, lead, zinc, antimony, aluminum, titanium, tin, secondary copper, iron and steel, ferroalloys, and ferrous foundries.

e. Profitability

Unfortunately, profitability data are only available for large industry groupings and not for the individual segment categories. Profitability in all three segments of the metal, smelting and refining industry fluctuated with the economy around a rather flat trend line between 1972 and

TABLE VIII-89

CHARACTERIZATION OF METAL SMELTING & REFINING INDUSTRY

Industry Segments	1976 Production 1,000's Metric Tons	Number of Producers	Number of Plants	Four-Firm Concentration Ratio	Projected[1] Demand Growth 1976-1985	Price Elasticity of Demand	Product Substitution	Import Competition	Capacity Utilization %
Nonferrous Metals									
Tungsten (APT)	6.32	4	4	100	6	low	low	low	80-90
Mercury	.80	4	4	100	< 1	moderate	very low*	high	~50
Primary Copper Smelting	1,448	9	16	80	3	high	moderate	high	60-80
Primary Lead Smelting	600	4	7	100	2	moderate	low	moderate	60-80
Primary Zinc Smelting	452.6	6	6	high	2.6	moderate	moderate	high	60-80
Primary Aluminum Smelting	3,855.8	12	31	80	6	moderate	moderate	low	70-90
Primary Antimony Smelting	2.0	3	3	100	4	moderate	low	moderate	moderate
Primary Titanium Smelting	10.46	3	3	100	3	moderate	low	moderate	NA
Primary Tin Smelting	5.70	1	1	100	< 1	moderate	moderate	low	100.0
Secondary Copper Smelting	341		80		3	moderate	moderate	moderate	NA
Secondary Lead Smelting	657.8		82		3	moderate	low	moderate	NA
Secondary Aluminum Smelting	643.0	69	97	low	3	moderate	moderate	low	NA
Ferrous Metals									
Iron & Steel	116,000	20	155	52.8	1.5-2.5/Yr.	moderate	moderate	high	70-90
Ferroalloys	1,730	9	22	~45	1.5-2.5/Yr.	moderate	low	high	50-80
Ferrous Foundries	15,230	1,500	1,760	low	~ 1.75/Yr.	moderate	moderate	low	70-80

*Some substitution is occurring as a result of environmental regulations concerning mercury use.

Sources: Arthur D. Little, Inc., estimates based on our 1978 report entitled, "Economic Impact of Proposed Hazardous Waste Management Regulations on Selected Industries," prepared for the U.S. Environmental Protection Agency, Office of Solid Waste Management.

1976. Profitability is measured in terms of after-tax return on sales and after-tax return on net income. The levels of profitability of non-ferrous metals, iron and steel, and ferrous foundries do not differ significantly (Table VIII-90).

f. Capital Investment

Capital investment has risen steadily in the iron and steel industry, whereas it exhibits a more uneven upward trend in non-ferrous metals and ferrous foundries (Table VIII-90).

2. Economic Impact on Metal Smelting and Refining

a. Cost of Compliance and Economic Impact of Option B

The estimated incremental annual cost of compliance for regulatory Option B to go from Level I to Pathways Level III is shown in Table VIII-91. The cost of compliance as a percent of production value for the metal smelting and refining industry ranges from a low of 0.002% for ferrous foundries to a high of 7.0% for mercury production. The range of error is from −39% to +146%.

Under this regulatory option, plant closures are considered likely for mercury, secondary copper smelting and secondary lead smelting (Table VIII-92). They are considered probable for secondary aluminum smelting, and unlikely for tungsten. Little or no impact is expected on the other segments of the industry.

b. Cost of Compliance and Economic Impact of Option A

The estimated incremental annual cost of compliance under regulatory Option A to go from Level I to Pathways Level III is shown in Table VIII-93. The cost of compliance as a percent of production value ranges from a low of 0.002% for ferrous foundries to a high of 19.6% for mercury production. The range of error is from −43% to +136%.

Under this regulatory option, plant closures and other adverse economic impacts are considered likely for mercury, secondary copper smelting, secondary lead smelting and secondary aluminum smelting. They are considered unlikely for tungsten, primary lead smelting, primary zinc smelting and ferroalloys. Little or no impact is expected on the other segments covered (Table VIII-94).

c. Cost of Compliance and Economic Impact of Option C

The estimated incremental annual cost of compliance under regulatory Option C to go from Level I to Pathways Level III is shown in Table VIII-95. The cost as a percent of production value ranges from a low of 0.002% for ferrous foundries to a high of 6.3% for mercury production. The range of error is from −24% to +62%.

Under this regulatory option, plant closures are considered likely for mercury production, secondary copper smelting, and secondary lead smelting. They are considered probable for secondary aluminum smelting. They are considered unlikely for tungsten. Little or no impact is expected on the remainder of the industry under study (Table VIII-96).

TABLE VIII-90

FINANCIAL PROFILE OF NONFERROUS METALS

Total Industry (SIC 333)	**1976**	**1975**	**1974**	**1973**	**1972**
Profitability[1]					
Net Income After Taxes/Sales (%)	3.7	3.1	7.0	5.4	3.7
Net Income After Taxes/Net Worth (%)	7.3	5.0	15.1	11.7	5.8
Revenues[2]					
Value of Shipments ((MM$)	13,149.3	10,867	13,370.7	9,951.3	8,065.3
Value Added/Shipments (%)	27.5	27.5	30.0	27.1	26.2
New Capital Expenditures (MM$)	551.2	660.5	632.6	343.7	327.2

Sources: 1. U.S. Federal Trade Commission, *Quarterly Financial Report for Manufacturing, Mining, and Trade Corporations*, 1972-1977. This data includes nonferrous foundries

2. *Census of Manufactures*, 1972 and *Annual Survey of Manufacturers*, 1973-1976.

TABLE VIII-90 (Continued)

FINANCIAL PROFILE OF IRON & STEEL

Total Industry* (SIC 331)		1976	1975	1974	1973	1972
Profitability[1]						
Net Income After Taxes/Net Sales (%)	upper quartile	5.70	6.17	7.20	5.29	4.31
	median	4.05	4.45	6.13	4.31	3.21
	lower quartile	2.15	2.31	4.27	2.34	1.66
Net Income After Taxes/Net Worth (%)	upper quartile	15.08	15.68	21.42	15.48	11.89
	median	9.13	10.31	16.81	10.11	6.77
	lower quartile	6.22	7.57	13.93	6.96	3.92
Revenues[2]						
Value of Shipments (MM$)		46,687.3	42,211.7	49,648.8	36,240.2	28,665
Value Added/Shipments (%)		37.2	37.4	40.4	41.2	42.3
New Capital Expenditures (MM$)		2,372.6	2,287.8	1,857.3	1,263.9	1,059.1

*Includes ferroalloys

Sources: 1. Dun and Bradstreet, *Ratios of Manufacturing*, 1973-1977.
2. *Census of Manufactures*, 1972 and *Annual Survey of Manufacturers*, 1973-1976.

TABLE VIII-90 (Continued)

FINANCIAL PROFILE OF FERROUS FOUNDRIES

Total Industry (SIC 332)		**1976**	**1975**	**1974**	**1973**	**1972**
Profitability[1]						
Net Income After Taxes/Net Sales (%)	upper quartile	6.74	9.25	6.15	5.22	4.86
	median	3.53	6.16	4.36	3.56	3.19
	lower quartile	1.89	3.52	2.11	2.01	2.07
Net Income After Taxes/Net Worth (%)	upper quartile	16.55	24.82	19.31	13.17	15.92
	median	11.11	16.11	13.38	8.95	9.39
	lower quartile	5.26	10.00	6.15	5.38	5.55
Revenues[2]						
Value of Shipments (MM$)		9,787.0	8,871.4	8,535.2	6,857.7	7,042.4
Value Added/Shipments (%)		56.2	56.1	55.3	59.3	61.1
New Capital Expenditures (MM$)		643.2	519.6	554.1	297.0	322.6

Sources: 1. Dun and Bradstreet, *Ratios of Manufacturing,* 1973-1977.
2. *Census of Manufactures,* 1972 and *Annual Survey of Manufacturers,* 1973-1976.

TABLE VIII-91

OPTION B
METALS SMELTING & REFINING

ESTIMATED INCREMENTAL ANNUAL COST OF HAZARDOUS WASTE MANAGEMENT ACTIVITIES
(The cost of going from Level I to Pathways Level III)

Industry Segments	Estimated 1977 Production Value	1977 Incremental Annual Cost					Incremental Hazardous Waste Management Cost as a Percent of Production Value*
		Generation	Transportation	HW Treatment, Storage & Disposal	Total	Range	
	$MM	$MM	$MM	$MM	$MM	%	%
Nonferrous Metals							
Tungsten (APT)	18.0	0.001	0.000	0.990	0.991	-39, +122	5.5
Mercury	4.6	0.001	0.000	0.322	0.323	-32, +95	7.0
Primary Copper Smelting	2500.0	0.013	0.000	2.059	2.072	-32, +89	0.1
Primary Lead Smelting	361.0	0.004	0.000	0.683	0.687	-31, +84	0.2
Primary Zinc Smelting	313.0	0.003	0.000	1.241	1.244	-37, +112	0.4
Primary Aluminum Smelting	4600.0	0.030	0.009	4.524	4.563	-31, +86	0.1
Primary Antimony Smelting	48.0	0.001	0.000	0.101	0.102	-30, +72	0.2
Primary Titanium Smelting	263.0	0.001	0.000	0.144	0.145	-32, +87	0.1
Primary Tin Smelting	50.0	0.000	0.000	0.013	0.013	-38, +146	0.03
Secondary Copper Smelting	450.0	0.052	0.000	7.290	7.342	-27, +64	1.6
Secondary Lead Smelting	430.0	0.054	0.000	7.400	7.454	-26, +64	1.7
Secondary Aluminum Smelting	1600.0	0.058	0.001	11.739	11.798	-30, +82	0.7
Ferrous Metals							
Iron & Steel	35,000.0	0.186	0.060	88.314	88.560	-39, 121	0.3
Ferroalloys	400.0	0.009	0.000	4.099	4.108	-37, +113	1.0
Ferrous Foundries	6500.0	0.111	0.000	0.000	0.111	0, 0	0.002

*Percent impact is defined as the ratio of compliance cost to metal selling price (except in tungsten and mercury). It should be noted that in many cases, production costs for the smelting and refining segments are significantly less than the metal selling price.

Source: Arthur D. Little, Inc. estimates

TABLE VIII-92

OPTION B
ECONOMIC IMPACT ON METALS SMELTING AND REFINING*

Industry Segments	Number of Existing Plants in 1976	Plant Closures[2]	Job Losses[2]	U.S. Production Cutbacks[2]	Price Increases[1]	U.S. Demand Reduction[3]	Balance of Payments Effects
Tungsten (APT)	4	unlikely	unlikely	unlikely	large	unlikely	none
Mercury	4	likely	likely	likely	small	none	likely
Primary Copper Smelting	16	none	negligible	negligible	small	negligible	none
Primary Lead Smelting	7	none	negligible	negligible	small	negligible	none
Primary Zinc Smelting	6	none	negligible	negligible	small	unlikely	unlikely
Primary Aluminum Smelting	31	none	negligible	negligible	slight	negligible	none
Primary Antimony Smelting	3	none	negligible	negligible	small	negligible	unlikely
Primary Titanium Smelting	3	none	none	none	slight	none	none
Primary Tin Smelting	1	none	negligible	negligible	slight	negligible	none
Secondary Copper Smelting	80	likely	likely	likely	small	unlikely	possibly
Secondary Lead Smelting	82	likely	likely	likely	small	unlikely	none
Secondary Aluminum Smelting	97	probably	probably	probably	small	negligible	none
Iron and Steel	155	none	unlikely	unlikely	small	none	none
Ferroalloys	22	none	unlikely	unlikely	small	unlikely	unlikely
Ferrous Foundries	1,760	none	none	none	slight	none	none

*This analysis is only concerned with impacts resulting from regulations on the smelting and refining segments of the industry. Significant impacts may be felt by these segments as a result of regulation on other segments of the industry. Specifically, the mining and milling segments may be severely impacted by RCRA regulation and this may affect the smelting and refining segments significantly (e.g., lead and zinc).

1. Except for tungsten and mercury, we are analyzing the selling price of the metal after processing. It should be noted that regulatory costs may represent a much larger fraction of the segment production costs than metal selling price.
2. These impacts were analyzed based on the relation between regulatory cost and segment (e.g., smelting) production costs: in many cases this is significantly different from metal selling price.
3. Taking into account price change and demand elasticity.

Source: Arthur D. Little, Inc., estimates.

TABLE VIII-93

OPTION A
METALS SMELTING & REFINING

ESTIMATED INCREMENTAL ANNUAL COST OF HAZARDOUS WASTE MANAGEMENT ACTIVITIES
(The cost of going from Level I to Pathways Level III)

Industry Segments	Estimated 1977 Production Value	1977 Incremental Annual Cost					Incremental Hazardous Waste Management Cost as a Percent of Production Value*
		Generation	Transportation	HW Treatment, Storage & Disposal	Total	Range	
	$MM	$MM	$MM	$MM	$MM	%	%
Nonferrous Metals							
Tungsten (APT)	18.0	0.004	0.000	1.572	1.576	-42, +98	8.8
Mercury	4.6	0.002	0.000	0.901	0.903	-42, +71	19.6
Primary Copper Smelting	2500.0	0.021	0.000	6.312	6.333	-42, +69	0.3
Primary Lead Smelting	361.0	0.007	0.000	2.230	2.237	-42, +67	0.6
Primary Zinc Smelting	313.0	0.005	0.000	2.476	2.481	-42, +85	0.8
Primary Aluminum Smelting	4600.0	0.069	0.009	14.111	14.189	-42, +67	0.3
Primary Antimony Smelting	48.0	0.002	0.000	0.405	0.407	-42, +62	0.8
Primary Titanium Smelting	263.0	0.002	0.000	0.465	0.467	-43, +67	0.2
Primary Tin Smelting	50.0	0.000	0.000	0.014	0.014	-43, +136	0.03
Secondary Copper Smelting	450.0	0.080	0.000	30.349	30.429	-42, +60	6.8
Secondary Lead Smelting	430.0	0.083	0.000	31.053	31.136	-42, +60	7.2
Secondary Aluminum Smelting	1600.0	0.088	0.001	39.480	39.569	-42, +66	2.5
Ferrous Metals							
Iron & Steel	35,000.0	0.605	0.060	136.688	137.353	-42, +99	0.4
Ferroalloys	400.0	0.021	0.000	8.025	8.046	-42, +86	2.0
Ferrous Foundries	6500.0	0.111	0.000	0.000	0.111	0, 0	0.002

*Percent impact is defined as the ratio of compliance cost to metal selling price (except in tungsten and mercury). It should be noted that in many cases, production costs for the *smelting and refining segments are significantly less than the metal selling price.*

Source: Arthur D. Little, Inc. estimates

TABLE VIII-94

OPTION A
ECONOMIC IMPACT ON METALS SMELTING AND REFINING*

Industry Segments	Number of Existing Plants in 1976	Plant Closures[2]	Job Losses[2]	U.S. Production Cutbacks[2]	Price Increases[1]	U.S. Demand Reduction[3]	Balance of Payments Effects
Tungsten (APT)	4	unlikely	unlikely	unlikely	large	unlikely	none
Mercury	4	likely	likely	likely	small	none	likely
Primary Copper Smelting	16	none	unlikely	unlikely	small	negligible	unlikely
Primary Lead Smelting	7	unlikely	unlikely	unlikely	small	unlikely	none
Primary Zinc Smelting	6	unlikely	possibly	possibly	small	possibly	unlikely
Primary Aluminum Smelting	31	none	negligible	negligible	small	negligible	negligible
Primary Antimony Smelting	3	none	unlikely	unlikely	small	unlikely	unlikely
Primary Titanium Smelting	3	none	negligible	negligible	small	negligible	none
Primary Tin Smelting	1	none	none	negligible	slight	negligible	none
Secondary Copper Smelting	80	likely	likely	likely	small	unlikely	probably
Secondary Lead Smelting	82	likely	likely	likely	small	unlikely	none
Secondary Aluminum Smelting	97	likely	likely	likely	small	negligible	none
Iron and Steel	155	none	unlikely	unlikely	small	none	none
Ferroalloys	22	unlikely	possibly	possibly	moderate	possibly	possibly
Ferrous Foundries	1,760	none	none	none	slight	none	none

*This analysis is only concerned with impacts resulting from regulations on the smelting and refining segments of the industry. Significant impacts may be felt by these segments as a result of regulation on other segments of the industry. Specifically, the mining and milling segments may be severely impacted by RCRA regulation and this may affect the smelting and refining segments significantly (e.g., lead and zinc).

1. Except for tungsten and mercury, we are analyzing the selling price of the metal after processing. It should be noted that regulatory costs may represent a much larger fraction of the segment production costs than metal selling price.
2. These impacts were analyzed based on the relation between regulatory cost and segment (e.g., smelting) production costs: in many cases this is significantly different from metal selling price.
3. Taking into account price change and demand elasticity.

Source: Arthur D. Little, Inc., estimates.

TABLE VIII-95

OPTION C
METALS SMELTING & REFINING

ESTIMATED INCREMENTAL ANNUAL COST OF HAZARDOUS WASTE MANAGEMENT ACTIVITIES
(The cost of going from Level I to Pathways Level III)

Industry Segments	Estimated 1977 Production Value	1977 Incremental Annual Cost					Incremental Hazardous Waste Management Cost as a Percent of Production Value*
		Generation	Transportation	HW Treatment, Storage & Disposal	Total	Range	
	$MM	$MM	$MM	$MM	$MM	%	%
Nonferrous Metals							
Tungsten (APT)	18.0	0.001	0.000	0.966	0.967	-4, +10	5.4
Mercury	4.6	0.001	0.000	0.289	0.290	-13, +35	6.3
Primary Copper Smelting	2500.0	0.012	0.000	1.885	1.897	-15, +38	0.1
Primary Lead Smelting	361.0	0.003	0.000	0.615	0.618	-17, +43	0.2
Primary Zinc Smelting	313.0	0.002	0.000	1.184	1.186	-7, +18	0.4
Primary Aluminum Smelting	4600.0	0.023	0.000	4.073	4.096	-16, +41	0.1
Primary Antimony Smelting	48.0	0.001	0.000	0.089	0.090	-24, +57	0.2
Primary Titanium Smelting	263.0	0.001	0.000	0.126	0.127	-18, +47	0.05
Primary Tin Smelting	50.0	0.000	0.000	0.013	0.013	0.0, +8	0.03
Secondary Copper Smelting	450.0	0.045	0.000	6.358	6.403	-24, +61	1.4
Secondary Lead Smelting	430.0	0.047	0.000	6.446	6.493	-24, +62	1.5
Secondary Aluminum Smelting	1600.0	0.050	0.000	10.595	10.645	-17, +44	0.7
Ferrous Metals							
Iron & Steel	35,000.0	0.130	0.002	85.967	86.099	-4, +10	0.2
Ferroalloys	400.0	0.008	0.000	3.923	3.931	-7, +17	1.0
Ferrous Foundries	6500.0	0.111	0.000	0.000	0.111	0.0, 0.0	0.002

*Percent impact is defined as the ratio of *compliance cost to metal selling* price (except in tungsten and mercury). It should be noted that in many cases, production costs for the smelting and refining segments are significantly less than the metal selling price.

Source: Arthur D. Little, Inc. estimates

TABLE VIII-96

OPTION C
ECONOMIC IMPACT ON METALS SMELTING AND REFINING*

Industry Segments	Number of Existing Plants in 1976	Plant Closures[2]	Job Losses[2]	U.S. Production Cutbacks[2]	Price Increases[1]	U.S. Demand Reduction[3]	Balance of Payments Effects
Tungsten (APT)	4	unlikely	unlikely	unlikely	large	unlikely	none
Mercury	4	likely	likely	likely	small	none	likely
Primary Copper Smelting	16	none	negligible	negligible	small	negligible	none
Primary Lead Smelting	7	none	negligible	negligible	small	negligible	none
Primary Zinc Smelting	6	none	negligible	negligible	small	unlikely	unlikely
Primary Aluminum Smelting	31	none	negligible	negligible	slight	negligible	none
Primary Antimony Smelting	3	none	negligible	negligible	small	negligible	unlikely
Primary Titanium Smelting	3	none	none	none	slight	none	none
Primary Tin Smelting	1	none	none	none	none	none	none
Secondary Copper Smelting	80	likely	likely	likely	small	unlikely	possibly
Secondary Lead Smelting	82	likely	likely	likely	small	unlikely	none
Secondary Aluminum Smelting	97	probably	probably	probably	small	negligible	none
Iron and Steel	155	none	unlikely	unlikely	small	none	none
Ferroalloys	22	none	unlikely	unlikely	small	unlikely	unlikely
Ferrous Foundries	1,760	none	none	none	slight	none	none

*This analysis is only concerned with impacts resulting from regulations on the smelting and refining segments of the industry. Significant impacts may be felt by these segments as a result of regulation on other segments of the industry. Specifically, the mining and milling segments may be severely impacted by RCRA regulation and this may affect the smelting and refining segments significantly, (e.g., lead and zinc).

1. Except for tungsten and mercury, we are analyzing the selling price of the metal after processing. It should be noted that regulatory costs may represent a much larger fraction of the segment production costs than metal selling price.
2. These impacts were analyzed based on the relation between regulatory cost and segment (e.g., smelting) production costs: in many cases this is significantly different from metal selling price.
3. Taking into account price change and demand elasticity.

Source: Arthur D. Little, Inc., estimates.

N. ELECTROPLATING AND METAL FINISHING

1. Characterization of Electroplating and Metal Finishing

a. *Industry Description*

This industry is characterized by three major activities. Metal finishing job shops are often fairly small operations averaging fewer than 10 production employees and selling less than $500,000 worth of products annually. Independent manufacturers of printed wiring boards are also small businesses. Typically, these firms have some 30 production employees and cluster in areas noted for electronic goods manufacture. Captive metal finishing plants are in-house operations found in many durable goods manufacturing establishments. Although the parent company may have several hundred to thousands of employees, the captive metal finishing operation itself is quite comparable in size to a job shop and generally employs some 20 persons.

The whole industry employs about 100,000 persons and shipped products in 1977 valued at approximately $1.7 billion.

b. *Segmentation*

For purposes of assessing economic impact, the electroplating and metal finishing industry was analyzed as a single entity.

c. *Structure*

The four-firm concentration ratio for electroplating and metal finishing is a very low 5% because there are a large number of small producers in this business (Table VIII-97).

d. *Supply and Demand*

The growth in unit demand for electroplating and metal finishing is expected to be 4% per year (Table VIII-97). Although there is relatively little product substitution, there are so many producers that the industry is highly competitive. Thus, in many of the larger cities, the demand curve facing any individual producer is highly elastic because the customer can easily switch to an alternative supplier. Import competition is low and operating rates, though difficult to determine precisely, are probably at reasonable levels because capital requirements for entering the business are low.

e. *Profitability*

Industry profitability has been mixed, with the after-tax return on sales inching upward from a very low level between 1972 and 1976, while the after-tax return on net worth fluctuated around a flat trend line (Table VIII-98).

f. *Capital Investment*

New capital expenditures increased from 1972 to 1976 but at a lesser rate than the value of shipments (Table VIII-98).

TABLE VIII-97

CHARACTERIZATION OF ELECTROPLATING AND METAL FINISHING

Industry Segment	1976 Production 1,000's Metric Tons	Number of Producers	Number of Plants	Four-Firm Concentration Ratio	Unit Demand Growth %/Year 1976-81	Price Elasticity of Demand	Product Substitution	Import Competition	Capacity Utilization %
Electroplating and Metal Finishing (SIC 3471)	NA	5,000	5,000	5	4	moderate	moderate	low	NA

Source: Arthur D. Little, Inc., estimates based on *Economic Analysis of Proposed Pretreatment Standards for Existing Sources of the Electroplating Point Source Category* prepared by Booz Allen and Hamilton for the U.S. Environmental Protection Agency, Office of Planning and Evaluation, Economic Analysis Division.

TABLE VIII-98

FINANCIAL PROFILE OF ELECTROPLATING AND METAL FINISHING

Electroplating & Metal Finishing (SIC 3471)	**1976**	**1975**	**1974**	**1973**	**1972**
Profitability[1]					
Net Income After Taxes/Sales (%)	3.0	2.6	2.8	2.5	2.0
Net Income After Taxes/Net Worth (%)	11	8	14	11	8
Revenues[2]					
Value of Shipments (MM$)	1,610	1,319	1,333	1,264	1,040
Value Added/Shipments (%)	68	65	71	70	72
New Capital Expenditures	589	518	470	487	447

Sources: 1. Arthur D. Little, Inc. Estimates based on Robert Morris Associates, *Annual Statement Studies*
2. U.S. Department of Commerce, *Census of Manufacturers* 1972, *Annual Survey of Manufacturers* 1973-1976

2. Economic Impact on Electroplating and Metal Finishing

a. Cost of Compliance and Economic Impact of Option B

The estimated incremental annual cost of compliance under regulatory Option B to go from Level I to Pathways Level III is shown in Table VIII-99. The hazardous waste treatment, storage and disposal activities associated with 3004 and 3005 constitute the largest component of these costs. The cost of compliance as a percent of production value for the electroplating and metal finishing industry is 3.6%. The range of error is from −25% to +59%.

Under this regulatory option, plant closures are considered probable for the electroplating and metal finishing industry (Table VIII-100). This means there is a probability of between 50% and 75% that more than 0.5% of the industry would be adversely affected if Option B is proposed. We expect these negative impacts because moderate price increases will be necessary to overcome the cost of Option B for the electroplating and metal finishing industry. Significant competition and high product substitution coupled with the low profitability of the industry are expected to make it difficult for all producers to absorb the added cost of Option B.

b. Cost of Compliance and Economic Impact of Option A

The estimated incremental annual cost of compliance under regulatory Option A to go from Level I to Pathways Level III is shown in Table VIII-101. The cost of compliance as a percent of production value for the electroplating and metal finishing industry is 13.8%. The range of error is −41% to +58%.

Under this regulatory option, job losses and production cutbacks are considered likely for this industry (Table VIII-102). This means that the probability is at least 75% that more than 0.5% of the industry would be adversely affected if Option A is proposed. Under Option A, large price increases would be required by an industry with heavy competition, high product substitution, and relatively low profitability. It seems highly unlikely that the whole industry could absorb the cost of Option A without adverse consequences.

c. Cost of Compliance and Economic Impact of Option C

The estimated incremental annual cost of compliance under regulatory Option C to go from Level I to Pathways Level III is shown in Table VIII-103. The cost of compliance as a percent of production value for the electroplating and metal finishing industry is 2.8%. The range of error is from −25% to +63%.

Under this regulatory option, job losses and production cutbacks are considered probable for the industry (Table VIII-104).

O. SPECIAL MACHINERY MANUFACTURING

1. Characterization of Special Machinery Manufacturing

a. Industry Description

The special machinery manufacturing industry group includes special industry machinery (SIC 355) and office, computing and accounting machines (SIC 357). Special industry machinery

TABLE VIII-99

OPTION B
ELECTROPLATING AND METAL FINISHING

ESTIMATED INCREMENTAL ANNUAL COST OF HAZARDOUS WASTE MANAGEMENT ACTIVITIES
(The cost of going from Level I to Pathways Level III)

Industry Segment	Estimated 1977 Production Value	1977 Incremental Annual Cost					Incremental Hazardous Waste Management Cost as a Percent of Production Value
		Generation	Transportation	HW Treatment, Storage & Disposal	Total	Range	
	$MM	$MM	$MM	$MM	$MM	%	%
Electroplating & Metal Finishing	1700.0	2.759	0.159	57.442	60.360	-25, +59	3.6

Source: Arthur D. Little, Inc. estimates

TABLE VIII-100

OPTION B
ECONOMIC IMPACT ON ELECTROPLATING AND METAL FINISHING

Industry Segment	Number of Existing Plants in 1976	Plant Closures	Job Losses	U.S. Production Cutbacks	Price Increases	U.S. Demand Reduction	Balance of Payments Effects
Electroplating and Metal Finishing	5,000	probably	likely	likely	moderate	likely	none

Source: Arthur D. Little, Inc., estimates.

TABLE VIII-101

OPTION A
ELECTROPLATING & METAL FINISHING

ESTIMATED INCREMENTAL ANNUAL COST OF HAZARDOUS WASTE MANAGEMENT ACTIVITIES
(The cost of going from Level I to Pathways Level III)

Industry Segment	Estimated 1977 Production Value	1977 Incremental Annual Cost					Incremental Hazardous Waste Management Cost as a Percent of Production Value
		Generation	Transportation	HW Treatment, Storage & Disposal	Total	Range	
	$MM	$MM	$MM	$MM	$MM	%	%
Electroplating & Metal Finishing	1700.0	6.418	0.153	227.222	233.793	-41, +58	13.8

Source: Arthur D. Little, Inc. estimates

TABLE VIII-102

OPTION A
ECONOMIC IMPACT ON ELECTROPLATING AND METAL FINISHING

Industry Segment	Number of Existing Plants in 1976	Plant Closures	Job Losses	U.S. Production Cutbacks	Price Increases	U.S. Demand Reduction	Balance of Payments Effects
Electroplating and Metal Finishing	5,000	likely	likely	likely	large	likely	negligible

Source: Arthur D. Little, Inc., estimates.

TABLE VIII-103

OPTION C
ELECTROPLATING & METAL FINISHING

ESTIMATED INCREMENTAL ANNUAL COST OF HAZARDOUS WASTE MANAGEMENT ACTIVITIES
(The cost of going from Level I to Pathways Level III)

Industry Segment	Estimated 1977 Production Value	1977 Incremental Annual Cost					Incremental Hazardous Waste Management Cost as a Percent of Production Value
		Generation	Transportation	HW Treatment, Storage & Disposal	Total	Range	
	$MM	$MM	$MM	$MM	$MM	%	%
Electroplating & Metal Finishing	1700.0	1.781	0.006	46.480	48.267	-25, +63	2.8

Source: Arthur D. Little, Inc. estimates

TABLE VIII-104

OPTION C
ECONOMIC IMPACT ON ELECTROPLATING AND METAL FINISHING

Industry Segment	Number of Existing Plants in 1976	Plant Closures	Job Losses	U.S. Production Cutbacks	Price Increases	U.S. Demand Reduction	Balance of Payments Effects
Electroplating and Metal Finishing	5,000	possibly	probably	probably	small	probably	none

Source: Arthur D. Little, Inc., estimates.

plants are concentrated in the major manufacturing areas of the country and employ approximately 190,000. The office, computing and accounting machines segment is changing rapidly due to innovations in production technologies and electronic applications. This segment employs about 175,000 people.

b. Segmentation

The two segments of the special machinery manufacturing industry are analyzed separately in this report.

c. Structure

The office, computing and accounting machines segment has approximately 1,000 plants and a moderately high concentration ratio; in contrast, to the special machinery industry segment has 4,000 plants and a low concentration ratio (Table VIII-105).

d. Supply and Demand

The price elasticity of demand for office, computing and accounting machines is moderate, due to a moderate degree of product substitution coupled with import competition that varies from moderate to high, depending on the product. The situation is similar for special industry machinery, except that some product groups face negligible import competition and product substitution. The expected annual growth in demand through 1981 runs from 5% to 9% depending on the product. No supply constraints are anticipated in the near term.

e. Profitability

Since 1972, the profitability for these two segments of special machinery manufacturing has fluctuated with the state of the economy while generally trending upward. As of 1976, the median after-tax profit on sales was about 4.5% for each of the segments while the median profitability on net worth was roughly 11.5% for both segments (Table VIII-106).

f. Capital Investment

New capital expenditures for the office, computing and accounting machines segment increased 67% between 1972 and 1976. Over the same period, in the special industry machinery segment, new capital expenditures increased 34% (Table VIII-106).

2. Economic Impact on Special Machinery Manufacturing

a. Cost of Compliance and Economic Impact of Option B

The estimated incremental annual cost of compliance under regulatory Option B to go from Level I to Pathways Level III is shown in Table VIII-107. The cost of compliance as a percent of production value for the special machinery manufacturing industry segment is 0.4% and for the office, computing and accounting machine segment, 0.1%. The range of error is −23% to +55%.

Under this regulatory option, plant closures and other adverse economic impacts are not expected (Table VIII-108). Job losses in the special machinery segment are possible.

TABLE VIII-105

CHARACTERIZATION OF SPECIAL MACHINERY MANUFACTURING

Industry Segments	1976 Production 1,000's Metric Tons	Number of Producers	Number of Plants	Four-Firm Concentration Ratio	Unit Demand Growth %/Year 1976-81	Price Elasticity of Demand	Product Substitution	Import Competition	Capacity Utilization %
Office, Computing and Accounting Machines (SIC 357)	NA	700	1000[a]	61[a]	5-8	moderate	moderate	moderate[b] to high	80[a]
Special Industry Machinery (SIC 355)	NA	3,250	4000[a]	33[a]	5-9	low to[b] moderate	low to[b] moderate	negligible to high	80[a]

[a]Arthur D. Little, Inc., estimates.

[b]Depending on product.

Source: "Economic Impact Analysis of Hazardous Waste Management Regulations on the Batteries, Electronics, & Special Machinery Industries." Kearney Management Consultants, February 1978.

TABLE VIII-106

FINANCIAL PROFILE OF SPECIAL MACHINERY MANUFACTURING

Office Computing, and Accounting Machines (SIC 357)		**1976**	**1975**	**1974**	**1973**	**1972**
Profitability[1]						
Net Income After Taxes/Sales (%)	upper quartile	8.2	7.3	6.7	7.4	NA for 1972
	median	4.4	3.7	3.7	4.3	
	lower quartile	0.8	.6	1.4	1.6	
Net Income After Taxes/Net Worth (%)	upper quartile	17.1	15.5	17.6	16.0	
	median	11.6	9.5	11.9	10.7	
	lower quartile	3.0	2.5	3.9	2.6	
Revenues[2]						
Value of Shipments (MM$)		13,722.8	11,528.0	12,178.8	10,053.9	8,604.9
Value Added/Shipments (%)		59.0	55.9	58.6	59.0	57.0
New Capital Expenditures (MM$)		480.3	389.5	377.9	281.7	287.0
Special Industry Machinery (SIC 355)						
Profitability[1]						
Net Income After Taxes/Sales (%)	upper quartile	6.6	6.8	6.1	5.4	5.3
	median	4.6	3.8	3.5	3.7	3.0
	lower quartile	2.3	1.7	1.8	1.8	1.0
Net Income After Taxes/Net Worth (%)	upper quartile	18.9	15.7	18.6	13.7	13.9
	median	11.4	11.2	10.0	9.9	7.0
	lower quartile	5.6	5.1	4.0	4.4	1.7
Revenues[2]						
Value of Shipments (MM$)		9,453.5	8,891.3	8,561.7	7,297.6	6,207.2
Value Added/Shipments (%)		54.7	54.8	59.2	59.9	79.0
New Capital Expenditures (MM$)		214.9	199.5	263.7	202.9	160.0

Sources: 1. Dun and Bradstreet, Ratios of Manufacturing
2. Annual Survey of Manufactures

TABLE VIII-107

OPTION B
SPECIAL MACHINERY MANUFACTURING

ESTIMATED INCREMENTAL ANNUAL COST OF HAZARDOUS WASTE MANAGEMENT ACTIVITIES
(The cost of going from Level I to Pathways Level III)

Industry Segments	Estimated 1977 Production Value	1977 Incremental Annual Cost: Generation	Transportation	HW Treatment, Storage & Disposal	Total	Range	Incremental Hazardous Waste Management Cost as a Percent of Production Value
	$MM	$MM	$MM	$MM	$MM	%	%
Special Industry Machinery	10,000.0	4.233	0.016	36.221	40.470	-23, +55	0.4
Office, Computing & Accounting Machines	15,000.0	1.066	0.003	9.139	10.208	-23, +55	0.1

Source: Arthur D. Little, Inc. estimates

TABLE VIII-108

OPTION B
ECONOMIC IMPACT ON SPECIAL MACHINERY MANUFACTURING

Industry Segments	Number of Existing Plants in 1976	Plant Closures	Job Losses	U.S. Production Cutbacks	Price Increases	U.S. Demand Reduction	Balance of Payments Effects
Special Industry Machinery	4,000	negligible	unlikely	unlikely	small	negligible	negligible
Office, Computing and Accounting Machines	1,000	none	none	none	slight	none	none

Source: Arthur D. Little, Inc., estimates.

b. *Cost of Compliance and Economic Impact of Option A*

The estimated incremental annual cost of compliance under regulatory Option A to go from Level I to Pathways Level III is shown in Table VIII-109. The cost of compliance as a percent of production value for the special machinery segment is 1.7% and for the office, computing and accounting machine segment, 0.3%. The range of error is from −40% to +56%.

Under this regulatory option, plant closures are not expected (Table VIII-110). Job losses in the special machinery segment are possible.

c. *Cost of Compliance and Economic Impact of Option C*

The estimated incremental annual cost of compliance under regulatory Option C to go from Level I to Pathways Level III is shown in Table VIII-111. The cost of compliance as a percent of production value for the special machinery segment is 0.2% and for the office, computing and accounting machines segment it is 0.04%. The range of error is from −23% to +59%.

Under this regulatory option, plant closures and other adverse economic impacts are not expected to take place (Table VIII-112).

P. ELECTRONIC COMPONENTS

1. Characterization of Electronic Components

a. *Industry Description*

The electronic components industry encompasses the manufacture of six different components which are used in a variety of final products including radios, computers, and navigation systems. The structure of this industry is complicated by the frequency of technological innovation, the variety of product markets, the volatility of demand, and the interrelationships between component markets. The major components manufactured in this industry are electron tubes, semiconductors, capacitors, resistors, inductors, and integrated circuit packages.

b. *Segmentation*

For purposes of this project, the electronic components industry has been analyzed as a single entity.

c. *Structure*

There are approximately 3,000 plants in the electronic components industry. The four-firm concentration ratio varies considerably among products but the average is about 45% (Table VIII-113).

d. *Supply and Demand*

The growth in demand is expected to be 6% to 7% per year in real terms for the electronics components industry through 1981. The price elasticity varies from low to moderate, because

TABLE VIII-109

OPTION A
SPECIAL MACHINERY MANUFACTURING

ESTIMATED INCREMENTAL ANNUAL COST OF HAZARDOUS WASTE MANAGEMENT ACTIVITIES
(The cost of going from Level I to Pathways Level III)

Industry Segments	Estimated 1977 Production Value	1977 Incremental Annual Cost					Incremental Hazardous Waste Management Cost as a Percent of Production Value
		Generation	Transportation	HW Treatment, Storage & Disposal	Total	Range	
	$MM	$MM	$MM	$MM	$MM	%	%
Special Industry Machinery	10,000.0	10.092	0.016	155.262	165.370	–40, +56	1.7
Office, Computing & Accounting Machines	15,000.0	2.542	0.003	39.033	41.578	–40, +56	0.3

Source: Arthur D. Little, Inc. estimates

TABLE VIII-110

OPTION A
ECONOMIC IMPACT ON SPECIAL MACHINERY MANUFACTURING

Industry Segments	Number of Existing Plants in 1976	Plant Closures	Job Losses	U.S. Production Cutbacks	Price Increases	U.S. Demand Reduction	Balance of Payments Effects
Special Industry Machinery	4,000	unlikely	possibly	possibly	small	unlikely	possibly
Office, Computing and Accounting Machines	1,000	none	negligible	negligible	small	negligible	negligible

Source: Arthur D. Little, Inc., estimates.

TABLE VIII-111

OPTION C
SPECIAL MACHINERY MANUFACTURING

ESTIMATED INCREMENTAL ANNUAL COST OF HAZARDOUS WASTE MANAGEMENT ACTIVITIES
(The cost of going from Level I to Patheays Level III)

Industry Segments	Estimated 1977 Production Value	1977 Incremental Annual Cost					Incremental Hazardous Waste Management Cost as a Percent of Production Value
		Generation	Transportation	HW Treatment, Storage & Disposal	Total	Range	
	$MM	$MM	$MM	$MM	$MM	%	%
Special Industry Machinery	7500.0	1.481	0.000	15.768	17.249	-23, +59	0.2
Office, Computing & Accounting Machines	13,800.0	0.521	0.000	5.708	6.229	-23, +59	0.04

Source: Arthur D. Little, Inc. estimates

TABLE VIII-112

OPTION C
ECONOMIC IMPACT ON SPECIAL MACHINERY MANUFACTURING

Industry Segments	Number of Existing Plants in 1976	Plant Closures	Job Losses	U.S. Production Cutbacks	Price Increases	U.S. Demand Reduction	Balance of Payments Effects
Special Industry Machinery	4,000	none	negligible	negligible	slight	none	none
Office, Computing and Accounting Machines	1,000	none	none	none	none	none	none

Source: Arthur D. Little, Inc., estimates.

TABLE VIII-113

CHARACTERIZATION OF ELECTRONIC COMPONENTS

Industry Segment	1976 Production 1,000's Metric Tons	Number of Producers	Number of Plants	Four-Firm Concentration Ratio	Unit Demand Growth %/Year 1976-81	Price Elasticity of Demand	Product Substitution	Import Competition	Capacity Utilization %
Electronic Components (SIC 367)	NA	2,500	3,000[a]	45[a]	6-7	low[b] to moderate	low[b] to moderate	low	80[a]

[a]Arthur D. Little, Inc., estimates.

[b]Depending on product.

Source: "Economic Impact Analysis of Hazardous Waste Management Regulations on the Batteries, Electronics & Special Machinery Industries." Kearney Management Consultants, February 1978.

import competition is low and product substitution varies according to the product being evaluated. No capacity constraints are anticipated over the forecast period.

e. *Profitability*

The profitability of the electronic components industry reflects the general state of the economy in addition to the industry's shifting product mix and volatile demand. The median firm in the industry earned almost 5% on sales and just over 12% on net worth in 1976 (Table VIII-114).

f. *Capital Investment*

New capital expenditures in the electronic components industry grew rapidly between 1972 and 1974, and after a substantial drop in 1975, had yet to recover fully the 1974 high by 1976 (Table VIII-114).

2. Economic Impact on Electronic Components

a. *Cost of Compliance and Economic Impact of Option B*

The estimated incremental annual cost of compliance under regulatory Option B to go from Level I to Pathways Level III is shown in Table VIII-115. The cost of compliance as a percent of production value for the electronic components industry is 0.3%. The range of error is from −26% to +57%.

Under this regulatory option, plant closures and other adverse impacts are not expected (Table VIII-116).

b. *Cost of Compliance and Economic Impact of Option A*

The estimated incremental annual cost of compliance under regulatory Option A to go from Level I to Pathways Level III is shown in Table VIII-117. The cost of compliance as a percent of production value for the electronic components industry is 1.1%. The range of error is −40% to +57%.

Under this regulatory option, plant closures and other adverse economic impacts are not expected (Table VIII-118).

c. *Cost of Compliance and Economic Impact of Option C*

The estimated incremental annual cost of compliance under regulatory Option C to go from Level I to Pathways Level III is shown in Table VIII-119. The cost of compliance as a percent of production value for the electronic components industry is 0.2%. The range of error is −25% to +58%.

Under this regulatory option, plant closures and adverse economic impacts are not expected (Table VIII-120).

TABLE VIII-114

FINANCIAL PROFILE OF ELECTRONIC COMPONENTS

Electronic Components (SIC 367)		**1976**	**1975**	**1974**	**1973**	**1972**
Profitability[1]						
Net Income After Taxes/Sales (%)	upper quartile	8.1	6.0	9.6	7.0	5.3
	median	4.8	3.5	4.0	4.1	3.4
	lower quartile	2.8	0.6	2.2	1.8	1.0
Net Income After Taxes/Net Worth (%)	upper quartile	21.6	16.7	19.6	20.5	15.4
	median	12.4	9.9	14.3	14.3	8.9
	lower quartile	5.4	1.3	6.9	7.0	3.7
Revenues[2]						
Value of Shipments (MM$)		12,432.7	10,089.0	11,300.9	10,782.9	8,836.6
Value Added/Shipments (%)		60.9	59.3	61.6	61.2	60.1
New Capital Expenditures (MM$)		650.5	536.2	785.3	628.8	343.8

Sources: 1. Dun and Bradstreet, *Ratios of Manufacturing,* 1973-1976.
2. *Annual Survey of Manufacturers,* 1973-1976.

TABLE VIII-115

OPTION B
ELECTRONIC COMPONENTS

ESTIMATED INCREMENTAL ANNUAL COST OF HAZARDOUS WASTE MANAGEMENT ACTIVITIES
(The cost of going from Level I to Pathways Level III)

Industry Segment	Estimated 1977 Production Value	1977 Incremental Annual Cost					Incremental Hazardous Waste Management Cost as a Percent of Production Value
		Generation	Transportation	HW Treatment, Storage & Disposal	Total	Range	
	$MM	$MM	$MM	$MM	$MM	%	%
Electronic Components	15,000.0	3.257	0.012	40.492	43.761	-26, +57	0.3

Source: Arthur D. Little, Inc. estimates

TABLE VIII-116

OPTION B
ECONOMIC IMPACT ON ELECTRONIC COMPONENTS

Industry Segment	Number of Existing Plants in 1976	Plant Closures	Job Losses	U.S. Production Cutbacks	Price Increases	U.S. Demand Reduction	Balance of Payments Effects
Electronic Components	3,000	none	none	none	small	none	none

Source: Arthur D. Little, Inc., estimates.

TABLE VIII-117

OPTION A
ELECTRONIC COMPONENTS

ESTIMATED INCREMENTAL ANNUAL COST OF HAZARDOUS WASTE MANAGEMENT ACTIVITIES
(The cost of going from Level I to Pathways Level III)

Industry Segment	Estimated 1977 Production Value	1977 Incremental Annual Cost					Incremental Hazardous Waste Management Cost as a Percent of Production Value
		Generation	Transportation	HW Treatment, Storage & Disposal	Total	Range	
	$MM	$MM	$MM	$MM	$MM	%	%
Electronic Components	15,000.0	8.424	0.012	157.102	165.538	-40, +57	1.1

Source: Arthur D. Little, Inc. estimates

TABLE VIII-118

OPTION A
ECONOMIC IMPACT ON ELECTRONIC COMPONENTS

Industry Segment	Number of Existing Plants in 1976	Plant Closures	Job Losses	U.S. Production Cutbacks	Price Increases	U.S. Demand Reduction	Balance of Payments Effects
Electronic Components	3,000	none	negligible	negligible	small	negligible	none

Source: Arthur D. Little, Inc., estimates.

TABLE VIII-119

OPTION C
ELECTRONIC COMPONENTS

ESTIMATED INCREMENTAL ANNUAL COST OF HAZARDOUS WASTE MANAGEMENT ACTIVITIES
(The cost of going from Level I to Pathways Level III)

Industry Segment	Estimated 1977 Production Value	1977 Incremental Annual Cost					Incremental Hazardous Waste Management Cost as a Percent of Production Value
		Generation	Transportation	HW Treatment, Storage & Disposal	Total	Range	
	$MM	$MM	$MM	$MM	$MM	%	%
Electronic Components	15,000.0	1.367	0.000	23.994	25.361	-25, +58	0.2

Source: Arthur D. Little, Inc. estimates

TABLE VIII-120

OPTION C
ECONOMIC IMPACT ON ELECTRONIC COMPONENTS

Industry Segment	Number of Existing Plants in 1976	Plant Closures	Job Losses	U.S. Production Cutbacks	Price Increases	U.S. Demand Reduction	Balance of Payments Effects
Electronic Components	3,000	none	none	none	small	none	none

Source: Arthur D. Little, Inc., estimates.

Q. BATTERY INDUSTRY

1. Characterization of the Battery Industry

a. Industry Description

The battery industry consists of 125 firms which operate about 250 manufacturing plants. However, the industry is dominated by 10 major companies. Although there are many small, independent battery plants, close to 90% of the value of shipments comes from plants employing 100 or more persons. The battery industry also includes the captive plants of major original equipment manufacturers.

b. Segmentation

The battery industry is segmented according to the major battery types: (1) storage (secondary) batteries; and, (2) primary batteries. The two main types of storage batteries are lead-acid (typified by the SLI automotive battery) and nickel cadmium. The two principal primary battery types are carbon-zinc and alkaline-manganese, used primarily in flashlights and radios.

c. Structure

There are approximately 230 storage battery plants, 200 of which are the lead-acid battery type (Table VIII-121). The concentration ratio is 57% for storage batteries and 92% for primary batteries. Product substitution is low for both segments, whereas import competition is low to moderate for primary batteries and low for storage batteries. As a result, the price elasticity of demand tends to be lower for storage batteries than for primary batteries.

d. Supply and Demand

A 3% increase in unit demand through 1981 is expected in the storage battery segment, and a 2.3% per year increase is expected in the primary battery segment. Both these segments are operating at about 80% of capacity, so there appears to be adequate supply over the foreseeable future.

e. Profitability

The 10 major battery manufacturing firms are estimated to have an average after-tax profit of about 4.6% of sales. The smaller companies have more difficulty in maintaining profitability when faced with the capital costs of the new equipment needed to remain competitive as well as the costs of meeting government regulations. In recent years, many of these small firms have abandoned less-profitable manufacturing operations in order to distribute batteries purchased from the major firms (Table VIII-122).

f. Capital Investments

New capital expenditures increased steadily for both segments in the 1972 to 1976 period (Table VIII-122). Capital expenditures per sales dollar are greater for storage batteries than for primary batteries.

TABLE VIII-121

CHARACTERIZATION OF BATTERIES

Industry Segments	Production* 1,000's Metric Tons	Number Number of Producers	Number of Plants	Four-Firm Concentration Ratio	Unit Demand Growth %/Year to 1981	Price Elasticity of Demand	Product Substitution	Import Competition	Capacity* Utilization %
Storage Batteries (SIC 3691)	1,650	110	230*	57%	3.0	low	low	low	80
Primary Batteries (SIC 3692)	60	15	20*	92%	2.3	low-moderate	low	low-moderate	80

*Arthur D. Little, Inc., estimates.

Source: "Economic Impact Analysis of Hazardous Waste Management Regulations on the Batteries, Electronics and Special Machinery Industries," Kearney Management Consultants, February 1978.

TABLE VIII-122

FINANCIAL PROFILE OF BATTERIES

Storage Batteries (SIC 3691)	**1976**	**1975**	**1974**	**1973**	**1972**
Profitabilitv					
Net Income After Taxes/Sales (%)		4.6%*	relatively	unchanged	
Revenues					
Value of Shipments (MM$)	1,519.0	1,302.3	1,234.2	1,070.8	971.3
Value Added/Shipments (%)	47.6	44.4	49.9	50.0	49.3
New Capital Expenditures (MM$)	86.2	77.1	60.2	39.4	30.8
Primary Batteries (SIC 3692)					
Profitability					
Net Income After Taxes/Sales (%)		4.6%*	relatively	unchanged	
Revenues					
Value of Shipments (MM$)	627.1	437.7	423.3	380.7	348.1
Value Added/Shipments (%)	57.5	59.7	57.5	61.0	63.6
New Capital Expenditures (MM$)	24.8	15.4	13.2	7.9	7.2

*Industry Average for 10 major battery manufacturers from Kearney report.

Source: U.S. Census of Manufacturers, 1972 and Annual Survey of Manufacturers, 1973-1976.

2. Economic Impact on the Battery Industry

a. Cost of Compliance and Economic Impact of Option B

The estimated incremental annual cost of compliance under regulatory Option B to go from Level I to Pathways Level III is shown in Table VIII-123. The cost of compliance as a percent of production value for the storage battery segment of the battery industry is 0.4% and for the primary battery segment, 0.1%. The range of error is from −26% to +64%.

Under this regulatory option, plant closures and other adverse economic impacts are not expected (Table VIII-124).

b. Cost of Compliance and Economic Impact of Option A

The estimated incremental annual cost of compliance under regulatory Option A to go from Level I to Pathways Level III is shown in Table VIII-125. The cost of compliance as a percent of production value for the storage battery segment of this industry is 1.7% and for the primary batteries, 0.3%. The range of error is from −42% to +60%.

Under this regulatory option, plant closures and other adverse economic impacts are not expected (Table VIII-126).

c. Cost of Compliance and Economic Impact of Option C

The estimated incremental annual cost of compliance under regulatory Option C to go from Level I to Pathways Level III is shown in Table VIII-127. The cost of compliance as a percent of production value for storage batteries is 0.4% and for primary batteries, 0.1%. The range of error is from −25% to +64%.

Under this regulatory option, plant closures and other adverse economic impacts are not expected (Table VIII-128).

TABLE VIII-123

OPTION B
BATTERIES

ESTIMATED INCREMENTAL ANNUAL COST OF HAZARDOUS WASTE MANAGEMENT ACTIVITIES
(The cost of going from Level I to Pathways Level III)

Industry Segments	Estimated 1977 Production Value	1977 Incremental Annual Cost					Incremental Hazardous Waste Management Cost as a Percent of Production Value
		Generation	Transportation	HW Treatment, Storage & Disposal	Total	Range	
	$MM	$MM	$MM	$MM	$MM	%	%
Storage Batteries	2000.0	0.208	0.031	8.259	8.498	-26, +64	0.4
Primary Batteries	700.0	0.014	0.000	0.536	0.550	-26, +61	0.1

Source: Arthur D. Little, Inc. estimates

TABLE VIII-124

OPTION B
ECONOMIC IMPACT ON BATTERIES

Industry Segments	Number of Existing Plants in 1976	Plant Closures	Job Losses	U.S. Production Cutbacks	Price Increases	U.S. Demand Reduction	Balance of Payments Effects
Storage Batteries	230	negligible	negligible	none	small	none	none
Primary Batteries	20	none	none	none	slight	none	none

Source: Arthur D. Little, Inc., estimates.

TABLE VIII-125

OPTION A
BATTERIES

ESTIMATED INCREMENTAL ANNUAL COST OF HAZARDOUS WASTE MANAGEMENT ACTIVITIES
(The cost of going from Level I to Pathways Level III)

Industry Segments	Estimated 1977 Production Value	1977 Incremental Annual Cost					Incremental Hazardous Waste Management Cost as a Percent of Production Value
		Generation	Transportation	HW Treatment, Storage & Disposal	Total	Range	
	$MM	$MM	$MM	$MM	$MM	%	%
Storage Batteries	2000.0	0.387	0.031	33.163	33.581	–42, +60	1.7
Primary Batteries	700.0	0.027	0.000	2.301	2.328	–42, +59	0.3

Source: Arthur D. Little, Inc. estimates

TABLE VIII-126

OPTION A
ECONOMIC IMPACT ON BATTERIES

Industry Segments	Number of Existing Plants in 1976	Plant Closures	Job Losses	U.S. Production Cutbacks	Price Increases	U.S. Demand Reduction	Balance of Payments Effects
Storage Batteries	230	unlikely	unlikely	negligible	small	negligible	none
Primary Batteries	20	none	none	none	small	none	none

Source: Arthur D. Little, Inc., estimates.

TABLE VIII-127

OPTION C
BATTERIES

ESTIMATED INCREMENTAL ANNUAL COST OF HAZARDOUS WASTE MANAGEMENT ACTIVITIES
(The cost of going from Level I to Pathways Level III)

Industry Segments	Estimated 1977 Production Value	1977 Incremental Annual Cost					Incremental Hazardous Waste Management Cost as a Percent of Production Value
		Generation	Transportation	HW Treatment, Storage & Disposal	Total	Range	
	$MM	$MM	$MM	$MM	$MM	%	%
Storage Batteries	2000.0	0.157	0.001	7.040	7.198	-24, +61	0.4
Primary Batteries	700.0	0.009	0.000	0.462	0.471	-25, +64	0.1

Source: Arthur D. Little, Inc. estimates

TABLE VIII-128

OPTION C
ECONOMIC IMPACT ON BATTERIES

Industry Segments	**Number of Existing Plants in 1976**	**Plant Closures**	**Job Losses**	**U.S. Production Cutbacks**	**Price Increases**	**U.S. Demand Reduction**	**Balance of Payments Effects**
Storage Batteries	230	negligible	negligible	none	small	none	none
Primary Batteries	20	none	none	none	slight	none	none

Source: Arthur D. Little, Inc., estimates.

IX. CHARACTERIZATION AND IMPACT ON HAZARDOUS WASTE TRANSPORTATION AND HAZARDOUS WASTE MANAGEMENT FACILITIES

A. INTRODUCTION

This chapter contains a description of the types of facilities engaged in the transportation of hazardous waste and a discussion of the economic impact of each of the three RCRA Options upon the cost of transportation. Similarly, it contains a description of firms in the business of hazardous waste management (treatment, storage and/or disposal of hazardous waste) and an analysis of the impact of each of the three RCRA Options upon the price/cost of these TSD services.

The analysis of total cost (Chapter VII) included the costs of compliance for both the transportation and TSD activities. Further, the cost of compliance and economic impact discussed in Chapter VIII includes the impact upon generator industries of higher cost/prices for hazardous waste transportation and treatment, storage and/or disposal.

The analysis of economic impact and cost/price increases includes only the direct impact of the cost of compliance under each RCRA option studied. Potential shortages of TSDF capacity and any associated price increases are excluded from this study.

B. CHARACTERIZATION OF HAZARDOUS WASTE TRANSPORTATION[1]

1. Introduction

The basic role of the transportation sector in the hazardous waste management network is to convey hazardous waste from the point of generation to an off-site waste facility for storage, treatment, resource recovery, and/or disposal. The modes of transportation involved in this activity are: motor truck, rail, barge, air, and pipeline, with truck by far the dominant mode and rail a distant second. The portion of hazardous waste transported by truck has been estimated as over 95%, and hazardous waste quantities transported by air and pipeline are minimal. Therefore this discussion focuses upon truck transportation.

2. Industry Description/Segmentation

Three groups of participants have been identified as transporters[2] of hazardous waste. They are:

- Generator/Transporter — Generators, including industrial, commercial, and governmental organizations, that act as private carriers and self-haul hazardous wastes, invariably by truck, to off-site waste management facilities.

1. The information in this section is based upon *Characterization and Economic Impact Assessment of Hazardous Waste Transportation Regulations*, report to the U.S. Environmental Protection Agency by Arthur D. Little, Inc., August 1978.

2. The transporter is, by definition, the party providing the motive power for the shipment. Thus, a generator of hazardous waste who owns and loads a rail tank car is considered a Generator/Transporter only if that party also operates the locomotive.

- General Transporter — Common and contract carriers that transport hazardous waste from the point of generation to the disposal destination.

- Disposal Processor/Transporter — Operators of hazardous waste management facilities that act as contract or private carriers in transporting hazardous waste from the point of generation to the final waste management destination.

These participants, especially the Generator/Transporter, generally do not view themselves as being part of an industry devoted to hazardous waste transportation, and indeed these transportation activities do not conform to the customary definition of an industry. Rather, they view themselves as being engaged in an activity which is part of a larger set of business activities; they engage in hazardous waste transportation because of convenience or for economic reasons. General transporters are in the business of hauling cargo which is only sometimes hazardous waste. Many of the waste management facilities (Disposal Processor/Transporter) are engaged in waste transportation as a complement to their other waste management activities.

The choice of transport mode depends upon the distance of the waste management facility from the point of generation, the frequency of collection, the environmental setting, the plans for usage of the hazardous waste, and the like. For example, a firm located on or near a waterway may utilize barge transportation. Or firms that have wastes transported more than 50 miles may employ truck or rail services.

The following matrix below indicates the relative amounts of hazardous waste moved by each combination of sector transportation mode.

	Generator/ Transporter	Disposal Processor/ Transporter	General Transporter
Air	None	None	Very Small
Rail	None	None	Moderate
Highway	Small	Large	Large
Waterway	None	None	Small
Pipeline	Very Small	Very Small	None

3. Supply/Demand

The supply and demand elements of this sector are dictated by the quantities and characteristics of the hazardous waste generated. A small firm generating a low volume of hazardous waste is more likely to use its own trucks to transport the wastes off-site. Also, this may be the case when contract transporters refuse to handle small quantities of waste. On the other hand, firms generating high volumes of hazardous waste may require contract transporters to collect the wastes daily, weekly, or as necessary, if they do not transport waste themselves.

Treatment, storage and disposal facilities (TSDF's) sell transportation service as a means of obtaining a hazardous waste to treat or dispose. About 67% to 75% of disposal facilities also provide transportation service. They also typically accept waste transported by generators and transportation companies.

Transportation companies hauling hazardous waste are predominantly trucking companies, except for a few instances of barge transport or rail shipment of battery parts and other miscellaneous wastes.[3] For trucking companies, hazardous waste is but a small portion of their total business and they view the shipment of hazardous waste in the same way as the shipment of hazardous material.

Transportation companies can be contract haulers, in which case the price is a figure mutually agreed upon by the generator or hauler. In some cases, particularly where interstate transport is involved, the transport rate may be a tariff price, particularly for rail (non-bulk, tank car) shipments and possibly also for some truck transport.

Treatment, storage and disposal facilities which provide transportation service often do not break out the transportation charge. Where they do, the range varies widely, from $.075 to $1.00 per ton-mile, and there is no consistency from company to company for price variations. Since TSDF's do not generally keep track of transport costs, the price for transport could be below the average transportation cost per ton-mile under some conditions.

4. Profitability

Pro-forma financial statements, developed from a composite of sources are shown in Table IX-1. Each of the sources was also based upon a composite of companies so there could be a good deal of variability from company to company. However, the pro-forma financial statements were consistent with investment costs and depreciation periods for truck equipment. A trucking company also has other capital assets than trucks, which amount to 16% of fixed assets. General and administrative expenses for this type of company amount to 15% of sales.[4]

In general, the financial risk perceived for a trucking company is less than that for a TSDF of comparable size. Transport companies do not have the long-term liability of TSDF's, do not have their pollution problems, and are more numerous (i.e., there is a greater experience base for the evaluation of financial risk). Also, the assets of truck companies engaged in hazardous waste transport are trailers and tractors which are fungible with those used in the transport of other commodities. In simple terms, this means that if a bank must repossess a truck because of payment default, there is a market for such vehicles so the bank has less at risk if the truck company cannot meet its payment obligations. Trucking companies are generally able to finance equipment purchase. Smaller companies may be required to put up more of a down payment than larger companies (20% versus 10%) in the case of purchased equipment with bank financing.[5] Also, the truck company has the option of leasing the equipment.

To contrast this with the financial characteristics of TSDF's (Section D), the latter can also probably obtain similar financing for truck equipment but not for investments in incineration equipment, pollution control equipment and landfill construction.

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3. Generators own or lease the rail tank cars used for hazardous waste, representing the overwhelming bulk of rail transport.

4. *Motor Carrier Industry Financing*, Regular Common Conference, Washington, D.C. 1968.

5. Ibid.

TABLE IX-1

FINANCIAL PROFILE FOR TRANSPORTERS OF HAZARDOUS WASTE

Income Statement

Revenue	100.0%
Expenses	84.2%
Depreciation	9.9%
Interest Income	1.2%
Interest Expense	1.7%
Profit Before Tax	5.5%
Tax	2.6%
Profit After Tax	2.9%

Balance Sheet

Assets		Liabilities	
Cash	8.6%	Accounts Payable	15.8%
Marketable Securities	0.5%	Long Term Debt	28.8%
Accounts Receivable	23.8%	Equity	55.4%
Total Current Assets	33.1%		
Fixed Assets	66.9%		

Source: Derived by Arthur D. Little from *Annual Statement Studies,* Robert Morris Associates, 1976 Edition and *Motor Carrier Industry Financing,* Regular Common Carrier Conference, Washington, D.C., 1968.

5. Market Structure

There is potential substitution of one mode of transport for another and substitutability among transportation services that could be provided by generators, transporters or hazardous waste management facilities. In addition, some generators have the option of on-site disposal which requires no transportation service. The decision for a generator to self-haul or use an outside service is made at the plant level. Also, a plant generating a small volume of waste is more likely to self-haul than a plant generating a large volume, because of the probable inability to find a permitted contractor to handle a small quantity of waste, as well as the fact that off-site disposal may be less costly, given the scale economies involved with disposal (Chapter V). The nature of hazardous waste disposal and the role of hazardous waste transport in this process indicate that the price elasticity of demand for the transportation activity is likely to be inelastic.

6. Capacity Utilization and Growth

While commercial TSDF's have been operating at about 50% of capacity in recent years,[6] transportation equipment at TSDF's has been operated at 75% to 80% of capacity. Current data describing the length of time trucks were utilized per day (8-14 hours) indicate that utilization is

6. *Potential for Capacity Creation in the Hazardous Waste Management Services Industry,* Environmental Protection Agency PB-257 187, August, 1976, pp 11-12.

closer to 100%. Generators who self-haul appear to have the lowest capacity utilization rates because they typically make one short-haul per day. The implication of current capacity utilization rates is that TSDF's can handle some expansion in hazardous waste transported without purchasing additional equipment while many transporters would require additional equipment if the amount of hazardous waste transported off-site increases significantly.

C. IMPACTS ON TRANSPORTATION SECTOR

1. Cost of Compliance by Truck Type

Under Options A and B, the increase in operating cost as a consequence of RCRA will be greater for transportation of drummed waste and other waste that the truck operator must manually handle during loading and unloading operations (Table IX-2). This is attributable to the allocation of additional truck driver's time to have the manifest signed. The relative increase is greater for truck Models 4 and 5 because they represent transportation of drummed waste, a high annual mileage, scenario.

The increase in operating cost under Option C will be less than half of the Option A and B cost because the manifest or shipping papers will no longer require a signature.

The EPA expects an annual hazardous waste spill incidence of about 200. The relatively modest cost of spill clean-up used here amounts to from 3.2% to 4.5% percent or more of annual operating cost, and the total cost of spill clean-up is estimated at $345,000.

2. Economic Impact of Options A, B and C

Two company financial models, one for a transporter and one for a treatment, storage and disposal facility also engaged in transportation, were analyzed to determine the impact of the cost of compliance with transportation activity regulated by RCRA.

a. General Transporter

To establish a baseline for gauging impact, the precompliance revenues consistent with historic truck company rates-of-return and the revenues required to recover the cost of compliance with RCRA were generated (Table IX-3). The precompliance price per ton-mile implicit in the model is $0.122 for the 14-truck composite.

The effect of compliance is measured in two ways:

(1) The decrease in return on capital (profitability) if rates do not increase; and

(2) The increase in revenues (prices) necessary to recover the cost of compliance, and earn the historic rate of return.

In the absence of a price increase, profitability will decline by 19% under Options A and B. However, an increase in revenue of 3.4% overall is needed to maintain the historic rate of return. The impact of compliance upon the transportation company, assuming a balanced mixture of vehicle types, is between those for the high impact and low-impact models.

TABLE IX-2

INCREASE IN TRUCK OPERATING COSTS FROM COMPLIANCE WITH RCRA

		Cost of Compliance – Options A & B				Cost of Compliance – Option C				Spill Cleanings	
		First Year		Recurring Years		First Year		Recurring Years			
Truck Type/Model	Annual Operating Cost	$	% Operating Costs	$	% Operating Costs	$	% Operating Costs	$	% Operating Costs	$ Cost	% Operating Costs
Tank 1	32,500	1360	4.2%	990	3.0%	500	1.5%	300	0.9%	1320	4.1%
Tank 2	28,375	1360	4.8	990	3.5	500	1.8	300	1.1	1320	4.7
Tank 3	41,500	850	2.0	650	1.6	500	1.2	300	0.7	1320	3.2
Drum 4	34,000	1630	4.8	1430	4.2	500	1.5	300	0.9	1320	3.9
Drum 5	29,625	1630	5.5	1430	4.8	500	1.7	300	1.0	1320	4.5

Source: Truck model operating costs: *Characterization and Economic Impact Assessment of Hazardous Waste Transportation Regulations.*

Cost of Compliance: Derived from Chapter V.

TABLE IX-3

REQUIRED INCREASE IN REVENUE TO RECOVER COSTS OF COMPLIANCE WITH SECTION 3003

		Baseline		Options A and B				Option C			
				Required Increase In Revenue		Impact on Profit With No Price Increase		Required Increase In Revenue		Impact On Profit With No Price Increase	
	Number of Vehicles	Revenue	ROC[1]	$	% Change	ROC[1]	% Change	$	% Change	ROC[1]	% Change
Transportation Company	14	$ 670,292	6.7	22,500	3.4	5.4	-19	5,950	0.9	6.3	-6
Treatment, Storage and Disposal Facility	7	1,635,190	15.4	11,250	0.7	14.8	-4	2,975	0.2	15.2	-1

1. ROC: return on capital.

Source: Arthur D. Little, Inc., estimates.

There could be a differential impact upon rates that generators pay if the differential cost impact per truck, type or trip is precisely reflected in rates and this will cause a higher rate increase for short-haul, low-volume drummed waste generators.

b. Treatment, Storage and Disposal Facilities (TSDF's)

In addition to the direct costs of owning and operating trucks, TSDF's have other expenses and pricing policies which can result in a different impact on rates than indicated by examining trucks alone. An increase in truck expenses can be offset by increases in revenues from transportation activities, and/or disposal operations.

A change in transportation expenses due to related compliance activities will require a lower increase in total revenue required to recover costs than for the transportation company. The impact of the cost of compliance with RCRA was measured in the same two ways as for the general transporter.

Under Options A and B the decline in profitability in the absence of a price increase will be 4%, and a price increase of 0.7% is required to cover the cost of compliance with RCRA transportation activity (Table IX-3). The impact on the TSDF produces a lower decrease in profit than for the transportation company because transportation represents only 22% of the former's revenues.

D. CHARACTERIZATION OF TREATMENT, STORAGE AND DISPOSAL FACILITIES

1. Introduction

Treatment, storage and disposal facilities constitute an industry which is small and fragmented. The industry arose as environmentalists, state agencies and local governments, as well as the EPA, became more aware of the danger posed by casual disposal of hazardous wastes.

2. Industry Structure

As of 1975, there were 95 corporations operating 110 TSDF's[7]. In addition, some municipal facilities are also designated as handling hazardous wastes. About 43% of the facilities are large common stock corporations or subsidiaries of common stock corporations while another 40% are closely held corporations (Table IX-4). The former group controls 65% to 70% of industry revenues.

The corporations which are not closely held tend to be larger and part of multi-facility operations. The large TSDF corporations combined accounted for 47 sites (43% of the total) and 65-70% of revenues in 1975.[8]

In 1975, sales revenue from hazardous waste operations ranged between $35,000 and $12 million per firm; the median sales value was $1 million (Table IX-5). In the same year, total

7. *Potential for Capacity Creation in the Hazardous Waste Management Services Industry*, Environmental Protection Agency, PB 257-187, p. 7.

8. Ibid

TABLE IX-4

FORM OF OWNERSHIP
TREATMENT, STORAGE AND DISPOSAL FACILITIES
1975

Form	No. of Facilities	% Total	% Industry Revenue
Common Stock Corporation	16	15	65-70
Division/Subsidiary of Another Corporation	31	28	
Closely Held Company	54	49	30-35
Municipally Controlled	9	8	
	110	100	

Source: *Potential for Capacity Creation in the Hazardous Waste Management Service Industry,* Environmental Protection Agency, P.B.-257-187, p. 9

TABLE IX-5

DISTRIBUTION OF COMPANIES BY SALES
TREATMENT, STORAGE AND DISPOSAL FACILITIES
1975

Sales Volume	% Firms
Up to $100,000	19
$100,000 – $500,000	21
$500,000 – $1,000,000	15
$1,000,000 – $2,000,000	31
$2,000,000 – $5,000,000	10
$5,000,000 or greater	4

Median Value = $1,000,000

Source: "Potential for Capacity Creation in the Hazardous Waste Management Service Industry," Environmental Protection Agency, PB-257-187, August 1976.

employment was about 2,000 in TSDF's, with about 230 of these classified as professionals.[9] Approximately 175 of these employees were chemists or chemical engineers with the remainder of the professionals being in sales, accounting, and management.[10]

3. Market Structure

Barriers to entry/expansion described by firms in the hazardous waste management industry include:

- Uneven enforcement of regulation, producing price pressure compared with non-environmentally adequate disposal;

- Competition from municipal disposal sites (forcing price downward);

- Siting constraints, preventing expansion of old sites or opening of new ones; and

- Resistance from residents of an area to locating a TSDF nearby.

4. Supply and Demand Characteristics

TSDF's provide disposal and treatment of hazardous waste in the form of secure landfills, landfarms, incineration, chemical treatment, and, in some cases, recycling. Sanitary landfills, deep well injection and ocean dumping services are generally not adequate methods of hazardous waste disposal. In addition, inadequate disposal service is said to be provided by illegal dumpers. Some facilities offer a full range of disposal and treatment services whereas others offer only one. Similarly, some facilities will accept a wide variety of wastes whereas others are quite restrictive as to what they will accept for treatment.[11]

The prices of treatment, storage and disposal services "often include ... transportation, storage, actual treatment and disposal."[12] Other factors which cause differences in disposal cost include form (solid, liquid, concentrate), and container characteristics (type, condition, etc.), and these factors can cause greater variation in disposal price than the method of disposal. Companies surveyed reported that prices for treatment or disposal are based on cost and that competition forces the industry to maintain low prices.[13] Premium pricing is possible in areas where regulations are strictly enforced.[14]

Generators of hazardous waste (Chapter VIII) purchase hazardous waste disposal services rather than self-dispose for a variety of reasons. First, a generator may not have available land to construct a landfill or other treatment/disposal process. Second, a generator may not have sufficient volume of waste to enable self-disposal for a lower price than a TSDF can do so. Third, a generator may wish to reduce the liability associated with operating a disposal facility itself.

Hazardous waste disposal services can be purchased through a long-term contract or on a spot basis. The former is more likely for a regular type and steady volume of hazardous waste. Spot disposal is more likely for an unusual or non-regular hazardous waste.

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9. Ibid, p. 21.
10. Ibid.
11. Ibid.
12. Ibid, p. 26
13. Ibid, p. 29
14. Ibid.

The industry capacity is concentrated in the midwest, Region V (Table IX-6). Resource recovery services are offered by many TSDF's and while recovery operations account for up to 20% of waste volume, they can produce up to 40% of facility revenue.

Of the total 7,103 thousand gallons per day of capacity, one-third takes the form of chemical treatment, 24% is "secure landfill," 20% is resource recovery capacity, 13% deep well injection and 10% incineration (Table IX-6). The overall capacity utilization rate was 58% and thus some 4.1 million gallons of hazardous waste were disposed in TSDF's in 1974. There is considerable variation in capacity utilization among disposal methods and among regions.

While "secure landfill" capacity is listed in most regions, these landfills will not all be in compliance with provisions of RCRA. According to EPA listings of TSDF's,[15] there are seven secure landfills outside the State of California, located as follows:

Illinois (1)
Missouri (1)
Nevada (1)
New York (2)
Texas (2)

As a result, most landfills will incur costs associated with technical requirements for landfills, including the requirements for monitoring and leachate collection.

5. Profitability

There is a wide range of facility size in terms of revenue in the hazardous waste management industry. An EPA contractor who collected financial data classified the industry into:[16]

- Firms whose main objective was hazardous waste management; and
- Divisions or operations of large companies.

The basis of the division was that larger firms have a somewhat different capital structure and have fewer constraints in obtaining capital.

During the 1971-1975 period, smaller firms had a higher margin on sales (net income/sales) and sales turnover (sales/tangible assets) than larger firms and thus had higher returns on net worth and tangible assets (Table IX-7). This is consistent with the finding that most treatment, storage and disposal facilities did not have strong financial backing and were considered high risks by financial institutions.

In 1975, 17% of the firms principally engaged in treatment, storage and disposal activities were unprofitable and there was no relationship between size and profitability.[17] While this would be a reflection of the downturn in generator manufacturing activity in 1975, it could also indicate that there is a substantial marginal segment in the industry.

15. *Hazardous Waste Management Facilities in the United States - 1977,* EPA/530/SW-2463, January, 1977.

16. *Potential for Capacity Creation in the Hazardous Waste Management Service Industry.*

17. Ibid, page 83.

TABLE IX-6

DISTRIBUTION OF PROCESS CAPACITY TREATMENT, STORAGE AND DISPOSAL FACILITIES 1974

EPA Region	Number of Facilities	Chemical Treatment % Capacity	Chemical Treatment Capacity Utilization	Incineration % Capacity	Incineration Capacity Utilization	Secure Landfill % Capacity	Secure Landfill Capacity Utilization	Deep Well Injection % Capacity	Deep Well Injection Capacity Utilization	Resource Recovery % Capacity	Resource Recovery Capacity Utilization
I	6	2%	47%	1%	30%	0%	30%	—	—	1%	50%
II	18	3	50	23	50	14	50	—	—	4	60
III	9	12	45	5	75	1	30	—	—	1	50
IV	7	1	60	7	60	3	40	—	—	—	—
V	27	65	50	54	65	14	50	11%	75%	21	50
VI	10	3	40	7	40	8	50	89	75	16	60
VII	8	11	50	1	75	4	60	—	—	3	60
VIII	1	—	—	—	—	—	—	—	—	—	—
IX	19	2	80	2	80	37	80	—	—	27	75
X	5	1	50	—	—	19	30	—	—	27	60
Total	110	100%	50%	100%	60%	100%	57%	100%	75%	100%	62%
Total Capacity[1]	7,103	2,337 33%		676 10%		1,714 24%		895 13%		1,481 20%	

1. Thousands of gallons per day.

Source: *Potential for Capacity Creation in the Hazardous Waste Management Industry,* EPA, PB-257-187, August 1976, pp. 11-12.

TABLE IX-7

SELECTED FINANCIAL RATIOS FOR TSDF'S
1971-1975 AVERAGE

	Type of Firm	
	Principally HWM	HWM Division
Net Income/Sales	0.074	0.059
Current Ratio	1.476	1.714
Sales/Tangible Assets	1.119	0.969
Land/Fixed Assets	0.187	0.144
Fixed Assets/Total Assets	0.609	0.608
Total Debt/Equity	1.362	1.802
Profits/Net Worth	0.191	0.149
Profits/Tangible Assets	0.091	0.058

Source: Derived from *Potential for Capacity Creation in the Hazardous Waste Management Industry,* pp. 42 and 46.

E. IMPACTS ON TREATMENT, STORAGE AND DISPOSAL SECTOR

1. Economic Impact

The economic impact of RCRA upon TSDF's is evaluated in this section for each option studied and for the following TSD methods;

- Landfills
- Incinerators
- Landfarms
- Lagoons

The analysis is based upon the models of each disposal method described in Chapter V. However, it examines the impact in a stand-alone framework. Additional or lesser costs and impacts could be incurred by generators as a consequence of required changes in treatment, storage or disposal methods.

Estimates were made of long-run price increases necessary to recover the costs associated with compliance activities under RCRA Options A, B and C (Table IX-8). The differences among the options are in the financial requirements, recordkeeping and reporting costs, the administrative costs and in the monitoring and testing cost.

TABLE IX-8

INCREMENTAL COST OF COMPLIANCE BY OFF-SITE DISPOSAL METHOD
($000)

	OPTION A			OPTION B			OPTION C		
		Operating Cost			Operating Cost			Operating Cost	
	Investment	First Year	Recurring	Investment	First Year	Recurring	Investment	First Year	Recurring
Technical									
Landfill[1]	1,300.0	257.6	257.6	1,300.0	257.6	257.6	1,300.0	257.6	257.6
Landfarm[2]	115.0	–	–	109.0	–	–	109.0	–	–
Incinerator[3]	72.0	–	–	61.0	–	–	61.0	–	–
Financial Requirements									
Landfill[1]	–	594.3	594.3	–	103.2	103.2	–	76.9	76.9
Landfarm[2]	–	20.0	20.0	–	20.0	20.0	–	15.0	15.0
Incinerator[3]	–	80.0	80.0	–	80.0	80.0	–	63.8	63.8
Recordkeeping/Reporting	–	2.7	2.6	–	2.0	1.9	–	2.0	1.9
Administrative	–	65.8	15.8	–	57.9	8.0		57.9	8.0
Training	–	16.8	7.5	–	16.8	7.5	–	16.8	7.5
Contingency									
Landfill[1]	1.0	34.4	33.5	1.0	34.4	33.5	1.0	34.4	33.5
Landfarm[2]	1.0	100.9	100.0	1.0	100.9	100.0	1.0	100.9	100.0
Incinerator[3]	1.0	16.7	15.8	1.0	16.7	15.8	1.0	16.7	15.8
Monitoring/Testing									
Landfill[1]	–	248.6	248.6	–	231.8	215.0	–	231.3	214.5
Landfarm[2]	–	287.1	287.1	–	270.3	253.5	–	269.8	253.0
Incinerator[3]	–	252.6	252.6	–	234.3	217.5	–	233.8	217.0

1. Annual volume of 50,000M^3/yr. Technical cost includes differnece between natural containment system and liner system with leachate collection.
2. Annual volume of 100,000M^3/yr.
3. Annual volume of 5,000M^3/yr.

Source: Derived from Chapter V.

2. Cost and Impact on Landfills

a. *Price of Disposal Service*

Options B and C have successively less stringent financial requirements in that the post-closure monitoring and maintenance fund covers 20 years and 10 years of care respectively (compared with 40 years in Option A) and the post-closure cost of liability will be provided by separate legislation (Table IX-9). As a result of the compliance cost, the price of commercial landfill disposal can be expected to increase by 258% under Option A, 162% under Option B, and 158% under Option C.

When the compliance activity requires expenditures in proportion to landfill size, e.g., lining materials, the increase in price required to cover cost is roughly equivalent per cubic meter. Where compliance costs are not borne proportionally to size — e.g., financial requirements — the absolute dollar value of price increases and also the percentage increase in price are considerably larger for the small landfill than for the large landfill.

b. *Demand for Disposal Service*

An EPA contractor estimated[18] that approximately twice the volume of hazardous waste would be disposed in off-site TSDF's after regulation. Given the impact on price (or cost to a self-disposer) of the RCRA, the nature and extent of a from on-site to off-site disposal is not clear. Several types of shifts might occur and to some extent they are offsetting. For example, the price of disposal service (or self-disposal) in a small landfill will approach that for certain types of incineration. While self-disposers who landfill may find it more economical to dispose off-site rather than comply, in some parts of the country where landfills are small, it may be more economical for a generator to incinerate on-site or off-site rather than dispose of hazardous waste in a landfill if that is a feasible method of disposal for the waste.

c. *Change in Scale Economies*

The increases in disposal cost under RCRA are not strictly proportional for small and large landfills. As a result, RCRA will change scale economies somewhat, and cause a absolute change in the cost per ton of disposal for small landfills. As a result, there is an incentive for landfills to become larger.

d. *Financing Requirements*

Even if one assumes that landfills will realize long-run price increases immediately, they could still require external financing in order to comply with RCRA because capital expenditures are required and cash flows may not be sufficient to finance investment internally.

3. Incineration

a. *Price Impacts*

The compliance activities required for the incineration method of waste treatment are less burdensome than for landfills, primarily because they do not have post-closure financial requirements; however, monitoring and testing costs will represent a significant cost of compliance.

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18. Ibid, p. 94.

TABLE IX-9

CHANGE IN PRICE OF HAZARDOUS WASTE DISPOSAL IN OFFSITE LANDFILLS FROM RCRA COMPLIANCE COSTS

	Option A		Option B		Option C	
	$\$/M^3$	% Baseline	$\$/M^3$	% Baseline	$\$/M^3$	% Baseline
Baseline Price[1]	11.00		11.00		11.00	
Technical Cost[2]	9.95	90	9.95	90	9.90	90
Financial Requirements	12.00	109	2.05	19	1.65	15
Recordkeeping & Reporting	.05	1	.05	1	.05	1
Monitoring & Testing	5.00	45	4.50	41	4.50	41
Administrative Cost	.50	5	.35	3	.35	3
Training	.20	2	.20	2	.20	2
Contingency	.70	6	.70	6	.70	6
Post Compliance Price	39.40		28.80		28.35	
Change in Price	28.40	258	17.80	162	17.35	158

1. Excluding liner, leachate collection system and all monitoring and testing equipment.
2. Includes liner, leachate collection system and all monitoring and testing equipment.

Source: Arthur D. Little, Inc. estimates.

The only retrofitting of incineration systems would be for air pollution equipment (Chapter V). Some 15% of the incineration facilities surveyed in an EPA contractor study[19] had air pollution equipment in place. Based upon the directory of TSD facilities published by the EPA[20], this translates into 5 facilities with air pollution equipment and 26 without.

The increase in cost of incineration from compliance with the RCRA options studied for incineration of various wastes[21] depends upon the volume of wastes handled and the process used for incineration (Table IX-10). The relative impact of RCRA is lower for high-cost incineration (low volume/high hazard). Under Option A, incineration costs will increase by 11% to 57%, while under Option C, costs will increase by 9% to 50%. Thus, the variability among incineration costs attributable to waste type and incineration method is far greater than the differences between the RCRA options studied.

b. Demand for Incineration

Incineration may be cost-competitive with small landfill after compliance, especially for generators who self-dispose. Therefore, some voluntary shifts from landfill to incineration may occur. In addition, the Pathway III method of disposal is incineration for some wastes currently landfilled, which will increase the demand for incineration services.

c. Capacity

As in the case with landfills, some incineration facilities will probably discontinue treatment of hazardous wastes rather than comply. This would most likely occur where the incineration system is not in compliance with the technical requirements of Section 3004, thus requiring investment of the same order as for a new facility.

The incineration capacity in off-site, independent TSDF's in 1974[22] was on the order of 800,000 to 900,000 metric tons per year, which is less than half the level of disposal volume that must be incinerated under Pathway Level III. However, the capacity of on-site systems is not known.

There could be a capacity shortfall in incineration disposal in the early years of the regulation, especially given the 12- to 24-month lead time[23] required to install new capacity.

4. Landfarming

Landfarming is a Pathway III disposal method for some types of wastes from the petroleum refining industry. Monitoring and testing requirements are by far the largest component of compliance cost (Table IX-11) because testing costs vary with waste volume whereas most other costs exhibit scale economies, i.e., they decrease with increases in facility waste volume.

While the cost of landfarming will exhibit a substantial increase under each of the three options studied (75%, 68%, and 67%, respectively), the cost of landfarming will still be substantially below the costs of landfill disposal or incineration treatment.

19. Ibid.
20. *Hazardous Waste Management Facilities,* EPA, 1977.
21. See Appendix C for an indication of process associated with each incinerated waste.
22. *Potential for Capacity Creation in the Hazardous Waste Management Service Industry,* p. 11-12.
23. Op. cit., p. 81.

TABLE IX-10

CHANGE IN COST OF HAZARDOUS WASTE INCINERATION DUE TO RCRA

	Type of Waste and Volume of Incineration			
	Phenol 22,800 M^3/yr	Rubber 6000 M^3/yr	PCB Capacity 5000 M^3/yr	PVC Waste 6000 M^3/yr
	Cost M^3	Cost M^3	Cost M^3	Cost M^3
Baseline Financial				
Requirement	140.00	117.00	741.00	582.00
Options A & B	3.50	13.30	16.00	13.30
Option C	2.80	10.60	12.75	10.60
Recordkeeping and Reporting				
Option A	0.10	0.40	0.50	0.40
Options B & C	0.10	0.40	0.50	0.40
Administrative				
Option A	1.05	3.95	4.75	3.95
Options B & C	0.70	2.65	3.20	2.65
Training	0.40	1.50	1.80	1.50
Contingency	3.25	3.25	3.25	3.25
Monitoring and Testing[1]				
Option A	11.60	44.10	52.90	44.10
Option B	10.40	39.65	47.60	39.65
Option C	10.40	39.55	47.50	39.55
Total Increase				
Option A	19.90	66.50	79.20	66.40
% Baseline	14%	57%	11%	11%
Option B	18.35	60.75	72.35	60.75
% Baseline	13%	52%	10%	10%
Option C	17.76	57.95	69.00	57.95
% Baseline	13%	50%	9%	10%

1. Includes investment in equipment (Technical Cost)

Source: Derived from Chapter V.

TABLE IX-11

CHANGE IN COST OF HAZARDOUS WASTE LAND FARMING DUE TO RCRA
$/$M^3$

	Option A	Option B	Option C
Baseline (100,000 M^3/yr)	5.00	5.00	5.00
Technical	0.15	0.15	0.15
Financial Requirements	0.20	0.20	0.15
Recordkeeping and Reporting	0.03	0.02	0.02
Administration	0.24	0.16	0.16
Training	0.09	0.09	0.09
Contingency	0.16	0.16	0.16
Monitoring and Testing	2.87	2.60	2.60
Post Compliance Cost	8.74	8.38	8.33
Total Increase	3.74	3.38	3.33
Percent Baseline	75%	68%	67%

Source: Derived from Chapter V.

5. Lagooning

The technical costs in Table IX-12 include the cost of a liner system as well as the monitoring equipment required to comply with monitoring requirements. Under each of the three options studied the costs of lagoon storage/disposal will more than double. However, the cost per cubic meter will be lower than the post-RCRA costs of landfilling the waste.

TABLE IX-12

CHANGE IN COST OF HAZARDOUS WASTE LAGOONING DUE TO RCRA $/M^3

	Option A	Option B	Option C
Baseline[1] (13,680 M^3/yr	$4.70	$4.70	$4.70
Technical	2.05	1.90	1.90
Financial Requirements	1.45	1.45	1.10
Recordkeeping and Reporting	0.20	0.15	0.15
Administrative	1.75	1.20	1.20
Training	0.65	0.65	0.65
Contingency	0.10	0.10	0.10
Monitoring and Testing[2]	1.80	1.70	1.65
Post Compliance Cost	12.20	11.85	11.45
Total Increase	8.00	7.15	6.75
% Baseline	170%	152%	144%

1. Excluding liner and sampling equipment.
2. Based upon one "shipment per day".

Source: Derived from Chapter V.

X. CHARACTERIZATION AND IMPACT ON FEDERAL FACILITIES

A. INTRODUCTION

The effort described in this chapter was undertaken for the purpose of defining the economic impact of RCRA Subtitle C regulatory options on Federal facilities. The scope of work included: (1) Identification of Federal facilities that generate and/or treat/store/dispose of hazardous waste, as defined in Section 3001 draft regulations. (2) Estimation of the volumes of hazardous wastes generated by typical Federal facilities. (3) Estimation of incremental control costs incurred by Federal facilities as a result of any changes in present treatment and disposal practices likely to be effected in response to proposed RCRA regulations.

B. FEDERAL FACILITIES LIKELY TO BE IMPACTED BY RCRA

The following Federal agencies are potential generators of hazardous wastes:

- Department of Defense (DOD)
- National Aeronautics and Space Administration (NASA)
- Tennessee Valley Authority (TVA)
- General Services Administration (GSA)
- Department of Agriculture
- Housing and Urban Development (HUD)
- U.S. Government Printing Office (Department of Treasury)
- Veterans' Administration (VA)
- Health, Education, and Welfare (HEW)
- Federal Communications Commission (FCC)
- Department of Interior (DOI)
- U.S. Postal Service
- Department of State
- Department of Transportation (DOT)
- Department of Energy (DOE)

None of the agencies have carried out a comprehensive hazardous waste inventory. From available data, the total annual rate of hazardous waste generation is estimated to be approximately 300,000 MT/year (exclusive of utility wastes). Most agencies believe current estimates significantly understate the actual waste generation rates. Utility wastes (flue gas desulfurization sludges and fly ash) from TVA coal-burning boilers are estimated at more than 1,000,000 MT/year, wet basis.

The largest generator of potentially hazardous wastes within the Federal government is DOD. However, DOD has not yet undertaken a comprehensive hazardous waste inventory. Contact was made with branches of DOD — the Army, the Navy and the Air Force. Some information was obtained, but it was generally incomplete and of variable quality. Data required for development of a compliance plan will be obtained, according to DOD representatives, after the RCRA Subtitle C regulations have been promulgated.

The second largest generator of potentially hazardous wastes within the Federal government is believed to be NASA. A third Federal agency identified as likely to be significantly impacted by RCRA regulations is TVA. The high-volume waste streams from TVA installations are fly ash and flue gas desulfurization sludges, which if hazardous by virtue of their characteristics, would fall under the category of "Special Wastes." Special waste standards for TSDFs handling these wastes have been established under proposed Option B, Section 3004, RCRA regulations.

Other Federal agencies appear to generate relatively minor quantities of hazardous waste, if any. A summary of potential sources of hazardous wastes within the Federal government is given in Table X-1.

C. WASTE STREAM CHARACTERIZATION AND CURRENT DISPOSAL METHODS

Available data characterizing potentially hazardous waste streams generated by Federal facilities are spotty and incomplete. Estimating waste generating rates is difficult, because of problems with the definition of hazardous waste given in Section 3001 as it applies to Federal facilities. The problem with the listing of hazardous wastes under Section 3001 is that it is based on industry-specific data, organized by SIC numbers for manufacturing industries. Although the same SIC numbers apply to Federally owned and operated business establishments as to private establishments engaged in similar activities, the Federal and private facilities are not generally competitive and therefore are often not recognized as engaged in similar work.

Most Federal facilities have not run the prescribed tests, and often do not know enough about their waste streams to determine whether or not the streams have hazardous characteristics. Therefore, it will require new sampling and analysis of wastes to establish a reasonably accurate inventory.

Apart from some apparent confusion between water effluents and hazardous wastes, the available data probably represent reasonable estimates of the quantities of wastes generated, in the categories reported. Due to some lack of understanding of the kinds of wastes that should be designated as hazardous, the quantitative estimates are probably low.

1. Department of Defense

a. Navy

The Navy has estimated that ships and shore establishments generate approximately 19,000,000 gallons/year of liquid wastes and 17,000 MT/year of solid wastes that are likely to fall under the RCRA definition of "hazardous." The total estimated quantity of hazardous waste is approximately 97,000 MT/year (assuming a liquid density of 8.34 lbs/gal).

TABLE X-1

FEDERAL FACILITIES LIKELY TO BE IMPACTED BY RCRA

Agency	Facility(ies)	Potential Sources of Hazardous Wastes
DOD	Army Depots (11-12 active)	Plating wastes; paint sludge
	Army Ammunition Plants	Baghouse ash; scrubber water sludge; clogged filters; leaching pit residues; other ordnance wastes
	Navy	Waste oils and solvents; ordnance wastes; paint sludge; pesticide wastes; PCB's; corrosion inhibitors; sandblast grit; batteries
	Air Force:	
	Logistics Command	Industrial waste sludges; solvents; cleaning agents
	Strategic Air Command	Photographic wastes; solvents; cleaning agents
	Tactical Air Command	Solvents
	Training Command	Pesticides; solvents; cleaning agents
	Systems Command	Solvents
NASA	JPL, Pasadena, CA	Solvents; plating wastes; sludges; waste oils; propellants
	Johnson Space Center Houston, TX	Solvents; sludges; plating wastes; photographic wastes
	Marshall Space Flight Center	Sludges; photographic wastes; corrosion inhibitors
	National Space Technology Laboratories	Photographic wastes; solvents
	Michaud Assembly Facility, New Orleans, LA	Solvents; sludges; waste oil
	Goddard Space Flight Center	Solvents; plating wastes; photographic wastes
	Lewis Research Center Cleveland, OH	Oils; photographic wastes; pesticides; fluorescent lamps; mercury
	Ames Research Center, Moffett Field, CA	Solvents; miscellaneous lab. chemicals
	Langley Research Center, Hampton, VA	Solvents; sludges; photographic wastes
TVA		Fly ash; bottom ash; flue gas desulfurization sludge

TABLE X-1 (Continued)

Agency	Facility(ies)	Potential Sources of Hazardous Wastes
GSA	Public buildings	Asbestos removed from old ceiling tile systems, roofing, and dust insulation; PCB-containing transformers, capacitors and ballasts; fly ash and bottom ash from fuel boilers and furnaces
	National Strategic Stockpile	Contaminated pallets and other items
Department of Agriculture		Pesticides
DOI		Pesticide containers
Department of Treasury		Coin-minting
HUD		Asbestos from demolished buildings
HEW		Pathogenic and carcinogenic lab wastes
VA	Hospitals	Pathogenic wastes
DOE	Laboratories	Chemicals, lab. wastes
DOT		None
Department of Justice		None
Department of State		None
FCC		None
Postal Service auto maintenance shops		Waste oil

Current methods of disposal are reported to be approximately as follows:

Waste Type(s)	Quantity MT/yr	Current Disposition
Solvents and hydraulic fluids	20,000	Used as supplemental fuels and in fire training
Ordnance wastes	1,200	Open burning
—	37,000	Sanitary landfill
—	8,000	Secure landfill
—	14,000	Sanitary sewers
—	17,000	Long-term storage
Total	97,000	

With the exception of solvents, waste oils and ordnance wastes, as indicated, no information was provided on current disposal methods by waste type (i.e., the types of wastes currently going to sanitary landfill, secure landfill, sanitary sewers and long-term storage).

The Pathways Level III waste management modes for Navy wastes are as follows:

Waste Type(s)	Quantity MT/yr	Pathways Level III Disposal
Paint sludge Oil sludge Indust. treatment sludge Acids Caustics Plating wastes Mercury Corrosion inhibitors Decontam. metals Sandblast grit Batteries Firefighting agents Misc. solids	55,000	Secure chemical landfill
Strippers and thinners Pesticides PCB's Misc. liquids Ordnance	22,000	Incineration
Solvents Hydraulic fluids	20,000	Use as supplemental fuel in fire training

b. Air Force

Table X-2 summarizes the responses of Air Force installations to a letter from the Pentagon requesting information on types of chemical wastes, annual quantities, and methods of disposition. The total rate of hazardous waste generation as estimated from the table is 50,000 MT/year.

TABLE X-2

WASTES GENERATED AT AIR FORCE INSTALLATIONS, 1977

Waste Type	Quantity, MT/Yr	Disposal Method(s): Current	Disposal Method(s): PA III
Solvents	900	DPDO;* recovery; contract; secure landfill; used as fuel; sanitary landfill	Recovery or incineration
Paint Wastes	60	DPDO; secure landfill; contract	Secure landfill
Strippers and Thinners	200	Secure landfill; sanitary sewer; contract; DPDO	Incineration
Waste Oils	40	DPDO; secure landfill	Incineration
Industrial Treatment Sludge	16,000	Secure landfill	Secure landfill
Acids	400	Sanitary sewer; contract	Secure landfill
Caustics	400	Contract	Secure landfill
Plating Wastes	2	DPDO; secure landfill; contract	Secure landfill
Pesticides	20	DPDO; sanitary landfill	Incineration
PCB's	10	Storage; DPDO; contract; secure landfill	Incineration
Chromates	200	Off-site government; sanitary sewer; DPDO	Secure landfill
Cyanides	900	Contractor; alkaline chlorination	Alkaline chlorinate
Photographic Wastes	30,000	DPDO; Deepwell injection; sanitary sewer	Secure landfill
Rocket Fuel	5	Chemical oxidation in treatment pond	Chemical oxidation
Miscellaneous Chemicals	500	Sanitary sewer; DPDO; secure landfill	Secure landfill
Total	50,000		

*DPDO — Defense Property Disposal Organization.

Source: Arthur D. Little, Inc., summary of raw data supplied by the Air Force.

Much of the waste is transferred to the jurisdiction of the Defense Property Disposal Organization (DPDO). The DPDO has traditionally handled primarily scrap and surplus stock, for which there are fairly well-established markets. The disposal of chemical wastes is a relatively recent activity. Generally, the wastes are held in storage while an attempt is made to locate a customer interested in purchasing the material for use. No limit appears to have been set on storage times. When it becomes clear that the wastes are not a reusable resource, an environmentally adequate disposal method is sought. In the case of Herbicide "Orange," over 9,000 MT were stored for several years — 2,000 MT in Gulfport, Mississippi, and 7,000 MT in Johnson Island in the Pacific — prior to incineration at sea in 1977.

c. *Army*

Annual quantities of hazardous waste generated by the Army are not available. The major generating facilities include 11 or 12 active Army depots and 15 or so Army ammunition plants. About 40 additional Army bases may generate smaller quantities of waste.

Material that would be classified as hazardous waste is being stored at Army installations. About 150,000 MT of obsolete and surplus ordnance is being stored at 12 Army bases and 29 Navy bases. It is the intent of DOD to demilitarize this material as soon as feasible. More than 70,000 MT of obsolete chemical agents and related wastes are stored at 10 Army installations, awaiting the development and testing of appropriate TSD technology.

2. NASA

The total estimated rate of hazardous waste generation at NASA facilities is approximately 6,000 MT/year. (Table X-3)

3. TVA

By 1980, TVA expects to have limestone wet scrubbers in operation on two of its 12 boilers. The combined rate of generation of flue gas desulfurization sludge and fly ash is expected to be about 1,000,000 MT/year, on a wet basis (50% water).

4. Other Federal Agencies

Information available from other Federal agencies is mostly qualitative.

An inventory of non-radioactive hazardous waste produced by Federal agencies other than DOD was developed for Region IX by a Federal Task Force. (1) Data were received from 43 units of 26 agencies contacted (only GSA did not respond). Hazardous waste is generated in the normal activities of only six of the agencies responding. Results (Table X-4) are reported in three categories as follows:

(a) *Research and Development Agencies*

Includes: Agricultural Research Service (USDA)
Energy Resource and Development
Administration (ERDA)
U. S. Geological Survey (USDI)

TABLE X-3

WASTES GENERATED AT NASA INSTALLATIONS

Waste Type	Quantity, MT/Yr	Disposal Method(s) Current	Disposal Method(s) PA III
Degreasing Solvents	500	Contractor; recovery; deepwell injection; sanitary landfill	Recovery/incineration
Other Solvents	90	Contractor; recovery; deepwell injection; sanitary landfill	Recovery/incineration
Water Pollution Control Sludges	900	Contractor; lined lagoon; deepwell injection	Secure landfill
Electroplating Residues	400	Contractor; deepwell injection	Secure landfill
Paint Wastes	6	Contractor; lagoon (lined); landfill	Secure landfill
Hydraulic Cutting Oil	60	Contractor; secure landfill; incineration	Incineration
Cooling Tower Sludges	90	Contractor; lagoon (lined); landfill	Secure landfill
Etching Acids and Sludges	300	Contractor; deepwell injection; lagoon	Secure landfill
Photographic Wastes	3,000	Contractor; sanitary sewer; deepwell injection; incineration	Secure landfill
Propellants	3	Contractor	Incineration
Miscellaneous Chemicals	800	Contractor; secure landfill; lagoon; incineration	Secure landfill
Total	6,000		

Source: Arthur D. Little, Inc., summary of responses from NASA installations to a letter request for information.

TABLE X-4

HAZARDOUS WASTE GENERATION BY FEDERAL AGENCIES (OTHER THAN DOD) IN REGION IX

Waste Type	Agency Category, MT/yr 1 R&D	2 Land Management	3 Regulatory and Control	Total
Acids	30	0.2	3	30
Caustics	10	0.8	0.9	10
Pesticides	0.5	30	1	30
Paint Sludge	20	3	2	25
Solvents	6	10	25	40
Chemical Toilet Wastes		400		400
Tank Bottom Sediment		50	0.2	50
Oil	9	40	200	250
Drilling Mud	4000			4000
Contaminated Soil and Sand	100	20		120
Laboratory Waste	2		3	5
General	1	70		70
Totals (MT/yr)	4200	600	200	5000
Containers (No.)	300	7600	100	8000

Source: Region IX Federal Task Force

(b) Land Management Agencies

Includes: U.S. Forest Service (USDA)
Bureau of Land Management (USDI)
Bureau of Reclamation (USDI)
National Park Service (USDI)

(c) Regulatory and Control Agencies

Includes: Animal and Plant Health Inspection Services (USDA)
U.S. Coast Guard (DOT)
Postmaster General (USPS)
Environmental Protection Agency (EPA)
Bureau of Alcohol, Tobacco, and Firearms (DT)
U.S. Customs Service

The Task Force suggests that larger volumes of hazardous waste are actually generated; i.e., that "the assessment was reasonably complete ..., although probably a minimum value." The quantity of potential hazardous wastes generated by non-DOD agencies in Region IX is estimated to be of the order of 5,000 MT/year.

D. COSTS OF COMPLIANCE WITH RCRA

The first compliance activity for Federal facilities will be the development of hazardous waste inventories. The inventories would be similar in form to the EPA industry assessment studies, and would include for each Agency:

- Number and location of hazardous waste generating facilities
- Types and quantities of hazardous wastes generated by each facility
- Current TSD method for each waste, including on-site/off-site distribution and distance from the point of generation to off-site TSD facilities.
- Current TSD costs, including technical costs and transportation costs, broken down to the extent possible with respect to capital amortization, labor, materials, equipment, utilities, etc.

Because of the paucity of the available data base, any estimate at this time of the total cost of compliance of Federal facilities with proposed RCRA regulations would be grossly inaccurate.

Unit costs of compliance for each Federal facility identified as a generator of hazardous waste will be about the same as those listed in Chapter V, with the possible exception of financial responsibility. For GOGO (government owned/government operated) or GOCO (government owned/contractor operated) TSD facilities, it is unclear whether the insurance or surety bond, and the closure and post-closure fund requirements for financial responsibility will be the same as for privately owned facilities. The current requirements for posting of funds are designed to insure that funds will be available for post-closure care if the owner/operator of a TSDF should go bankrupt or disappear. Federal agencies can be assumed to exist for site life plus 20 years; therefore, a closure and post-closure fund may be unnecessary.

Hazardous wastes generated by Federal facilities fall into two broad categories. The first encompasses wastes resulting from manufacturing, maintenance, laboratory, utility, pollution control, and other operations, which are closely analogous to similar operations in the private sector. For these wastes, current TSD practice is similar in the private and public sectors, and TSD options for compliance with the regulations are also similar. The decisions with respect to on-site vs. off-site TSD, contractor vs. self-transport, and choice of permitted TSDF will be made similarly on the basis of least cost and perceived risk.

The second broad category of wastes consists of those unique to the Department of Defense, for which there is essentially no counterpart in the private sector. This category includes conventional ammunition wastes, obsolete and surplus ammunition and ordnance, and highly toxic chemical agents slated for demilitarization. Conventional ammunition wastes are currently destroyed by open burning or open demolition. Neither practice is likely to meet RCRA regulations, and alternative methods of thermal destruction are likely to increase costs by several fold. Even if ammunition wastes were to be exempt from proposed prohibitions of open burning, significant changes would be necessary in current practices because there is evidence of contamination of the soil beneath the burning and demolition grounds, with the potential of leaching to groundwater. New facilities would have to be designed, or existing ones upgraded, to protect the groundwater resource as required by the regulations.

Obsolete and surplus ammunition and ordnance are stored, awaiting disposal, at 41 DOD facilities in 25 states. Design of safe and environmentally acceptable disposal technology is difficult, and must be done with meticulous care. The 90-day limitation on storage of these wastes is thus impractical, and permit requests for longer-term storage will have to be filed to meet the requirements of the RCRA regulations. The added costs of obtaining the permits are negligible in comparison with the current non-RCRA related costs of long-term storage and demilitarization activity.

Obsolete and surplus chemical agents (such as BZ, Orange, phosgene, etc.) are also typically stored for periods of time far in excess of 90 days prior to demilitarization/destruction. Again, disposal is difficult and dangerous. The chemical demilitarization methods designed and ultimately implemented would generally meet and far exceed proposed RCRA regulations. However, permit requests would have to be submitted for long term storage during the period that treatment/disposal technology is being selected, designed and tested.

RCRA regulations are intended to control the management of hazardous wastes which are generated after the date of promulgation of the regulations. The regulations are not directed towards the cleanup of inactive existing sites which may be sources of environmental contamination. The largest program in the country designed to identify and control migration of contaminants from improperly managed waste disposal sites of the past is the Installation Restoration (IR) Program of the Department of Defense.

XI. LIMITS OF THE ANALYSIS

The limits of the analysis are in three categories: data availability; analysis methodology; and topics covered. Data availability is the primary limitation of the analysis. Important analysis limitations are as follows.

The hazardous waste generation estimates were based upon assumptions made in the hazardous waste assessment reports for the ratio between waste generation and production and then assumptions about production in 1977 and beyond. These estimates were made over a several year period beginning in 1973. In many cases the projected production values and therefore the waste generation estimates have been found to be significantly different from actual 1977 production. In some cases these differences have been corrected. In others it is not possible to determine the specific assumptions used in the assessment reports. In addition, the degree to which the waste generation estimates (and from them the cost of compliance estimates) are in error is unknown.

The definition of hazardous waste used in the assessment reports differed by industry and may be different from what was ultimately to be included in the regulations. The list proposed in the regulations contains additional wastes not covered by this study. The additional wastes are either outside the 17 generating industries or were not thought hazardous at the time the assessment study was conducted.

The assessment reports and the study which updated the cost estimates generally provided information aggregated to a total industry level. The data are much less complete for industry segments at the product or plant level, which is the only level at which there is a good correspondence between production and waste generation. Also, there is little information on whether waste is processed on-site or off-site at the product level, though estimates of the on-site/off-site division at the total industry level have been made. The reliability of these estimates must be questioned because of the absence of underlying information at the segment level.

None of the separate generator industry economic impact studies used the compliance cost estimates reported here, which included the financial requirements and administrative costs. As a result, the compliance costs for a number of industry segments are much higher than was assumed in the individual industry studies. For the industry segments now having compliance costs of 2% to 15% of production value, as compared with previous costs of less than 1%, the previous economic impact analysis results cannot be extrapolated to the current cost levels. Plant closures and production curtailments are likely results of this level of cost. As a result, the impacts of the higher costs have been qualitatively discussed in this report.

The impact analyses of the transportation sector and the off-site waste management industry have not included the potential for a shift in hazardous waste flow in the HWMN. A shift of waste off-site could exceed the available capacity and significantly alter the economic impacts assumed under a static analysis.

The impacts of non-operational requirements have not been addressed. These impacts could result from requirements that facilities not be located in a 100-year flood zone, for example.

The constraints on new capacity as a result of local opposition to building hazardous waste management facilities have not been considered in this analysis. These constraints may prevent facilities from being located near urban areas and increase transportation costs significantly. Severe problems in this area could impede the successful implementation of the regulations. At present, there is no basis on which to predict the magnitude of this problem.

XII. ARTHUR D. LITTLE, INC., PROJECT TEAM

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APPENDIX A

FLOW CHART FOR COMPUTER MODEL

APPENDIX A

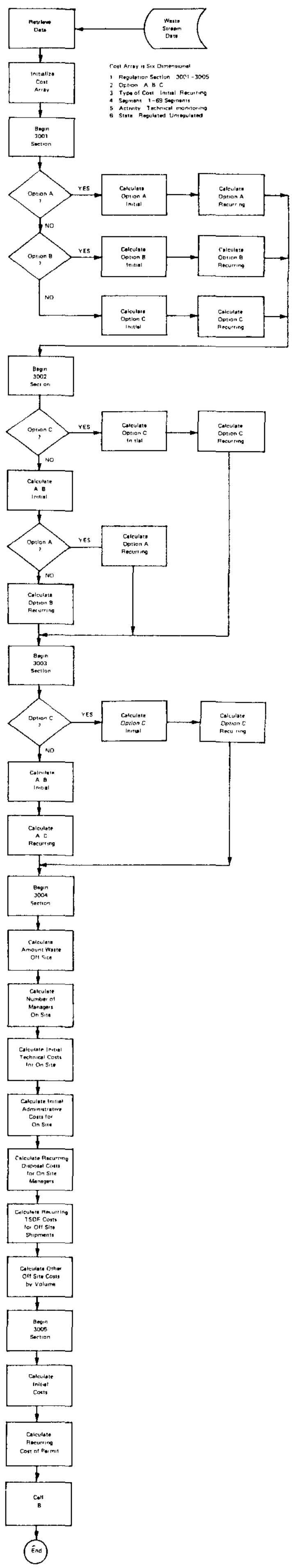
The model consists of two programs. Program A performs the calculations and Program B prints the report.

The data used in the program are summarized in Tables IV-1, IV-2, IV-3, IV-4, VII-7 and VII-8.

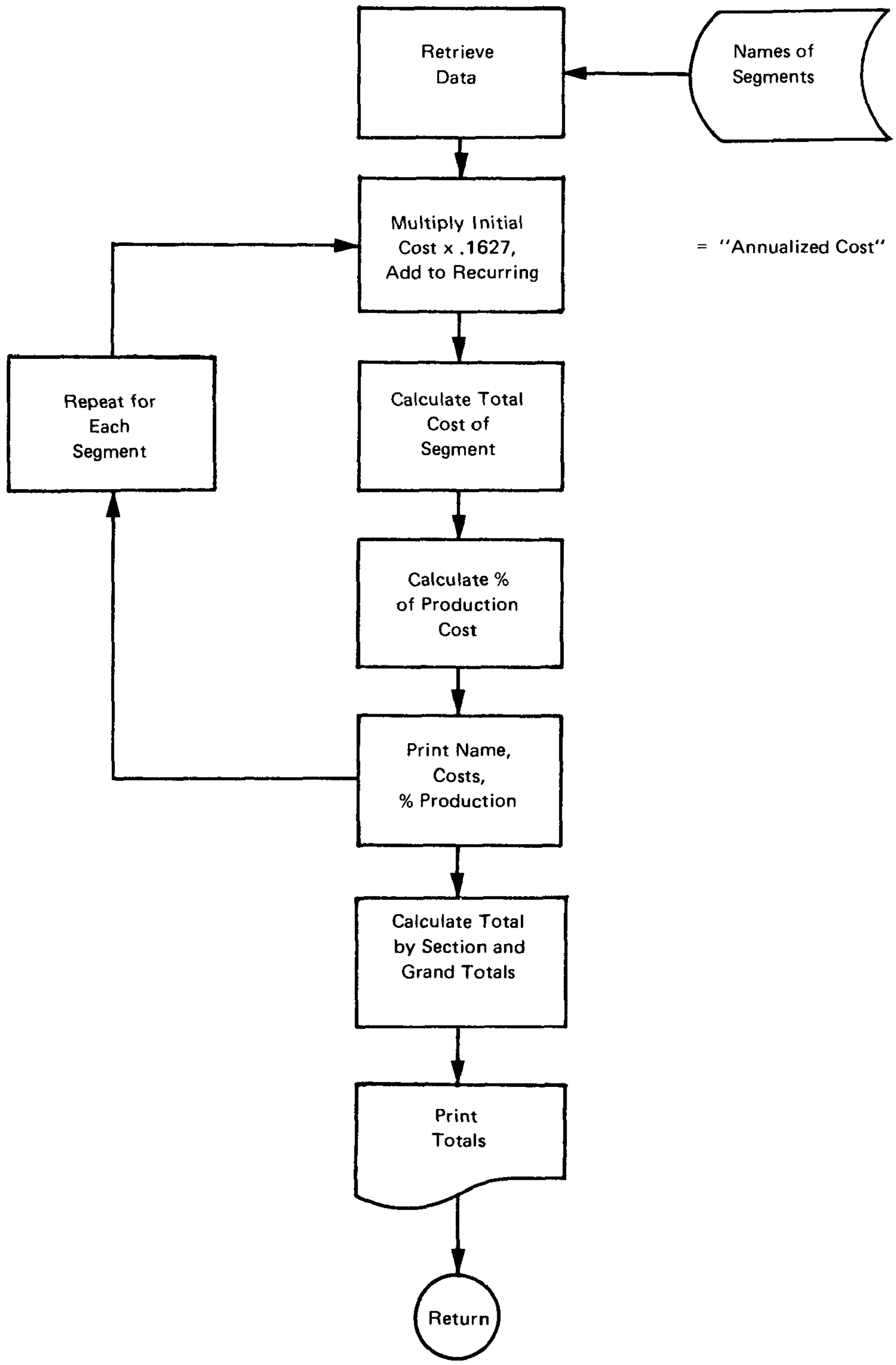
The methodology and equations used in the model are explained in Section D of Chapter IV, "Methodology for Calculating the Costs of Compliance."

The source language of the model was PL/I; containing approximately 500 statements.

PROGRAM A


Retrieve Data
Waste Stream Data
Cost Array is Six Dimensional
1 Regulation Section 3001 - 3005
2 Option A B C
3 Type of Cost Initial Recurring
4 Segment 1-69 Segments
5 Activity Technical monitoring
6 State Regulated Unregulated
Initialize Cost Array
Begin 3001 Section
Option A ?
YES
NO
Calculate Option A Initial
Calculate Option A Recurring
Option B ?
Calculate Option B Initial
Calculate Option B Recurring
Calculate Option C Initial
Calculate Option C Recurring
Begin 3002 Section
Option C ?
Calculate Option C Initial
Calculate Option C Recurring
Calculate A B Initial
Option A ?
Calculate Option A Recurring
Calculate Option B Recurring
Begin 3003 Section
Option C ?
Calculate Option C Initial
Calculate Option C Recurring
Calculate A B Initial
Calculate A C Recurring
Begin 3004 Section
Calculate Amount Waste Off Site
Calculate Number of Managers On Site
Calculate Initial Technical Costs for On Site
Calculate Initial Administrative Costs for On Site
Calculate Recurring Disposal Costs for On Site Managers
Calculate Recurring TSDF Costs for Off Site Shipments
Calculate Other Off Site Costs by Volume
Begin 3005 Section
Calculate Initial Costs
Calculate Recurring Cost of Permit
Call B
End

PROGRAM B


Retrieve Data
Names of Segments
Multiply Initial Cost x .1627, Add to Recurring
= "Annualized Cost"
Repeat for Each Segment
Calculate Total Cost of Segment
Calculate % of Production Cost
Print Name, Costs, % Production
Calculate Total by Section and Grand Totals
Print Totals
Return

APPENDIX B

SUMMARY

ECONOMIC IMPACT ANALYSIS OF HAZARDOUS WASTE MANAGEMENT REGULATIONS ON ADDITIONAL GENERATING INDUSTRIES

Prepared by

Energy Resources Company, Inc.

APPENDIX B

SUMMARY

This report has been prepared in support of the U.S. Environmental Protection Agency's development of an economic impact assessment of anticipated hazardous waste management regulations. The regulations, which will soon be proposed, are authorized by the Resource Conservation and Recovery Act of 1976 (RCRA, PL 94-580). This study involves the examination of two sets of draft RCRA regulations on seven industries which are generators of potentially hazardous wastes.

1.1 Regulatory Background

The Resource Conservation and Recovery Act of 1976 authorized EPA to promulgate such regulations for the control of hazardous wastes as may be necessary to protect human health and environment. EPA has developed two sets of draft regulations which provide for varying levels of environmental control. These are described below:

RCRA Option A: Regulations for Enhanced Protection of Public Health and Environment. This set of draft regulations provides for the maximum level of control in the handling and disposal of hazardous wastes.

RCRA Option B: Proposed Actions. This set of draft regulations incorporates a number of modifications to Option A requirements. Most importantly, RCRA Option B provides a modified definition of what constitutes a "hazardous waste." It also proposes separate disposal requirements for certain large-volume "special wastes."

An abbreviated comparison of major sections of RCRA Options A and B is provided in Table 1-1. Only several elements which are of particular importance in the assessment of economic impacts are shown in the table. Section 3001, which covers the definition of hazardous wastes, is significantly different between RCRA Options. In particular, the test protocol for potentially toxic wastes (The Toxicant Extraction Procedure [TEP]) was modified. Also, some of the toxicity tests, including that for aquatic toxicity, are not included in Option B. Section 3004, under only Option B, provides for definition of separate disposal requirements for "special wastes." These requirements have not been defined to date.

1.2 Industry Coverage and Basic Methodology

The six industries covered are shown in Table 1-2. Quite obviously, the industries covered vary from large (electric utilities, the paper industry) to small (chemical warehouses, drum reconditioners). A brief analysis was also made of waste generation among metal and mineral distributors. A summary of findings for that industry is included as Chapter 20.

For each industry, model and worst-case plants (or firms) were developed as an analytical tool. The model plant was defined to be representative of industry firms. Regulatory impacts on this firm are then an indication of impacts on most industry firms. The worst-case plant was defined to represent those plants which will face above-average compliance problems. These impacts are useful in estimating the likelihood of plant closures. The worst-case

TABLE 1-1

A HIGHLIGHT COMPARISON OF RCRA OPTIONS A & B[a]

REGULATION SECTION	COVERAGE	COMPARISON
Section 3001	Definition of Hazardous Waste	Option A provides a toxicity test protocol and several definitions of toxicity. Option B provides a less-stringent testing protocol and omits some of the definitions of toxicity.
Section 3002	Standards Applicable to Generators of Hazardous Wastes	Under Option B, generators of waste oil may transfer much of the cost of compliance to waste oil collectors. This provision is not included in Option A.
Section 3004	Standards Applicable to Hazardous Waste Management Facilities	Under Option A, all hazardous wastes must be handled in facilities which meet the general facility standards. Under Option B, separate requirements are to be defined for "special wastes," including electric utility wastes.

[a]Comparison is based on the RCRA regulations developed to date.

TABLE 1-2

SELECTED GENERATING INDUSTRIES

INDUSTRY	WASTE STREAM	MODEL PLANT	WORST-CASE PLANT
Electric utilities	Coal ash, FGD sludge	500-MW coal-fired plant	500-MW coal-fired plant[a]
Paper industry	Wastewater treatment sludge, chemical pulping wastes, bark and wood wastes, coal ash, secondary fiber reclamation wastes	910 MT/day[b] unbleached Kraft linerboard mill (virgin fiber)	360 MT/day folding boxboard mill (secondary fiber)
Gasoline service stations	Waste oil	Sales of $345,000 per year	Sales of $246,700 per year
Automotive repair shops	Waste oil	Sales of $80,000 per year	Sales of $40,000 per year
Drum reconditioners	Process wastes	1,000 drum/day reconditioning plant	1,000 drum/day reconditioning plant[a]
Chemical warehouses	Repackaging wastes	Sales of $10 million per year	Sales of $5 million per year
Agricultural services	Pesticide containers, dilute pesticide solutions and waste pesticides	3-aircraft aerial applicator (crop dusting)	1-aircraft aerial applicator (crop dusting)

[a]Worst-case impacts for these industries were defined as the generation of above-average waste quantities at a medium-sized facility.

[b]MT=metric ton.

impacts for most industries are likely to occur at small, economically vulnerable operations, and the worst-case firms have been designed accordingly.

1.2.1 Data Sources for Estimating Compliance Costs

The methodology for estimating compliance costs varies by industry. Consistent use was made of the work of two other EPA contractors, Arthur D. Little (Integrated Economic Impact Assessment of Hazardous Waste Management Relations, EPA, October 1978) and Battelle Columbus Laboratories (Cost of Compliance with Hazardous Waste Management Regulations, September 1978). The ADL study was used as the basis for estimating administrative costs (administrative costs are here interpreted to include monitoring and testing, reporting, training, contingency, and financial responsibility costs). However, a number of judgments had to be made concerning the applicability of various tasks and the costs which would be incurred in the various industries. As a result, the administrative costs should be considered ERCO estimates, based on the definition of tasks as supplied by ADL.

1.2.2 Limits of the Analysis

The estimates made in this study were based on data derived from a variety of sources. Each of the estimates and the basic data sources involve some degree of error. No estimation was made of the total probable error range for the cost estimates.

The waste stream designations made are also approximate. Available data in some cases were not sufficient to clearly assign a waste into the "hazardous" or "nonhazardous" category. Conclusions were drawn based upon the existing knowledge. This study was not designed to make a final identification of hazardous wastes in all of the study industries.

This study involves static analysis of the costs of compliance with regulations. It was assumed that access to all necessary treatment or disposal facilities would be available as needed at the estimated price or cost. Thus, for example, no estimation was made of the effect of increased demand due to regulation on the cost of services at hazardous waste facilities. Also no forecast was made of the future availability of such facilities.

1.3 Summary of Hazardous Waste Generation

The total hazardous waste generation by the six industries is provided in Table 1-3. The electric utility industry generates by far the largest amount of potentially hazardous wastes.

The total volume of hazardous wastes under the RCRA Options A and B is the same for all industries except pulp and paper. Several large volume wastes generated by pulp and paper mills are likely to be designated hazardous wastes only under RCRA Option A. The waste streams are wastewater treatment sludge, bark, and wood wastes and secondary fiber wastes.

The contribution of each waste stream to total industry wastes is shown in Table 1-4. Coal ash dominates the waste generation picture for electric utilities. Approximately 60 million metric tons (MT) of ash were generated in 1977 compared

TABLE 1-3

HAZARDOUS WASTE GENERATION BY SELECTED INDUSTRIES[a]

INDUSTRY	HAZARDOUS WASTE GENERATION, 1977 (000 MT)	
	AS DEFINED UNDER OPTION A	AS DEFINED UNDER OPTION B
Electric utilities	64,000	64,000
Pulp and paper	8,486	1,820
Gasoline service stations and automotive repair shops[b]	1,123	1,123
Drum reconditioners	170	170
Chemical warehouses	5	5
Agricultural services[b]	579	579

[a]ERCO estimates.

[b]Estimated waste volumes for 1978.

TABLE 1-4

MAJOR HAZARDOUS WASTE STREAMS FOR SIX INDUSTRIES (1977)[a]

INDUSTRY	WASTE STREAMS	VOLUME[b] (000 MT)
Electric utilities	Coal ash	60,300
	FGD sludge	3,700
	Oil ash	20
Pulp and paper	Wastewater treatment sludge[c]	2,580
	Chemical pulping wastes	523
	Bark and wood wastes[c]	2,700
	Coal ash	978
	Secondary fiber reclamation wastes[c]	1,694
Service stations and repair shops[d]		
Gas stations	Waste oil	619
Repair shops	Waste oil	183
New car and truck dealers	Waste oil	242
Fleets	Waste oil	79
Drum reconditioners	Process wastes	170
Chemical warehouses	Repackaging wastes	5
Agricultural services[d]	Pesticide containers	29
	Dilute pesticide solutions and waste pesticides	550

[a]ERCO estimates.

[b]Ash, FGD sludge, and bark quantities are expressed in dry weights. Approximate wet weights

[c]Wastes are hazardous only under the Option A version of Section 3001.

[d]Estimated waste volumes for 1978.

to roughly 4 million MT of sludge. A small volume of oil ash, which generally has a higher metals content (greater toxicity) than coal ash, was also generated. Coal ash is also generated in the paper industry in the amount of almost 1 million metric tons.

The largest volume waste streams among the other industries are waste oil (1.1 million MT) and dilute pesticide solutions (0.5 million MT). The total hazardous waste production for the drum reconditioning industry and for chemical warehouses was 170,000 MT and 5,000 MT respectively.

1.4 Summary of Compliance Costs

Total industry compliance costs under RCRA Options A and B are shown in Tables 1-5 and 1-6. Under Option A compliance costs total $1.1 billion, of which 75 percent are technical costs and 25 percent are administrative costs. Administrative costs are defined as the sum of monitoring, testing, reporting, training, contingency, and financial responsibility costs. The largest costs are incurred by the electric utilities industry ($606.6 million) and the pulp and paper industry ($354 million). Approximately $70 million in compliance costs would be incurred by both gasoline service stations and automotive repair shops. The major portion of Option A compliance costs under these industries are administrative costs. Total compliance costs equal approximately 1 percent of 1977 production value in all industries.

Compliance costs under RCRA Option B are substantially lower, although this is partly due to the interpretation given to the existing draft regulations. In particular,

TABLE 1-5

INDUSTRY INCREMENTAL HAZARDOUS WASTE MANAGEMENT COSTS (OPTION A)[a]

INDUSTRY	SIC CODE	1977 PRODUCTION VALUE ($MM)	TECHNICAL COMPLIANCE COSTS ($MM)	ADMINI-STRATIVE COMPLIANCE COSTS ($MM)	TOTAL COSTS ($MM)	TOTAL COSTS AS A PERCENT OF PRODUCTION VALUE
Electric utilities	4911	62,630	484.3	122.3	606.6	1.0
Paper and pulp	2611 2621 2631 2661	40,200	287.4	66.6	354.0	0.9
Gasoline service stations	5541	40,319[b]	27.4	42.7	70.1	0.2
Automotive repair shops	753	10,352[b]	21.8	44.8	66.6	0.6
Drum reconditioners	5085	640	7.1	0.5	7.6	1.2
Chemical warehouses	5161	2,700[b]	1.1	1.0	2.1	0.1
Agricultural services	0711 0721 0729	1,900	16.2	6.3	22.5	1.2
Totals		-	845.3	284.2	1,129.5	-

[a]ERCO estimates.

[b]Includes production value only among generators.

TABLE 1-6

INDUSTRY INCREMENTAL HAZARDOUS WASTE MANAGEMENT COSTS (OPTION B)[a]

INDUSTRY	SIC CODE	1977 PRODUCTION VALUE[b] ($MM)	TECHNICAL COMPLIANCE COSTS ($MM)	ADMINI-STRATIVE COMPLIANCE COSTS ($MM)	TOTAL COSTS ($MM)	TOTAL COSTS AS A PERCENT OF PRODUCTION VALUE
Electric utilities	4911	62,630	0.0	44.2	44.2	0.1
Paper and pulp	2611 2621 2631 2661	40,200	68.6	17.9	86.5	0.2
Gasoline service stations	5541	40,319[b]	27.4	9.7	37.1	0.1
Automotive repair shops	753	10,352[b]	21.8	10.2	32.0	0.3
Drum reconditioners	5085	630	7.1	0.4	7.5	1.2
Chemical warehouses	5161	2,700	1.1	0.9	2.0	0.1
Agricultural services	0711 0721 0729	1,900	16.2	5.5	21.7	1.1
Totals		-	142.2	88.8	231.0	-

[a]ERCO estimates.

[b]Includes production value only among generators.

technical compliance costs for electric utilities have been set at zero, pending the definition of facility standards for utility wastes. Costs are also significantly lower for the pulp and paper industry. The reduction is due to the likelihood of a "nonhazardous" label for most of the industry's wastes under RCRA Option B. Administrative costs for gasoline service stations and auto repair shops are also lower under Option B. Overall, RCRA Option B compliance costs for these six industries are $231 million.

1.5 Summary of Industry Impacts

The expected decline in net income (pretax) for the model and worst-case plants in each industry are shown in Table 1-7. These calculations were made under the assumption that no price change occurs which allows the firms to pass through compliance costs. Large declines in net income were noted for the agricultural services and drum reconditioning industries. Relatively small changes were noted for the model and worst-case plants in other industries. No numerical estimate was made of the decline in net income for the model plant in the electric utility industry. The regulatory process for electric utilities was not formally modelled, but the effect of RCRA on net income would, in all likelihood, be small. A small decline in net income would be expected due to the effect of normal regulatory lag on the ability of utilities to recover costs.

The overall industry impacts are presented for the two RCRA Options in Table 1-8. In these estimates, the likelihood of price increases and other factors were considered. The following definitions were used in defining the likelihood of plant closure: (1) "unlikely" means there

TABLE 1-7

MODEL PLANT IMPACTS UNDER RCRA OPTIONS A AND B[a,b]

INDUSTRY	% DECLINE IN NET INCOME			
	OPTION A		OPTION B	
	MODEL	WORST-CASE	MODEL	WORST-CASE
Agricultural services	24	46	23	44
Drum reconditioners	23	37	23	36
Paper and pulp (Kraft mill)	3	5	2	3
Automotive repair shops	5	7	3	4
Gasoline service stations	3	14	2	9
Chemical warehouses	1	4	1	3

[a]ERCO estimates.

[b]No numerical assessment of the change in model plant net income for electric utilities was made. Small impacts would be expected due to regulatory lag.

TABLE 1-8

POTENTIAL INDUSTRY IMPACT OF RCRA - OPTIONS A AND B[a,b]

INDUSTRY	NUMBER OF HAZARDOUS WASTE GENERATORS	PLANT CLOSURES	JOB LOSSES	PRODUCTION CUTBACKS	PRICE INCREASES	U.S. DEMAND REDUCTION	BALANCE OF PAYMENTS EFFECTS
Electric utilities	750	Unlikely	Unlikely	Unlikely	Small	Small	Slight import increase
Paper and pulp	561	Unlikely	Unlikely	Unlikely	Small	Small	None
Gasoline service stations	131,700	Unlikely	Unlikely	Unlikely	Small	Small	None
Automotive repair shops	138,300	Unlikely	Unlikely	Unlikely	Small	Small	None
Drum reconditioners	190	Possible	Possible	Unlikely	Small	Small	None
Chemical warehouses	360	Unlikely	Unlikely	Unlikely	Small	Small	None
Agricultural services	5,300	Probable	Probable	Unlikely	Small	Small	None

[a]ERCO estimates.

[b]Potential impacts as defined here are the same for both RCRA Options.

is estimated to be less than a 25 percent chance that 10 percent of the industry plants will close, (2) "possible" means there is a 25 to 50 percent chance that 10 percent of the industry plants will close, and (3) "probable" means there is a 50 to 75 percent chance that 10 percent of the industry plants will close. Price increases, all of which were estimated to be 3 percent or less, were defined as small.

Plant shutdowns appear most likely in the agricultural services industry. This industry includes a large number of small, economically vulnerable firms. Plant shutdowns are also possible in the drum reconditioning industry, as indicated by the estimated drop in net income for the model and worst-case plants. However, strong market conditions for this industry make it less likely that many firms will cease operations. Impacts on other industries should be small. Some plant closures could occur in the pulp and paper industry under RCRA Option A. However, it is extremely unlikely that 10 percent of the industry's mills would close.

No production cutbacks were forecast. Plant closures, where they occur, will be due to the combined influences of competitive and regulatory pressures. Remaining industry firms should, therefore, be able to handle the market demand.

A slight import increase is seen from the electric utility industry as a result of RCRA. The increase should occur from those utilities which are equipped to burn both coal and oil. In 1977, there were 96 utilities which burned coal and at least 100,000 barrels of oil. Some firms may increase oil purchases due to the added expense of coal ash disposal.

APPENDIX C

INCINERATION COSTS
FOR SELECTED WASTE STREAMS
AND
PROCESSES

TABLE C–1

ESTIMATED CAPITAL INVESTMENT AND OPERATING COSTS FOR FLUIDIZED BED COMBUSTION AND WET AIR OXIDATION OF WASTES USED

	Fluidized Bed Systech		Wet Air Oxidation Zimpro	
	Methyl Methacrylate Waste	Phenol Waste	Coke Plant Waste	Amiben® Waste
	13,200 cu m/yr	22,800 cu m/yr	700,000 cu m/yr	50,000 cu m/yr
Estimated Capital Investment, Millions of Dollars	5.98	6.07	10.7	2.20
Estimated Operating Costs, Dollars per Cubic Meter				
Operating Labor	9.30	6.60	0.35	2.50
Auxiliary Fuel	35.70	37.00	1.00	0.50
Utilities, Chemicals, and Freight	38.30	6.30	0.50	1.20
Maintenance	36.30	21.30	0.60	1.80
Cost of Follow-on Treatment			3.30	0.30
Capital Related Items	122.40	68.80	4.20	11.80
Total Estimated Operating Cost, Dollars per Cubic Meter	242.00	140.00	10.00	18.00

Source: Arthur D. Little, Inc., *estimates.*

TABLE C–2

ESTIMATED CAPITAL INVESTMENT AND OPERATING COSTS FOR PYROLYSIS OF WASTES*

	Surface Combustion Division of Midland Ross Corp.			
	API Separator Waste	Rubber		
	300 Metric Tons/yr	1000 Metric Tons/yr	2000 Metric Tons/yr	6000 Metric Tons/yr
Estimated Capital Investment, Millions of Dollars	0.44	0.67	0.92	1.50
Estimated Operating Costs, Dollars per Metric Ton				
Operating Labor	373.10	312.90	156.30	52.10
Auxiliary Fuel	52.80	21.10	21.10	21.10
Utilities, Chemicals, and Freight	5.80	5.60	5.60	4.50
Maintenance	117.30	53.60	36.80	20.00
Credit for Recovered Heat	(50.70)	(48.10)	(48.10)	(48.10)
Capital Related Items	395.70	180.90	124.30	67.40
Total Estimated Operating Cost, Dollars per Metric Ton	894.00	526.00	296.00	117.00

*No estimate was prepared for pyrolysis of styrene tars, since pyrolysis of this waste was not found to be a technically feasible destruction method.

Source: Arthur D. Little, Inc., estimates.

TABLE C–3
ESTIMATED CAPITAL INVESTMENT AND OPERATING COSTS FOR LIQUID INJECTION INCINERATION OF WASTES

	The Marquardt Company		Rollins Environmental Services	
	Ethylene Waste	Hexachlorocyclopentadiene Waste	Nitrochlorobenzene Waste	
	15,000 Metric Tons/yr	4500 Metric Tons/yr	4540 Metric Tons/4 mos	4540 Metric Tons/yr
Estimated Capital Investment, Millions of Dollars	1.82	1.63	1.25*	2.82**
Estimated Operating Costs, Dollars per Metric Ton				
Operating Labor	20.60	69.50	29.10	46.00
Auxiliary Fuel	–	94.00	51.70	20.20
Utilities, Chemicals, and Freight	5.90	201.30	62.10	18.10
Maintenance	9.70	30.00	24.80	31.00
Capital Related Items	32.50	97.20	74.30	167.70
Total Estimated Operating Cost, Dollars per Metric Ton	69.00	492.00	242.00	283.00

*Pro-rated investment for one-third time use of large facility.

***Based on engineering estimates of a facility dedicated only to destruction of nitrochlorobenzene wastes.*

Source: Arthur D. Little, Inc., estimates.

TABLE C–4

ESTIMATED CAPITAL INVESTMENT AND OPERATING COSTS FOR ROTARY KILN COMBUSTION OF WASTES

	Rollins Environmental Services	3M Company	
	PCB Capacitor Waste	PVC Waste	
	5000 Metric Tons/yr	335 Metric Tons/yr	6700 Metric Tons/yr
Estimated Capital Investment, Millions of Dollars	3.65	1.30	7.80
Estimated Operating Costs, Dollars per Metric Ton			
Operating Labor	79.20	380.30	44.50
Auxiliary Fuel	307.00	185.60	185.60
Utilities, Chemicals, and Freight	92.10	28.90	28.90
Maintenance	65.70	124.50	37.30
Capital Related Items	197.10	1,047.70	285.70
Total Estimated Operating Cost, Dollars per Metric Ton	741.00	1,767.00	582.00

Source: Arthur D. Little, Inc., estimates.

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