United States
Environmental Protection
Agency

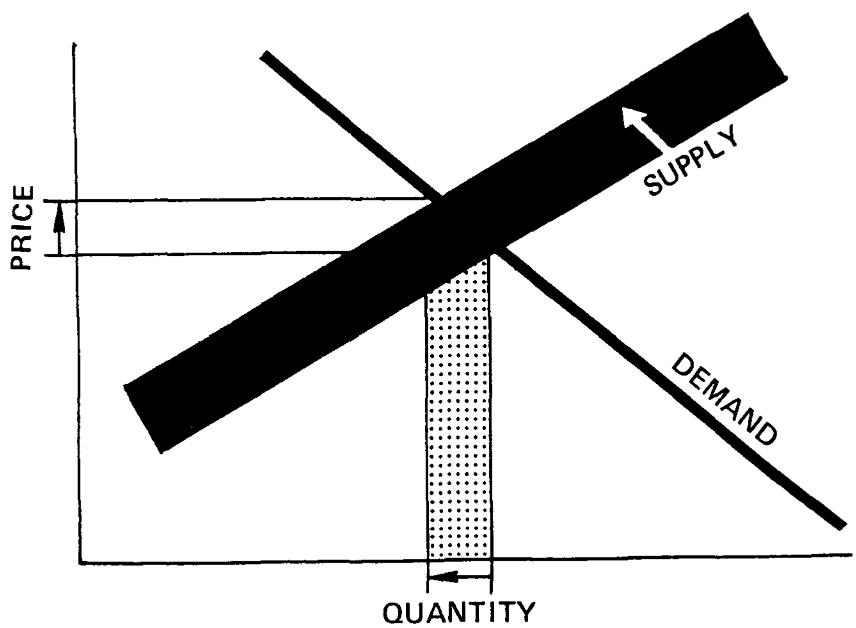
Office of Water Regulations
and Standards
Washington, DC 20460

EPA 440/2-85-027
September 1985

Water

EPA

Economic Impact Analysis of Effluent Limitations Guidelines and Standards for the Pesticide Chemicals Industry



ECONOMIC IMPACT ANALYSIS OF EFFLUENT LIMITATIONS GUIDELINES AND STANDARDS FOR THE PESTICIDE CHEMICALS INDUSTRY

Submitted to

Environmental Protection Agency
Office of Analysis and Evaluation
Office of Water Regulation and Standards
Washington, DC 20460

Submitted by

Meta Systems Inc
10 Holworthy Street
Cambridge, MA 02138

September 1985

This document is an economic impact assessment of the promulgated effluent limitations guidelines and standards. The report is distributed to EPA Regional Offices and state pollution control agencies and directed to the staff responsible for writing industrial discharge permits. The report includes detailed information on the costs and economic impacts of various treatment technologies. It should be helpful to the permit writer in evaluating the economic impacts on an industrial facility that must comply with BAT limitations or water quality standards.

The report is also being distributed to EPA Regional Libraries, and copies are available from National Technical Information Service (NTIS), 5282 Port Royal Road, Springfield, VA 22161, (703) 487-4550.

If you have any questions about this report, or if you would like additional information on the economic impact of the regulation, please contact the Economic Analysis Branch in the Office of Water Regulations and Standards at EPA Headquarters:

401 M. Street, SW (WH-586)
Washington, DC 20460
(202) 382-5397

The staff economist for this report is Mitchell Dubensky (202/382-5388).

P R E F A C E

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

This study supplements the Development Document (Section IV of the Pesticide Chemicals Industry Administrative Record) supporting the notice of these regulations. Section VI surveys existing and potential waste treatment control methods and technologies within particular industrial source categories and supports certain effluent limitations guidelines and standards based upon an analysis of the feasibility of these standards in accordance with the requirements of the Clean Water Act. Presented in Section VIII are the investment and operating costs associated with various control and treatment technologies. The attached document supplements this analysis by estimating the broader economic effects which might result from the application of various control methods and technologies. This study investigates the impact on product price increases, employment and the continued viability of affected plants, and foreign trade.

This study has been prepared with the supervision and review of the Office of Water Regulations and Standards of EPA. This report was submitted in fulfillment of EPA Contract No. 68-01-6774 by Meta Systems Inc. This analysis was completed in September 1985.

TABLE OF CONTENTS

Table of Contents (continued)

List of Tables and Figures

List of Tables and Figures (continued)

1. EXECUTIVE SUMMARY

1.1 Introduction

This report presents and analyzes the economic effects on the pesticide chemicals industry of effluent limitations guidelines and standards being promulgated at this time. This analysis utilizes data made available to the public subsequent to the proposal of regulations. The availability of this information was announced in Notices issued under authority of Sections 301, 304, 306, and 307 of the Federal Water Pollution Control Act, as amended by the Clean Water Act of 1977 (Public Law 92-500). The regulations analyzed in this document include limitations and standards based on:

- Best Practicable Control Technology Currently Available (BPT)
- Best Available Technology Economically Achievable (BAT);
- Pretreatment Standards for Existing Sources (PSES);
- New Source Performance Standards (NSPS); and
- Pretreatment Standards for New Sources (PSNS).

The primary factors examined by this study in determining the effects of these regulations include:

- Total capital and annual costs of compliance with the regulations;
- Potential changes in price, production costs, and profit;
- Potential plant and product line closures;
- Potential employment reductions;
- Balance of trade impacts;
- Impacts on new sources; and
- Impacts on small businesses.

For the purposes of this analysis, the pesticide chemicals industry is divided into three subcategories. The first is composed of plants that manufacture pesticide chemicals (active ingredients). This report analyzes 114, of the approximate 119, manufacturers of pesticide active ingredients affected by the regulation. These 114 plants comprise the majority of pesticide active ingredient production in the United States. Effluent limitations guidelines and standards are promulgated for both direct and indirect discharge plants.

The second subcategory includes plants that manufacture metallo-organic pesticides. This report analyzes the economic effects of the effluent limitations guidelines and standards for the one indirect discharging manufacturer of metallo-organic pesticides containing mercury which has been identified by the Agency.

The third subcategory is composed of pesticide formulating/packaging (PFP) plants that combine the pesticide active ingredients with substances such as diluents, emulsifiers, and wetting agents to produce final products and/or package them for distribution and sale. The plants included in the scope of this regulation encompass only those that formulate and/or package agricultural or household pest control products (herein referred to as PFP plants). A separate study was conducted for the soaps and detergents industry which included sanitizers and disinfectants (SIC 2841) and these products are not covered by the scope of this regulation. Since direct discharge plants already have been required to achieve zero discharge, the economic effects of the effluent limitations guidelines and standards examined in this report will apply only to indirect discharge PFP plants. The Agency estimates that this regulation applies to 169 indirect discharge PFP plants. A sample of 28 representative PFP plants is analyzed. The economic impacts for PFP plants are based on an extrapolation of data from the 28 indirect discharge PFP sample plants which submitted financial and production data, to the 169 plants in the industry. Total costs of compliance with the regulations are based on an extrapolation of the costs from these 28 sample plants to a total of 157 plants plus plant specific treatment costs for an additional 12 PFP plants.

A summary of the impacts for the three subcategories is shown on Table 1-1. The remainder of this chapter summarizes each of the following chapters of the report.

1.2 Methodology

1.2.1 Overview

The methodologies used to analyze the three subcategories of the pesticide chemicals industry are basically the same. The major steps in the analysis are:

- Estimate baseline prices and production levels (i.e., without additional treatment requirements).
- Estimate the effects of treatment costs on prices, production costs, and profitability.
- Estimate the likelihood of plant and product line closures based on a comparison of the current liquidation value of the plant to the net present value of the sum of earnings a plant could expect to earn if it met the regulations. This is called the net present value (NPV) test.

These steps are described in more detail in the following paragraphs.

Treatment cost estimates for specific plants are provided by the Industrial Technology Division, formerly the Effluent Guidelines Division, in EPA, based on their analyses of the waste streams at each plant and treatment systems which would enable each plant to meet the effluent limitations guidelines and standards. In addition, treatment cost estimates include monitoring costs for all plants and the incremental costs to comply with the Resource Conservation and Recovery Act (RCRA) requirements.

Table 1-1. Total Cost of Compliance and Industry Impacts
(Costs are in Thousands of 1985 Dollars)

	Pesticide Manufacturers			Pesticide Formulator/Packagers		Metallo-Organic Pesticide Manufacturers
	Total	Direct	Indirect	Indirect	Zero	Indirect
Number of Plants	119 *	42	36	169	1095	8
Number of Plants with Costs	42 *	21	21	169	0	1
Capital Cost of Compliance ($1,000)	107,705	68,656	39,049	22,559	21	+
Annual Cost of Compliance ($1,000)	53,795	35,107	18,688	16,963	16	+
% Increase in Price						
Total	1.30	1.30	1.30	0.0	0.0	0.0
Herbicides	1.70	1.70	1.70	0.0	0.0	0.0
Insecticides	0.64	0.64	0.64	0.0	0.0	0.0
Fungicides	0.81	0.81	0.81	0.0	0.0	0.0
% Increase in Production Cost						
Total	1.72	1.92	2.98	0.85	0.0	+
Herbicides	2.16	2.50	4.39	N.A.	0.0	+
Insecticides	0.81	0.95	1.23	N.A.	0.0	+
Fungicides	1.03	0.50	4.68	N.A.	0.0	+
% Decrease in Profit						
Total	0.73	0.80	1.61	2.00	N.A.	+
Herbicides	1.14	1.32	2.31	N.A.	N.A.	+
Insecticides	0.20	0.28	0.31	N.A.	N.A.	+
Fungicides	0.28	0.14	1.29	N.A.	N.A.	+

* 41 of 119 manufacturing plants analyzed incur treatment costs and/or RCRA costs and/or RCRA costs and/or monitoring costs. One plant is both a direct and an indirect discharger. Therefore, the plant is treated as two separate entities, one direct and one indirect discharger. In addition to the directs and indirects, there are 37 plants included in the total count that are zero dischargers.

N.A. Not applicable to the scope of this regulation.

\+ Not reported due to confidentiality.

1.2.2 Industry Surveys

Much of the analysis is based on the responses to two 308 Surveys conducted by EPA. In 1977, the Agency surveyed 117 pesticide active ingredient manufacturing plants. Since then, three of the plants have discontinued manufacturing pesticide active ingredients--therefore, only 114 manufacturing plants are included in this analysis.1/ In 1983, EPA surveyed formulator/packager plants. The survey consisted of two steps. First, a telephone survey was performed on a sample of plants drawn from the EPA Office of Pesticide Programs (OPP) file. The purpose of the telephone survey was to identify indirect discharge facilities that formulate and/or package agricultural pesticides or household pest control products, as defined by this regulation. Written questionnaires were sent to plants identified by the telephone survey as an indirect discharger within the scope of the regulation. Based on the results of the telephone and written surveys, it is estimated that there are approximately 1,264 PFP plants of which 169 are indirect dischargers covered by this regulation. The economic analysis for the PFP subcategory includes 40 indirect discharge PFP plants for which data are available from their written 308 Survey responses. The results for a scientifically designed sample of 28 plants are extrapolated to assess the effects on the estimated 169 indirect discharge PFP plants to be covered by the regulation.

1.2.3 Baseline Estimates

A baseline description of industry conditions (i.e., without additional treatment requirements) is developed separately for pesticide manufacturers and for pesticide formulator/packagers. The pesticide manufacturers 1982 baseline is derived from the production levels reported by individual manufacturing plants in the 1977 308 Survey. These 1977 levels of production are adjusted to reflect production levels and product mix in 1982. This adjustment is necessary because production levels of many pesticides decreased significantly between 1977 and 1982, while prices increased. Therefore, a baseline using 1977 production levels would overstate revenues for many plants in 1982. The quantity and price data are provided by the International Trade Commission (ITC).2/ Production quantity and value are also estimated separately for the three major product groups: herbicides, insecticides and fungicides, at each plant. This provides an adjusted total quantity of output for each of the 114 plants and an adjusted value of production. The total quantities and values of production for the manufacturing subcategory are equal to the sums of the quantities and values at all the individual plants. These adjusted plant quantities and revenues are used in the closure analysis.

1/Based on information currently available to the Agency, subsequent to the survey five additional plants have started to manufacture pesticide active ingredients.

2/ U.S. International Trade Commission, Synthetic Organic Chemicals, 1977 and 1982, USITC publications 920 and 1422.

The baseline value of production (i.e., production in the absence of additional treatment requirements) for formulator/packagers is derived from data provided primarily by the U.S. Bureau of the Census, for SIC Product Group 2879[1] and the 308 Survey results for indirect discharge formulator/packager plants. The 308 Survey is used to estimate a baseline for the indirect discharge PFP plants, while total PFP production is derived from the Census data. The difference between industry totals and indirect discharge estimates are attributed to the zero discharge plants. The PFP subcategory is analyzed as one market and not evaluated on a product group basis because the costs of compliance for this subcategory do not vary with the type of pesticide handled and because more detailed plant-specific and pesticide-specific financial data are available from the 1983 308 Survey, making product group analysis unnecessary.

1.2.4 Price, Production, and Profit Changes

It is assumed that manufacturers of pesticide active ingredients (Subcategory 1) will increase their prices in response to the regulations. The percentage increase in price for pesticide manufacturers is assumed equal to the average cost increase (i.e., the total annual cost of providing treatment for all plants in each product group divided by the total sales for that product group). This allows the percentage price increase to vary among the three product groups. The increase in prices will result in a decrease in demand, and thus a decrease in production levels and in profits. The amount by which production levels decrease depends on the price change and the price elasticity of demand. Price elasticities are estimated for each of the three product groups: -0.67 for herbicides, -0.32 for insecticides, and -0.35 for fungicides. It is assumed that the profit per pound of product is unchanged by the regulation. Therefore, profits drop by the amount of decrease in production.

It is assumed that the one plant identified by the Agency as an indirect discharge metallo-organic pesticide manufacturer of mercury will not be able to pass any of its treatment costs on to its customers. There are a number of other metallo-organic pesticide manufacturers who will not incur any costs as a result of this regulation since they are already zero dischargers due to the BPT regulation. In addition, the plant analyzed currently competes with foreign producers. Therefore, the no cost pass through assumption is reasonable. With no price change, there is no change in production levels and the total cost of compliance will come out of this plant's profits.

It is assumed that PFP plants will not increase their prices in response to the regulations. This assumption is based on several factors described in Chapter 2. In some cases, plants may be able to pass on all or part of the costs. Where this is possible, this analysis overstates the severity of the impacts on firms.

1/ U.S. Department of Commerce, 1981 Annual Survey of Manufactures, M81 (AS)-2.

1.2.5 Potential Plant and Product Line Closures

For the pesticide active ingredient manufacturing subcategory, the closure analysis as described when the regulations were proposed and in the June 1983 Notice of Availability began with a screening of plants to identify potentially impacted plants and product lines. The screening compared annual compliance cost to sales (ACC/S) at each plant. For plants with an ACC/S of one percent or more, a net present value analysis (NPV) was performed. The analysis presented in this report calculates the NPV ratio for all plants affected by the regulation. The NPV analysis is a comparison of the current liquidation value to the potential discounted earnings (including a final liquidation value) over a ten year period, with treatment costs included. If the current liquidation value is less than the sum of the discounted earnings, the Agency assumes that the company will invest in the necessary treatment equipment and remain open. For plants which are potential closure candidates according to the NPV test, additional factors are considered to refine the assessment of closure. These factors include: the pesticide products made, the financial strength of the parent company, and the degree to which this operation is important to the rest of the parent company's business.

This same net present value analysis is used to assess the potential for closure of the one metallo-organic pesticide manufacturer analyzed. However, there is one major difference between the analysis of plants in Subcategories 1 and 2. Pesticide active ingredient sales are not estimated on the basis of adjusted 1977 production levels for the one metallo-organic plant. Instead, sales are derived from the company's public comment to the Agency.

The NPV analysis is performed for each of the sample plants in Subcategory 3. Plant specific operating costs and revenues are available from the 1983 308 Survey. Therefore, the net present value without treatment costs, as well as with treatment costs, is calculated to determine the financial condition of each plant in the absence of this regulation. A plant which fails the net present value test without treatment costs is considered a baseline closure. Plants which fail the NPV test with treatment costs, but do not fail the NPV test without treatment, are considered potential closures due to the regulation.

1.3 Industry Characteristics

Pesticides are generally characterized by the type of pest controlled. There are three major product groups which describe both active ingredients and formulated/packaged products. These three product groups are:

- Herbicides, which control, prevent, or eliminate unwanted plants and plant parts;
- Insecticides, which control or prevent insects; and
- Fungicides, which control or destroy fungus and bacteria.

Herbicides are the most important product group in terms of quantity of pesticide active ingredients produced. Of the three product groups, it has experienced the most rapid growth over the past 15 years. This is the result of: increased acreage; development of new products; and more wide-spread, as opposed to infestation specific, use. The second most important group in terms of production is insecticides, and the smallest group is fungicides.

There are 114 plants which manufacture pesticide active ingredients analyzed by this report. Of the 114 plants, 40 are direct dischargers, 35 are indirect dischargers and two plants have both direct and indirect wastewater flows. Thirty-seven other plants are neither direct nor indirect because they utilize other means of discharge, such as deep well injection.

The 114 plants in the pesticide manufacturing subcategory are owned by 81 companies. These plants are located throughout the country with concentrations in the Southeast, the upper Midwest, the far West, and New York/New Jersey. Pesticides are generally manufactured in plants which also produce other products such as organic chemicals, including pharmaceuticals. With the exception of certain high-volume products, pesticides generally are not produced throughout the year.

It is difficult to obtain financial data on the pesticide operations of specific companies, since pesticide operations are generally not a major source of revenue for most of the companies and are not reported separately. Manufacturers of pesticide active ingredients include pertroleum companies, chemical companies, and pharmaceutical companies. The industry is relatively concentrated, with the top four companies accounting for 46 percent of the total industry value of pesticide production. Certain segments of the industry exhibit greater levels of concentration.

Agriculture constitutes the major market for pesticides. Demand is somewhat inelastic due to the relatively low cost of pesticides and their importance to farmers in maintaining crop production levels. The demand for pesticides is influenced by a number of factors which include: national farm policies and programs, crop acreage, pest conditions, weather, farm income, interest rates, pesticide prices, foreign crop production and exchange rates, and farming techniques.

The pre-tax profitability of specific pesticides varies from 10 percent to over 40 percent of sales, depending on the demand for the product, the product's effectiveness, whether the product is patented or not, and the availability of substitutes. The profitability of a specific product may shift as demand changes, as patents expire, and substitutes become available.

Entry into the pesticide active ingredient manufacturing sector of the pesticide industry usually requires a significant capital investment. Development of new products is also heavily dependent on research and development expenditures, or the licensing of the rights to produce a pesticide.

The United States is a net exporter of pesticides. On the basis of pesticide active ingredients, in 1980 the U.S. exported about 7.5 pounds for every pound imported. In 1980, exports of herbicides were equivalent to 16 percent of domestic production; for insecticides and fungicides, exports were 26 and 29 percent of U.S. production, respectively. Since 1980, imports have increased, while exports have declined. In 1982, the U.S. exported about four pounds for every pound imported.

There are about 1,264 plants which formulate and/or package pesticides; approximately 169 are indirect dischargers covered by the regulation. The plants tend to be concentrated in the Southeast and upper Midwest regions. Based on the 308 Survey about half of the indirect discharge PFP plants also manufacture some of the active ingredients that they formulate and package. There has been a significant trend over the past 10 years for manufacturers to integrate downstream and to formulate and package their own active ingredients. Formulating and packaging pesticides is less capital intensive than pesticide manufacturing.

1.4 Baseline Projections

Production of pesticide active ingredients by the 114 plants in 1982 is estimated to be 1.17 billion pounds, with sales valued at $3.85 billion. This production represents a capacity utilization rate of only 65 percent. Production in 1990 is projected to be 1.28 billion pounds, with a value (in 1982 dollars) of $4.95 billion. This represents an annual growth rate for production quantity of 1.7 percent and for unit value of 1.9 percent in real terms.

The value of PFP products by all plants in 1982 is estimated at $5.20 billion, of which indirect dischargers account for $1.56 billion (or 30 percent). The value of production for formulator/packager plants is estimated to grow at the same rate as for manufacturers, resulting in a value in 1990 of $6.69 billion for pesticide formulated/packaged products of which $2.01 billion will be produced by indirect dischargers.

1.5 Effluent Guideline Control Options and Costs

BPT, BAT, PSES, PSNS and NSPS effluent limitations guidelines and standards are analyzed for pesticide plants that manufacture active ingredients (Subcategory 1). Only PSES, PSNS and NSPS standards are analyzed for pesticide plants that manufacture metallo-organic pesticide active ingredients (Subcategory 2) and plants that formulate and/or package pesticides (Subcategory 3). BPT for Subcategories 2 and 3 already requires zero discharge.

The total capital and annual costs of compliance are shown in Table 1-1. For pesticide active ingredient manufacturing plants, the cost of compliance is the sum of three components: 1) the cost of the wastewater treatment system, 2) the monitoring costs, and 3) the incremental costs to comply with the Resource Conservation and Recovery Act (RCRA).

The treatment cost estimates to remove mercury for the one metallo-organic plant are presented by the company in their public comments. For pesticide formulating/packaging plants, all indirect discharge facilities incur costs under the recommended treatment technology and under an alternative technology where PFP limits were set equal to manufacturers.

1.6 Economic Impact Analysis

Price increases for manufacturers of pesticide active ingredients are expected to average approximately 1.30 percent, with associated increases in the cost of production of approximately 1.72 percent as shown in Table 1-1. For the three product groups, the percentage changes in prices and cost of production are: for herbicides, 1.70 percent increase in price and a 2.16 percent increase in the cost of production; for insecticides, 0.64 percent increase in price and 0.81 percent increase in the cost of production; and for fungicides, 0.81 percent increase in price and a 1.03 percent increase in the cost of production. The metallo-organic manufacturer is not expected to raise prices in response to this regulation. The change in the cost of production is not reported because the information is confidential. Formulator/packagers are not expected to increase prices in response to these regulations. Average profits will decline by approximately 2.0 percent for the indirect discharge PFP plants.

As a result of the NPV analysis, one plant which manufactures pesticide active ingredients (Subcategory 1) is expected to shut down its pesticide product line. Twenty four plants that formulate/package pesticides are also expected to shut down their pesticide product lines. Other products are also produced at these twenty five active ingredient and formulator/packager plants, and production of these other products is expected to continue. The one metallo-organic indirect discharger is not expected to close as a result of this regulation.

If the one manufacturing plant discontinues its pesticide production, this will result in the loss of one job. The twenty four formulator/packager plants that may discontinue PFP operations each employ less than one full-time PFP employee. The twenty five plants with potential product line closures are located in different, relatively large metropolitan areas and the job losses are not expected to significantly impact the surrounding communities.

The small price increases which will result from the regulation are expected to have little impact on overall foreign trade trends. Likewise, the product line closures are not expected to alter the structure of this industry.

Since there are no incremental costs above BAT and PSES associated with the new source performance standards (NSPS and PSNS), no additional impacts are expected.

The impacts projected for the pesticide chemicals industry in future years are less severe than for 1982. For pesticide active ingredient manufacturers the total cost of compliance represents about 0.8 percent of the value of production (in 1983 dollars) in 1990 compared to 1.1 percent in 1982. Therefore, changes in price, cost of production, and profits will be less severe in 1990 than the 1982 estimates. For the indirect discharge formulating/packaging plants, the profit reduction is estimated to be approximately 1.5 percent in 1990 compared to 2.0 percent in 1982.

1.7 Small Business Analysis

The small business analysis is conducted to determine whether the regulations may place a disproportionate burden on small businesses. For purposes of this analysis, companies that manufactured pesticide active ingredients are considered small if their annual sales are less than $10 million. Companies that formulate/package pesticides are considered small if corporate sales are less than $7.0 million. In terms of the number of closures, these regulations will have no small business impact on pesticide active ingredient manufacturers. In terms of the number of PFP closures, this regulation appears to have minimal impact on small businesses. The impact on each of these small pesticide formulator/packagers plants is neglible, with very few employees involved. Therefore, we conclude that the regulation does not have a small business impact.

2. ECONOMIC ASSESSMENT METHODOLOGY

2.1 Overview

This chapter describes the methodology, assumptions and data sources used in the analysis of the effects of treatment costs on the pesticide chemicals industry. The primary variables examined to determine the effects of the treatment costs are: changes in prices, production costs, profit, and employment; potential closures of plants and product lines; and shifts in foreign trade. The analysis also determines whether small businesses may bear a disproportionate share of the treatment costs to be incurred by the industry. Finally, the effects of treatment costs on new sources and the prospects for construction of new facilities or major modifications to existing facilities are considered.

The economic impact assessment utilizes wastewater treatment costs developed by the Industrial Technology Division (ITD) in EPA. The waste streams of pesticide plants were studied by ITD, and treatment systems (with associated costs) that enable each plant to meet the effluent guidelines limitations were identified. (These treatment costs include monitoring costs for all plants including those plants not incurring any treatment costs and the incremental costs to comply with the Resource Conservation and Recovery Act (RCRA).) The development of the estimated treatment costs for the pesticide chemicals industry, the assumptions made and the data used, are described in Section IV, Subpart B of the Pesticide Chemicals Rulemaking Record. The treatment costs are used along with the baseline estimates (an estimate of conditions in the industry in the absence of the regulations) to analyze the aggregate effect on the pesticide chemicals industry and on the major markets in which pesticides are used. In addition, a plant-level analysis is conducted to assess the likelihood that plants, or product lines, might close in response to the regulations. All pesticide manufacturing plants[1/] are subjected to a net present value (NPV) analysis to identify potential closure candidates. The NPV analysis is also used to identify formulator/packager plants[2/] which are potential closure candidates.

In general, the study proceeds through the following steps:

[1/] This includes Subcategory 1: Pesticide Active Ingredient Manufacturers, and Subcategory 2: Manufacturers of Metallo-Organic Pesticides.
[2/] This includes Subcategory 3: Pesticide Formulator/Packagers.

- Description of industry characteristics;
- Estimation of price elasticities;
- Development of industry baseline conditions;
- Analysis of compliance cost estimates;
- Estimation of changes in price, production costs, and profit;
- Assessment of plant closure potential;
- Assessment of other impacts;
- New source analysis; and
- Small business analysis.

As described in Chapter 3, the pesticide chemicals industry is a two-tiered industry. First the pesticide chemicals, or active ingredients, are manufactured. Second these chemicals are formulated into usable forms and packaged for sale and distribution. While many companies manufacture and formulate/package active ingredients at the same location, a majority of the plants do one or the other. The two tiers are analyzed separately, even though there are interrelationships, because separate effluent guidelines are being developed by EPA for the two tiers. The first tier, manufacturers, is broken into two subcategories: Pesticide Active Ingredient Manufacturers and Metallo-Organic Pesticides Manufacturers. The joint impact of the regulations on pesticide manufacturers and on formulator/packagers is analyzed where relevant.

2.2 Industry Characteristics

The first step in the analysis is to describe the basic characteristics of the pesticide chemicals industry. The characteristics are presented in Chapter 3, and include:

- Description of the industry subcategories;
- Plant characteristics;
- Product characteristics;
- Company characteristics, including concentration ratios, vertical and horizontal integration, and financial aspects;
- Description of markets; and
- Export and Imports.

Chapter 3 uses information obtained through the pesticide chemicals industry 308 Surveys described below, the U.S. Department of Commerce's Census of Manufactures, information from the U.S. Department of Agriculture, EPA, industry studies like the Kline Guide, and company annual reports.

2.3 Industry Surveys

Much of the analysis is based on the results of two 308 Surveys conducted by EPA. The 1978 survey addressed manufacturers of pesticide active ingredients and collected data for 1977. The 1983 survey addressed pesticide formulator/packagers and collected data for 1982.

2.3.1 Manufacturers of Pesticide Active Ingredients

The survey of pesticide active ingredient manufacturing plants collected data on production levels and wastewater characteristics. This survey covered 117 manufacturing plants within the scope of the regulations. Since then, three of these plants have discontinued manufacturing pesticide active ingredients. Therefore, 114 manufacturing plants are analyzed in this study and they are assumed to comprise most, if not all, of the manufacturing plants within the scope of this regulation. One of these 114 plants produces both pesticide active ingredients in Subcategory 1 and pesticide metallo-organic chemicals in Subcategory 2.

2.3.2 Pesticide Formulator/Packagers (PFP)

The majority of the information obtained on pesticide formulator/packager (PFP) plants is from a 308 Survey conducted by EPA in late 1983 and early 1984. Initially, EPA's Office of Pesticide Programs (OPP) generated a computerized list of 6,460 entries identified as potential PFP plants from Parts 2 through 5 of a FIFRA listing of Pesticide Formulators and Packagers. After an initial review to remove obvious duplicates, a listing of 3,980 individual plants remained. However, this number includes plants that formulate/package substances not included within the scope of this regulation, such as soaps and detergents, sanitizers and disinfectants. These products, which are part of SIC 2841, are covered by a separate study. In addition, the OPP list does not indicate the discharge status of any of these plants. Therefore a telephone survey was conducted on a sample of 1,263 of these plants. The plants in the sample are representative of all the plants on the list of 3,980, because they have been selected from the list on a random basis.

The telephone survey identified those plants that formulate/package agricultural or household pest control products and that discharge wastewater (or any other liquid) to a publicly owned treatment works (POTW) or to a privately owned treatment facility.[1/] That is, the telephone survey identified indirect discharge PFP plants as defined by this regulation.

A written questionnaire (described in Appendix 2-A) was sent to those plants identified by the telephone survey as indirect discharge PFP plants. In addition, written questionnaires were sent to two other groups from the sample of plants: 1) plants that would not answer the questions on the telephone, and 2) plants that could not be contacted by telephone because

---

[1/] If the privately owned treatment facility is owned by the same firm as the plant, the plant is excluded.

either no one answered the telephone or no telephone number was listed. The responses from those three groups are handled separately. In each of the three groups, not all surveys were returned. It is assumed that the non-respondents in each group are like the respondents in that group. In other words, the distribution across categories found in the responses is applied to the non-respondents to obtain an estimate for the total sample.

In many cases, the written survey confirms the results of the telephone survey. However, in some cases the plant responded that it was not a PFP plant and/or not an indirect discharger. Therefore, the number of indirect discharge PFP plants identified by the telephone survey is reduced, while additional PFP indirect discharge plants have been identified from the plants which did not respond to the telephone survey.

The number of plants and ratios shown in Table 2-1 reflect all the adjustments made to the telephone survey results as a consequence of the written responses. Counts according to the initial telephone survey are listed in the first column. These initial counts are adjusted positively or negatively based on follow-up surveys, and adjusted sample counts are listed in column six. The adjusted sample counts are extrapolated to the total inventory of 3,980 plants. The plants listed as not documented are allocated among the remaining categories. Finally, the plants not covered by the regulation are split from those that are covered by the regulation. These ratios are rounded to simplify the calculations and have been applied to the total of 3,980 plants. Complete financial and production cost information was available from 308 Surveys for only 28 of the 55 PFP indirect dischargers identified in the telephone survey. Therefore, total impacts (such as number of closures) are estimated by multiplying the impacts for the 28 by a factor of 6.04 (169/28).

2.4 Baseline Estimates

The baseline describes conditions in the pesticide chemicals industry in the absence of any additional costs for wastewater treatment. The conditions described are the value and volume of production, profit, plant capacity and employment. The baseline for manufacturers of active ingredients is developed separately from, but not independently of, the baseline for formulator/packagers. A separate baseline for metallo-organics pesticide chemicals is not estimated.

2.4.1 Manufacturers of Active Ingredients

The baseline for manufacturers of pesticide active ingredients is developed for the year 1982 and then projected to 1990. The baseline quantity of production is estimated from the production quantities (in pounds) reported for 1977 on the 308 Survey, adjusted to reflect changes in production levels between 1977 and 1982. The U.S. International Trade Commission (ITC) publishes data annually on the total quantity of active ingredients produced and the average unit value (dollars per pound) for all pesticides, based on reports of manufacturers. The ITC data show that overall production levels

Table 2-1. Extrapolation of Surveyed Plants to the Total Inventory of PFPs*

	Count according to initial phone survey	Change due to written survey of PFP/indirect 1/	Change due to written survey of plants unable to be contacted by phone 2/	Change due to written survey of plants unwilling to respond over phone 3/	Change due to zero discharge questionnaire of PFP/zero discharge plants 4/	Adjusted sample count 5/	Extrapolation of 3980 plants 6/	Allocation of not documented plants 7/	Corrected for unregulated pesticides 8/
Not a PFP	460	+30	+ 83	+20.5		593.5	1870.3	2151	2162
PFP/zero discharge	263	+38	+ 48	+20.5	-2.6	366.9	1156.2	1330	1095
PFP/indirect	99	-71	+ 19	+ 7	+2.6	56.6	178.4	205	169
PFP/not regulated	0					0	0	0	
Closed	8					8	25	29	
Foreign	18					18	57	66	
Duplicates	52	+ 3				55	173	199	
Unable to contact by phone	150		-150.0			0	0	0	
Not willing to respond by phone	48			-48.0		0	0	0	
Not documented	165					165	520	0	
Total	1263					1263	3980	3980	PFP = 1264

1/ 74 complete responses were received, allocation of the remaining 23 is based on response type ratios calculated from the 74 known responses from 97 plants initially identified as PFP/indirect.
2/ 47 complete responses were received, allocation of the remaining 103 is based on response type ratios calculated from the 47 known responses from 150 plants initially identified as unable to contact by phone.
3/ 35 complete responses were received, allocation of the remaining 13 is based on response type ratios calculated from the 35 known responses from 48 plants initially identified as not willing to respond to phone.
4/ Follow-up telephone surveys were made to 111 of the original 261 zero discharge PFP plants; 100 plants responded to the ZDO; 1 plant from the 100 surveyed is an indirect PFP. 261 plants were initially identified as PFP/zero discharge.
5/ Adjusted sample count is the sum of the initial survey and adjustments 1, 2, 3 and 4.
6/ Extrapolated values are based on a ratio, 3980/1263, multiplied by the final adjusted sample count.
7 520 plants listed here as not documented were proportionally allocated among nonPFP, PFP zero, PFP indirect, closed, foreign, and duplicate groupings.
8/ PFP's adjusted by ratio 28/34: six plants originally costed were found to be not regulated.

* A more complete discussion can be found in: "Evaluation of Regulatory Options and the Development of PSES and NSPS Compliance Costs for the Pesticide Formulating and Packaging Industry," Submitted to Industrial Technology Division, EPA, by JRB Associates.

of pesticide active ingredients have dropped significantly between 1977 and 1982.[1] In addition, production levels for different products have changed at different rates. Therefore, the 1977 production level of each pesticide reported in the 308 Survey is adjusted by applying the ratio of quantity sold in 1982 to quantity produced in 1977 for the relevant product subgroup. (See Table 2-2.) This yields an estimate of the quantity sold in 1982. The adjusted production level is estimated for each pesticide at each plant. These adjusted production levels are then summed to yield: total pesticide active ingredient production at each plant, total pesticide active ingredient production at all plants, and total production of each product group, (herbicides, insecticides, and fungicides).

Prices are estimated for each pesticide using the 1982 average prices (unit value) published by the International Trade Commission (ITC).[2] There are 19 subgroups to ITC's Pesticide and Related Products group for which ITC provides average prices. The subgroups are defined in terms of herbicide, insecticide, fungicide, and chemical composition, (e.g., by cyclic and acyclic groups and about 15 subgroups of these). In addition, prices on the other subgroups are published by ITC. Table 2-3 illustrates the breakdown used by the ITC. For certain pesticides, the ITC released product-specific price information for this study which is used instead of the published averages.[3] The 1982 prices multiplied by the adjusted quantities yield a reasonable baseline estimate of revenues at each plant, the total value of pesticide production, and the values of herbicide, insecticide, and fungicide production.

Profit, expressed as operating income after federal income taxes, is estimated as a percent of the total value of production or revenues. The percent is based on a 1982 analysis conducted by an investment firm of seven major pesticide manufacturing companies[4].

Industry production capacity is derived from the adjusted production quantity and from capacity utilization rates estimated by the U.S. Department of Agriculture from a survey of producers conducted in October-December 1982.[5]

1/ Synthetic Organic Chemicals, 1982 USITC Publication 1422, and 1977 USITC Publication 920.

2/ Ibid.

3/ ITC has released these prices only when the company involved has given written permission for the release.

4/ Smith Barney, Harris Upham and Company, Chemicals, July 23, 1982.

5/ U.S. Department of Agriculture, Inputs, Outlook and Situation, Economic Research Service, IOS-1, June 1983.

Table 2-2. Relationship of Quantity Sold in 1982 to Quantity Produced in 1977

Product	Quantity (000 lb.) 1982	Quantity (000 lb.) 1977	Ratio of 1982/1977
Cyclic			
Fungicides			
Naphthenic Acid	511	1,276	0.4005
All other	85,889	109,348	0.7855
Herbicides			
2,4-Dichlorophenoxy-ocetic acid dimethylamine salt	15,389	21,281	0.7231
2,4-Disoctyl ester	3,130	6,392	0.4897
All other	483,415	522,472	0.9252
Insecticides			
Organophosphorus	68,039	113,498	0.5995
All other	109,322	219,629	0.4978
Acyclic			
Fungicide			
Dithiocarbanic acid salts	21,189	29,650	0.7146
All other	2,443	3,003	0.8135
Herbicides	160,903	124,063	1.2969
Insecticides			
Organophosphorus	57,432	90,547	0.6343
Trichloronitro-methane	3,834	5,803	0.6607
All others	135,255	105,873	1.2775
Total ITC Pesticide Group1/	1,146,751	1,387,519	0.826
ITC Other Groups2/			
Chlorobenzene	63,799	325,518	0.1960
O-Dichlorobenzene	35,159	47,371	0.7422
P-Dichlorobenzene	49,468	65,094	0.7160
Trichlorobenzene	503,233	526,121	0.9565
EDB	75,777	244,238	0.3103
Grand Total	1,874,187	2,595,861	0.722

Source: *Synthetic Organic Chemicals*, 1977 and 1982, U.S. International Trade Commission.

1/ Section XIII, Pesticides and Related Products.

2/ Section III, Cyclic Intermediates; and Section XIV, Miscellaneous End-Use Chemicals and Chemical Products.

Table 2-3. ITC Prices for Subgroups

Pesticides and Related Products[1]	1982 Unit Value ($/lb)
Cyclic	
Fungicides	
Naphthenic acid, copper salt	.99
All other cyclic fungicides	3.04
Herbicides and Plant Growth Regulators	
2-Chloro-4-(ethylamino)-6-(isopropylamino)-5-triazine (Atrazine)	2.45
2,4,-Dichlorophenoxyacetic acid, climelthylamine salt	1.18
2,4-Dichlorophenoxyacetic acid, iso-octyal ester	1.17
3',4'-Dichloropropionanilide (Propanil)	---
All other cyclic herbicides	4.89
Insecticides and Rodenticides	
Organophosphorus	4.39
All other cylic insecticides and rodenticides	5.02
Acyclic	
Fungicides	
Dithiocarbamic acid salts	1.53
All other acyclic fungicides	2.62
Herbicides and Plant Growth Regulators	4.22
Insecticides, Rodenticides, Soil Conditioners, and Fumigants	
Organophosphorus	3.32
Trichloronitromethane (Chloropicrin)	0.91
All other acyclic insecticides	1.66
Other Subgroups[2]	
Chlorobenzene	0.32
O-Dichlorobenzene	0.38
P-Dichlorobenzene	0.36
Trichlorobenzene	0.40
EDB	0.27

Source: 1982 USITC publication 1422, Synthetic Organic Chemicals U.S. Production and Sales, 1982.

[1] Section XIII, Table 1.

[2] Section III, Table 1 and Section XIV, Table 1.

Baseline conditions are projected to 1990 based on rates of growth anticipated in a 1981 evaluation by the U.S. Department of Agriculture,[1] modified for the downturn in pesticide production that has occurred since then. The 1981 evaluation incorporated the trends in supply and demand and the changes in farming practices (e.g. no-till, integrated pest management) that are likely to occur. The projected dollar value of production in 1990 is based on an industry analysis with projected values adjusted to 1982 constant dollars.[2] Profits in 1990 are estimated using the same factors applied in deriving the baseline. The capacity utilization rate is based on the derived production level and the prospects for new pesticide active ingredient manufacturing plants.

2.4.2 Pesticide Formulator/Packagers

Estimates of total industry baseline value of production of formulated and packaged pesticide products are available from several sources that are independent from this economic impact assessment.[3][4][5] These sources were compared in order to select a baseline value of production. This comparison is presented in Appendix 4-B. Since the 308 Survey provided production and financial data on indirect discharge PFP plants only and zero discharge PFP plants tend to be smaller than indirect discharge PFP plants (see Chapter 4), the baseline for the total PFP industry is not estimated from the 308 Survey.

The value of PFP production accounted for by indirect dischargers is estimated from 308 Survey data. Twenty-eight plants submitted responses which are sufficiently complete to allow estimation of the value of production, employment, operating income and annual investment for the indirect discharger segment of the PFP industry. The questionnaire also requested the value of total plant production, and total plant employment. Employment, reported in estimated hours, is converted to full time equivalent (FTE) employees for the baseline using 1,960 work hours per year per full time employee.

As described above, it is estimated that 1,095 PFP plants are zero dischargers. It is assumed that these plants account for the difference between the total value of production and the value of production estimated for indirect dischargers. Employment at zero discharging plants is estimated, based on the average value of production per employee (FTE) as reported in the 308 Surveys and the total value of production estimated above. In other words, the total value of production for all zero discharge

---

1/ U.S. Department of Agriculture, Farm Pesticide Economic Evaluation, 1981, Economic and Statistic Service, Agricultural Economic Report 464.

2/ Frost and Sullivan, U.S. Pesticide Market, Report A907, May 1981.

3/ C.H. Kline & Company, The Kline Guide to the Chemicals Industry, Fourth Edition, Industrial Marketing Guide, IMG13-80, 1980.

4/ U.S. Department of Commerce, Bureau of the Census, Annual Survey of Manufactures.

5/ U.S. Department of Commerce, 1983 Industrial Outlook.

PFP plants is divided by the average value per employee at indirect discharge plants, yielding the estimated total number of employees at zero discharge plants.

Operating income and capital investment are estimated for indirect dischargers from 308 Survey data. These baseline variables are not estimated for the zero discharge segment of the industry, since these plants have already been regulated. However, the relatively small size of zero discharge plants suggest that the profit margins and scale of investment may be different from indirect discharge plants.

The baseline estimates for 1982 are projected to 1990. The total dollar value of production is estimated by applying the same real rate of growth derived for the pesticide active ingredient manufacturers in Chapter 4. The relative share of total production value for zero discharge and indirect discharge plants is assumed to be the same as used for the 1982 baseline. Employment in 1990 is projected using the 1982 production value per worker, adjusted for real growth in prices, and total value of production estimated for 1990. Operating income as a percent of production value is assumed constant over the future years; the dollar amount is therefore derived directly from the value of production.

2.5 Price Changes

Due to differences in the total number of plants, the proportion of plants incurring treatment costs in each subcategory, and the structure of the subcategories (e.g., patent protection), different assumptions about price responses were made for pesticide manufacturers and for pesticide formulator/packagers. As described below, it is assumed that manufacturers of pesticide active ingredients can pass on part of the treatment costs in the form of higher prices, and that manufacturers of metallo-organic pesticide chemicals and formulator/packagers absorb all of the costs and do not raise prices.

2.5.1 Manufacturers of Pesticide Active Ingredients

The economic impact analysis of manufacturers in Subcategory 1 assumes that the price increase for each product group (i.e., herbicides, insecticides, and fungicides) equals the average annual cost increase due to treatment requirements for all plants in the industry producing that product group.1/ Note that this does not imply that all costs are passed through

---

1/ Annual cost is the O&M cost for the treatment system plus an annualized portion of the capital investment, based on equipment life, cost of capital and tax rates.

in the form of higher prices, since the average includes those plants which do not incur any additional costs. The assumption of an average cost pass through is based on the fact that many of the products in this industry have little or no competition, which allows the companies to pass on some of the treatment costs. In addition, the smaller the proportion of industry production affected by the treatment costs, the smaller the proportion of the costs that can be passed on.

The price increase results in changes in demand and, in turn, changes in quantity and dollar value of pesticide sales, profit, and capacity utilization. Changes in the average prices of each product group (herbicides, insecticides, and fungicides) are calculated by summing the annual treatment costs for that product group for all plants, and dividing by the value of production of that product group using: a) the quantity reported in the 308 Survey adjusted to reflect production levels in 1982, and b) the 1982 price. This adjustment procedure is described above in section 2.4.1.

In order to estimate the effect of the price increase on production for the pesticide active ingredient manufacturing subcategory, an overall price elasticity of demand is estimated for all pesticides in addition to price elasticities of demand for each of three product groups. A price elasticity of demand measures how much the demand for a product will decline if the price increases by a given amount. It is defined as: the percent change in quantity divided by the percent change in price. Elasticities are estimated from historical data for the 1967-81 period using regression analysis. A description of the estimation procedure is presented in Appendix 2-B. The estimated price elasticities are:

- -0.67 for Herbicides;
- -0.32 for Insecticides;
- -0.35 for Fungicides; and
- -0.49 for all Pesticides.

In other words, if the price of herbicides goes up 10 percent, then the quantity of herbicides demanded by the market will decline by 6.7 percent. Likewise, a 10 percent increase in the prices of insecticides and fungicides will result in a 3.2 percent and 3.5 percent decline in demand, respectively.

2.5.2 Manufacturers of Metallo-Organic Pesticides

This analysis includes only indirect discharge metallo-organic plants, since direct discharge metallo-organic plants have already been required to achieve zero discharge under BPT. The Agency based the zero discharge PSES for Subcategory 2 plants which manufacture metallo-organic pesticides containing arsenic, cadmium and copper on the recommended treatment technologies of either contract hauling and incineration or recycle and reuse. The Agency did not calculate any compliance costs with this standard because there are currently no existing indirect dischargers manufacturing these pesticides. Since plants categorized as Subcategory 2 manufacture metallo-organic pesticide chemicals, they are analyzed in a manner similar to other pesticide manufacturing plants (Subcategory 1). However, the Agency identified only one plant that currently discharges to a POTW. The Agency believes that only this one plant will experience a cost increase due to this regulation. There are a number of other metallo-organic pesticide manufacturers who will not incur any additional costs as a result of this regulation because they do not discharge process wastewater. Lacking detailed market information on the competitive position of each product, it is not possible to estimate the portion of the treatment costs the plant could pass on to its customers. Therefore, the analysis assumes that none of the cost will be passed on and there will be no price increase resulting from this regulation.

2.5.3 Formulator/Packagers

This analysis concentrates on the microeconomic (plant-specific) effects of the regulation because the effects on the overall consumer or industrial price indices will be immeasurably small. Formulated products are made in a vast array of concentrations and forms, some requiring wet processes, and they frequently compete only in regional or other submarkets. Therefore, some plants may be able to pass on compliance costs, which causes the regulatory effects to be spread over all their customers. However, there are relatively few indirect discharging PFP plants within the scope of this regulation (approximately 169 out of an industry total of 1,264). Therefore, other plants will not be able to pass on the treatment costs. If, however, a plant must absorb the compliance costs and effectively reduce its profits, the effects of the regulation will be highly concentrated, resulting in a great likelihood of significant negative effects from the regulation. In order to understand what the concentrated effects on a plant might be, the Agency performs its economic analysis with the assumption of zero cost-past through by PFP plants.

2.6 Production, Profit and Employment Changes

Profit and employment changes are both a function of changes in production levels. As described above, production levels for manufacturers of pesticide active ingredients are expected to decline in direct response to the regulations, due to the resulting price increases. The percent reduction in production depends on the percent change in prices and the elasticities. Production levels for the metallo-organics and the PFP subcategories will not decline in direct response to the regulation, because the analysis assumes that there will be no price increases.

2.6.1 Manufacturers of Pesticide Active Ingredients

The percent changes in prices are multiplied by their elasticities to obtain the percent change in quantity produced. The production quantity before the regulation multiplied by the percent change in quantity yields the total change in pounds of production resulting from the effluent guideline requirements. Thus for herbicides (H):

$$\frac{(dp)}{(P)_H} = \frac{\text{Sum of treatment costs for herbicides}}{\text{Total value of all herbicides}} = \text{Percent Change in Price}$$

and

$$\frac{(dp)}{(P)_H} * \text{Elasticity} = \text{Percent Change in Quantity}$$

and

$$\frac{(dp)}{(P)_H} * \text{Elasticity} * \text{Quantity (lb.)} = \text{Quantity (lb.) Change as a Result of the Regulation}$$

And similarly for insecticides and fungicides.

The impact of treatment costs on value of production for the subcategory as a whole (and for each product group) is the difference between the baseline value of total production, and the new production quantity priced at baseline unit value plus average unit treatment cost. Impact on profit is derived from the absolute change in quantity produced multiplied by the unit profit before treatment; the assumption of average cost pass through, but without mark-up, maintains the same unit profit.

Change in employment is determined from the plant and product line closure estimates discussed later in this Chapter. Pesticide manufacturing employment for each plant is reported on the 1977 308 Survey, and those jobs are assumed to be lost at plants where closure is predicted. Change in the capacity utilization is calculated using the absolute change in production quantity and the subcategory-wide plant capacity.

2.6.2 Metallo-Organics

As discussed in the previous section, it is assumed that there are no price increases due to this regulation. The assumption of no cost pass through means that all of the compliance costs come out of profits for this plant and there will be no decrease in production.

2.6.3 Formulator/Packagers

As discussed above, it is assumed that there is no change in price for formulator/packagers, and so there is no change in production levels due to this regulation. Operating income (after income taxes) is estimated for each plant on the basis of the statutory tax rate, revenues, operating costs, and interest and depreciation for each plant as reported in the 308 Survey. This operating income is a proxy for profits. By including annual treatment costs in the calculation, a change in profits is estimated for the sample of plants. This is extrapolated for all indirect dischargers in the manner described in the section on the 308 Survey above.

2.7 Potential Plant and Product Line Closures

The Industrial Technology Division of EPA estimated costs of compliance for each plant in the study. The costs include capital investment and operating costs for wastewater treatment, plus monitoring and RCRA compliance costs. The costs are expressed as an annual cost by converting the capital cost to an annualized equivalent and adding it to the annual operating and maintenance cost. Capital costs are converted to an annual equivalent by multiplying by a capital recovery factor which measures the annual rate of return an investment must achieve to cover the cost of the investment and maintain net earnings, including depreciation and taxes. A capital recovery factor of 0.218 is used, based on a 10 year life for the treatment equipment, and a 13 percent annual cost of capital.

The central test used in the closure methodology is a comparison of the current liquidation value of the plant to the net present value of the stream of earnings the plant could expect to earn if it met the regulations. It is assumed that if the current liquidation value is less than the sum of the discounted stream of earnings (including a final liquidation), then the company will invest in the necessary treatment facilities and remain open. This is referred to as the net present value (NPV) test.[1/]

The mathematical representation of the net present value test is:

$$\sum_{y=1}^{Y} U_y \left(\frac{1}{1+r}\right)^y + \left(\frac{1}{1+r}\right)^Y L_Y \geq L_o$$

where: U_Y = operating income in year y
L_O = current liquidation value
L_Y = terminal liquidation value at the end of Y years
r = cost of capital.

The equation is in real terms (dollars and rates of return) not nominal terms. To facilitate the estimation, two simplifying assumptions are made.[2/]

1. Real operating income, U_r, is constant from year to year, i.e.

$$\bar{U}_Y = \bar{U}_r$$

2. The terminal liquidation value is equal to the current liquidation value, i.e.

$$\bar{L}_Y = \bar{L}_O$$

1/ Income to be received in future years is worth less today than the same income received today. Future income is discounted to take this into account.

2/ J. Yance, Office of Analysis and Evaluation, EPA, Analyzing Economic Impacts in a Period of Inflation, Draft, March 25, 1982.

Table 4-B-1. Estimates of Value of PFP Shipments; Various Data Sources

	Estimated Value (mill. $)			
Year	I	II	III	IV
1975			2056	2266
1976			2288	2430
1977	2704	2704	2443	3035
1978	3265	-	3045	3375
1979	3840	3840	3537	4150
1980	4688	4265		
1981	5234	4525		
1982		5160		

I. U.S. Department of Commerce, Bureau of the Census, 1981 Annual Survey of Manufactures, Value of Product Shipments, M81(AS)-2.

II. U.S. Department of Commerce, 1983 Industrial Outlook, Bureau of Industrial Economics, January 1983.

III. U.S. Department of Agriculture, The Pesticide Review 1978, Agriculture Stabilization and Conservation Service, February 1980 and unpublished data for later years provided by D. Lee Fowler, USDA pesticide specialist.

IV. C.H. Kline & Co., The Kline Guide to the Chemicals Industry, 1980. (The report notes that data shown for 1980 is probably low by 20%)

Appendix 4-B

Estimating the Formulator/Packager 1982 Baseline

Estimates of total industry value of PFP production are available from several sources independent of this report: The Annual Survey of Manufactures provides estimates for SIC product group 2879 up to 1981, the 1983 Industrial Outlook, presents estimates for selected years through 1982, the Kline Guide shows the value of shipments of formulated pesticides through 1980 (based primarily on the government publications cited above), and the USDA Pesticide Review. The Kline Guide notes that their estimates, based on government sources, probably underestimate the 1980 value by 20 percent because sales of some agricultural cooperatives and pesticide formulators are not included. The various estimates or value of PFP product shipments are summarized in Table 4-B-1.

Appendix 4-A

Estimating the Pesticide Manufacturing 1982 Baseline

Bureau of Labor Statistics data are used to compare 1982 and 1983 prices of pesticide active ingredients1/. The producer price index for code number 06-53 (i.e. "Other Agricultural Chemicals--i.e. herbicides, insecticides, fungicides, and other pesticides) is the relevant index for this analysis. For 1982 the index is 463.3 and for 1983 the index is 458.8. Thus 1983 prices are 99 percent of 1982 prices at the producers level; therefore 1983 prices are considered the same as 1982 prices for this analysis.

The profit estimate (i.e. after-tax operating income) is based on pre-tax operating income equal to 21.3 percent of sales value and an effective corporate income tax rate of 32.2 percent. These factors, developed in Chapter 2, represent averages for seven major pesticide producers analyzed in that section.

1/ Bureau of Labor Statistics, personal communication, March 1984.

19 percent of total fungicide farm use.[1] The major field crop markets for fungicides are peanuts, (84 percent of major crops fungicide use), followed by wheat (11 percent), soybeans (2 percent), and tobacco (2 percent). Approximately 81 percent of all fungicides for farm use are applied to fruits (particularly citrus), potatoes, sugar beet, and other vegetable crops.

Non-agricultural uses of fungicides constitute an important segment of the market. The industry which uses the greatest amount of fungicides is wood and lumber (for treating poles and posts). Other significant users include the paint, plastics, optical and photographic, leather, petroleum, pharmaceutical, and cosmetic industries.

The 1982 production of 111 million pounds represented only about 10 percent of total pesticide production and seven percent of total pesticide value. In 1982 fungicide production was about 33 million pounds less than in 1967 (see Table 3-22). The number of fungicide-treated acres increased 27 percent from 1964 to 1976, but decreased 35% between 1976 and 1982.[2] Relatively constant acreages for fruits and vegetables and major reliance on routine spray schedules assure a fairly stable demand.

1/ Eichers, T.R., P.A Andrilenas, T.W. Anderson, Farmers' Use of Pesticides in 1976, U.S. Department of Agriculture, Economics, Statistics, and Cooperative Service, Agricultural Economic Report 418, December 1978.

2/ U.S. Department of Agriculture Inputs--Outlook and Situation, Economic Research Service, IOS-1, June 1983.

but, by 1982, insecticide production of 379 million pounds was 144 million pounds less than that of herbicides. Thus, insecticides may be considered a more mature market; production quantity in 1982 was two thirds of the 1967 output. Sharp declines can be noted in the past decade: in 1976, 1980, 1981 and 1982 as shown in Table 3-21. Before the 1980 decline, the average annual growth rate between 1967 and 1979 was 1.8 percent, considerably lower than that for herbicides.

There are a number of reasons for the declines in insecticide production on a quantity basis. One major factor is the shift in types of insecticide chemicals used. There are three major types of insecticides used by farmers: carbonates, organophosphates, and organochlorines. The patterns of use of these three groups have changed because of environmental regulations and restrictions,* residue buildup, and reductions in efficiency due to pest resistance. These changes have led to corresponding changes in application rates. For example, in 1971, an average of 2.6 pounds of insecticides were applied to every treated acre while in 1976 this average declined to 2.0 pounds per acre. More recently, an even greater shift has occurred due to the introduction of a new class of chemicals, the synthetic pyrethroids. A major advantage of the pyrethroids is their effectiveness in controlling specific insect pests with a minimum of harm to beneficial insects. In addition, these chemicals are effective at much lower concentrations (some require only one-tenth the amount of chemical active ingredient per acre of other insecticides). The synthetic pyrethroids are used primarily on cotton. In the early 1970's, cotton accounted for about 50 percent of total insecticide use, but in 1980 the cotton share of the market had dropped to 40 percent, as production capacity for synthetic pyrethroids caught up with demand.

A second major reason for the decline in insecticide production has been the growing use of Integrated Pest Management (IPM), and alternative controls. Decrease in insecticide use is also a function of changes in the proportion of acres treated and changes in acres in production. In 1976, about 66 million acres were treated with insecticides, while by 1982 treatment declined to 54.2 million acres.

While the quantity of insecticide production has dropped since the mid-1970's, the unit value has increased. In 1982, unit value in real terms exceeded the value in 1974 by 102 percent. In comparison, the 1981 unit value of herbicides exceeded the 1974 value by only 19 percent.

Unlike herbicides and insecticides, fungicides are not used extensively on major field crops. As of 1976, major field crops accounted for less than

---

* For example, application of aldrin and dieldrin, the widely used organochlorine corn insecticide was suspended in 1974, as was the use of chlordane and heptachlor in 1976. The widely used organochloric cotton insecticide DDT, was also prohibited from being applied in the United States.

payment-in-kind (PIK) program implemented by the U.S. Department of Agriculture (discussed in Chapter 4). The increase in herbicide growth through 1981 can be attributed to the percentage increase in both planted acres of corn and soybeans, and the percentage of treated acres. Treated acreage of corn grew from 69 percent in 1972 to 93 percent in 1980 while the proportion of treated soybean acreage grew from an average of 71 percent to 92 percent.[1] The amount of herbicide applied, per acre, has also changed over the past two decades and is a second factor in the increasing growth rate of herbicide production. For example, in 1964 an average of 0.80 lbs of herbicides were applied per acre of major field crops while in 1976 and 1982 the proportion increased to 1.96 and 1.91 lbs/acre, respectively.[2] These higher use rates are attributable in part to increased use of multiple treatments and herbicide mixtures. More recently, over the 1977-1982 period, average unit value has increased by 5.8 percent while production quantity declined by 7.6 percent.

Until recently, application of insecticides was limited to fruits, vegetables, tobacco, cotton, and a few other specialized crops. In the past decade, however, a large percentage of corn and other field crops has also been treated with insecticides. For example, between 1972 and 1980, the proportion of all U.S. corn acreage treated has increased from 25 to 43 percent, and soybean acreage from 1 to 11 percent. In 1976, major field crops accounted for approximately 80 percent of the insecticide materials used on all crops and nearly 90 percent of the farm land treated with insecticides.[3] In 1976, the major agricultural uses, based on per pound of active ingredient, were cotton (40%); corn (20%); soybeans (5%); wheat (4.4%); and alfalfa/other hay (4.4%).

Insecticides are also used by livestock growers, particularly on beef cattle. These chemicals are applied in dilute sprays and at very low doses. Livestock insecticides constitute a very small percentage (2%) of the total insecticides market.

Insecticides accounted for 34 percent of U.S. pesticides production quantity and 30 percent of the value in 1982, down from 41 percent of the production quantity and 34 percent of the value in 1977 as shown in Table 3-19. In 1967, the 496 million pounds of insecticides produced represented 87 million pounds more than the herbicide volume for that year

---

1/ U.S. Department of Agriculture Inputs--Outlook and Situation, Economic Research Service, IOS-1, June 1983.

2/ Includes corn, soybeans, cotton, wheat, sorghum, rice, other small grains, tobacco, peanuts, alfalfa, hay and forage, and pasture and range land, excluding California.

3/ Eichers, T.R., P.A Andrilenas, T.W. Anderson, Farmers' Use of Pesticides in 1976, U.S. Department of Agriculture, Economics, Statistics, and Cooperative Service, Agricultural Economic Report 418, December 1978.

Appendix 3-E

Discussion of Major Markets and Uses for Pesticides

Approximately 85 percent of all herbicides for farm use (by weight of active ingredients) are used on four major crops: corn (53 percent); soybeans (21 percent); wheat (6 percent); and cotton (5 percent).1/ Constituting more than one-half of the agricultural herbicides market, corn also represents the single largest market for all pesticides in the U.S. The future demand for corn herbicides depends more on changes in corn acreage in production, than on significant changes in percentage of acres treated. This is because, as of 1976, more than 90 percent of all corn acreage in production was treated with herbicides. There is also a large proportion--about 90 percent--of soybean acreage currently treated with herbicides.

More than 95 percent of the herbicides produced are manufactured from synthetic organic chemicals. The herbicides most commonly applied are atrazine to corn, alachlor and trifluralin to soybeans, 2,4-D to wheat, and trifluralin and fluormeturon to cotton. The majority of pesticides marketed today are used to control pre-emergent weeds. However, due to changes in farming practices, use of post-emergent herbicides is increasing and it is estimated that markets for these chemicals will quadruple by 1985. The non-agricultural uses of herbicides include controlling unwanted plants on lawns, parks, and golf courses, and eradicating vegetation along right-of-way areas.

In 1982, herbicides accounted for 63 percent of total value and 56 percent of total quantity of all pesticides active ingredients produced, as shown in Table 3-14. Since 1967, herbicide production had grown from 409 million pounds to 623 million pounds in 1982, which is an average annual growth rate of 0.39 percent. During this period, the sharp decline in 1969 was attributed to disruption in the supply of the intermediate chemicals used in manufacturing herbicides. This disruption was caused by an increase in demand for defoliants during the Vietnam War which diverted the intermediate chemicals toward that end, and from which the industry took several years to recover. The sharp decline in 1982 is attributed to the downturn in the nation's economy, the large inventories carried over from prior years and the

---

1/ Eichers, T.R., and W.S. Serletis, Farm Pesticide Supply-Demand Trends, 1982, U.S. Department of Agriculture, Economic Research Science, Agriculture Economic Report, 485, April 1982.

Table 3-D-3. U.S. Fungicide Production (1967-1983)

Year	Production (Million Lbs.)	Production Value 1/ (Million $) Current	Constant 3/	Average Unit Value 2/ ($/lb) Current	Constant 3/
1967	144	66	66	0.46	.46
1968	154	72	69	0.47	.45
1969	141	68	62	0.48	.44
1970	140	71	61	0.51	.44
1971	149	82	68	0.55	.45
1972	143	93	74	0.65	.51
1973	154	114	85	0.74	.55
1974	163	139	96	0.85	.59
1975	155	174	116	1.12	.75
1976	142	165	99	1.16	.69
1977	143	203	115	1.42	.80
1978	147	214	112	1.46	.76
1979	155	279	135	1.80	.87
1980	156	309	137	1.98	.88
1981	143	358	145	2.50	1.01
1982	111	302	115	2.72	1.04
1983*	95	257	94	2.70	0.99
Average Annual Growth (%)					
1967-1974	1.8	11.2	5.5	9.2	3.6
1974-1982	-4.7	10.2	2.3	15.6	7.3

Sources: U.S. International Trade Commission, _Synthetic Organic Chemicals_, 1981 and prior issues; and, Arthur D. Little Inc., unpublished information furnished by EPA.

1/ Production value is derived as the average unit value multiplied by production quantity.
2/ Average unit value is production value divided by production.
3/ Constant 1967 dollar value is calculated using the GNP deflator (1967 = 1.00) from U.S. Department of Commerce, Bureau of Economic Analysis.
* Estimate for 1983 by Meta Systems Inc.

Table 3-D-2. U.S. Insecticide Production (1967-1983)

Year	Production (Million Lbs.)	Production Value[1/] (Million $) Current	Constant[3/]	Average Unit Value[2/] ($/lb) Current	Constant[3/]
1967	496	304	304	0.61	.61
1968	569	347	332	0.61	.58
1969	571	383	329	0.67	.61
1970	490	340	294	0.69	.60
1971	558	385	317	0.69	.57
1972	564	344	272	0.61	.48
1973	639	492	368	0.77	.58
1974	650	605	416	0.93	.64
1975	659	916	609	1.39	.92
1976	566	911	545	1.61	.96
1977	570	1,049	593	1.84	1.04
1978	606	1,232	647	2.03	1.07
1979	617	1,407	680	2.28	1.10
1980	506	1,265	560	2.50	1.11
1981	448	1,465	593	3.27	1.32
1982	379	1,282	490	3.38	1.29
1983*	326	1,092	401	3.35	1.23
Average Annual Growth (%)					
1967-1974	3.9	10.3	4.6	6.2	0.69
1974-1982	-6.5	9.8	2.1	17.5	9.2

Sources: U.S. International Trade Commission, Synthetic Organic Chemicals, 1981 and prior issues; and, Arthur D. Little Inc., unpublished information furnished by EPA.

1/ Production value is derived as the average unit value multiplied by production quantity.
2/ Average unit value is production value divided by production.
3/ Constant 1967 dollar value is calculated using the GNP deflator (1967 = 1.00) from U.S. Department of Commerce, Bureau of Economic Analysis.
* Estimate for 1983 by Meta Systems Inc.

Table 3-D-1. U.S. Herbicide Production (1967-1983)

Year	Production (Million Lbs.)	Production Value 1/ (Million $) Current	Constant 3/	Average Unit Value 2/ ($/lb) Current	Constant 3/
1967	409	617	617	1.51	1.51
1968	469	718	688	1.53	1.47
1969	393	662	602	1.68	1.53
1970	404	663	573	1.64	1.42
1971	429	781	643	1.82	1.50
1972	451	812	641	1.80	1.42
1973	496	843	630	1.70	1.27
1974	604	1,220	839	2.02	1.39
1975	788	1,781	1,184	2.26	1.50
1976	656	1,692	1,012	2.58	1.54
1977	674	1,867	1,054	2.77	1.56
1978	664	1,843	968	2.78	1.46
1979	658	2,020	977	3.07	1.48
1980	805	2,672	1,183	3.32	1.47
1981	839	3,373	1,366	4.02	1.63
1982	623	2,695	1,030	4.33	1.65
1983*	592	2,540	932	4.29	1.57
Average Annual Growth (%)					
1967-1974	5.7	10.2	4.5	4.2	-1.1
1974-1982	0.39	10.4	2.6	10.0	2.2

Sources: U.S. International Trade Commission, Synthetic Organic Chemicals, 1981 and prior issues; and, Arthur D. Little Inc., unpublished information furnished by EPA.

1/ Production value is derived as the average unit value multiplied by production quantity.
2/ Average unit value is production value divided by production.
3/ Constant 1967 dollar value is calculated using the GNP deflator (1967 = 1.00) from U.S. Department of Commerce, Bureau of Economic Analysis.
* Estimate for 1983 by Meta Systems Inc.

Appendix 3-D

Historical Data on Pesticide Active Ingredients; Production Quantity and Value

The tables show quantity and dollar value of production for herbicides, insecticides and fungicides.

Table 3-C-2. Profitability Ratios for Four Industries

(Percentage)

INDUSTRY	Profit Margin						Return on Equity						Return on Assets					
	Before Taxes			After Taxes			Before Taxes			After Taxes			Before Taxes			After Taxes		
	1982	1981	1980	1982	1981	1980	1982	1981	1980	1982	1981	1980	1982	1981	1980	1982	1981	1980
All Manufacturing	5.8*	7.4	7.7	3.8*	4.8	4.9	15.3*	21.4	22.0	10.1	13.7	14.0	Not available					
<u>Average</u>		7.0			4.5			19.6			12.6							
Chemicals and Allied Products	9.0*	4.8	10.5	6.4*	6.9	7.1	18.4*	21.7	22.6	13.0*	14.9	15.4	Not available					
<u>Average</u>		8.1			6.8			20.9			14.43							
Pesticides Manufacturing (All companies)	7.0	9.6	9.9	4.2	5.8	6.0	15.1	21.9	26.3	9.1	12.9	14.0	10.4	14.1	17.1	5.3	7.4	8.8
<u>Average</u>		8.8			5.3			21.1			12.0			13.9		6.2		
Pesticides Formulating/ Packaging	8.8	11.3	11.1	4.8	6.1	6.1	20.7	26.4	26.6	11.2	14.3	14.5	11.6	14.6	15.3	6.4	8.0	8.5
<u>Average</u>		10.4			5.6			24.6			13.3			13.9			7.6	

Source: Reference 18 and COMPUSTAT.

* First quarter only

Table 3-C-1
Financial Ratios For Pesticide
Formulating and Packaging Corporations*
(Percentage)

Formulating & Packaging Company	PROFIT MARGIN (PRE-TAX) 1982	1981	1980	PROFIT MARGIN (POST-TAX) 1982	1981	1980
Nalco Chemical	16.94	21.43	21.07	10.00	12.18	11.72
American Cyanamid	5.30	8.41	7.61	3.83	5.40	4.61
FMC Corp	6.00	7.66	5.01	4.36	5.24	4.10
Rohm & Haas	7.05	8.38	8.66	4.68	4.94	5.43
Du Pont	8.42	9.56	8.26	2.68	4.74	5.24
Gulf Corp.	8.96	12.11	15.85	3.17	4.36	5.31
Average	8.78	11.26	11.08	4.78	6.14	6.07
Avg. All Years	10.37			5.67		

	RETURN ON EQUITY (PRE-TAX) 1982	1981	1980	RETURN ON EQUITY (POST-TAX) 1982	1981	1980
Nalco Chemical	32.42	42.52	42.46	19.13	24.17	23.61
American Cyanamid	11.56	20.09	18.33	8.34	12.89	11.09
FMC Corp	13.69	19.86	14.02	11.34	13.60	11.46
Rohm & Haas	15.96	20.79	21.26	10.60	12.25	13.33
Du Pont	25.86	20.85	19.82	8.24	10.34	12.58
Gulf Corp.	25.70	34.26	43.55	9.08	12.33	14.60
Average	20.86	26.40	26.57	11.12	14.26	14.45
Avg. All Years	24.61			13.28		

	RETURN ON ASSETS (PRE-TAX) 1982	1981	1980	RETURN ON ASSETS (POST-TAX) 1982	1981	1980
Nalco Chemical	23.47	30.65	31.22	13.84	17.42	17.36
American Cyanamid	6.11	10.02	9.02	4.41	6.43	5.46
FMC Corp	6.65	9.41	6.67	5.51	6.45	5.45
Rohm & Haas	9.44	11.71	12.05	6.27	6.90	7.56
Du Pont	11.53	9.15	11.69	3.67	4.54	7.42
Gulf Corp.	12.47	16.75	22.52	4.40	6.03	7.55
Average	11.61	14.61	15.53	6.35	7.96	8.47
Avg. All Years	13.92			7.59		

* Based on data from Corporate COMPUSTAT, Standard and Poors Compustat Service, Inc.

Appendix 3-C

Comparison of Profitability Ratios for Formulator/Packaging Firms

Table 3-C-1 lists the six profitability ratios for the three years 1980, 1981 and 1982. The data are shown for six firms. Table 3-C-2 compares four sectors of the manufacturing industry.

Table 3-B-2. Profitability Ratios For Three Industries
(Percentage)

INDUSTRY	Profit Margin						Return on Equity						Return on Assets					
	Before Taxes			After Taxes			Before Taxes			After Taxes			Before Taxes			After Taxes		
	1982	1981	1980	1982	1981	1980	1982	1981	1980	1982	1981	1980	1982	1981	1980	1982	1981	1980
All Manufacturing	5.8*	7.4	7.7	3.8*	4.8	4.9	15.3*	21.4	22.0	10.1	13.7	14.0				Not available		
Average		7.0			4.5			19.6			12.6							
Chemicals and Allied Products	9.0*	4.8	10.5	6.4*	6.9	7.1	18.4*	21.7	22.6	13.0*	14.9	15.4				Not available		
Average		8.1			6.8			20.9			14.43							
Pesticides (All companies) Manufacturing	6.6	9.2	9.5	4.1	5.6	5.8	14.5	21.3	23.0	8.7	12.5	13.7	7.0	10.9	11.7	4.1	6.5	7.0
Average		8.4			5.1			19.6			11.6			9.9		5.8		

Source: Federal Trade Commission, Quarterly Financial Report, U.S. Government Printing Office, various issues, Washington, DC, and COMPUSTAT.

* First quarter only

Table 3-B-1. Profitability Ratios for Thirty-One Firms (cont.)

Return on Assets

Corporation	Pre-Tax Return on Assets 1982	1981	1980	Post-Tax Return on Assets 1982	1981	1980
Assets Less than $1 Billion						
Alco Standard	11.46	11.37	12.47	6.68	6.36	6.88
Great Lakes Chemical	12.68	15.50	24.81	8.12	10.59	16.01
Pennwalt Corp.	4.83	7.89	8.01	3.24	4.73	5.22
Reichhold Chemicals	2.47	7.29	6.23	1.25	4.17	3.76
Vulcan Materials	11.64	19.55	18.99	7.70	11.58	11.79
Witco Chemical	7.58	9.42	11.55	4.51	5.32	6.49
GAF Corp.	0.86	-5.90	1.30	2.60	-5.05	1.48
Fairmount Chemicals	-39.20	-7.98	-4.49	-36.40	-6.44	-2.24
Average of all Companies	1.54	7.14	9.86	-0.29	3.91	6.17
Average of all Years	6.18			3.26		
Average of First 6 Companies	8.44	11.84	13.68	5.25	7.13	8.36
Average of all Years	11.32			6.91		
Assets $1 - $10 Billion						
American Cyanamid	6.11	10.02	9.02	4.41	6.43	5.46
CPC International	15.81	14.81	14.17	9.68	8.87	8.48
Diamond Shamrock	7.25	12.47	11.80	4.68	7.63	7.20
FMC Corp	6.65	9.41	6.67	5.51	6.45	5.45
Hercules	5.35	9.39	7.27	4.34	6.83	6.83
Kerr-Mcgee	9.07	11.06	11.85	5.57	6.18	6.49
Martin Marietta	3.24	11.13	13.46	3.23	7.86	9.89
Merck & Company	16.41	17.71	22.89	11.38	12.83	14.58
Monsanto	8.24	11.42	3.55	5.41	7.33	2.57
Olin Corp.	3.36	8.39	2.47	3.26	5.74	2.19
Pfizer	14.52	11.99	12.24	8.88	7.54	7.57
PPG	6.23	11.93	13.11	4.74	7.15	7.40
Rohm & Haas	9.44	11.71	12.85	6.27	6.98	7.56
Stauffer	9.27	11.75	8.78	5.64	7.37	6.47
Uniroyal	3.11	5.21	1.43	1.85	3.11	-0.51
Upjohn	8.20	12.03	13.95	6.26	9.37	10.20
Average of all Companies	8.27	11.28	10.29	5.69	7.30	6.43
Average of all Years	9.95			6.54		
Assets Greater than $10 Billion						
Dow Chemical	2.66	5.95	10.73	2.90	4.51	6.98
Du Pont	11.53	9.15	11.69	3.67	4.54	7.42
Eastman Kodak	17.62	23.11	22.42	10.94	13.12	13.18
Gulf Corp.	12.47	16.75	22.52	4.40	6.03	7.55
Mobil Oil Corp.	12.32	19.84	25.73	5.05	9.00	11.03
Shell Oil	12.70	15.00	15.40	7.51	8.46	8.73
Union Carbide	3.81	9.15	11.20	2.92	6.23	6.97
Average of all Companies	10.44	14.14	17.10	5.34	7.41	8.84
Average of all Years	13.89			7.20		
TOTAL - All Companies	7.02	10.86	11.72	4.07	6.45	7.01
TOTAL - Average All Years	9.87			5.84		

Table 3-B-1. Profitability Ratios for Thirty-One Firms (cont.)

Return on Equity

Corporation	Pre-Tax Return on Equity 1982	1981	1980	Post-Tax Return on Equity 1982	1981	1980
Assets Less than $1 Billion						
Alco Standard	26.56	29.39	29.83	15.49	16.43	16.45
Great Lakes Chemical	21.19	24.23	31.59	13.56	16.56	20.38
Pennwalt Corp.	9.99	15.83	16.96	6.70	9.50	11.04
Reichhold Chemicals	4.47	14.19	12.88	2.26	8.13	7.78
Vulcan Materials	19.23	32.61	32.15	12.72	19.32	19.96
Witco Chemical	16.79	23.08	27.40	9.99	13.03	15.39
GAF Corp.	2.28	-24.53	7.44	6.70	-20.97	8.46
Fairmount Chemicals	-63.84	-13.13	-7.00	-59.28	-10.61	-3.50
Average of all Companies	4.57	12.71	18.91	1.02	6.42	12.00
Average of all Years	12.06			6.48		
Average of First 6 Companies	16.37	23.22	25.14	10.12	13.83	15.17
Average of all Years	21.58			13.04		
Assets $1 - $10 Billion						
American Cyanamid	11.56	20.09	18.33	8.34	12.89	11.09
CPC International	29.23	29.52	29.80	17.74	17.68	17.83
Diamond Shamrock	16.45	27.88	26.55	10.63	17.05	16.21
FMC Corp	13.69	19.86	14.02	11.34	13.60	11.46
Hercules	9.93	17.84	13.61	8.05	12.98	11.30
Kerr-Mcgee	20.40	25.16	24.79	12.54	14.06	13.59
Martin Marietta	21.04	23.61	25.25	20.99	16.67	17.06
Merck & Company	27.16	29.29	35.21	18.84	19.90	22.30
Monsanto	14.36	20.81	7.33	9.43	13.37	5.30
Olin Corp.	6.82	17.11	5.11	6.62	11.70	4.52
Pfizer	27.57	25.76	26.20	16.86	16.12	16.21
PPG	11.93	21.65	24.68	9.09	12.97	13.94
Rohm & Haas	13.96	20.79	21.26	10.60	12.25	13.33
Stauffer	18.70	23.23	19.81	11.39	14.57	14.59
Uniroyal	8.05	14.58	4.43	4.80	8.68	-1.59
Upjohn	16.97	24.18	26.93	12.95	18.83	19.70
Average of all Companies	16.86	22.58	20.21	11.89	14.59	12.93
Average of all Years	19.89			13.13		
Assets Greater than $10 Billion						
Dow Chemical	6.23	15.21	27.88	6.79	11.53	18.13
Du Pont	25.86	20.85	19.82	8.24	10.34	12.58
Eastman Kodak	24.82	32.25	32.56	15.41	18.30	19.14
Gulf Corp.	25.70	34.26	43.55	9.08	12.33	14.60
Mobil Oil Corp.	26.78	42.73	58.30	10.97	19.38	25.00
Shell Oil	26.38	32.64	33.48	15.60	18.40	19.04
Union Carbide	7.83	18.13	22.65	6.01	12.33	14.09
Average of all Companies	20.52	28.01	34.04	10.30	14.66	17.51
Average of all Years	27.52			14.16		
TOTAL - All Companies	14.52	21.26	23.00	8.72	12.49	13.72
TOTAL - Average All Years	19.59			11.65		

Table 3-B-1. Profitability Ratios for Thirty-One Firms

Profit Margin

Corporation	Pre-Tax Profit Margin 1982	1981	1980	Post-Tax Profit Margin 1982	1981	1980
Assets Less than $1 Billion						
Alco Standard	3.70	4.10	4.13	2.16	2.29	2.27
Great Lakes Chemical	15.10	17.55	23.19	9.66	11.99	14.96
Pennwalt Corp.	3.84	5.79	5.59	2.57	3.47	3.64
Reichhold Chemicals	1.11	3.13	3.81	8.56	1.79	1.82
Vulcan Materials	11.49	16.86	14.93	7.60	9.99	9.27
Witco Chemical	3.84	5.29	6.28	2.29	2.99	3.48
GAF Corp.	8.64	-4.91	1.34	1.95	-4.53	1.52
Fairmount Chemicals	-23.96	-4.94	-2.76	-22.25	-3.99	-1.38
Average of all Companies	1.97	5.36	6.95	0.57	3.00	4.45
Average of all Years	4.76			2.67		
Average of First 6 Companies	6.51	8.76	9.51	4.14	5.42	5.91
Average of all Years	8.27			5.16		
Assets $1 - $10 Billion						
American Cyanamid	5.30	8.41	7.61	3.83	5.40	4.61
CPC International	9.33	8.39	8.81	5.66	5.03	4.79
Diamond Shamrock	7.28	11.14	10.48	4.71	6.82	6.40
FMC Corp	6.00	7.66	5.01	4.36	5.24	4.10
Hercules	4.34	6.98	5.53	3.52	5.02	4.59
Kerr-Mcgee	9.03	9.87	9.56	5.55	5.52	5.24
Martin Marietta	2.68	8.60	10.63	2.60	6.07	7.18
Merck & Company	19.34	20.01	23.99	13.55	13.60	15.19
Monsanto	7.92	9.97	3.13	5.20	6.41	2.26
Olin Corp.	3.01	6.78	2.87	2.92	4.64	1.83
Pfizer	13.76	13.46	13.39	9.64	8.42	8.41
PPG	6.18	10.51	11.73	4.71	6.30	6.62
Rohm & Haas	7.05	8.38	8.66	4.68	4.94	5.43
Stauffer	12.54	13.85	18.94	7.63	8.68	8.06
Uniroyal	2.18	3.36	8.95	1.38	2.00	-0.34
Upjohn	9.03	12.30	13.23	6.89	9.57	9.68
Average of all Companies	7.94	9.98	9.07	5.42	6.48	5.88
Average of all Years	9.00			5.93		
Assets Greater than $10 Billion						
Dow Chemical	2.96	6.27	11.65	3.22	4.75	7.58
Du Pont	8.42	9.56	8.26	2.68	4.74	5.24
Eastman Kodak	17.31	21.12	20.16	10.74	11.99	11.85
Gulf Corp.	8.96	12.11	15.85	3.17	4.36	5.31
Mobil Oil Corp.	7.38	10.35	13.77	3.02	4.69	5.90
Shell Oil	13.53	13.95	13.68	8.00	7.86	7.78
Union Carbide	4.46	9.38	10.83	3.42	6.38	6.73
Average of all Companies	9.00	11.82	13.46	4.89	6.40	7.20
Average of all Years	11.43			6.16		
TOTAL - All Companies	6.62	9.20	9.51	4.05	5.57	5.81
TOTAL - Average All Years	8.44			5.14		

Appendix 3-B

Comparison of Profitability Ratios; Pesticide Manufacturing Firms

Table 3-B-1 shows the six profitability ratios for 32 pesticide manufacturing firms for 1980, 1981 and 1982. Table 3-B-2 compares pesticides manufacturing profitability with two other industry sectors: Chemical and Allied Products, and All Manufacturing.

Table 3-A-2. Pesticide Formulator/Packagers Zero Dischargers

Statistical Parameter	Year Established
Minimum	1880
Maximum	1977
Average	1945
Median	1948
Standard Deviation	21
Number of Respondents	46

Table 3-A-1. Pesticide Formulator/Packagers Zero Dischargers: SIC Code Summary

	Number of Times Reported		
SIC Code	Total	By Single SIC Code Plants *	By Multiple SIC Code Plants **
2879	52	34	18
2842	14	6	8
2899	9	5	4
2851	9	6	3
2873	7	3	4
2869	5	-	5
2841	4	1	3
2048	4	2	2
2819	3	-	3
2874	3	-	3
2875	3	2	1
2834	3	2	1
2861	2	-	2
2992	2	1	1
2870	2	2	-
3499	2	2	-
3523	2	1	1
2491, 2812 3079, 3221 3991	1 Each	1 Each	-
2047, 3292 3423, 3996 2891, 2649 2833, 2821	1 Each	-	1 Each

Source: Various state industrial guides. See the end of the Reference Section for a complete list.

* 72 plants reported a single SIC.

** 26 plants reported multiple SIC.

Appendix 3-A

Information on Zero Discharger Formulating/Packaging Plants

As described in Chapter 3, data are collected from state industrial guides for a sample of plants determined to be zero discharge PFP plants by the telephone survey. The state industrial guides used are listed in the reference section of this report. Table 3-A-1 summarizes the data on SIC codes reported by the zero dischargers in the state industrial guides. Since some plants report more than one SIC, the total number of times the codes are reported is greater than the number of plants reporting SIC codes. Ninety-eight plants report a total of 139 SIC codes, 72 plants report a single SIC and 26 plants report multiple SIC codes. Over thirty-seven percent of the codes reported SIC 2879--Pesticide Formulators and Packagers. This SIC is followed by:

SIC 2842--plants which manufacture specialty cleaning, polishing or sanitation preparations (10 percent).

SIC 2899--plants which manufacture or prepare miscellaneous chemicals, i.e., chemicals other than pesticides; soaps; other cleaning agents; paints and allied products; industrial organic and inorganic chemicals; plastics, and medicinal chemicals (6 percent).

SIC 2851--plants that manufacture or package paints, varnishes, lacquers, enamels, and allied products (6 percent).

SIC 2873--plants which formulate nitrogenous fertilizers (5 percent).

As expected, a majority of the SIC codes reported fall into the larger group of SIC 28--Chemicals and Allied Products. Out of the 139 SIC codes reported, 86 percent (120) fall in SIC 28. The distributions for single versus multiple SIC plants look similar. Of those reporting a single SIC, 47 percent (34 plants) report SIC 2879. Therefore it can be concluded that for a large proportion of formulator/packagers, this is neither their most important nor their sole product.

The year the plant was established is reported by 46 plants (see Table 3-A-2). For the most part, these are plants which have been established for some time. While the year established ranges from 1880 to 1977, the average (1945) is close to the median (1948). Unfortunately, no information is available on whether or not expansion or modernization have taken place recently.

$$\sum_{j=1}^{N} \frac{(\pi - t\pi) / (.9-C)}{(1 + K_f)^j} = 1$$

Assuming as before that the numerator is a constant over all periods, it represents the annuity whose present value is 1, given discount rate K_f and lifetime N.

Therefore:

$$\frac{\pi}{.9-C} - \frac{t\pi}{.9-C} = A(K_f, N) \qquad (2D\text{-}10)$$

$$\pi \left(\frac{1-t}{.9-C}\right) = A(K_f, N) \qquad (2D\text{-}11)$$

$$\pi = \frac{A(K_f, N)(.9-C)}{1-t} \qquad (2D\text{-}12)$$

Note that if the numerator is assumed constant (i.e., constant R-C, depreciation and tax rates) over all periods, it represents the annuity whose present value is 1, given discount rate K_f and lifetime N, i.e., $A(K_f,N)$. We can then "solve" equation (B-6) for ʊ using the tables for "Annuity whose Present Value is 1." Then ʊ will be the "capital recovery factor," expressed as a percentage of initial investment, which must be added to direct operating costs to ensure the project return equals its cost of capital. The result is given below:

$$\pi - t\pi + td = A(K_f,N)$$

$$\pi = \frac{A(K_f,N) - td}{1 - t} \qquad (2D\text{-}7)$$

Alternative Form

The 1981 tax reform act allows firms to depreciate capital stock for tax purposes at a rate faster than depreciation for economic purposes. Therefore d is no longer the inverse of N as above. In addition, a 1l tax credit is allowed on new investments, thus reducing the initial cost of the investment to 91 of its original cost. Therefore, equation (B-6) above becomes:

$$\sum_{j=1}^{N} \frac{\pi - t\pi}{(1+K_f)^j} + \sum_{1=1}^{n} \frac{td}{(1+K_f)^1} = .9 \qquad (2D\text{-}8)$$

where:

n = depreciation lifetime under tax code
d' = new depreciation rate

Setting:

$$\sum_{1=1}^{n} \frac{td'}{(1+K_f)^1} = C$$

Then:

$$\sum_{j=1}^{N} \frac{\pi - t\pi}{(1 + K_f)^j} = .9\text{-}C \qquad (2D\text{-}9)$$

remain constant over the next several years. Given changes in tax codes, and changes in the availability of certain sources of capital such as industrial revenue bonds, this is unlikely. Therefore we expect that the cost of capital will be higher than 11 percent. Given the mix of financing sources available, it is unlikely to be as high as 15 percent and we believe that 13 percent is a good estimate of the weighted cost of capital for the period covered by this study.

Original Form

The capital recovery factor can be expressed analytically as follows. Let:

R	=	annual revenue
C	=	annual variable costs: labor, materials, energy, etc.
I	=	investment cost
υ	=	capital recovery factor = (R-C)/I
d	=	depreciation rate
t	=	tax rate
K_f	=	weighted cost of capital (after-tax)
N	=	investment lifetime in years
$A(K_f,N)$	=	annuity whose present value equals 1, given discount rate K_f and lifetime N.

Given revenues and direct costs, average cost of capital, tax rates, depreciation rates, and investment lifetime, the problem is to find that gross return per dollar of invested capital which allows the firm to just cover its costs of capital, depreciation, and taxes and maintain the value of the firm. Equation (B-5) expresses the relationship that must hold for the firm to break even on its invested capital, I. In other words, the present discounted value of the net income flow (using the average cost of capital as the discount factor) just equals the cost of the firm's initial investment:

$$\sum_{j=1}^{N} \frac{(R-C) - t(R-C) + tdI}{(1 + K_f)^j} = I \qquad (2D\text{-}5)$$

The numerator of the left-hand side of equation (B-5) shows net profits plus the tax subsidy on depreciation. Note that the tax subsidy on interest payments is not included because it is already taken into account by using the after-tax cost of debt in the average cost of capital. Dividing equation (B-5) by I and substituting υ for (R-C)/I gives:

$$\sum_{j=1}^{N} \frac{\pi - t\pi + td}{(1 + K_f)^j} = 1 \qquad (2D\text{-}6)$$

Table 2-D-1. Alternative Derivations of the Capital Recovery Factor

Variable	Values						
Weighted cost of capital (K_f)	.10	.15	.20	.10	.13	.15	.20
Life of asset (N)	10	10	10	10	10	10	10
$A(N, K_f)$	.163	.199	.239	.163	.185	.199	.239
Depreciation life (n)	10	10	10	5	5	5	5
Depreciation rate (d)	.10	.10	.10	.20	.20	.20	.20
Tax rate (t)	.50	.50	.50	.50	.50	.50	.50
c				.330	.310	.310	.275
CRF(1)	.226	.298	.378				
CRF(2)				.218	.255	.279	.347
CRF(3)				.185	.218	.239	.299

where: CRF(1) is original formula (2D-1 in text)
CRF(2) allows for rapid depreciation but not investment tax credit
CRF(3) allow for both rapid depreciation and investment tax credit (2D-2 in text)

changes in the federal tax code, the economic life of a capital item is now considerably longer than the depreciation life for tax purposes. Based on earlier work the lifetime of capital stock for this industry is assumed to be about 11 years.1/ The depreciation rate for most personal property now is straight-line over five years (21). These values are used in the revised calculation of the capital recovery factor.

Tax Rate

The current federal corporate income tax rate is 21 percent on the first $25,111 of profits, 22 percent on the next $25,111, and 46 percent on all profits over $51,111. For this analysis, we assume that plants are paying an even 46 percent federal tax on all profits. A study by Lin and Leone2/ indicates that state and local income taxes also are a significant factor in pollution control investments. State corporate income tax rates may be as high as 9.5 percent. In their study, a weighted average of 7 steel-producing states yielded an average state corporate income tax rate of 7.55 percent. State income taxes, of course, are deductible expenses in computing corporate income tax. We assume a state corporate income tax rate of 8 percent. Deducting this figure before computing the federal income tax rate reduces the net effect of the 8 percent rate to about 4 percent. Thus, the overall effective income tax rate is approximately 51 percent.

Sensitivity Analysis

Table 1 presents various values for the capital recovery factor, assuming various weighted costs of capital (K_f) and different formulations allowing for changes in the federal tax code. Both the rapid depreciation and the investment tax credit serve to lower the capital recovery factor, thus reducing the return necessary to justify a given investment.

In previous work in both the pulp and paper industry and the organic chemical industry, we have estimated the weighted cost of capital based on the current costs as reflected in the current prices and yields of a sample of corporate stocks and bonds for that industry. In August of 1979, the weighted cost of capital for the organic chemical industry was estimated to be about 11. There are two major assumptions in using this method. First that current prices and yields accurately reflect future costs of capital. However, interest rates have increased significantly since the summer of 1979. Second, that the current portfolio mix will

---

1/Draft Industry Description: Organic Chemical Industry, Vol I, December 1979.

2/An Loh-Lin and Robert A. Leone, "The Iron and Steel Industry," in Environmental Controls, (Robert A. Leone, ed.), Lexington, MA: Lexington Books (1976), p. 70.

1) yield to maturity
2) debt outstanding
3) closing price

First, the total market value of each bond issue is calculated as the bond price multiplied by the amount of debt outstanding. Second, the average cost of debt is calculated as a weighted average of the various values for yield to maturity, where the weights equal the ratio of the market value of each bond issue to the total value of debt. The average before-tax cost of debt for these companies is 9.89 percent.

Cost of Equity. A firm's cost of equity can be expressed in equation form as:

$$r = \frac{e}{P} + g \qquad (2D\text{-}4)$$

where e is the annual dividend, P is the stock price, and g the expected growth rate of dividends.[1] To estimate the firms' cost of equity, the following data were obtained from Standard and Poor's Stock Guide (August 1979):

1) dividend yield;
2) closing price;
3) number of shares outstanding.

Information was collected for common stocks. The existence of preferred stocks complicates the calculations substantially, since a preferred stock is more nearly a stock-bond hybrid. Preferred stocks are ignored except where they represent more than 11 percent of the market value of all stocks. In those cases where preferred socks represent a signficiant portion of equity, the company was removed from the survey.

An estimate of the expected growth rate was obtained using data from the USITC Organic Chemicals (1977) and the DRI Chemical Review. A weighted average of annual growth rates for plastics, fibers, and elastomers sales was obtained for the entire industry:

$$g = \underset{\text{Plastics}}{.745(7.1)} + \underset{\text{Elastomers}}{.125(1.6)} + \underset{\text{Fibers}}{.130(3.8)} = 6.0$$

Depreciation

Depreciation is normally defined as the fraction of revenues set aside each year to cover the loss in value of the capital stock. Due to recent

---

[1]See, for example, J. Weston and F. Brigham, op.cit.

A single, industry-wide CRF equal to 21.8 percent has been used in our analysis. For a given investment, a firm's CRF will vary with their cost of capital and mix of financing. However, it was not possible to estimate a separate CRF for each establishment or firm.

Average Cost of Capital

The cost of capital, K_f, is the average percentage return that suppliers of debt and equity demand. For firms which have more than one type of capital, K_f is calculated as the average of the after-tax costs of debt and the costs of equity, weighted by the share of market value of each relative to the total market value of the firm. In equation form:

$$K_f^* = bi(1-t) + (1-b)r \qquad (2D-3)$$

where:

K_f^* = average cost of capital after taxes
i = average of cost of debt
r = average cost of equity
t = corporate income tax rate
b = share of debt financing

The costs of debt and equity are measured by the current market value of outstanding debt and stock, rather than the original costs when the debt and equity were issued. The argument that projects should be evaluated using the weighted average cost of capital as the discount factor has been made elsewhere 1/ and rests on several assumptions. Firms are assumed to have an optimal debt/equity ratio (or at least some preferred debt/equity ratio), to have already obtained that ratio, and to strive to maintain it over time. In addition, it is assumed that new projects do not alter the overall risk position of the firm. (A change in the risk level might result in a change in the debt/equity level.) Therefore, new projects, on average, will be financed with these same desired fractions of debt and equity.

Cost of Debt. Since firms often have more than one debt issue, it is necessary to calculate an average cost within a company as well as across companies. The following information on the debts of 41 chemical companies was obtained from Standard and Poor's Bond Guide (August 1979).2/

1/See, for example, J. Fred Weston and Eugene F. Brigham, Managerial Finance (6th ed.), Dryden Press, 1978, Chapter 19.

2/See: Draft Industry Description: Organic Chemical Industry, Vol. I, December 1979, pages 3-7 through 3-16, for a detailed presentation of the data.

Appendix 2-D. Derivation of Capital Recovery Factor

The capital recovery factor (CRF) measures the rate of return that an investment must achieve each year in order to cover the cost of the investment and maintain net earnings, including depreciation and taxes. Stated another way, the capital recovery factor is the excess of revenues over variable costs, per dollar of invested capital, needed to cover the cost of borrowing, depreciation and net profit-related taxes, while preserving the market value of the firm's stock.

The formula for CRF used in previous analyses was:

$$CRF = \frac{A(N,K_f) - td}{1 - t} \qquad (2D\text{-}1)$$

where:

- N = lifetime of investment
- K_f = average after-tax cost of capital
- $A(N,K_f)$ = annuity whose present value is 1, given N and K_f $[K_f/(1-(1+K_f)^{-N})]$
- d = depreciation rate
- t = corporate income taxes

Changes in the tax code dealing with rapid depreciation and investment tax credits, require alterations in the formula for calculating the capital recovery factor. The revised formula is:

$$CRF = \frac{A(N,K_f)(.9-c)}{1 - t} \qquad (2D\text{-}2)$$

where: $$c = \sum_{1=1}^{n} \frac{td'}{(1+K_f)^1}$$

where:

- n = depreciation lifetime under tax code
- d' = new depreciation rate

Other variables as above.

The derivation of these formulas are given in the back of this Appendix. The assumptions and data used to obtain values for the above variables are described below.

Table 2-C-3. Estimated Real Rate of Return

Company	1980	1982	Simple Average
Stauffer	7.6%	7.3%	7.4%
DuPont	7.6	6.3	7.0
American Cyanamid	8.2	7.2	7.7
Union Carbide	10.3	5.8	8.1
Rohm & Haas	NA	9.4	9.4
Dow	NA	5.5	5.5
Monsanto	NA	NA	NA
Simple Average	8.4%	6.9%	7.5%
Simple Average for four companies with data for 1980-1982			7.5%

Source: Meta Systems Inc calculations and company annual reports for 1980 and 1982.

Liquidation Value (L_O). It is assumed that the plant and equipment have no scrap value except as a tax write-off. This is appropriate since much of the pesticide active ingredient manufacturing takes place at plants which produce other chemicals as well. Even if the production were discontinued, it would not be possible to sell just the pesticide manufacturing capacity. Therefore, the liquidation value is calculated as:

$$L_O = 0.70 \text{ (Current Assets)} + (t') \text{ (Book Value of Fixed Assets)}$$

where t' is the statutory tax rate (0.46). The statutory rate is appropriate because of the assumption that the company will be writing off the value against taxes. This equation assumes that a majority but not all (i.e. 70 percent) of the value of current assets can be recovered.

Current Assets. Current assets include: cash and equivalents, accounts and notes receivable, and inventory. Since this current asset information is not available for individual business segments within a firm, the ratio of current assets to sales is calculated from company-level data. An average value of this ratio is then applied to each plant's sales to obtain an estimate of that plant's current assets. For the sample of seven firms, the ratio of current assets to sales averages 0.400. The value of inventories is not adjusted for replacement value since this information is not available for assets. Any underestimate of the current asset value resulting from this is expected to be small because inventories are not held for long periods of time.

Non-Current Assets. As with value of current assets, this information is only available on a company basis. Non-current assets are the book value of plant and equipment. A ratio of non-current assets to sales is calculated for the sample of seven firms and for three years, and then averaged. The average ratio of 0.490 is applied to individual plant sales to obtain an estimate of the plant's non-current assets.

Planning Horizon (Y)

The net present value is discounted over a period of 10 years. This approximates the useful life of the treatment equipment.

Table 2-C-2. Ratio of Operating Income to Sales (Operating Margins) for Pesticide Production and for Total Corporate Sales, 1980

Company	Pesticide Operating Margin	Corporate Operating Margin
American Cyanamid	.169	.093
Dow	.148	.114
DuPont	.250	.102
Monsanto	.396	.031
Rohm & Haas	.112	.100
Stauffer	.281	.150
Union Carbide	.136	.129

Source: Smith Barney, Harris Upham & Co., Chemicals, July 23, 1982.

Table 2-C-1. Ratios to be used in Net Present Value Calculations Based on Simple Average of Values for 1982, 1981 and 1980*

Company Name	OI/S	T/OI	CA/S	BV/S
American Cyanamid	.169	.360	.423	.374
Dow	.148	.272 **	.389	.559
DuPont	.250	.512	.349	.440
Monsanto	.396	.325	.372	.485
Rohm & Haas	.112	.322	.398	.289
Stauffer	.281	.258	.492	.684
Union Carbide	.136	.210	.386	.597
Average	.213	.323	.400	.490

OI = Operating income, before federal income tax

S = Sales

T = Taxes

CA = Current assets

BV = Book value of plant and equipment

* Ratio OI/S is for pesticide operations of each firm for only one year (1980) from industry study by Smith Barney, Harris Upham & Co., Chemicals, July 23, 1982. All other ratios calculated as 3-year average (except as noted) by Meta Systems Inc from company annual reports.

** Based on 1980 and 1981 only.

minus cost of sales and operating expenses (which includes depreciation and interest). For the sample of seven firms, the ratios of operating margin (i.e., operating income before taxes to sales) for pesticide production range from 0.112 to 0.396. The simple average is 0.213 (the sales-weighted average is 0.247). See Table 2-C-1. It is assumed that the ratio of before-tax operating income to sales for the pesticide production averages 21.3 percent. (The weighted average is larger since the very profitable firms are also the largest; if the weighted average is used instead of the 21.3 percent, it yields higher, more optimistic, estimates of operating income and net present value).

The tax rate is calculated from company annual reports data as:

$$t = \frac{\text{Income Taxes (or Reserve for Taxes)}}{\text{Operating Income}}$$

For the sample of seven companies, the effective tax rate is 0.323. Therefore, after-tax operating income for each plant is equal to:

$$(0.213) \text{ Plant Sales } (1-0.323) = (0.144) \text{ Plant Sales}$$

This estimate overstates the after-tax operating income slightly because depreciation is included at book value not at replacement value. However, the correction necessary to use replacement value is possible only at the corporate level since depreciation for pesticide production (either book value or replacement value) is not known. The firm-level operating margins for these seven companies is much lower than the operating margins for their pesticide production as shown in Table 2-C-2. Thus, the after-tax operating income based on operating margins for pesticide operations without correction for inflation is closer to the true value than the corporate margins would be even though they could be corrected.

Real Cost of Capital ($\bar{r}$). It can be shown that the cost of capital is equivalent to the rate of return on assets. Since the net present value test requires the real rate of return, it can be calculated from corporate annual report data as:

$$\bar{r} = \frac{\text{Real Earnings}}{\text{Assets Adjusted For Replacement Value}}$$

In other words, the real cost of capital is estimated by comparing the after-tax operating income, corrected for inflation, plus interest (i.e. real earnings) to current net replacement costs of assets. The correction for inflation involves adjusting the historical values of depreciation, plant, property and equipment, and inventories for current dollars. Since this information is not available on a business segment basis, the real cost of capital is estimated using company data. Based on 1980 and 1982 figures for six of the seven companies used to calculate profit rates, the real rate of return is 7.5 percent as shown in Table 2-C-3. The value of each plant's assets is needed in order to calculate plant liquidation value as explained below.

Appendix 2-C. Estimating the Net Present Value (NPV)

Manufacturers

As described in Chapter 2, the net present value test compares the estimated rate of return on its liquidation value that a plant would earn if it complied with the regulation, to the real cost of capital for this industry. In order to perform the NPV test, the values for several factors are needed for each plant. In most cases, these values are not known on the plant level and so must be estimated. A valid estimate of the value of pesticide production before treatment is available for each plant. This value (called sales in the following sections) is calculated on the basis of: 1977 production, as reported in the 308 Survey, adjusted to 1982 levels, and 1982 prices, as discussed in the chapter. 1/ The average rate of price increase under the regulation is calculated for each of the three product groups by dividing the total annual treatment cost for the product group by the total sales of the product group. The price increase for each product is estimated by applying the relevant percentage price increase to the product's price. Using the elasticity relevant to each product group (herbicide, insecticide, fungicide), a new quantity sold is estimated. This new price and new quantity yield a post-treatment value of sales which is used in the analysis of impacts. A plant's sales equals the sum of the sales of its products. The other values needed for the calculation are estimated by applying ratios, calculated from annual report data for a group of pesticide producing firms, to the plant sales. The specific ratios and the sources of the data are listed as follows.

Sample of Firms Used to Estimate Ratios. The ratios are calculated for a sample of seven pesticide producing companies. These companies are used because estimates of pesticide sales and pesticide operating incomes, as distinguished from total sales and income, are available for each company. (The firms are identified in Table 2-C-1). The values are calculated from 1980 data, which is a fairly representative year. In other words, profits and sales in 1980 are fairly typical of the last five years--neither the low point nor the high point of the period. These seven firms make up a large percentage of total pesticide sales. Their sales are 89 percent of the total sales for the 13 largest producers and 77 percent of the total sales of 34 producers.

Operating Income, After-taxes (U). After-tax operating income after treatment is defined as operating income before federal income tax, minus annual treatment costs and federal income taxes. The pre-tax operating income is reported as such on annual reports, and is usually equal to: sales

---

1/ Prices are from two sources: 1) ITC average prices for groups of pesticides as found in Synthetic Organic Chemicals, USITC Publication 1422, 1982, and 2) pesticide-specific prices from the ITC, if permission for release by the company.

stable (i.e., they were unchanged when it was included). For these reasons, the industrial production index is not included for insecticides and fungicides.

The equation for insecticides is estimated for a shorter time series than the other equations. Insecticide production in 1980 and 1981 dropped significantly due to unusually large carry-overs. These carryovers were in part the result of unusually low insect infestations during those years. It is assumed that the price elasticity of demand will continue at its historical levels and that these drops in production were a short-term correction. There has been a decrease in the amount of insecticides produced due to the substitution of synthetic pyrethroids for more conventional pesticide ingredients. The synthetic pyrethroids are very powerful (and expensive) so that lower dosages offset the higher costs, thus reducing the weight of production. However, in terms of total insecticide production, these impacts are not large.

Table 2-B-1. Estimated Coefficients for Pesticide Production (Total and for Each Product Group)*

Ln of Production of	Intercept	Ln Acres	LN Real Price	LN Production Previous Year	Industrial Production Index
	Independent Variables				
Herbicides**	-12.93	3.19	-0.67	0.299	-0.00651
R^2 = .98	(-3.51)	(4.02)	(-2.49)	(1.88)	(-3.24)
Insecticides***	-3.49	1.53	-0.32	0.142	
R^2 = .68	(-1.32)	(2.90)	(-2.51)	(0.57)	
Fungicides**	-1.46	1.04	-0.35	0.05	
R^2 = .35	(-0.47)	(2.02)	(-2.07)	(0.18)	
Total Pesticides**	-6.42	1.88	-0.49	9.427	-0.00254
R^2 = .89	(-2.26)	(3.02)	(-2.37)	(1.84)	(-1.17)

Data Sources:

Acres-Various U.S. Department of Agriculture publications.
Real Price-Average price for each product group and total pesticides calculated from U.S. International Trade Commission, Synthetic Chemicals, various years, and converted to real prices by use of: GNP Deflator, U.S. Department of Commerce, Bureau of Economic Analysis.
Production--U.S. International Trade Commission, Synthetic Chemicals, various issues.
Industrial Production Index--U.S. Board of Governors of the Federal Reserve System, Federal Reserve Bulletin, various issues.

* T-Statistics shown in parentheses. In logarithmic form with Koych Lag.
** Estimated for 1967-81.
*** Estimated for 1967-79.

Appendix 2-B. Estimation of Price Elasticities of Demand

For purposes of estimating price elasticities, production is a function of the number of agricultural acres planted, the real price of pesticides, and the pesticide production in the previous year, all expressed in terms of natural logarithms. In addition, the industrial production index is added to see if production is sensitive to the overall business cycle.

The basic equation form used is:

$$\ln PROD_t = a + b \ln PROD_{t-1} + c \ln ACRE_t + d \ln RPRICE_t + f (IX_t)$$

where:

$PROD_t$, $PROD_{t-1}$	=	production of pesticide active ingredients in year t and t-1.
$ACRE_t$	=	Acreage of principal crops planted in year t
$RPRICE_t$	=	Real unit price for pesticide active ingredients in year t
IX_t	=	Industrial production index in year t

The estimated coefficients are shown in Table 2-B-1. Business cycles are statistically significant only in the case of herbicides. Since the regressions are estimated in terms of logs, the coefficients can be interpreted as elasticities, with the coefficient on the Real Price term equal to the price elasticity of demand. The overall price elasticity of pesticides is -0.49. In other words, a ten percent increase in real prices would result in a 4.9 percent decrease in the amount demanded. The price elasticity for herbicides (at -0.67) is much larger than that for the other two product groups (insecticides at -0.32 and fungicides at -0.35). During the 1970's, herbicides experienced a large increase in application rates and the proportion of acres treated, and the coefficient on acres in the herbicide equation reflects this. One of the reasons that the amount of variation explained by the fungicide equation is so low ($R^2 = .35$) is that a very large proportion of fungicides are used for non-agricultural purposes. Attempts to develop a variable which would indicate the demand for these other uses, in the way that acreage indicates the demand for farm useage, have been unsuccessful. However, the coefficient on the real price term is statistically significant and therefore is considered a reasonable estimate of the price elasticity. There is no ready explanation for why business cycles are important for herbicides and not for the other two product groups. Not only is the coefficient of the industrial production index very insignificant in the case of insecticides and fungicides and the R^2 unchanged when it was included, but the other coefficients are quite

Appendix 2-A. 308 Survey of Pesticide Formulator/Packagers

As described in Chapter 2, a sample of indirect discharging PFP plants has been identified by a telephone survey conducted by EPA. A written questionnaire was sent to these plants, and to plants which refused to answer questions on the telephone and to plants which could not be contacted by telephone.

Information obtained from the completed written questionnaires includes plant characteristics such as: number of plant personnel, formulating/packaging production value, wastewater characteristics, and wastewater treatment/control technology currently in place. The methodology used to develop the baseline and impact estimates is based primarily on specific data obtained from the survey such as the following plant characteristics:

- Number of PFP plants with and without production of active ingredients at the plant;
- Annual PFP production value and total plant production value;
- Employment in production of PFP products;
- Employment in production of other products;
- Employment in nonproduction work; and
- Fraction of plant operating days during which PFP production occurred;
- Percent of active ingredients used that are manufactured on site.

The quantitative information is tabulated so that averages and high-low ranges of the different variables can be determined from the responses.

1/ 1983 308 Survey for the Formulating/Packaging Subcategory of the Pesticide Chemicals Industry, OMB No. 2040-0041.

64. Environmental Protection Agency, Office of Pesticide Programs, Economic Analysis Branch. Pesticide Industry Sales and Usage, 1982 Market Estimates. December 1982.

65. U.S. International Trade Commission. Synthetic Organic Chemicals, United States Production and Sales, 1982. USITC Publication 1422 and prior issues, U.S. Government Printing Office, Washington, DC.

66. Washington Manufacturers Register, 1982-83, Times Mirror Press, California, 1982.

67. Wyoming 1982 Directory of Manufacturers and Mining, Wyoming Department of Economic Planning and Development, 1981.

47. Oklahoma Directory of Manufacturers & Products 1983, Oklahoma Economic Development Department, 1982.

48. Pimentel, D., et al. "Benefits and Costs of Pesticide Use in U.S. Food Production." Bioscience, pp. 772-783, December 1978.

49. Predicasts, as quoted in "Pesticides: $6 Billion by 1990."Chemical Week, p. 45, May 7, 1980.

50. South Carolina 1983 Industrial Directory, South Carolina State Development Board, 1983.

51. Standard & Poor, Compustat, Standard and Poors' Compustat Services, Inc., data on six companies.

52. Storck, W.J. "Pesticides Head for Recovery." Chemical and Engineering News, 62 (1984): pp. 35-57.

53. Tennessee Directory of Manufacturers 1982, Tennessee Department of Economic and Community Development.

54. U.S. Department of Agriculture. Agricultural Outlook. March 1982.

55. U.S. Department of Agriculture. Agricultural Outlook. March 1983.

56. U.S. Department of Agriculture. Inputs--Outlook and Situation. Economic Research Service, IOS-1, June 1983.

57. U.S. Department of Agriculture. Inputs--Outlook and Situation. Economic Research Service, IOS-2, October 1983.

58. U.S. Department of Agriculture, Crop Reporting Board, SRS, June 1981.

59. U.S. Department of Agriculture. The Pesticide Review. Agricultural Stabilization and Conservation Services, Washington, DC, Annual issues from 1976-1979.

60. U.S. Department of Commerce, Bureau of the Census. 1977 Census of Manufactures. Washington, DC, 1980.

61. U.S. Department of Commerce. 1981 Annual Survey of Manufactures. Bureau of the Census, M81(AS) May, 1983.

62. U.S. Department of Commerce. 1983 Industrial Outlook. Bureau of Industrial Economics, January, 1983.

63. U.S. Department of Commerce. 1982 U.S. Industrial Outlook. Bureau of Industrial Economics, January 1982.

REFERENCES (continued)

30. Federal Trade Commission. Quarterly Financial Report. Washington, DC, 3rd Q 1983.

31. Frost and Sullivan. U.S. Pesticides Market. Report A907, May 1981.

32. Georgia Manufacturing Directory 1982-83, Georgia Department of Industry and Trade, 1982.

33. Harris, 1983 Indiana Marketers Industrial Directory, Harris Publishing Company, Ohio, 1982.

34. Harris, 1983 Ohio Marketeers Industrial Directory, Harris Publishing Company, Ohio, 1982.

35. Illinois Manufacturers Directory 1983, Manufacturers News Inc., Illinois, 1983.

36. Iowa Works 1983-84, Directory of Iowa Manufacturers, Iowa Development Commission, 1983.

37. 1983 Kentucky Directory of Manufacturers, Kentucky Department of Economic Development.

38. McRae's Industrial Directory New Jersey, 1984, McRae's Blue Book Inc., New York, 1983.

39. McRae's New York State Industrial Directory, 1983, McRae's Blue Book Inc., New York, 1982.

40. McRae's Pennsylvania State Industrial Directory 1982, McRae's Blue Book, Inc., New York, 1982.

41. Meta Systems Inc, Memorandum to the Organic Chemicals file, October 22, 1981.

42. Meta Systems Inc, Memorandum to EPA, "Effect of RCRA Costs on Pesticide Plant Closures," October 11, 1981.

43. Meta Systems Inc, Memorandum to EPA, "Pesticide Plant and Product Line Closures," January 29, 1982.

44. Michigan Manufacturers Directory 1983, Pick Publications, Michigan, 1983.

45. Mississippi Manufacturers' Directory 1982, Mississippi Research and Development Center, 1982.

46. Missouri Directory 1983, Mining, Manufacturers, Industrial Services, Industrial Supplies, Informative Data Company, 1983.

15. Directory of New England Manufacturers 1983-84, the New England Council, George D. Hall Company, Massachusetts, 1983.

16. 1983-84 Directory of North Carolina Manufacturing Firms, North Carolina Department of Commerce, 1982.

17. Directory of Oregon Manufacturers 1982-83, State of Oregon Economic Development Department.

18. Dun and Bradstreet, Inc. Million Dollar Directory. 1981.

19. Eichers, T.R. Evaluation of Pesticide Supplies and Demand for 1979. U.S. Department of Agriculture, Economic, Statistics and Cooperative Service, Agricultural Economics Report No. 422, April 1979.

20. Eichers, T.R. Farm Pesticide Economic Valuation, 1981. U.S. Department of Agriculture, Economic and Statistics Service, Agricultural Economic Report, 464.

21. Eichers, T.R. The Farm Pesticide Industry. U.S. Department of Agriculture, Economics, Statistics and Cooperatives Service, Agricultural Economic Report 461, September 1980.

22. Eichers, T.R., P.A Andrilenas, T.W. Anderson. Farmers' Use of Pesticides in 1976. U.S. Department of Agriculture, Economics, Statistics, and Cooperative Service, Agricultural Economic Report 418, December 1978.

23. Eichers, T.R., and W.S. Serletis. Farm Pesticide Supply-Demand Trends, 1982. U.S. Department of Agriculture, Economic Research Science, Agriculture Economic Report, 485, April 1982.

24. Environmental Science and Engineering, Inc. Revised Contractor Report for Best Available Technology, Pretreatment Technology, New Source Performance Technology and Best Correlational Pollution Control Technology in the Pesticide Chemicals Industry. est. No. 79-238-001, November 1980.

25. Environmental Science and Engineering Memorandum "Additional NSPS Product Information, Pesticide BAT Reviews," January 19, 1981.

26. Environmental Science and Engineering Memorandum, "Revised New Source Performance Standards Cost," January 7, 1981.

27. Farm Chemicals, "A Look at World Pesticide Markets" September 1981.

28. Farm Chemicals, "Presstime News Report" April 1983.

29. Federal Trade Commission. Competition in Farm Outputs: An Examination of Farm Industries. February, 1981.

REFERENCES

1. 1980-81 Alabama Directory of Mining and Manufacturing, Alabama Development Office, 1980.

2. Arthur D. Little, Inc. Evaluation of the Possible Impact of Pesticide Legislation on Research and Development Activities of Pesticide Manufacturers. Report to Office of Pesticide Programs, U.S. Environmental Protection Agency, 1975.

3. Aspelin, A. Economic Aspects of Current Pesticide Regulatory Programs and Outlook for the Future. U.S. Environmental Protection Agency, Office of Pesticide Programs, Washington DC, February 1983.

4. C.H. Kline & Co. The Kline Guide to the Chemicals Industry. Fourth Edition, Industrial Marketing Guide, IMG 13-80, 1980.

5. California Manufacturers Register 1983, Marketing Research Department, L.A. Times.

6. Carlson, G.A. "Long-Run Productivity of Insecticides." American Journal of Agricultural Economics, 59, pp. 543-548, August 1977.

7. Chemical Week. "Forecast 1984,--The Gains for Chemicals Will Continue" pp. 30-41, January 4, 1984.

8. 1984 Classified Directory of Wisconsin Manufacturers 1980-81, Wisconsin Association of Manufacturers and Commerce.

9. Directory of Florida Industries 1983-84, The Florida Chamber of Commerce, Inc., 1983.

10. Directory of Kansas Manufacturers and Products 1983-84, Kansas Department of Economic Development, 1983.

11. 1982 Directory of Louisiana Manufacturers, Louisiana Department of Commerce, 1982.

12. The Directory of Maryland Manufacturers 1981-82, Department of Economic and Community Development, 1981.

13. Directory of Montana Manufacturers 1980-81, Governor's Office of Commerce and Small Business Development.

14. Directory of Nebraska Manufacturers and Products 1982-83, Nebraska Department of Economic Development.

condition of the plants in the absence of any additional regulations by estimating the NPV without treatment costs. Lacking enough information to estimate price responses and the price elasticity of demand for individual PFP products, the conservative assumption is made that all treatment costs come out of profits. For many plants, this is an appropriate assumption, since a large majority of the PFP plants are already at zero discharge and will not incur additional costs due to this regulation. As a result, competing indirect discharge PFP plants will not be able to raise their prices. There will be instances where all competing plants do incur equivalent treatment costs. Certain products can be produced only with wet processes, and therefore they all have some wastewater. In addition, some products are produced by a single firm in a given market (either geographically or user determined). Any bias due to this assumption of no cost pass through will be in the form of an overestimate of the impact on profits and closures.

As with operating income and liquidation value, the value of production in 1982 is determined directly from the 1983 308 Survey. There is no need to estimate the dollar value of pesticide output on the basis of production quantity and unit price (as is the case for the pesticide active ingredient manufacturing plants), making for a more accurate value.

Therefore, this ratio is appropriate for large firms. To test the sensitivity of the results for small business, estimated operating income was reduced and the NPV ratio recalculated. There are only two plants with treatment costs that are owned by small firms. One of these plants is both a manufacturer of active ingredients and a formulator/packager. In the analysis reported in the earlier chapters, the joint impact of manufacturing and PFP costs and sales was calculated. However, the manufacturer costs were calculated separately from the PFP costs and the PFP costs assumed contract hauling of PFP wastewater. In actuality, the plant is likely to run its PFP wastewater through its treatment facility, thus avoiding the PFP contract hauling costs with no additional manufacturer treatment costs. Therefore, the sensitivity analysis is calculated including the manufacturer treatment costs with zero additional costs for treating PFP wastewater. The operating income can be reduced by 25%, and there is no change in the number of estimated closures among plants owned by small business. Therefore, the results are insensitive to the ratio used to estimate operating income as a function of sales.

In addition, the sensitivity of the results to changes in the estimated liquidation value was tested for small businesses. The larger the estimated liquidation value, the more likely the plant is to close because it will have to earn more money in order to maintain its rate of return. Increasing the liquidation value in the NPV ratio for plants owned by small firms by 15% results in no changes in the estimated number of closures. Therefore, the results are not sensitive to the ratios used to estimate the liquidation value.

8.2 Metallo-Organics Pesticides

The impact assessment is based on data for the single indirect discharge plant known to the Agency. The sales estimate used in the analysis is based on the firm's public comments to the Agency and thus does not involve any use of average prices nor adjustments in production quantities. Therefore, it is very accurate. The operating income and liquidation values used in the net present value calculation are estimated on the basis of plant sales, by applying the same ratios used in the pesticide active ingredient manufacturer's analysis. It is assumed that these ratios are appropriate, since both Subcategory 1 and Subcategory 2 involve the manufacture of pesticide chemicals. Data are not available for a separate estimate of these ratios for metallo-organic pesticide manufacturing.

8.3 Pesticide Formulator/Packagers

Since the sample of plants analyzed is selected in a scientifically determined way to be a random sample, it is representative of all indirect discharge PFP plants. It is not necessary to estimate industry-wide operating income to sales and liquidation value to sales ratios, since the 1983 308 Survey provides the information required to estimate the amounts directly. This information also makes it possible to evaluate the financial levels are adjusted to reflect industry changes in production quantity and the mix of pesticide products between 1977 and 1982. The U.S. International Trade Commission (ITC) reports total production levels and prices for groups of pesticides each year. Production levels in 1982 and 1977 for the appropriate groups are used to adjust the plant level outputs of specific pesticides. For some insecticides, the adjustments derived from the ITC groups include changes in non-pesticide uses of the chemicals as well. Production at any individual plant may not have followed the industry trends observed in the pesticide groups as reported by ITC. However, we feel that these adjustments are appropriate and necessary since these adjusted production levels are closer to actual 1982 production levels than are the 1977 levels. For a few plants, actual changes in production level and mix were available and these were used in place of adjusted levels.

Sales for each plant are estimated by multiplying the adjusted production levels by the 1982 prices as reported for the groups of pesticides by ITC. Companies were requested by EPA to grant ITC permission to release the product-specific pesticide active ingredient prices. These product-specific prices are used in all cases when they are available. However, permission was not granted to release prices for most of the pesticide active ingredients. When product-specific prices are not available, the average price for the product subgroup, as published by ITC, is used. Since there are 19 subgroups, there is sufficient disaggregation in the ITC data that these average prices are reasonable estimates of the product-specific price.

The 1977 308 Survey did not ask for profits and/or operating costs. Therefore, profits are estimated using an industry average of operating income to sales. Since the average is obtained from information on the pesticide operations of seven major firms it is considered representative of the industry. However, profit margins will vary among individual plants for such reasons as: different geographical regions, applicable crops, and types of pesticides. Therefore, individual plant profit levels may be higher or lower than the seven firm average. The sensitivity of the results to our assumptions about operating income and liquidation value are discussed below.

8.1.1 Sensitivity Analysis for Pesticide Manufacturers

As stated above, after-tax operating income is estimated for each plant, based on the average ratio of operating income to sales (OI/S) for seven large pesticide producers. Various public comments on the proposed regulations argue that small firms face a higher cost of capital and frequently have a lower profit margin than large firms. To accomodate the higher capital costs, the analysis uses separate costs of capital for large manufacturers (7.5 percent) and small manufacturers (9.5 percent).

The sensitivity analysis reported in this section investigates whether the closure results for small firms are sensitive to the OI/S ratio or to the calculation of liquidation values. The NPV ratio in the earlier chapters calculates operating income as a function of sales, using the average ratio of operating income to sales for seven large pesticide manufacturing firms.

8. LIMITS OF THE ANALYSIS

This section discusses the limitations of the economic impact analysis. It focuses on the methodological assumptions and on the restrictions placed on the analysis by data limitations. Limitations which pertain to the plant-specific compliance cost estimates used in this analysis are outlined in Section IV of the Pesticide Chemicals Industry Administrative Record. Limitations for the pesticide active ingredient manufacturers, for the metallo-organic subcategory, and for formulator/packagers are discussed separately.

8.1 Pesticide Active Ingredient Manufacturers

The major variables used in the economic impact analysis are compliance cost and sales estimates for each plant. The compliance cost estimates are provided by the Industrial Technology Division of EPA. The sales estimates are made by the Agency on the basis of production levels reported by the plants in 1977, adjusted to reflect changes in production levels and product mix between 1977 and 1982, and 1982 prices. It is necessary to adjust the production levels because total production in the industry has declined during the 1977-1982 period, while the production of certain products has increased. Using the 1977 production levels would provide an incorrect estimate, and in many cases an over-estimate, of sales for individual plants. Every attempt has been made by the Agency to accurately estimate sales, since operating income and liquidation values are estimated for each plant on the basis of its sales and industry-wide ratios. This approach is necessary because the 1977 308 Survey did not request information on operating income, assets, or liquidation values from pesticide active ingredient manufacturers. The industry-wide ratios used are:

- After-tax Operating Income = 0.144 Sales
- Liquidation Value = 0.70 (Current Assets) + (.46)(Book Value)
  = 0.51 Sales
- Real Cost of Capital = 7.5 percent for large firms
  = 9.5 percent for small firms

We feel that these are accurate estimates since they are based on the pesticide operations of seven firms that make up a large proportion of pesticide active ingredient production. The estimation procedures are discussed in more detail in the following paragraphs and in Appendix 2-C.

It was necessary to estimate plant sales for 1982 in order to make valid comparisons with the current compliance costs. The sales estimates start with the 1977 production levels reported by the 114 plants. These production

Table 7-2. Distribution of Treatment Cost Impacts on Large and Small Firms: Pesticide Formulator/Packagers

	Small Firms	Large Firms
Total number of firms	16	12
Total number of plants	16	12
Number of plants that fail NPV Test*	3	1
Number of plants with:		
Plant Closures	0	0
Line Closures	3	1
Number of plants with cost to sales ratios in these ranges:		
cost / sales = 0-0.5%	1	1
cost / sales = 0.5-1.0%	5	5
cost / sales = 1.0-2.0%	2	2
cost / sales greater than 2.0%	7	5

Source: 1983 308 Survey; Corporate Compustat, as of February 23, 1984, Standard & Poor's Compustat Services, Inc.; and Meta Systems Inc calculations.

*All plants fail if their NPV is less than 9.5 percent.

7.4 Pesticide Formulator/Packagers (PFP)

For the PFP subcategory, a small business is defined as a firm with annual sales of $7.0 million or less. The criterion of $10 million, used for manufacturers, is not considered compatible with the intent of the Small Business Act. The regulatory flexibility analysis is primarily concerned with small firms with limited resources or those that would face barriers to entry due to regulation. Since the PFP sector requires lower capital investment as well as lower R&D expenditures than the pesticide manufacturing sector, it is easier to enter the industry, and a lower sales criterion is appropriate. About 65 percent of the firms involved in PFP operations would be considered small businesses if the $10 million annual sales criterion used.

The $7.0 million definition was selected after ordering 28 firms by sales from lowest to highest. There was a break in the distribution at that point, and the $7.0 million sales criterion divides the sample into two groups with approximately 57 percent of the firms considered small. However, sales data were available for only five out of the 28 firms. These 5 firms own one plant each. When firm sales were not known, the plant sales were used in place of corporate sales. This tends to overstate the number of small firms, for many small plants are owned by large firms.

Table 7-2 summarizes impact imformation on plants owned by small firms and plants owned by large firms. All of the PFP plants analyzed had treatment costs. For the 28 plants forming the basis of the estimate of the total number of closures, 57 percent belong to small firms, and a slightly higher percentage of plants owned by small firms have cost-to-sales ratios of over 2%. Three out of the four plants likely to close their pesticide product lines under the regulation are owned by small firms.

However, in each case, the production and employment loss resulting from the regulation is so small as to have a neglible impact on the overall operations of the plant. In addition, to some indeterminate degree, we may have overstated the impacts on small businesses since some plants were considered small businesses when they are really large businesses. For example, the twelve plants which volunteered data and were included in the estimate of total cost, but not in the estimate of closures, are 1/3 small firms and 2/3 large firms. There are no closures associated with these 12 plants. In conclusion, EPA believes that there is no small business impact.

Table 7-1. Distribution of Treatment Cost Impacts on Large and Small Firms: Pesticide Active Ingredient Manufacturers

	Small Firms	Large Firms
Total number of firms	14	60
Total number of plants	14	100
Total number of plants with treatment costs	2	38*
Number of plants that fail NPV Test**	1	1
Number of plants with		
Plant Closures	0	0
Line Closures	0	1
Number of plants with cost to sales ratios in these ranges:		
cost / sales = 0%	12	62
cost / sales = 0-2%	0	13
cost / sales greater than 2%	2	25

Source: 1977 308 Survey; Corporate Compustat, as of February 23, 1984, Standard & Poor's Compustat Service, Inc.; and Meta Systems calculations.

* Excludes one plant which has a treatment cost, but sales data are not available.

** Small firm plants fail if their NPV is less than 9.5 percent and large firm plants fail if their NPV is less than 7.5 percent.

following stipulations: the firm is independently owned and operated, is not dominant in its field of operation, does not have a net worth in excess of $6 million, and does not have an average post-tax net income in excess of $2 million for the preceding two years. Assuming a pre-tax profit margin on sales of 20 percent,[1] and a corporate income tax rate of 48 percent, together with the SBA criterion of $2 million net income total for two years, the two-year annual sales would equal $20 million. Thus, if a firm is to be considered a small business, annual sales must be no larger than $10 million.

7.3 Pesticide Manufacturers

For purposes of this analysis, a small pesticide manufacturing business is defined as a firm with annual sales of $10 million or less. By this definition, about 18 percent (14 out of 74) of the firms which manufacture pesticide active ingredients are designated as small business entities. Annual company sales in 1982 are obtained from COMPUSTAT, where possible.[2] If not available, annual sales for past years are used.[3] In a few cases, company sales are not available and plant sales are used instead. This results in an overestimation of the number of small firms.

Table 7-1 presents impact information on plants owned by small firms and plants owned by large firms. Fifteen percent (two out of the 14) of the plants belonging to small firms incur treatment costs. Of the 100 plants belonging to large firms, 38 percent incur treatment costs. Both of the small-firm plants incurring costs have cost-to-sales ratios of over 2%, while 25 out of the 38 large-firm plants have cost-to-sales ratios of over 2%.

One plant owned by a small company and one plant owned by a large company each have NPV ratios, after incurring treatment costs, that are smaller than their respective cut-offs. The plant owned by a large company will experience a product-line closure. However, the plant owned by the small company is not expected to close when the joint impacts on its PFP and manufacturing operations are considered. These joint impacts must be considered, since this plant is integrated, with its PFP operations highly dependent on the continuation of its manufacturing operations. Therefore, there are no small business impacts for the manufacturing subcategory as a result of this regulation.

---

[1] Herbicide Suicide, December 1975, Loeb, Rhodes and Company, cited in The Economic Health of the Pesticide Industry, Seehusien, M.H., January 1978.

[2] Corporate COMPUSTAT, as of February 23, 1984, Standard & Poor's Compustat Service, Inc.

[3] These were collected from corporate annual reports for the analysis of proposed regulations: "Economic Impact Analysis of Proposed Effluent Limitations Guidelines, New Source Performance Standards and Pretreatment Standards for the Pesticides Industry Point Source Category," November 1982.

7. SMALL BUSINESS ANALYSIS

7.1 Introduction

The Regulatory Flexibility Act of 1980 (Public Law 96-354) amends the Administrative Procedures Act and requires Federal regulatory agencies, such as EPA, to consider small business entities throughout the regulatory process. If a substantial number of small firms will be significantly impacted, the act requires the evaluation of alternative regulatory approaches to mitigate or eliminate the small business economic impacts. This chapter addresses these objectives by identifying the impacts on small businesses likely to result from the regulation. The primary variables considered are those which are also analyzed in the general impact analysis: the number of plants with treatment costs, the number of plant and/or product-line closures, and employment lost due to closures.

7.2 Definition of Small Business

Two approaches are considered to define small pesticide chemicals industry operations: (1) The Small Business Administration (SBA) definition and (2) a firm's net income and sales.

The Small Business Act, Section 3, defines a small business in the following statement:

> "....a small business concern shall be deemed to be one which is independently owned and operated and which is not dominant in its field of regulation. In addition to the foregoing criteria the Administration (of the SBA), in making a detailed definition, may use these criteria, among others: number of employees and dollar volume of business."1/

The Small Business Administration definition of "small business" for the Pesticide Chemicals Industry is a business (including its affiliates) that employs less than five hundred people.

An alternative definition of a small business is based on income and sales. For the purpose of pollution control guarantee assistance, the definition of a small business is addressed in Section 121.3.16 of the Federal Code under Public Law 94-305, which in turn, refers to Section 121.3.11. This section defines small business and includes some of the

---

1/ 536 85 Congress 2nd Session.

6.5 New Source Impacts

The new source standards (NSPS and PSNS) are equal to BAT and PSES standards for Subcategory 1. The technology basis of physical/chemical or physical/chemical plus biological will continue to be the recommended treatment technology. The Agency is not establishing NSPS or PSNS for Subcategory 2 pursuant to paragraph 8 of the Consent Decree. For Subcategory 3, PSNS is equal to PSES and NSPS is equal to the PSES with controls also of the conventional pollutants BOD and TSS, all of which are regulated by BPT. Since there are no incremental costs, no separate economic analysis was performed. The Agency believes new sources will be similar to existing sources and treatment costs will be similar to and may actually be less for new sources. New sources could take advantage of potential lower treatment costs including water flow reduction capabilities and avoidance of retrofit and repiping required of existing sources. Based on the economic impact analysis presented for existing sources, the impacts for new sources are assumed to equal existing sources and impacts are not large enough to constitute an additional barrier to entry.

As pesticides are subjected to more stringent regulatory controls, U.S. producers may shift production overseas due to a decline in U.S. demand as other environmentally safer pesticides are produced.

Based on these findings and the pesticide-specific impacts, including the small price increases that are estimated by this analysis, this regulation will not have an impact on the U.S. balance of trade. In addition, none of the pesticides identified as facing severe foreign trade competition will cease production due to this regulation. Domestic firms which are expanding overseas do so for many reasons, particularly to take advantage of lower wage costs and to be nearer their foreign markets since pesticides production and use banned domestically can still be undertaken overseas.

No foreign trade impacts are expected for formulated/packaged products. This conclusion is based on our assumption that this regulation will have a small impact on prices, affect a small percent of the PFP industry, and is based on our finding that the regulation will have a small effect on industry closures.

6.4.3 Industry Structure Effects

The potential pesticide active ingredient manufacturing product line closure represents a small fraction of the total industry capacity. In addition, this plant is owned by a large company, and the regulation will not result in a reduction in the proportion of production coming from small firms. Therefore, no change in market structure is anticipated as a result of this regulation.

The formulator/packager product line closures are a very small fraction of the total industry capacity. There will be no change in market structure as a result of this regulation.

6.4.4 Future Impacts

Based on the industry growth projections in Chapter 4, the future impacts will be less severe than the impacts estimated for 1983 and 1982. For pesticide manufacturers, total annual cost of compliance is $52.5 million in 1983 dollars ($53.8 million in 1985 dollars) which is about 1.36 percent of the total value of production in 1983. In 1990, the total annual cost of compliance represents only about 1.0 percent of production value. Therefore, price changes, production quantity impacts and profit impacts will be less severe than the 1982 estimates.

For pesticide formulator/packagers, the total annual cost of compliance is $15.5 million, in 1982 dollars (17.0 million in 1985 dollars), which is about 1.0 percent of the total value of PFP production by the indirect discharge plants in 1982. By 1990, the treatment costs represent 0.8 percent of production value. Decrease in profit in 1990 will be 1.5 percent, compared to 2.0 percent estimated for 1982.

As discussed in Chapter 3 of this report, exports greatly exceed imports of pesticide active ingredients. The pesticide industry continues to generate a very positive trade balance with the total value of exports exceeding the value of imports by about an 8 to 1 margin in recent years.1/ Additionally, few U.S. producers have opened facilities overseas to manufacture pesticides for marketing in the United States.

This is not to say that some segments in the pesticide industry have not experienced increases in imports. Imports of benzenoid pesticides have grown quickly during the past decade. Imports of these pesticides increased from a level equal to 5 percent of U.S. production (1977) of benzenoid pesticides to 15.8 percent in 1982 as a result of decline in U.S. production by volume.2/ It is important to note that import of these pesticides increased rapidly due to the introduction of new, patented pesticides by European and Japanese companies. Another reason that U.S. imports of certain pesticides have risen is that the 17 year patent protection period for U.S. manufacturers has expired for older pesticides. Foreign companies, freed from the need to pay licensing fees, have stepped up sales of these products in the U.S. market.3/ The loss of these proprietary rights was a major cause of location changes that took place in the 1970's.

Expanded imports of some pesticides can be linked to environmental factors. Three pesticides in particular showed increased imports after U.S. production ceased in the 1970's because of environmental problems. Lindane imports rose dramatically in the late 1970's but imports have since decreased as registration for many uses has been suspended.4/ DBCP production in the U.S. ended when it was learned that chemical workers in several DBCP formulatng plants had low or zero sperm counts. Two countries began to produce DBCP but the situation proved temporary as one country ceased production due to work place hazards and the other country had plants shut down on several occasions due to work place hazards. EPA has banned domestic uses of DBCP except for pineapple growing in Hawaii. Dicofol has been imported in recent years as domestic production has ceased. EPA has since curbed these imports when high concentrations of DDT were discovered in the imported products.

1/Leonard, Jeffrey H., "Are Environmental Regulations Driving U.S. Industry Overseas?", The Conservation Foundation 1984.

2/Calculated from figures in U.S. International Trade Commission reports, Synthetic Organic Chemicals 1982, p. 225 and Imports of Benzenoid Chemicals and Products 1982, p. 97.

3/Leonard, Jeffrey H., "Are Environmental Regulations Driving U.S. Industry Overseas?", The Conservation Foundation 1984.

4/U.S. Department of Health and Human Services, Public Health Service, "Second Annual Report on Carcinogens" (Washington, D.C.: U.S. Government Printing Office, 1981), pp. 152-153.

6.4.1 Employment and Community Impacts

The one pesticide active ingredient manufacturing product line closure identified above employs one person. The plant is located in a large metropolitan area, and its employees account for a very small proportion of the total labor force in the area. Therefore, the impact on local employment will not be significant.

The four formulator/packager product line closures identified from the 28 plant sample employ from 0.1 to 0.8 full-time worker each. The plants are located in large metropolitan areas and, therefore, the closures will have no impact on local employment. The same is assumed for the other closures expected on the basis of extrapolating the sample impacts to all the indirect discharger PFP plants. A maximum of 90 part-time or 11 full-time equivalent PFP jobs will be lost and they are expected to have no impact of local employment.

6.4.2 Foreign Trade Impacts

As discussed in Chapter 3, the export market for manufacturers of pesticide active ingredients is important to the pesticide industry. Assembling information on the competitive position of specific products in foreign markets, and of foreign products in U.S. markets, is difficult since a product's competitive position depends on a great many factors. Among the relevant issues are: the relative production costs in the U.S. versus other countries, transportation costs, demand levels and availability of competing products in foreign markets, and subsidies provided by and/or restrictions imposed by foreign markets to promote production in their own countries. The impact of the regulations on foreign trade was assessed in terms of impacts in addition to these other factors.

A search was undertaken to collect available data on products that are under foreign trade pressure. In particular, products that were highlighted in the Public Comments were examined. This search included telephone calls to several firms to gather more information than was available from the 308 Survey. These included calls to: Pfizer concerning DEET, PPG concerning Chlorobenzilate and related products, Cosan concerning PMA (phenyl mercuric acetate), and Rohm and Haas. In addition, the extensive resources of EPA's Office of Pesticide Programs (OPP) were used. These include estimates made by OPP staff based on their expert judgment, plus information from various reports including those published by: Doane Western, RvR Consultants, C.H. Kline, Technomics Inc., and the SRI Chemical Economics Handbook.*

---

* Product profiles were written on PMA, DEET, DNCA, and the chlorobenzenes and related products. These are filed in the Confidential portion of the Administrative Record for this report. Records of the phone conversations are in the Confidential sections of the Administrative Record for this report and for the report at Notice.

of the total plant's treatment cost and 16 percent of the value of production whereas the formulating/packaging component accounts for 14 percent of the cost but 84 percent of the value. This plant is not considered a closure candidate under the combined impact of these regulations.

Based on the results presented in Table 6-2, the one metallo-organic (Subcategory 2) plant will not close. The net present value ratio is large enough to indicate that the plant will stay open.

There are an estimated 24 possible product line closure candidates among the 169 indirect discharge formulator/packager plants in the industry. The closure assessment is based on applying the net present value test twice (i.e., with and without treatment cost), and a consideration of the products made and the strength of the company. If the plant fails the net present value test without including treatment cost, the plant is considered a baseline closure, i.e., a closure not attributable to additional wastewater treatment requirements. There are an estimated 17 baseline closures in Subcategory 3. Whether a plant actually closes depends on a number of factors specific to the plant and the parent company. If the plant does not fail the NPV test without treatment costs but does fail when treatment costs are included, it is considered a possible closure candidate. Based on this dual application of the net present value test, four plants in the sample of plants analyzed are judged possible closure candidates due to the regulation. For each of these plants, pesticide formulator/packager operations are a small part of total plant operations but treatment costs have a large impact on the net present value comparisons. Therefore, these plants are likely to close the product lines while maintaining their other operations. Extrapolating this conclusion to all PFP indirect discharge plants subject to this regulation, yields an estimate of twenty-four closures and all are expected to be product line closures.

The four product line closure plants identified in the sample of 28 PFP plants each produce more than one PFP product. The closure analysis projects that all PFP operations at these four plants will be discontinued. The multiproduct PFP operations at these 4 plants represent a very small percent of total plant operations. In particular, for Plant 74, of the three PFP products produced, two were reported in the 308 survey as being in production for only one day per year. The third is produced about 20 days per year. For Plant 108, two PFP products are produced: one for one day per year and the other for five days per year. At Plant 87, six PFP products are produced, ranging from two to 64 days of production per year. For plant 73, five PFP products are produced, ranging from one to 18 days of production per year.

6.4 Other Economic Impacts

The effects of the regulations on employment, the community, foreign trade, and industry structure are addressed in the following sections.

Table 6-3. Summary of Plant and Product Line Closures

	Active Ingredients Manufacturers*	Manufacturers of Metallo-Organics	Formulator/Packagers Indirect Dischargers	
	Total Industry	Indirect	Sample	Total Industry
Number of Plants	119	1	28	169
Number of Plants Incurring Treatment Costs	42**	1	28	169
Number of Plants that Failed Net Present Value Test	2	0	4	24
Likely Closure: Plants	0	0	0	0
Product Lines	1	0	4	24

* The sample equals the total industry for manufacturers.

** This includes one plant that was not analyzed for closure because it was not possible to estimate its sales.

were no further regulations. For Subcategory 1 plants, both operating income before installation of additional treatment and liquidation value are estimated as a function of the plant's sales. Therefore, it is not possible to identify plants with operating costs before treatment that are particularly high in relation to their sales or liquidation value.

The potential for closure is assessed by applying the net present value test (NPV) to plants with treatment costs. This involves comparing the returns the owner would expect to receive if the plant closes (i.e., the current liquidation value) with the returns the owner would expect to receive if the plant remains in operation and the additional treatment is provided (i.e., the net present value of earnings--with treatment costs--over the next ten years plus liquidation value at the end of the ten years). If the current liquidation value is less than the net present value of earnings, then it is assumed that the treatment will be provided and the plant will continue to operate. Two manufacturing plants fail the net present value test. 1/ These plants are further analyzed to determine the likelihood of closing (See Table 6-3).

One of the two manufacturing plants that fail the net present value test is likely to close its pesticide product line, while continuing the rest of its operations. The plant has a negative estimated after-tax operating income, based on industry-wide average tax rates and ratio of operating costs to sales, and the plant specific treatment cost estimate. The plant produces pesticide active ingredients for a relatively few days out of the year and its production levels are small. It has a very high cost to sales ratio and a large, negative net present value ratio. Therefore, this plant is likely to close its pesticide operations.

The other possible closure candidate is both a manufacturer of active ingredients and a formulator/packager of pesticide products. Since a large majority of the active ingredients it formulates and packages are produced on site, the plant could not close its manufacturing operations while continuing its PFP operations. Therefore, it is appropriate to consider the impact of the regulation on the manufacturing and formulating/packaging operations jointly. Considering its manufacturing activities alone, it fails the net present value test. However, considering manufacturing and formulating/packaging production and treatment costs jointly, the plant is not a closure candidate. This was done by summing the Subcategory 1 and Subcategory 3 treatment costs for this plant and comparing this to the sum of the value of its Subcategory 1 and Subcategory 3 production. The costs for the two subcategories were estimated independently of each other and thus the sum is a conservative estimate (i.e. likely to be high) of the total treatment cost for this plant. The manufacturing component of the plant accounts for 86 percent

---

1/ One plant is not included in this part of the analysis because it did not provide production data, and it was not possible to estimate its revenues nor perform this comparison. This plant is owned by a large company that also produces pharmaceuticals.

Table 6-2. Price, Quantity and Profit Impacts for Pesticide Manufacturers and Formulator/Packagers

	Change Due to Treatment Costs (percent)		
Subcategory	Price Increase	Quantity Decrease*	Profit Decrease
Manufacturers of Active Ingredients			
Herbicides	1.70%	1.14%	1.14%
Insecticides	0.64%	0.20%	0.20%
Fungicides	0.81%	0.28%	0.28%
All Pesticides	1.30%	0.64%	0.73%
Metallo-Organics Manufacturers			
All Pesticides	0	0	+
Formulator/Packagers**			
All Pesticides	0	0	2.0%

Source: Meta Systems Inc estimates.

* Quantity decrease is a function of the percentage change in price and the price elasticities which are developed in Chapter 2.

\+ Not reported due to confidentiality restrictions.

** Indirect dischargers only.

Profit reductions will occur because the quantity of pesticides produced is declining and some of the treatment costs cannot be passed on to customers. Profit reduction for all pesticides is expected to be 0.73 percent, with: 0.20 percent for insecticides, 0.28 percent for fungicides, and 1.14 percent for herbicides (See Table 6-2.)

While there are several metallo-organic pesticide chemical manufacturing plants that will not incur compliance costs under this regulation because they do not discharge process wastewater, none of them currently produce the metallo-organic pesticide that is the subject of this analysis of the regulation. However, the plant analyzed here does compete with foreign producers. 1/ Therefore, the analysis assumes that this one plant will not be able to increase its prices. If there is no change in the quantity produced by this plant, then all of the costs come out of its profits. Since only one plant is analyzed, the profit decrease is not reported.

There are many more formulator/packager plants in this industry than there are pesticide active ingredient manufacturing plants. However, of the total number of plants that formulate/package agricultural and/or household pesticides (about 1264 plants), only 13 percent are indirect dischargers subject to this regulation. Not all of these plants are in direct competition with each other. A variety of products are produced and plants may specialize in a specific user market or in geographical markets. Also, some products cannot be produced with a dry process and plants using wet processes will have wastewater to handle. Nevertheless, because there are relatively few indirect dischargers, it is assumed that these plants will also absorb their treatment costs and will not increase prices. If there is no price increase, there is no change in quantity produced. Based on the assumption that all treatment will come out of profits, the profit reduction for indirect dischargers will be about 2.0 percent for all pesticides. To the extent that this assumption is incorrect and plants are able to pass on their treatment costs, this analysis has overestimated impacts in terms of number of closures and estimated profit reductions.

6.3 Plant Closure Potential

Based on the analytic steps described in Chapter 2, it is concluded that one plant that manufactures pesticide active ingredients is likely to close its product line in response to this regulation. The plant also produces non-pesticide chemicals and this production will continue. It is not possible to estimate baseline closures for Subcategory 1, because the necessary plant-specific information is not available. Baseline closures are plant and/or product-line closures that are expected to take place even if there

---

1/Based on work done as part of the promulgation of BPT regulations, including: Economics Analysis of Effluent Limitations Guidelines for the Pesticide Chemicals Manufacturing Point Source Category, EPA-230/2-78-065f, February 1978, and public comments.

Total capital costs for Subcategory 1 direct dischargers will be $68.7 million and total annualized costs will $35.1 million, while total capital costs for Subcategory 1 indirect dischargers will be $39.0 million and total annualized costs will be $18.7 million.

Among Subcategory 2 plants, only indirect dischargers will incur costs due to this regulation since BPT imposed zero discharge on all direct dischargers. It is estimated that the total capital costs for Subcategory 2 will be $47 million and total annualized costs will be $129.8 million.

For Subcategory 3 plants, only indirect dischargers will incur costs since BPT imposed zero discharge on direct dischargers. For the recommended treatment technology, total capital cost will be $22.6 million and total annualized costs will be $17.0 million. The Agency also calculated costs for compliance with a treatment option allowing a discharge based on the manufacturer's standards. Total capital costs were $22.2 million and total annualized costs were $16.9 million.

6.2 Price, Quantity and Profit Changes

For the pesticide active ingredient manufacturing plants in Subcategory 1, price increases due to treatment costs, and the associated decreases in production, were calculated for each of the three major product groups: herbicides, insecticides and fungicides. In all three product groups, the changes were small. As described in Chapter 2, it is assumed that manufacturers will pass on the average treatment cost per unit of output in the form of a price increase. The average cost is calculated as the total treatment costs for pesticides in that product group divided by the total sales of all pesticides in that product group. Therefore, the larger the percentage of products with costs, the larger the percentage of costs passed on. This is probably a conservative estimate in that many individual pesticides are protected by patents and/or manufactured by only one company, and these plants may be able to raise their prices to cover all of their treatment costs. The average price increase for all pesticides is 1.30 percent and the increases for the three product groups are: 0.64 percent for insecticides, 1.70 percent for herbicides, and 0.81 percent for fungicides.

In response to higher prices, the quantity of pesticides demanded will decline. The amount by which the quantity demanded declines is expressed in terms of the demand elasticity. Separate demand elasticities were calculated for each product group. 1/ Based on these elasticities, the decrease in quantity of all pesticides produced is estimated to be 0.64 percent and the decreases for the three product groups are estimated to be: 0.20 percent for insecticides, 0.28 percent for fungicides, and 1.14 percent for herbicides.

1/ The size of the percentage decrease in production depends on both the percentage increase in price and the price elasticity of demand for the product group. (Chapter 2 discusses this derivation in detail.)

Table 6-1. Total Cost of Compliance
(Costs are in 1st Quarter 1985 dollars)

	Number of plants incurring costs	Capital costs ($000)	Annual costs ($000)
Manufacturers			
Total	42*	107,705	53,795++
Direct	21	68,656	35,107++
Indirect	21	39,049	18,688++
Metallo-Organics			
Total+	1	47	129.8
Formulator/Packager**			
Total +	169	22,559	16,963

* 41 of 119 manufacturing plants incur treatment costs and/or RCRA costs and monitoring costs. One plant is both a direct and indirect discharging plant. Separate costs are assigned to the direct and indirect flows. Therefore, the plant is treated as two separate entities: one indirect and one direct discharger and the total reflects this.

\+ Includes only indirect discharge facilities.

** Based on extrapolation from a sample of 28 plants.

++ Annualized costs for manufacturers include the annualized capital cost, operating and maintenance costs, and annualized land costs.

6. ECONOMIC IMPACT ANALYSIS

This chapter provides estimates of the economic impacts associated with the costs of the effluent treatment technologies described in Chapter 5. The analysis is based upon an examination of the estimated compliance costs and other economic, technical, and financial characteristics using the methodology described in Chapter 2. The economic variables examined include: changes in prices, quantities produced, employment, foreign trade, and plant closures.

The pesticide chemicals industry is divided into two sectors or tiers: plants that manufacture the pesticide active ingredients, including metallo-organic chemicals (Subcategories 1 and 2), and plants that formulate and/or package the pesticide products (Subcategory 3). The analysis of active ingredient manufacturing plants in Subcategory 1 is based on a survey of 114 plants, which includes most of the manufacturing plants in the United States. The analysis of metallo-organic chemical manufacturers (Subcategory 2) is based on a single indirect discharge plant. The Agency believes that this is the only plant to be affected by the regulation since it is the only indirect discharging manufacturer of metallo-organic pesticide active ingredients. The analysis of pesticide formulator/packager plants is based on survey information from a sample of indirect discharging plants. Since the sample of indirect discharge formulator/packager plants surveyed was scientifically drawn and conducted, they are representative of all the estimated 169 plants to which the regulation applies. See Chapter 2 for an explanation of the sampling procedures and the extrapolation to the entire industry. The impact analysis is based on sales and operating income data for 1982 and 1983, using costs in 1982 dollars.

6.1 Total Compliance Costs for Existing Sources

Table 6-1 presents the total compliance costs, both capital investment and annual, for existing plants in the pesticide chemical industry. These costs are estimated for 1985. For the 42[1/] manufacturing plants in Subcategory 1 that will incur costs under this regulation, the total capital investment will be $107.71 million and the total annual costs will be $53.8 million. The annual costs include operating and maintenance, annualized land cost, as well as the annualized portion of the capital cost including interest and depreciation. The annualized portion of the capital costs is calculated using a capital recovery factor (CRF) of 0.218[2/].

1/ 41 of 119 manufacturing plants analyzed incur treatment costs and/or RCRA and monitoring costs. One plant is both a direct and indirect discharging plant. Separate costs are assigned to the direct and indirect flows. Therefore, the plant is treated as two separate entities: an indirect and a direct discharger, and the total reflects this.

2/ See Chapter 2 and Appendix 2D for a more detailed discussion of the derivation and use of the CRF.

Subcategory 1: Manufacturers of organic pesticide chemicals

- The 308 surveys reported production and sales in 1977 and were updated to 1982 production and 1982 dollars. ITC price information by pesticide group was obtained to update prices to 1982.

- Treatment costs developed by ITD are expressed in 1983 dollars and are used in determining plant specific economic impacts (it was not necessary to inflate 1982 sales dollars to 1983 dollars because the pesticide producer price index used to inflate prices did not change). Therefore, impacts can be analyzed in the later year of 1983.

- Total capital and annual treatment costs to comply with the regulation are expressed in first-quarter 1985 dollars.

- Plant compliance costs are based on the amount of effluent flow and on process chemistry determinations of the pollutants and their amounts in the effluent.

- Capital costs are annualized based on a captial recovery factor of .218 (see appendix 2-D for derivaton of CRF), and on Operating and Maintenance costs adjusted for total operating days.

Subcategory 2: Metallo-organic manufacturers

- Plant sales and treatment costs taken from plant's comments at Proposal and Notice. 1983 sales and costs used.

- Total capital and annual treatment costs to comply with the regulation are expressed in first-quarter 1985 dollars.

Subcategory 3: Pesticide formulator/packager plants

- The 308 Surveys for pesticide formulator/packager plants were reported in 1982 sales.

- Treatment costs developed by ITD are expressed in 1984 dollars and are deflated to 1982 dollars (based on the engineering construction cost index) in determining plant specific economic impacts.

- Total capital and annual treatment costs to comply with the regulation are expressed in first-quarter 1985 dollars.

The total costs of compliance for each regulatory option analyzed are presented in the next chapter.

For indirect discharging manufacturers of metallo-organic pesticides containing mercury, the Agency established PSES based upon the recommended treatment technology of zinc precipitation. The capital and operating costs assumed by the Agency for compliance with this PSES were based upon the data submitted by the one indirect discharging manufacturer of mercury-based metallo-organic pesticides.

The Agency is not establishing BAT effluent limitations guidelines for this industry because BPT currently requires zero discharge.

5.2.3 Subcategory 3: Pesticide Formulators and Packagers

The Agency established the zero discharge PSES for PFP's based upon recommended treatment technologies of contract hauling and incineration or physical/chemical treatment followed by recycle and reuse. Of an estimated 1,264 PFP's that are subject to the PSES, the Agency estimated that 169 currently are indirect dischargers that will have to incur costs to comply.

The Agency determined that approximately 96 percent of the PFP's that would have to incur costs have wastewater flows considered low enough that contract hauling with incineration was the recommended treatment technology. The Agency calculated costs for contract hauling and incineration for these plants. For the remaining estimated four percent, the Agency determined these plants had high wastewater flows thereby making treatment and recycle/reuse the recommended technology. Costs for such treatment was calculated for this four percent of the industry.

For the four percent of plants with high flows, the Agency also costed, for comparison purposes, a treatment option for meeting effluent limitations based on the manufacturers' effluent limitations rather than zero discharge. Treatment technologies which the Agency costed included contract hauling for highly concentrated wastestreams and treatment and discharge of the remainder of the wastestream. The total costs for this alternative were similar to the costs for the recommended treatment technology.

RCRA compliance costs are included for both low and high flow PFP plants. There are no monitoring costs associated with low and high flow plants under this recommended treatment technology.

5.3 Compliance Cost Estimates

5.3.1 Critical Assumptions

The assumptions made to estimate compliance costs are outlined in Section IV of the Pesticide Chemicals Industry Administrative Record. Some of the critical assumptions are summarized below:

For indirect dischargers, the Agency recommended physical/chemical treatment for the 24 of 28 priority pollutants (five volatiles and phenol are not regulated by PSES). Two priority pollutants (cyanide and 2, 4-dinitrophenol) have limitations based on physical/chemical plus biological and two priority pollutants (1,3-dichloropropene, Bis-(2-chloroethyl)ether) have PSES equal to no discharge. The same level of physical/chemical treatment as recommended for BAT is recommended for the 34 nonconventional pesticide pollutants. The recommended technology for the other 49 nonconventional pesticide pollutants is physical/chemical plus biological treatment. The same six nonconventional pesticides with no discharge under BAT are also no discharge under PSES.

EPA has identified 119 existing organic chemical pesticide manufacturers covered by BAT or PSES. Of these 119 plants, the Agency estimates that 42 will incur costs to achieve compliance with the applicable requirements. These plants include 21 direct dischargers and 21 indirect dischargers.

The Agency determined that for all of the direct dischargers, the recommended treatment technology would be physical/chemical plus biological to comply with BAT. In calculating the costs, the Agency assumed that the 21 plants would incur costs for physical/chemical treatment only because biological treatment was already in place at these plants.

For the 21 indirect dischargers that the Agency assumed would incur costs, the recommended treatment technology for eight of the plants was physical/chemical plus biological and for the remaining 13 plants, physical/chemical treatment only. The Agency costed physical/chemical plus biological treatment at seven of the eight plants, since an eighth plant which already had biological treatment installed, was costed for physical/chemical only. The Agency calculated costs for the remaining 13 plants based on the cost of physical/chemical treatment.

The total costs calculated by the Agency include costs for monitoring priority and nonconventional pesticide pollutants four times per month, daily monitoring for conventional pollutants, and RCRA compliance costs for both direct and indirect dischargers that would have to dispose of contaminated sludges. Monitoring costs of $54,000 were also applied to the remaining 73 manufacturing plants not incurring treatment costs. As a result, no incremental closures occur.

5.2.2 Subcategory 2: Metallo-Organic Pesticide Manufacturers

The Agency based the zero discharge PSES for Subcategory 2 plants which manufacture metallo-organic pesticides containing arsenic, cadmium, and copper, on the recommended treatment technologies of either contract hauling and incineration or recycle and reuse. The Agency did not calculate any compliance costs with this standard because there currently are no existing indirect dischargers manufacturing these pesticides.

5. EFFLUENT LIMITATIONS GUIDELINES AND STANDARDS CONTROL OPTIONS AND COSTS

5.1 Overview

The alternative water treatment control systems, costs, and effluent limitations for the Pesticide Chemicals Industry Point Source Category are enumerated in Section IV of the Pesticide Chemicals Industry Administrative Record. Section IV also identifies various characteristics of the industry, including manufacturing processes; products manufactured; volume of output; raw waste characteristics; supply, volume, and discharge destination of water used in the production processes; sources of wastewaters; and the constituents of wastewaters. Using these data, pollutant parameters requiring effluent limitations guidelines and standards of performance are selected by EPA.

Section IV also identifies and assesses the range of control and treatment technologies for the industry. This involved an evaluation of both in-plant and end-of-pipe technologies. This information is then evaluated for existing surface water industrial dischargers to determine the effluent limitations required for the Best Practicable Control Technology Currently Available (BPT), and the Best Available Technology Economically Achievable (BAT). Existing dischargers to Publicly-Owned Treatment Works (POTWs) are required to comply with Pretreatment Standards for Existing Sources (PSES). New direct and indirect dischargers are required to comply with New Source Performance Standards (NSPS) and Pretreatment Standards for New Sources (PSNS), respectively. Identified technologies are analyzed to calculate cost and performance above treatment-in-place. Cost data are expressed in terms of capital investment and annualized costs. Annualized costs are calculated using a capital recovery factor (CRF) of 0.218 and an O&M cost adjusted for the number of days of operation per year (see Appendix 2-D for discussion of CRF).

5.2 Control and Treatment Technology Costing

5.2.1 Subcategory 1: Organic Chemicals Pesticide Manufacturers

The Agency based the final effluent limitations and standards for Subcategory 1 on use of physical/chemical treatment technologies, sometimes in combination with biological treatment. The physical/chemical processes include activated carbon, hydrolysis, resin adsorption, multimedia filtration, stream stripping, chemical oxidation, and/or metal separation while the biological processes include aerated lagoons or activated sludge.

For direct dischargers, the Agency recommended that physical/chemical plus biological treatment could be used to achieve the BAT limitations for 23 priority pollutants and 49 of the 89 nonconventional pesticide pollutants. The Agency is not establishing BAT limitations for nine priority pollutants. Two priority pollutants have BAT equal to zero discharge. For 34 nonconventional pesticide pollutants, the Agency recommended physical/chemical treatment only to meet BAT limitations. Six nonconventional pesticides have BAT equal to no discharge.

Table 4-4. Baseline Value of Production and Employment Estimates, 1982 and 1990 Pesticide Formulating/Packaging*

	1982	1990
Value of PFP Production (mil. $)		
Total PFP Industry	$5,200	$6,690
Indirect Dischargers	$1,561	$2,008
Employment in PFP Production - FTE**		
Total PFP Industry	7,104	8,143
Indirect Dischargers	2,133	2,445
Operating Income (mil. $)***		
Indirect Dischargers	$253	$326

Source: Meta Systems Inc estimates.

* Dollar values are in constant 1982 dollars.

** FTE = Full time equivalent employees; (i.e. one full time worker = 1,960 hours per year).

*** Operating income after federal income taxes.

Table 4-4 shows the baseline estimates for 1982 and 1990 for indirect dischargers and the total PFP industry. Employment in 1990 is estimated by dividing the 1990 dollar value of production by the 1990 dollar value per employee.1/ Operating income is estimated for 1990 by applying the 1982 relationship between dollar value of production and profit.

1/Value of production per employee in 1990 is derived from the 1982 value per employee adjusted for real price increase of 1.9 percent per year between 1982 and 1990.

Table 4-3. 1982 Baseline Value of Production and Employment Estimates For All PFP Plants

	Number of Plants	Value of PFP Production mill.$	PFP Employment FTE	PFP Operating Income mill.$
Indirect Dischargers (per plant Average)	169	$1,561 ($9.24)	2,133 (12.6)	$253 ($1.5)
Zero Dischargers: (per plant Average)	1,095	$3,639 ($3.32)	4,971 * (4.54)	** **
Total PFP	1,264	$5,200	7,104	**

Source: Meta System Inc estimates.

FTE Full time equivalent employees; one full-time worker = 1,960 hours per year.

* Estimate based on value per employee for indirect dischargers of $0.732 million per FTE.

** Not estimated.

In addition to value of PFP production and PFP employment, Table 4-2 shows plant average estimates. For the average indirect discharge PFP plant, value of pesticide products is $9.2 million and average PFP employment is 13; the average PFP value per employee is $732,000. One reason for this high value per employee is that the cost of the inputs, particularly the active ingredients, is high. This value per employee should not be confused with value-added per employee, which would be much lower. Value-added per employee measures how much the value has increased between the inputs and the outputs of the facility. Value per employee simply measures the value of the output.

The average annual capital investment for PFP operations over the last few years has been $44 thousand for each of the 169 plants, as determined from the 308 Survey data.

4.2.1.2 Other PFP Plants

There are an estimated 1095 zero discharge plants out of a total of 1,264 plants estimated for the PFP industry. The average plant size in this segment of the industry is small relative to indirect discharge plants. Estimated employment for zero dischargers is 49 per plant, based on a sample of 97 plants described in the industry profile compared to an average total plant employment of 135[1/] per indirect discharge plant, based on the results of the 308 Survey. Since PFP employment is not known for zero dischargers, it is estimated on the basis of the unit value per employee (FTE) derived for indirect discharging plants ($0.732 million per employee). Assuming this same unit value for zero dischargers, the total PFP employment for zero discharge plants is about 4,971. A summary of the PFP industry showing all groups of dischargers is shown in Table 4-3.

4.2.2 Projected Baseline

The pesticide active ingredient manufacturers and the pesticide formulator/packagers are projected to grow at the same average rate because the formulating/packaging operations are the downstream activities which follow pesticide manufacturing. The value of pesticide active ingredient production is projected to grow at a real rate of 3.2 percent annually between 1982 and 1990; this rate accounts for growth in quantity produced and growth in real prices. Applying this rate to the $5.20 billion estimated as the value of PFP production in 1982, the projected value of PFP production is about $6.70 billion in 1990 (expressed in constant 1982 dollars), of which indirect dischargers account for $2.01 billion.

[1/]For the indirect discharge PFP plants, hours worked have been converted to full time equivalent (FTE) employment based on 1,960 hours per year per full time employee.

Table 4-2. 1982 Baseline for Indirect Discharge PFP Plants

Number of plants	169
Value of Production	
-PFP production (mil. $)	$ 1,561
-Total plant (mil. $)	$ 8,761
-PFP as percent of total plant	17.8%
Employment	
-PFP employment-FTE*	2,133
-Total Plant-FTE*	14,535
-PFP as percent of total plant employment	14.7%
Operating Income From PFP**	
-Percent of PFP production value	16.2%
-Millions of Dollars	$252.95
Averages***	
-Value of PFP production per plant (mil. $)	$9.24
-Value of PFP production per employee (mil. $)*	$0.732
-PFP employment per plant*	12.6

Source: Meta Systems Inc calculations from 308 Survey.

* FTE = Full time equivalent employees; i.e. one full time worker = 1,960 hours per year.

** Operating income after federal income taxes.

*** Value of production and employment are for PFP operations only, not total plant.

4.2 Pesticide Formulating and/or Packaging (PFP)

The scope of this regulation includes plants that formulate and/or package agricultural and household pest control products and the notation, PFP, (Pesticide Formulator/Packager) refers to those plants.

The 308 Survey requested information for the year 1982 and therefore PFP baseline conditions are described for that year. The baseline also is projected to 1990. The variables used to describe conditions in the PFP industry are value of production, profit (expressed as after-tax operating income), employment, and average annual capital investment.

4.2.1 Current Baseline

The PFP industry is comprised of approximately 1,264 plants. The total value of production in 1982 for formulated and packaged pesticide products is estimated to be $5.20 billion. The estimate is based on information published in the 1983 U.S. Industrial Outlook, the Annual Survey of Manufacturers, the Kline Guide, and USDA information. Appendix 4-B presents the information provided by these sources.

The value of PFP production accounted for by indirect discharge plants is estimated using the EPA 308 Survey responses. The remainder of the total PFP industry value is assigned to zero dischargers.

4.2.1.1 Indirect Discharging PFP Plants

The estimated value of PFP 1982 baseline production by 169 indirect dischargers is $1.56 billion; employment is 2,133. (See Table 4-2.) The baseline for the 169 plants is derived by extrapolating estimates for the 28 representative sample indirect discharge PFP plants that supplied this information in response to the EPA 308 Survey. The 169 plants represent 13.4 percent of the total number of PFP plants (1,264) and account for 30.0 percent of the total $5.20 billion PFP industry value. For most of the indirect discharge plants, PFP operations are not the primary production activity; value of PFP production represents 17.8 percent of the total plant production value for the 169 plants.

Similarly, employment in PFP operations does not account for the major portion of total employment at these indirect discharge PFP plants. Total plant employment for indirect dischargers is about 14,535 with employment for PFP of 2,133, or about 14.7 percent.

As a measure of profit, after-tax operating income is estimated to be 16.2 percent of the total value of PFP production at indirect discharge PFP plants. In absolute terms, the profit was $252.95 million in 1982.

Table 4-1. Baseline Production Quantity and Value of Pesticide Active Ingredients*

	1982	1990
All pesticides		
Quantity (mill. lbs.)	1168	1280
Total Value (mill. $)	$3850	$4950
Herbicides		
Quantity (mill. lbs.)	521	600
Average Unit Value ($/lb.)	$4.095	$4.760
Insecticides		
Quantity (mill. lbs.)	423	435
Average Unit Value ($/lb.)	$2.873	$3.340
Fungicides		
Quantity (mill. lbs.)	224	245
Average Unit Value ($/lb.)	$2.239	$2.603

Source: Meta System Inc calculations.

* Dollar values are in constant 1982 dollars.

million, cotton acreage is 4 million, sorghum acreage is 3.5 million and rice acreage is one million.1/ These conditions which depressed pesticide production in 1983 are not expected to persist.

More robust growth rates than assumed above for the baseline projection might be argued, based on crop acreage increases expected in 1984 and the general economic upturn that has occurred in 1984. However, the large inventory carry overs of pesticides into 1984 anticipated by the USDA tempers such optimism at this time.2/ If higher growth rates had been used for the projection, then the estimated impacts of treatment costs would be reduced. Thus the projected baseline provides a conservative basis upon which to assess the future impacts of treatment costs.

An analysis in 1981 by Frost and Sullivan supports the conclusion of relatively low average rates of growth over the 1980-1985 period and anticipates a production growth rate of 1.4 percent for the total industry.3/ Total dollar value of production is projected to increase at a rate of about 8.4 percent in current dollars, equivalent to an average increase of 6.9 percent in dollar per pound (unit value) of pesticide active ingredients. Assuming an average rate of inflation of five percent over the 1980-85 period, the average annual real rate of increase in unit value would average 1.9 percent.

To estimate the dollar value of production in 1990, the unit values in the current baseline for the three product groups are increased using the 1.9 percent real annual rate of growth derived above. The value of production equals the projected quantity of production times the unit value, expressed in constant 1982 dollars. Table 4-1 summarizes the 1982 and 1990 baseline estimates of value and quantity of production.

The production levels predicted for the next several years can be accommodated by the existing capacity. Assuming no major plant shutdowns occur due to factors such as plant obsolescence, the 1990 production levels represent a capacity utilization rate of 71 percent for the total industry; 86 percent for herbicides, 62 percent for insecticides and 61 percent for fungicides. Also pesticide active ingredients are manufactured on a "campaign" basis in many of the existing plants; that is, production is by batch operations carried out over a period of several weeks or a few months and the output satisfies annual production targets. Thus existing plants have potential for greater output by extending the batch operation periods rather than investing in new facilities.

1/ O. Overboe, U.S. Department of Agriculture, personal communication, August 1983.

2/ U.S. Department of Agriculture, Inputs-Outlook and Situation, Economic Research Service, IOS-2, October 1983.

3/ Frost and Sullivan, U.S. Pesticide Market, Report A907, May 1981.

The growth rates for production quantities are based on a 1981 USDA evaluation which concluded that U.S. production of all pesticides would show an average annual growth rate of only slightly over one percent between 1978 and 1990.[1] For herbicides, production is projected to increase at a rate of 1.8 percent, insecticides at 0.4 percent and fungicides at 1.1 percent. The higher growth rate for herbicides is attributed to increasing use of reduced tillage practices by farmers. Reduced tillage is advantageous to farmers since it reduces the amount of top-soil lost to erosion, and reduces the amount of fuel used by farmers. Instead of tilling, the trend will be to apply herbicides on a routine basis to control vegetation before planting and in the early phase of crop growth. In contrast, insecticides will be used with greater selectivity than in the past to minimize use of chemicals toxic to animal life, or which may come in contact with food supplies, or may enter the environment.

In the 1981 study, the USDA examined demand as well as supply, and concluded that domestic use for agricultural and non-agricultural purposes would increase at an average annual rate of 0.3 and 0.8 percent, respectively, over the 1978-1990 period. Growing use of integrated pest management programs, more government restrictions, and market saturation in the U.S. were cited as the reasons for the relatively low growth rate. In other areas of the world, particularly the developing nations, agricultural use was expected to increase at a faster rate than in the U.S. because current use of pesticides is less intense and pressures are greater to increase food production. Thus, exports by the U.S. were projected to grow at a faster rate than domestic use.

The depressed conditions in pesticide manufacturing since that study--particularly in 1983--make 1983 an inappropriate year on which to base long-run projections. As discussed in the industry profile, U.S. production of pesticide active ingredients as reported by the ITC was about 1.4 billion pounds annually between 1977 and 1981. Production declined to approximately 1.1 billion pounds in 1982 (about 78 percent of the 1981 level) and declined again in 1983. The production declines are due to large inventory carry overs into 1983 which, in turn, are attributable to several factors: the economic downturn, the payment-in-kind (PIK) program implemented by the U.S. Department of Agriculture in 1983, and to insect infestations that were lower than usual. Under the PIK program, the Commodity Credit Corporation entered into contracts with farmers who agreed to divert acreage from crop production in 1983 to approved conservation uses. The eligible crops were wheat, corn, sorghum, upland cotton, and rice. The farmers were compensated in the form of quantities of these commodities which had accumulated over the years in the nation's inventory. The USDA does not intend to make PIK a long-term program, although it will be extended another year for the wheat crop. The effect of PIK on the 1983 crop year has been to take about 48 million acres out of production of which corn acreage is 22 million, wheat acreage is 18

1/ T.R. Eichers, Farm Pesticide Economic Evaluation, 1981, USDA, Economic and Statistic Service, Agricultural Economic Report, 464.

The plant-by-plant production quantities for 1977 are adjusted to 1982 rather than 1983 because industry output in 1983 was unusually low. As discussed later in this chapter, 1983 is considered to be atypical of industry conditions, and thus is not an appropriate basis from which to project future levels of production. Pesticide prices are adjusted to 1982 based on ITC data. Pesticide-specific prices for 1983 were not available from the ITC. However they are essentially the same as 1982 based on a comparison of pesticide producer price indexes for those two years. (These indexes are discussed in Appendix 4-A. The adjustment for changes in production quantity and price between 1977-82 have been discussed in Chapter 2.)

Profits for manufacturers of pesticide active ingredients are estimated to be $555 million in 1982 dollars. Profits are expressed as after-tax operating income and are derived from pesticide sales as explained in Chapter 2 and Appendix 4-A.

Total industry capacity is approximately 1.8 billion pounds; herbicide and insecticide production capacities are each about 0.7 billion pounds and fungicides about 0.4 billion pounds. These estimates are based on capacity utilization rates reported by the U.S. Department of Agriculture (USDA) for 1982 (summarized in Chapter 3) and the estimated baseline quantities of pesticides sold by the manufacturing plants. The 1982 capacity utilization rates are 65 percent overall; 71 percent utilization of herbicide production capacity, 60 percent utilization for insecticides and 55 percent for fungicides.

4.1.2 Projected Baseline

Production of pesticide active ingredients is projected to increase at an average annual rate of 1.17 percent, reaching 1.28 billion pounds in 1990 valued at $4.95 billion (in constant 1982 dollars). Production quantities for the three major groups are: 600 million pounds for herbicides, 435 million pounds for insecticides and 245 million pounds for fungicides. Applying the same profit margins and tax rates used for the current baseline, profits in 1990 are estimated at $715 million.

Based on comments by USDA experts, it can be concluded that 1983 was an aberrant year for purposes of estimating long-term trends (discussed below), and that 1982 production is a more reasonable year on which to base projections of production levels in 1990.[1/] According to predictions made in mid-1983 by USDA, 1983 production was expected to be down about nine percent from 1982.[2/] Long-term growth rates estimated by the USDA in 1981 on the basis of their on-going analysis of pesticide use and production levels are applied to the current baseline production quantities to project the 1990 quantities.

1/ Eichers, T.R., and Salathe, L., personal communications, USDA, March and February 1984.

2/ U.S. Department of Agriculture, Inputs-Outlook and Situation, Economic Research Service, IOS-1, June 1983.

4. BASELINE PROJECTIONS OF INDUSTRY CONDITIONS

This chapter provides estimates of current and future conditions in the pesticide chemicals industry in the absence of additional effluent limitations guidelines and standards, i.e. baseline conditions. Baseline estimates are made for pesticide active ingredient manufacturers and for pesticide formulator/packagers (PFP).

4.1 Pesticide Manufacturing

The baseline conditions for manufacturers of pesticide active ingredients are derived from 1977 308 Survey data for each plant, updated to 1982 levels as explained in Chapter 2. In addition to describing current baseline conditions, industry trends are projected to 1990, so that the severity of treatment cost impacts after 1982 can be assessed in Chapter 6.

The variables selected to describe industry conditions are: quantity and dollar value of pesticides sold (total for the subcategory and separately for each of the major product groups, i.e. herbicides, insecticides, and fungicides), profit, production capacity and capacity utilization rate.

4.1.1 Current Baseline

The 1982 baseline quantity of pesticide active ingredients sold by the 114 1/ manufacturing plants is 1.17 billion pounds of which herbicides account for 521 million pounds, insecticides for 414 million pounds, and fungicides for 224 million pounds. The value of pesticide active ingredients sold by the manufacturers is $3.85 billion of which herbicides account for $2.14 billion, insecticides for $1.2 billion and fungicides for $0.5 billion.

Though referred to as the 1982 baseline, the estimated values of baseline variables are not identical to the actual performance of the manufacturing plants in the industry in 1982 because 1982 production quantities were not available for individual plants and therefore, are derived from 1977 data. The baseline describes the recent performance of the plants included in the analysis, assuming that changes between 1977-82 in pesticide manufacturing output at each plant and in price are the same as the changes for pesticide chemical groups reported by the U.S. International Trade Commission (ITC).2/

1/ Baseline projections are based on the 308 data, which are available from 114 of the approximately 119 pesticide active ingredient manufacturers.

2/ U.S. International Trade Commission USITC publication number 1422, Synthetic Organic Chemicals, 1982, and USITC publication number 920, Synthetic Organic Chemicals, 1977.

Table 3-18. The World Pesticide Market, 1980,
User's Level, Percent of Market*

	U.S.	Western Europe	Japan & Far East	Rest of World
Herbicides	44%	24%	11%	21%
Insecticides	23%	13%	26%	38%
Fungicides	10%	39%	24%	27%

Source: Farm Chemicals, September 1981 and Meta Systems Inc calculations.

* Based on Millions of U.S. 1980 Dollars.

Import quantities have been much less than exports. In 1980, herbicide imports were 31 million pounds, insecticides 6.7 million pounds and fungicides 2.9 million pounds. However, in 1982, imports of the two major pesticide product groups--herbicides and insecticides--were about 1.5 times the 1980 quantities, while imports of fungicide active ingredients showed a ten percent decline. (See Tables 3-14, 3-15 and 3-16.)

The 40 million pounds of pesticide active ingredients imported in 1980 originated in a relatively few number of nations with established chemical technology. Switzerland accounted for 36 percent of imports by weight, West Germany 27 percent, the United Kingdom ten percent, and Japan four percent. (Based on value of the imported pesticides, West Germany accounted for 36 percent while Switzerland, Japan and the United Kingdom accounted for 19, 16 and 11 percent, respectively.)

In 1980, the U.S. accounted for the greatest dollar share (44 percent) of the world herbicide market, 23 percent of the world insecticide market and 10 percent of the world fungicide market. Western Europe accounted for the greatest share of the fungicide market (39 percent), and the rest of the world (other than Japan, the Far East and Western Europe) was the largest market for insecticides, as noted in Table 3-18.

There are a number of growing world markets from which U.S. pesticide industries should be able to profit. The largest are Brazil, The People's Republic of China, Mexico, and Japan. 1/ Corn and soybean herbicides offer the greatest opportunities for continued growth in world herbicide markets. The developing countries are likely to continue increasing their use of pesticides by five or six percent per year as many of the countries strive to obtain a better balance between fertilizer and pesticide use. One industry observer predicts that exports will provide greater growth than domestic markets during the next decade, averaging an increase of 2.7 percent per year. 2/

1/ Farm Chemicals, April 1981.

2/ Predicasts, as quoted in Chemical Week, May 7, 1980.

Table 3-17. Annual Growth Rates for Volume and Value of U.S. Pesticide Exports (1970-1980)

Product Group	Volume (Percent)	Value* (Percent)
Herbicides	12.7	22.9
Insecticides	1.2	14.5
Fungicides	8.1	23.8
All Pesticides**	5.1	18.7

Source: U.S. Department of Agriculture, The Pesticide Review, Agricultural Stabilization and Conservation Services, Washington, DC, Annual issues from 1975-1979.

* Based on current dollars.

** Includes other pesticides such as miticides.

Table 3-16. U.S. Production and Trade in Fungicides 1/

Year	Production (Mil. Lbs.)	Exports (Mil. Lbs.)	Exports as a Percent of U.S. Production	Imports 2/ (Mil. Lbs.)	Imports as a Percent of U.S. Production
1966	137	21.2	15.5	NA	NA
1967	144	19.2	13.3	NA	NA
1968	154	18.8	12.2	NA	NA
1969	141	18.1	12.8	0.3	0.2
1970	140	20.6	14.7	1.2	0.9
1971	149	21.5	14.4	2.0	1.3
1972	143	21.0	14.7	NA	NA
1973	154	29.2	19.0	NA	NA
1974	163	30.0	18.4	1.6	1.0
1975	155	23.9	15.4	4.0	2.6
1976	142	25.2	17.7	4.4	3.1
1977	143	27.1	18.9	3.2	2.2
1978	147	39.8	27.1	1.5	1.0
1979	155	38.3	24.7	1.0	0.6
1980	156	45.2	29.0	2.5	1.6
1981	143	39.7	27.8	2.5	1.7
1982	111	44.1	39.7	2.4	2.2
1983	95	38.0	40.0	NA	NA

Source: U.S. International Trade Commission, Synthetic Organic Chemicals, 1981 and prior issues, U.S. Government Printing Office, Washington, DC. U.S. Department of Agriculture, The Pesticide Review, Agricultural Stabilization and Conservation Services, Washington, DC, Annual issues from 1976-1981. Unpublished information from Lee Fowler, Pesticide Specialist, USDA.

1/ Imports and exports are converted to an active ingredient basis by halving values.

2/ Estimated by Meta Systems Inc by country of origin, and proportionate share of herbicides, insecticides, and fungicides as reported for selected chemicals in U.S. Department of Agriculture, The Pesticide Review, Agricultural Stabilization and Conservation Services, Washington, DC, Annual issues from 1976-1981 and unpublished information from Lee Fowler, Pesticide Specialist, USDA.

NA Not available.

Table 3-15. U.S. Production and Trade in Insecticides 1/

Year	Production (Mil. Lbs.)	Exports (Mil. Lbs.)	Exports as a Percent of U.S. Production	Imports 2/ (Mil. Lbs.)	Imports as a Percent of U.S. Production
1966	552	131	23.7	NA	NA
1967	496	140	28.3	NA	NA
1968	569	161	28.3	NA	NA
1969	571	128	22.4	0.5	0.1
1970	490	118	24.1	0.6	0.1
1971	558	119	21.3	0.5	0.1
1972	564	104	18.4	NA	NA
1973	639	172	26.9	NA	NA
1974	650	184	28.3	1.1	0.2
1975	659	155	23.5	1.0	0.2
1976	566	136	24.0	2.5	0.4
1977	570	146	25.6	1.5	0.3
1978	606	143	23.6	5.0	0.8
1979	617	144	23.3	7.0	1.1
1980	506	133	26.3	6.7	1.3
1981	448	99.7	22.2	9.4	2.1
1982	379	91.8	24.2	11.0	2.9
1983	326	95.0	29.0	NA	NA

Source: U.S. International Trade Commission, Synthetic Organic Chemicals, 1981 and prior issues, U.S. Government Printing Office, Washington, DC. U.S. Department of Agriculture, The Pesticide Review, Agricultural Stabilization and Conservation Services, Washington, DC, Annual issues from 1976-1981. Unpublished information from Lee Fowler, Pesticide Specialist, USDA.

1/ Imports and exports are converted to an active ingredient basis by halving values.

2/ Estimated by Meta Systems Inc by country of origin, and proportionate share of herbicides, insecticides, and fungicides as reported for selected chemicals in U.S. Department of Agriculture, The Pesticide Review, Agricultural Stabilization and Conservation Services, Washington, DC, Annual issues from 1976-1981 and unpublished information from Lee Fowler, Pesticide Specialist, USDA.

NA Not available.

Table 3-14. U.S. Production and Trade in Herbicides 1/

Year	Production (Mil. Lbs.)	Exports (Mil. Lbs.)	Exports as a Percent of U.S. Production	Imports 2/ (Mil. Lbs.)	Imports as a Percent of U.S. Production
1966	324	22.5	6.9	NA	NA
1967	409	32.4	8.0	NA	NA
1968	469	37.0	8.1	NA	NA
1969	393	34.7	8.9	2.9	0.7
1970	404	39.0	9.7	4.8	1.2
1971	429	42.3	9.9	7.9	1.8
1972	451	44.0	9.8	NA	NA
1973	496	70.0	16.3	NA	NA
1974	604	95.2	17.6	11.5	1.9
1975	788	100.4	13.5	20.2	2.6
1976	656	99.0	15.9	24.2	3.7
1977	674	105.5	16.0	20.1	3.0
1978	664	117.1	17.6	29.0	4.4
1979	658	131.8	20.1	32.6	5.0
1980	805	129.3	16.1	31.0	3.9
1981	839	111.6	13.3	37.4	4.5
1982	623	111.4	17.9	45.7	7.3
1983	593	125.0	21.0	NA	NA

Sources: U.S. International Trade Commission, Synthetic Organic Chemicals, 1981 and prior issues, U.S. Government Printing Office, Washington, DC. U.S. Department of Agriculture, The Pesticide Review, Agricultural Stabilization and Conservation Services, Washington, DC, Annual issues from 1976-1981. Unpublished information from Lee Fowler, Pesticide specialist, USDA.

1/ Imports and exports are converted to an active ingredient basis by halving values.

2/ Estimated by Meta Systems Inc from total imports reported by country of origin; and proportionate share of herbicides, insecticides, and fungicides as reported for selected chemicals in U.S. Department of Agriculture, The Pesticide Review, Agricultural Stabilization and Conservation Services, Washington, DC, Annual issues from 1976-1981 and unpublished information from Lee Fowler, Pesticide Specialist, USDA.

NA Not available.

pest management (IPM). IPM is practiced mostly on large grain crops and cotton, and consists of scouting and monitoring pest populations to optimize the time of pesticide applications. The timing of planting and harvesting is also part of the IPM strategy. Another factor is the use of more complex pesticides, such as synthetic pyrethroids, which are applied less frequently and at lower rates than traditional insecticides. The highest growth will occur in herbicides because of the increasing use of less intensive tillage practices which tend to increase the likelihood of weeds, as discussed earlier. Some of the primary use characteristics of each of these three major pesticide classes are discussed in Appendix 3-E.

3.4 Exports and Imports

The export-import analysis is based on pesticide active ingredients, but the trends are, in general, applicable to formulated products as well. The U.S. is a net exporter of pesticides. In 1980, exports exceeded imports by 270 million pounds on the basis of pesticide active ingredients. In 1982, the net balance declined to 190 million pounds. Tables 3-14, 3-15, and 3-16 present data on U.S. exports and imports of the three major product groups from 1966 to 1982. Exports and imports are described in terms of pounds and percent of U.S. production quantities.

In 1982, the U.S. exported 111 million pounds of herbicides active ingredients, or about 18 percent of U.S. production. For insecticides and fungicides, the 1982 export quantities were 92 million pounds and 44 million pounds, respectively. For insecticides, the 1982 exports represent 28 percent of U.S. production and for fungicides, 40 percent of U.S. production.

Exports in 1983 are expected to show an increase over 1982. Exports for herbicides are estimated to be 125 million pounds, for insecticides about 95 million pounds and for fungicides 38 million pounds. 1/ The estimates are based on a survey of major producers by the U.S. Department of Agriculture in mid-1983. 2/ The major producers expected exports of herbicides to be 21 percent of the U.S. production, for insecticides and fungicides, the exports were estimated at 29 percent and 40 percent, respectively. (The percentage estimates refer to depressed production levels for pesticide manufacturers in 1983 due to large inventory carryovers, the Department of Agriculture's acreage set aside program (PIK) and general economic conditions.)

Table 3-17 displays the average annual growth rates over the 1970-1980 decade for both the quantity and value of pesticides exports. The quantity of herbicide exports showed the highest quantity rate of growth (12.7 percent). The value of exports of herbicides and fungicides showed growth rates exceeding 22 percent compared to 14.5 percent for insecticides.

1/Meta Systems Inc estimates.

2/U.S. Department of Agriculture, Inputs--Outlook and Situation, Economic Research Service, IOS-1, June 1983 and IOS-2 October 1983.

Table 3-13. Estimated Composition of U.S. Pesticide Chemicals Production*

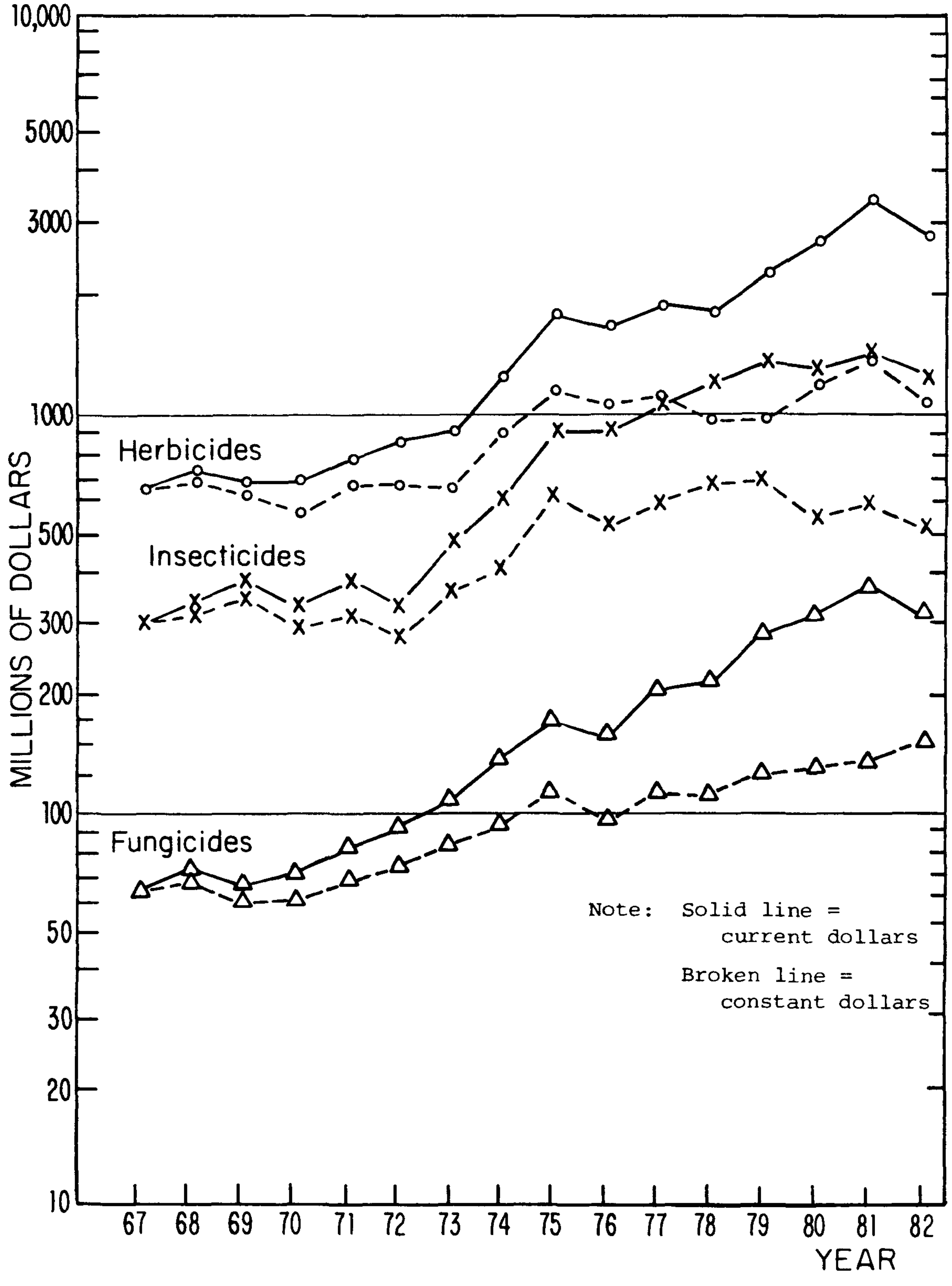
Year	Class	Production Quantity: Mill Lbs.	Production Quantity: Percent	Production Value, Million Dollars: Current	Production Value, Million Dollars: Constant**	Production Value: Percent	Average Unit Value, Dollars/Pound: Current	Average Unit Value, Dollars/Pound: Constant	GNP Deflator
1977	Herbicides	674	49	1,867	1,054	60	2.77	1.56	1.772
	Insecticides	570	41	1,049	593	34	1.84	1.04	
	Fungicides	143	10	203	115	6	1.42	0.80	
	Total	1,387	100	3,119	1,762	100			
1978	Herbicides	664	47	1,843	968	56	2.78	1.46	1.904
	Insecticides	606	43	1,232	647	37	2.03	1.07	
	Fungicides	147	10	214	112	7	1.46	0.76	
	Total	1,417	100	3,289	1,727	100			
1979	Herbicides	658	46	2,020	977	55	3.07	1.48	
	Insecticides	617	43	1,407	680	38	2.28	1.10	2.068
	Fungicides	155	11	279	135	7	1.80	0.87	
	Total	1,430	100	3,706	1,792	100			
1980	Herbicides	805	55	2,672	1,183	63	3.32	1.47	2.258
	Insecticides	506	34	1,265	560	30	2.50	1.11	
	Fungicides	156	11	309	137	7	1.98	0.88	
	Total	1,467	100	4,246	1,880	100			
1981	Herbicides	839	59	3,373	1,366	64	4.02	1.63	2.470
	Insecticides	448	31	1,465	593	29	3.27	1.32	
	Fungicides	142	10	358	145	7	2.50	1.01	
	Total	1,429	100	5,196	2,104	100			
1982	Herbicides	623	56	2,695	1,030	63	4.33	1.65	2.616
	Insecticides	379	34	1,282	490	30	3.38	1.29	
	Fungicides	111	10	302	115	7	2.72	1.04	
	Total	1,113	100	4,279	1,635	100			

Source: U.S. International Trade Commission, Synthetic Organic Chemicals, 1982 and prior issues, U.S. Government Printing Office, Washington, DC., and Meta Systems Inc calculations.

* Average unit value is total value divided by total production.

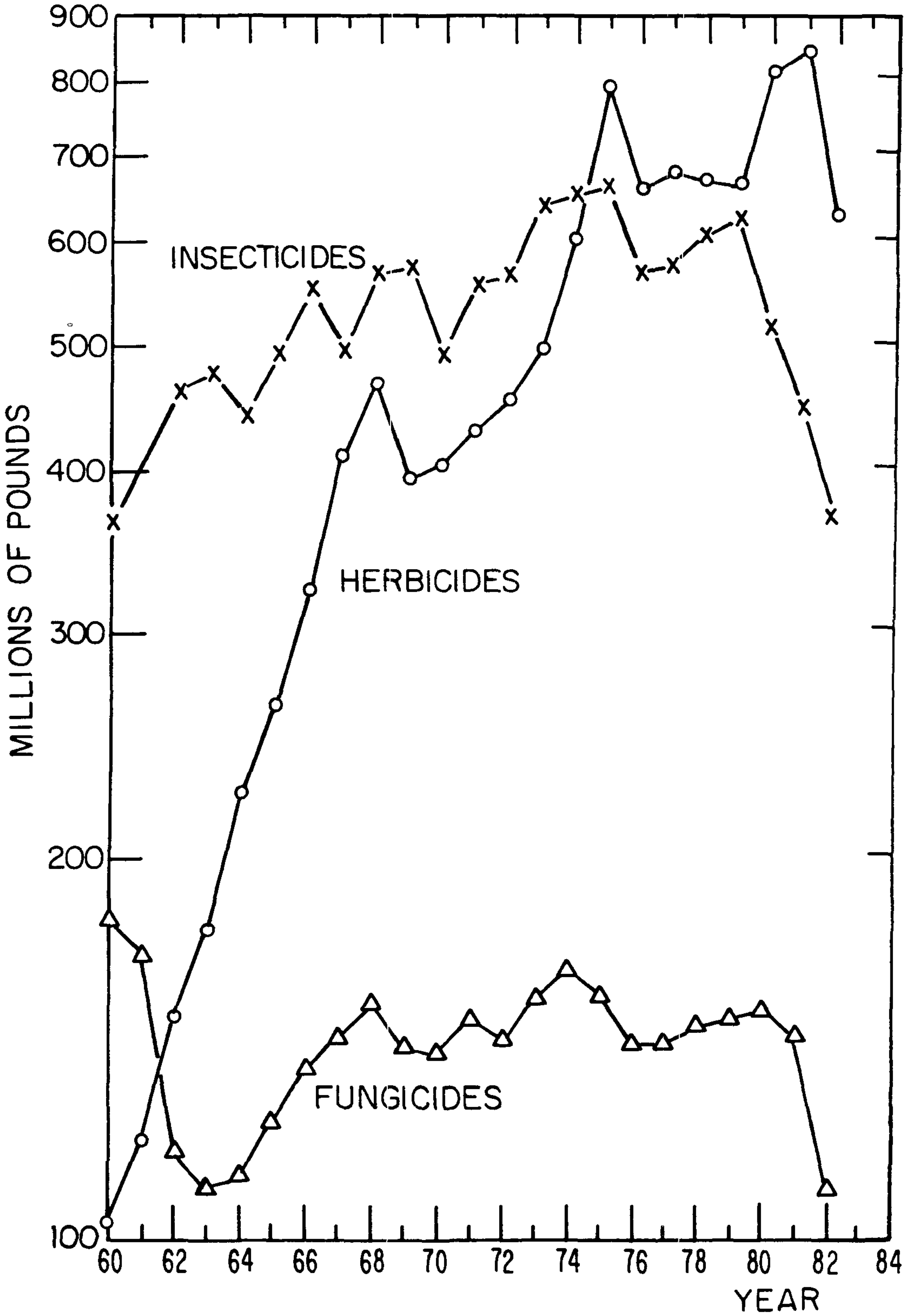
** Constant 1967 dollar value is calculated using the GNP deflator (1967 = 1.00) from U.S. Department of Commerce, Bureau of Economic Analysis.

Figure 3-2. Annual Pesticide Value by Product Type



Source: U.S. International Trade Commission, Synthetic Organic Chemicals, 1982 and prior issues, U.S. Government Printing Office, Washington, DC. Also, Arthur D. Little Inc., unpublished information furnished by EPA.

Figure 3-1. Annual Pesticide Production by Product Type



Source: U.S. International Trade Commission, Synthetic Organic Chemicals, 1982 and prior issues, U.S. Government Printing Office, Washington, DC. Also, Arthur D. Little Inc., unpublished information furnished by EPA.

provide attractive habitats for some insects. In 1982, pesticides were expected to account for two to 16 percent of total farm production costs depending on the crop; e.g., 2.3 percent of the cost for wheat, 11.3 percent for soybeans and cotton, and 15.7 percent of peanuts, averaging 3 percent for all pesticide expenditures. 1/

The demand for pesticides is also directly related to crop acreages, pest conditions, and the weather. For example, demand for herbicides will increase with increasing acres in production, severe cold or drought will usually decrease the need for and use of insecticides, while fungicide demand depends on disease levels which, in turn, are influenced by humidity and temperature.

Total annual production of pesticide active ingredients, which increased rapidly in the sixties and early seventies, had leveled off to about 1.4 billion pounds in the last several years through 1981. In addition, the production mix of herbicides, insecticides and fungicides changed considerably over the past two decades as shown in Figure 3-1. Herbicides have taken the lead in production quantity only since 1975. However, the value of herbicide production had exceeded that of insecticides even prior to 1975 as shown in Figure 3-2; for example, between 1967 and 1975 the value of herbicide production ranged from 1.7 to 2.4 times as great as the value of insecticide production.

3.3.3.2 Market Maturity

Between 1977 and 1981, pesticide production grew less than four percent overall while the value of production had increased by 20 percent in real terms, with herbicides showing the greatest gain. However, the six year period ending in 1982 shows a production decline of almost 20 percent and only a seven percent increase in value due to the 1982 production downturn. Table 3-13 shows the relative contribution of each major pesticide group to total production quantity and value in recent years. (Appendix 3-D presents historical data since 1967 on production quantity and value for the three pesticide groups.) In general, the U.S. pesticide market appears to have reached maturity and the highest growth rate some analysts expect to see is about one percent. 2/ This maturity is related to a number of factors, including the increasing use of integrated

---

1/ op. cit. EPA, Office of Pesticide Programs, Dec. 1982.

2/ Eichers, T.R., Farm Pesticides Economic Valuation, 1981, USDA, Economic and Statistics Service, Agricultural Economic Report, 464. Frost and Sullivan, U.S. Pesticide Market, Report A907, May 1981.

based on volume of active ingredients. Home and garden use accounted for five percent of herbicides, 12 percent of insecticides, and two percent of fungicides. 1/

3.3.3.1 Factors Influencing Demand

The demand for pesticides has been characterized as somewhat inelastic due to pesticides' importance in increasing crop production and the general lack of pesticide substitutes. 2/ Nevertheless, demand is influenced by a number of variables including crop acreages, pest conditions, weather, farm income, interest rates, dollar exchange rates, pesticide prices, foreign crop production, and farming techniques. The effect of prices on demand is considered to be less important than some of these other factors.

The FTC study noted that in cases where pesticide costs are a small portion of input expenditures, farmers view pesticides as necessary insurance for a large crop yield. 3/ Even if their pesticide cost doubled or tripled, these costs would easily be recovered by an increase of only one to two percent in the crop yield.

During the decade ending in 1981, pesticide prices increased much less than other agricultural inputs. 4/ Nominal prices for pesticides increased 78 percent compared to 137 percent for labor, 186 percent for fertilizer, 207 percent for machinery and 391 percent for interest rates. During this period, quantities of pesticides used almost doubled while fuel and fertilizer use increased by one-third and machinery sales were unchanged. These changes in use patterns are due, in part, to the relative price changes among these farm inputs. Farmers can opt to reduce machinery use and fuel consumption in favor of applying more pesticides. Such reductions can be achieved by less intensive tillage practices--such as minimum tillage and no-till--which have been gaining acceptance since the mid-1970's. Reduced tillage leaves the soil surface undisturbed in contrast to the conventional practice of plowing under the crop residues. Thus, less machinery and fuel is used. However, pesticide use tends to increase, because undisturbed crop residues promote weed growth and

---

1/EPA, Office of Pesticide Programs, Economic Analysis Branch, Pesticide Industry Sales and Usage, 1982 Market, Estimates, December 1982.

2/Federal Trade Commission, Competition in Farm Outputs: An Examination of Farm Industries, February, 1981.

3/op. cit. Federal Trade Commission, February 1981.

4/Eichers, T.R., and W.S. Serletis, Farm Pesticide Supply-Demand Trends, 1982, U.S. Department of Agriculture, Economic Research Service, Agriculture Economic Report, 485, April 1982.

3.3.3 The Market for Pesticides

The end use markets for pesticide active ingredients and formulated pesticide products are the same, excluding the effects of international trade. The specific information discussed here is based on active ingredients, unless stated otherwise, but we assume market trends are the same for both tiers of the industry since one provides the inputs to the other.

The agricultural sector constitutes the major market for pesticide products. In 1982 the agricultural share of total U.S. domestic use of all pesticides used was 70.3 percent. 1/ Agricultural use accounts for 79 percent of total 1982 domestic use of herbicides (based on weight of active ingredients) and 76 and 39 percent, for insecticides and fungicides, respectively. Considering all three pesticide product groups, agricultural use has grown steadily since the mid-1960's, and in terms of pounds used, has more than doubled from 1964 to 1982. The number of acres of major field crops treated with pesticides at least once has increased 180 percent. Based on weight of active ingredients, farm use of insecticides has declined relative to other domestic uses as more effective chemicals such as synthetic pyrethroids have been introduced into the agricultural sector. 2/

There is evidence that the market is not yet saturated and this implies future growth possibilities. It is estimated that 12 percent of U.S. crop production, valued at over $12 billion, is lost to weeds each year. Further, it is estimated that for every dollar spent on pesticides, the farmer currently obtains, on the average, three dollars in increased yields as a result of lower crop losses. 3/4/

Use of pesticides is not confined to the agricultural sector. Industrial and commercial pest control constitute a market sector, as do pesticide products sold for use in the home and garden. In 1982, the industrial/commercial/government use of pesticides was 16 percent of herbicides, 12 percent of insecticides, and 52 percent of fungicides,

---

1/EPA, Office of Pesticide Programs, Economic Analysis Branch Pesticide Industry Sales and Usage, 1982 Market, Estimates, December 1982.

2/Eichers, T. R., personal communication. U.S. Department of Agriculture, August 1983.

3/Senechel, D.M., personal communication, Agribusiness Associates, Inc., Wellesley Hills, MA.

4/A value of four dollars return for every dollar spent on pesticides was estimated for 1978 by D. Pimental et al., Benefits and Costs of Pesticides Use in U.S. Food Production, Bioscience, December 1978.

percent of expenditures went to all other materials and components, parts, and supplies. 1/

Hochberg, a chemical consulting firm in Chester, NJ, predicts a growth in the demand for chemicals used to formulate agricultural pesticides of 16 percent by 1987, to $245 million. 2/ Reasons cited for this growth are: end of the PIK program, general economic recovery, and technological improvements in pesticide delivery systems and toxicants. Surfactants will represent 45 percent of this total market, solvents will account for 22 percent, and carriers/diluents will represent 19 percent. The remaining 14 percent would be comprised of deactivators, thickeners, preservatives, antifreezes, antifoams, alcohols, and oils.

Limited insights can be gained by examining profitability ratios for companies that are involved in PFP operations. The 1983 308 Survey provides information on 28 PFP plants. The 28 plants represent only 2.2 percent of the estimated 1264 total PFP plants. An examination of the affiliations of the 28 plants reveals there are 28 different owners. Profitability ratios for six of these firms are available from the COMPUSTAT data base. 3/ The sample is too small to subdivide by firm size. All six firms are relatively large compared to the many small firms that own PFP plants. The smallest of the six firms has assets of $400 million; all the other firms have assets over $1 billion. Also five of the six firms--including DuPont and American Cyanamid--are represented in the 31 plant sample of pesticide manufacturers that was analyzed earlier. While the six firms do not constitute a statistical sample of PFP plants, their profitability ratios are informative about large firms which formulate/package pesticides.

The same profitability ratios defined for manufacturers are compiled from the COMPUSTAT data base and are presented in Appendix 3-C. Based on three-year (1980-1982) averages, all six profitability ratios are higher than the 31 plant averages for manufacturers (shown in Table 3-12) by 0.5 to 5.0 percentage points. For example, average after-tax return on equity for the six PFP firms is 13.3 percent compared to the average of 11.6 percent for the 31 manufacturing firms, a difference of 1.7 percentage points.

Compared to other industry sectors, the six firms with PFP plants show lower profitability ratios for after-tax profit margin and return on equity than the chemicals and allied products sector, but higher ratios than the average for all manufacturing. The specific ratios for the PFP-owning firms are shown in Appendix 3-C together with the averages for the other manufacturing sectors.

1/ U.S. Department of Commerce, Bureau of the Census, 1977 Census of Manufactures.

2/ Chemical Week, October 5, 1983, p. 17.

3/ Corporate COMPUSTAT, op. cit.

infrequent availability of these patents can prohibit patent acquisition. These two barriers make it difficult for new, small companies to enter the industry.

3.3.2 Companies that Formulate/Package Pesticide Products

Twenty-eight companies own the 28 formulator/packager plants in the sample of plants discussed earlier. Therefore it is estimated that the total 169 indirect discharge PFP plants are owned by approximately 169 firms.

Vertical integration in the PFP industry is high. As noted earlier, a major share of PFP production is carried out by firms that manufacture pesticide active ingredients. Analysis of interplant transfers indicate that pesticide formulator/packager production retained by manufacturers had increased from 5.8 percent to 1958, to 11.3 percent in 1972, and to 13.6 percent in 1977. 1/

3.3.2.1 Profitability

A study by the USDA found that during the 1966-76 period, prices at the manufacturer level increased at nearly twice the rate as prices at the retail level. 2/ Thus, the manufacturers' share of the farmer's pesticide dollar increased from 45 percent to 66 percent during this period. The study attributed this shift to: (1) manufacturers performing more of the formulating, packaging, and distribution of the pesticides themselves, (2) use of more highly concentrated pesticides which thereby reduced formulating, packaging, and distribution costs, and (3) a reduction in margins in the more competitive distributor sector in an attempt to retain customers' patronage for fertilizer and other farm supplies.

Pesticide active ingredients account for a large share of the price of formulated/packaged products. In 1977, 27.0 percent of material costs for SIC 2879 were attributable to synthetic organic pesticides and related synthetic organic agricultural chemicals (SIC 286941), 10.7 percent was attributed to containers, 9.1 percent to solvents, 6.9 percent to inorganic chemicals (SIC 281900), 1.3 percent to inorganic carriers, 0.8 percent to surfactants, and 0.1 percent to aerosol propellants. The remaining 44.2

1/Federal Trade Commission, Office of Policy Planning, Competition in Farm Inputs: An Examination of Four Industries, February 1981.

2/Cited in Competition in Farm Inputs: An Examination of Four Industries, op. cit.

respectively, due to the litigation over the 1978 Amendments to FIFRA. However, the average number of new chemicals registered each year was 17 between 1970 and 1975, and 16 between 1979 and 1982.

- On average, the time from discovery of a new chemical until its registration under FIFRA is six to eight years. Development costs for each new chemical can range from $15 to $30 million (in terms of 1980 dollars). About 20 to 25 percent of the total cost is for registration-related R&D expenditures.

In the opinion of some industry observers, R&D costs in the pesticide industry are expected to increase. 1/ 2/ The likely consequence of such an increase will be further concentration of the industry with only large firms able to afford the high R&D costs. High R&D costs and the uncertainty inherent in the commercialization of a new pesticide are major barriers to new firms seeking to enter the industry. The successful companies in the future are likely to be those with existing technical bases (e.g., pharmaceutical companies) and/or those with long-term positions in the industry.

3.3.1.3 Barriers to Entry

There are several obstacles to overcome before a potential entrant to the pesticide chemicals industry can expect to be profitable. If a firm is already a producer of organic chemicals, then the additional equipment and plant construction, and associated capital outlay, would be relatively small. However, the cost for an entirely new chemical plant could pose a significant barrier to entry.

A second potential barrier in this industry is obtaining access to a patented, profitable chemical. Manufacturing rights are generally acquired in one of two ways. A firm can develop a new pesticide chemical "in-house" and patent it. This is the approach commonly used by large, existing pesticide producers. Developing a new chemical takes several years and is sufficiently expensive so as to be prohibitive for most potential industry entrants. The second route is to buy the rights to an existing patent. The capital required for such a purchase and the

---

1/ Goring C., "The Costs of Commercializing Pesticides," in Pesticide Management and Insecticide Resistance, Harcourt Brace Jovanovich, NY, pp. 1-33, 1977.

2/ Arthur D. Little, Inc., Evaluation of the Possible Impact of Pesticide Legislation on Research and Development Activities of Pesticide Manufacturers, Report to Office of Pesticide Programs, EPA, 1975.

If the ratios for the pesticide manufacturing industry are compared for each year between 1980-1982 (rather than the three year average), the ratios are highest for 1980 and lowest for 1982. The decline results from the general downturn in the manufacturing sector of the economy over that period and these ratios are expected to improve with improvement in the overall economy.

Compared to other manufacturing sectors (shown in Table 3-12), the average after-tax profit margin for pesticides manufacturing is lower than that for producers of chemicals and allied products (5.1 percent versus 6.8 percent), but higher than all manufacturing industry average (5.1 percent versus 4.5 percent). However, the average return on equity for pesticide active ingredient manufacturing (11.6 percent) is lower than either chemicals and allied products (14.4 percent) or all manufacturing (12.6 percent).

3.3.1.2 Research and Development

Research and Development (R&D) plays a major role in the continued success of chemical producers. Because of the time and cost required to develop new pesticides, R&D activities are concentrated in about 30 companies. 1/ Analysis of information obtained from a survey by the National Agricultural Chemicals Association (NACA) in 1981 reveals several major characteristics of the industry's R&D activities. 2/

- o Expenditures for R&D in 1981 represented 8.3 percent of sales, which is higher than the average for all of U.S. industry. R&D effort appears to be maintaining the same relationship to sales (about 8 percent) as in the late 1960's, although it has been as high as 9.7 percent and as low as 6.5 percent between 1970 and 1981.

- o Considering three categories of firm size, different levels of R&D are sustained. Companies with sales of less than $15 million averaged 22.9 percent of sales for their R&D; companies in the $15 to $100 million sales category averaged 12.4 percent; and companies over $100 million averaged 7.2 percent of sales.

- o Each year, about 15 to 20 new pesticide chemicals are registered under the Federal Insecticide, Fungicide and Rodenticide Act (FIFRA). There was a temporary drop in new pesticide registration to three and eight in 1977 and 1978,

---

1/Frost and Sullivan, U.S. Pesticides Market, Report A907, May 1981.

2/Industry Profile Survey, National Agricultural Chemicals Association, 1982 and previous years, prepared by Ernst & Whinney.

Table 3-12. Comparison of Profitability Ratios: Pesticide Manufacturing

	Manufacturing Sector in Which Firms Participate					
	Pesticide Active Ingredients				Chemicals and Allied Products	All Manufacturing
Size of Firm (Value of Assets)	Less than $1 billion	$1 to $10 billion	Greater than $10 billion	All	All	All
Number of Firms	8 6 **	16	7	31	NA	NA
Avg. Profit Margin, After Taxes (Percent)*	2.3 5.2 **	5.9	6.2	5.1	6.8	4.5
Avg. Return on Equity, After Taxes (Percent)	6.5 13.0 *	13.1	14.2	11.6	14.4	12.6
Avg. Return on Assets, After Taxes (Percent)	3.3 6.9 **	6.5	13.9	5.8	NA	NA

Source: COMPUSTAT and Meta Systems calculations.
* Percents shown are three-year averages for 1980, 1981 and 1982.
** Figures based on excluding two of eight firms that had negative profit margins in any year between 1980-1982; see Appendix 3-B.

However, a detailed examination of the annual reports and 10-K statements of pesticide producers reveal that line-of-business, pre-tax profit margins in 1978 typically range between 10 and 15 percent. (See Appendix 3-B.) This range is consistent with the Federal Trade Commission's statement that chemical industry pre-tax profit margins in 1978 averaged 10.6 percent (versus 8.0 percent for all manufacturing).1/

There are many individual pesticide products, however, on which profit margins exceed 40 percent. These are proprietary (patented) products without competitive substitutes, allowing the patent holder to price the product considerably higher than cost.

The profitability of the pesticide industry can also be assessed by examining the profitability ratios for the corporations which have subsidiaries that are involved in pesticide manufacturing. Six profitability ratios for 31 corporations which manufacture pesticides are analyzed. Table 3-12 presents average ratios for the 31 corporations, calculated on the basis of total firm profits--not just pesticide profits.2/ Firms are grouped on the basis of asset size: companies with assets less than $1 billion; $1 billion to $10 billion, and assets greater than $10 billion. (There are eight firms in the smallest asset group, 16 firms in the middle group and 7 firms in the largest group.) Also, measures of profitability for pesticide manufacturers are compared to two other manufacturing sectors: chemicals and allied products, and the all manufacturing industry averages.3/

Based on three year averages (1980-1982), the after-tax profit margin, and the returns on equity and on assets are highest for the largest firm group (assets over $10 billion) and lowest for the smallest firm group (assets less than $1.0 billion). See Table 3-12. Profit margins range from 2.3 to 6.2 percent, return on equity from 6.5 to 14.2 percent, and return on assets from 3.3 to 13.9 percent. Two of the six firms in the smallest group had negative profits in one or more years between 1980 and 1982. If these two firms are excluded, the profitability ratios are similar for the three groups; for example, profit margins range from 5.2 to 6.2 percent; returns on equity and assets range from 13.0 to 14.2 percent and from 6.9 to 13.9 percent, respectively. (If these ratios are compared on the basis of pre-tax conditions, the ratios increase by a factor of 1.5 to 2.0 which is shown in Appendix 3-B.)

1/Federal Trade Commission, Quarterly Financial Report, various issues, Washington, DC.

2/Profitability ratios based on data obtained from Corporate COMPUSTAT, as of February 23, 1984, Standard & Poor's Compustat Service, Inc. See Appendix 3-B for individual company ratios.

3/Quarterly Financial Report, op. cit.

Table 3-11. Concentration Ratios Based on Pesticide Active Ingredient Sales

Number of Corporations	Number of Plants Owned by These Corporations	Corporations	
		Concentration Ratio (in %)	1977 Plant Pesticide Sales (Million $)
Top 4	10	46.16	1,355
Top 8	22	67.15	1,970
Top 16	41	87.03	2,560
Total	114	100.0	2,940

Source: U.S. EPA, 1977 308 Survey for the Pesticide Active Ingredient Manufacturers Subcategory and Meta Systems Inc calculations.

Table 3-10. Raw Materials and Key Chemical Intermediates Used in Pesticide Manufacture

Product Group	Percent of Total Estimated Value of Production
Phenol and derivatives	25.3
Aniline derivatives	12.4
Cyanide derivatives	12.3
Carboxylic acid derivatives	11.3
Higher alkyl amines	8.5
Phosphorous pentasulfide	5.5
Benzene and related compounds	4.9
Phosgene	4.2
Chlorine	3.7
Phosphorous trichloride	3.2
Mercaptans	3.0
Monomethylamine	1.2
Aldehydes	1.1
Carbon disulfide	0.4
L-Pinene	0.4
Cyclodienes	--
Total	100.0%

Source: Frost and Sullivan, U.S. Pesticides Market, Report A907, May 1981.

The production of active ingredient chemicals used in pesticides is the first and most complex phase of the pesticides industry. Pesticide production involves synthesizing technical-grade chemicals from raw materials, and requires substantial capital and technical background to conduct research and to construct and operate process facilities. There are twenty major classes of raw materials and chemical intermediates used in the manufacture of pesticides, and in recent years about 2.5 billion pounds of these raw materials, valued at over $1.6 billion, have been consumed annually by the pesticide industry. Table 3-10 lists the major chemical groups and raw materials that are used in manufacturing pesticides. It also shows the proportional contribution that each group makes to the total estimated value of pesticide production.

Information from the 1977 308 Survey indicates concentration ratios as follows: the top four companies account for 46 percent of 1977 total value of active ingredient production and the top eight firms account for 67 percent, as shown in Table 3-11. Another source has estimated that in 1980, the top four firms had 44 percent of the market and the top eight had 82 percent.[1/] Major product groups within the pesticide industry exhibit varying degrees of concentration; for example, in 1976 the top four producers of insecticides used on corn accounted for 31 percent of the market while the top four soybean insecticide producers had 77 percent of the market.[2/]

Vertical integration among firms that produce pesticide active ingredients is common. Most active ingredient producers formulate pesticide products captively. A 1980 assessment reported in the Kline Guide to the Chemicals Industry indicates approximately 80 percent of the formulated pesticide industry is controlled by pesticide active ingredients manufacturers.

3.3.1.1 Profitability

As mentioned earlier, most of the U.S. pesticide production is carried on by diversified companies and their sales of pesticides are a minor source of the firm's revenue. Therefore, financial data specifically on pesticide production vary between sources. While investment analysts regard pesticide production as a very profitable business, profit margins suggested by an analysis of income statements are lower than those quoted by these analysts. For example, one investment firm estimates that the average pre-tax profit margin on sales exceeds 20 percent.[3/]

[1/] Frost and Sullivan, U.S. Pesticide Market, May 1981.

[2/] U.S. Department of Agriculture, The Farm Pesticide Industry, Agricultural Economic Report, No. 461, September 1980.

[3/] Loeb, Rhodes & Co., Herbicide Suicide, December 1975, cited in Seehusen, M.H., The Economic Health of the Pesticide Industry, January 1978.

Table 3-9. Pesticide Formulator/Packagers Employment Summary for Zero Discharge Plants*

	All Plants	Plants Reporting Single SIC	Plants Reporting Multiple SIC
Employment Levels Reported: **			
Minimum	1	1	2
Maximum	750	150	750
Average	49	32	82
Median	26	20	30
Standard Deviation	90	32	159
Number of Plants Reporting	97	68	24

Source: Industrial Guides for 31 states (listed in the References Section).

* Based on a sample of plants which identified themselves as zero dischargers on the telephone survey, and information in State Industrial Guides.

** Employment is total count reported, not full time equivalent employment. When a range was reported, the mid-point of the range is used. 34 plants gave employment ranges, 63 gave discrete values.

Table 3-8. Characteristics of Pesticide Formulator/Packager Plants (PFP) Plants by Percent of Internally Manufactured Active Ingredients

Percent of Active Ingredients Manufactured Internally	Number of Plants	Percent of Plants	Average Number of Formulating/Packaging Employees*
0	14	50	3.2
0.1 - 9.9	6	21.4	4.9
10 - 24.9	1	3.6	7.6
25 - 49.9	1	3.6	20.4
50 - 74.9	2	7.1	3.4
75 - 99.9	2	7.1	36.7
100	1	3.6	156.8
Unknown	1	3.6	

Source: U.S. EPA, 1983 308 Survey for the Pesticide Formulator/Packager Subcategory and Meta Systems Inc calculations.

* Employment expressed as full time equivalent employees.

Half of all formulator/packager plants (50.0 percent) manufacture at least some of their own active ingredients as shown in Table 3-8. Plants that manufacture high percentages of their active ingredients tend to be plants with a large number of PFP employees.

3.2.3.2 Zero-Discharging Pesticide Formulating/Packaging Plants

There are about 1,095 zero discharge PFP plants. Since BPT has required all direct discharge PFP plants to meet a zero discharge limit, all PFP plants are either indirect or zero discharge. While zero discharge plants are not included in the impact assessment because they already meet the regulation, some of their major characteristics are summarized here. Information on 103 of these plants is obtained from state industrial guides, and is presented in this section. In terms of total employment, zero discharge plants vary greatly in size as shown in Table 3-9; specific pesticide related employment data are not available. Total plant employment ranges from one employee to between 500 and 999 employees. While the average size is 49, the median is only 26. This indicates that plants tend to be concentrated at the lower end of the scale.

Zero discharge plants identify their activities in terms of one or more SIC codes. Plants reporting more than one SIC code have an employment range of from one to 150 employees. The range for plants with multiple SIC codes is from two to 750 employees. However, based on the median size of plants, the multiple SIC code plants are only slightly larger. (The average size of multiple SIC plants is so much higher due to a few very large plants.) For additional information on the zero discharge plants, see Appendix 3-A.

Most of the zero discharge plants are relatively old; with 1945 the average year of establishment. Additional statistics on plant age are included in Appendix 3-A.

3.3 Structure of the Pesticide Industry

3.3.1 Company Characteristics of Pesticide Active Ingredient Manufacturers

There are no publicly-owned companies for which the manufacture of pesticides is the prime source of revenue. However in 1982, 77 companies reported the manufacture of pesticide active ingredients to the U.S. International Trade Commission. These producers included petroleum companies (e.g., Shell), chemical companies (e.g., Dow and DuPont), and pharmaceutical-based firms (e.g., Eli Lilly and Pfizer).

Table 3-7. (continued) Geographic Location of Pesticide Formulator/Packager (PFP) Plants

Location	Written Survey	Percent of All Plants
Region VI Total	4	14.3
Texas	4	
Oklahoma	0	
Arkansas	0	
Louisiana	0	
Region VII Total	3	10.7
Nebraska	0	
Iowa	1	
Kansas	0	
Missouri	2	
Region VIII Total	0	0.0
Montana	0	
South Dakota	0	
Wyoming	0	
Colorado	0	
North Dakota	0	
Region IX Total	5	17.9
California	5	
Arizona	0	
Region X Total	1	3.6
Washington	1	
Oregon	0	
Idaho	0	
Totals	28	100

Source: U.S. EPA, 1983 308 Survey for the Pesticide Formulator/Packager Subcategory and Meta Systems Inc calculations.

Table 3-7. Geographic Location of Pesticide Formulator/Packager (PFP) Plants

Location	Written Survey	Percent of All Plants
Region I Total	0	0.0
Maine	0	
Massachusetts	0	
Connecticut	0	
Region II Total	3	10.7
New York	1	
New Jersey	2	
Puerto Rico	0	
Region III Total	0	0.0
Pennsylvania	0	
West Virginia	0	
Virginia	0	
Delaware	0	
Maryland	0	
Washington, DC	0	
Region IV Total	7	25.0
Kentucky	0	
Tennessee	2	
North Carolina	0	
South Carolina	0	
Mississippi	0	
Alabama	0	
Georgia	3	
Florida	1	
Region V Total	7	25.0
Minnesota	0	
Wisconsin	0	
Illinois	2	
Michigan	1	
Indiana	1	
Ohio	2	

Table 3-6. Indirect Discharge Pesticide Formulator/Packagers (PFP)

	In Sample	Industry Total
Number of Companies	28	NA
Number of Establishments	28	169
Value of PFP Production in 1982 ($000)	258,621	1,560,959
Total Plant Value of Production in 1982 ($000)	1,451,520	8,760,960
Ratio of Value of PFP Production to Total Plant Production (percent)	*	17.8
Number of PFP Employees**	341***	2,133
Ratio of Value of PFP Production to PFP Employment ($)	*	731,814

Source: U.S. EPA, 1983 308 Survey for the Pesticide Formulator/Packager Subcategory and Meta Systems Inc calculations.

* Not calculated for the sample, ratios based on total industry estimates.

** Employment expressed as full time equivalent employees (FTE).

*** Estimate based on 27 plants that reported number of PFP employees on 1983 308 Survey.

arsenic or mercury. Metallo-organic compounds are the smallest in both volume and value of pesticide sales. They are used primarily as fungicides and herbicides, although compounds which act as miticides are also produced. The particular products affected by this regulation are concentrated in the fungicide product group and may be used for non-agricultural uses such as paint additives. Based on the public comments the Agency received, domestic production of these products has declined while the imports of these products have increased over the past few years.

3.2.3 Pesticide Formulator/Packagers (PFP)

There are an estimated 1,264 pesticide formulator/packager plants as defined by this regulation, of which approximately 169 are indirect dischargers. Data, in response to a written 1983 308 Survey, are provided by 28 indirect discharge PFP plants. The sample of 28 plants is randomly selected, and therefore their survey responses are representative of the industry.1/ Most of the following discussion is based on these replies, using 1982 data.

3.2.3.1 Indirect Dischargers

In 1982, the 169 indirect discharge PFP plants had a value of PFP production of $1.56 billion and PFP employment of 2,133 as shown in Table 3-6. On average for these plants, only about 18 percent of the total value of their production is derived from their PFP operation. For most of the plants, employment in PFP operations is small; 82 percent of the plants employ less than 20 PFP people.2/ These plants, with employment of less than 20, only account for 11 percent of total formulator/packager production value. In contrast, 18 percent of the plants employ between 21 and 200 formulator/packager employees, but these larger plants represent 89 percent of the production value.

The 28 indirect discharge PFP plants are located in fourteen states and territories of the United States. The regions with the heaviest concentrations of plants are the North Central (Region V), South Atlantic (Region IV), and Southwest (Region IX, specifically California), with 19.0, 16.7 and 16.4 percent, of the nation's plants, respectively. A breakdown of plant locations is presented in Table 3-7.

1/ See Section 2.3.2 of Chapter 2 for discussion of the sampling and other procedures used to derive these estimates.

2/ The 1983 308 Survey provided employment data expressed as the number of employment hours in PFP operations. The hours are converted to full time equivalent employment (FTE) for this analysis, based on 1,960 production hours per year, per full time worker.

Table 3-5. Pesticide Production Capacity Utilization and Expansion

	Production as a Percent of Capacity				Capacity Expansion, Percentage Change			
	All Pesticides	Herbicides	Insecticides	Fungicides	All Pesticides	Herbicides	Insecticides	Fungicides
1976	86	91	85	82	12	19	2	0
1977	80	85	76	77	16	23	8	12
1978	83	81	87	83	3	3	4	3
1979	80	74	85	84	4	4	3	11
1980	78	77	79	84	2	2	1	3
1981	73	74	72	63	2	3	0	0
1982	65	71	60	NA	5	4	7	0
1983 1/	60	67	51	NA	*	*	*	NA

Sources: Eichers, T.R., and W.S. Serletis, Farm Pesticide Supply-Demand Trends, 1982, U.S. Department of Agriculture, Economic Research Science, Agriculture Economic Report, 485, April 1982. Eichers, T.R., Evaluation of Pesticide Supplies and Demand for 1979, U.S. Department of Agriculture, Economic Statistics and Cooperative Service, Agricultural Economics Report No. 422, April 1979. Eichers, T.R., Farm Pesticide Economic Valuation, 1981, U.S. Department of Agriculture, Economic and Statistics Service, Agricultural Economic Report, 464. U.S. Department of Agriculture Inputs--Outlook and Situation, Economic Research Service, IOS-1, June 1983. U.S. Department of Agriculture, Inputs--Outlook and Situation, Economic Research Service, IOS-2, October 1983.

1/ Projected by U.S. Department of Agriculture

* Less than one percent

Plants producing only insecticides are subdivided into aldrin-toxaphene, cyclic organophosphorus, acyclic organophosphorus, carbamates, chloro-organics, nematocides, rodenticides, attractants/repellants, synergists, and miscellaneous. Acyclic organophosphorus is the most important group, and the insecticides in this group have a wide range of applications, particularly to corn and livestock. The cyclic organophosphorus group includes methyl parathion, which is used on wheat and corn. Insecticides in the aldrin-cyclic group are used on soybeans and livestock. The fungicides are subdivided into polychloroaromatics, chloroalkyl amides, and miscellaneous.

Forty-seven of the 114 plants produce herbicides. Of these, 24 plants produce herbicides exclusively and their average production value is twice that of plants that make only insecticides, and nine times that of plants that make only fungicides. Of the 66 plants producing insecticides, 39 make only insecticides and of the 42 fungicide producers, 12 manufacture fungicides exclusively. In all, there are 39 mixed-product plants and these tend to be larger than the single product plants; for example, their average production value is almost twice that of plants that make only herbicides.

3.2.1.2 Plant Capacity

Capacity utilization in 1983 for production of pesticide active ingredients is estimated to have been 60 percent, significantly lower than prior years as seen in Table 3-5.1/ The average capacity utilization for the five-year period 1978 to 1982 was 75 percent. The recent low utilization rates are attributable to the large carryovers from previous years. The carryover from 1982 amounted to 49 percent of the 1982 production of herbicides, 42 percent of the insecticide production and 46 percent of the fungicide production. The carryover into 1982 averaged about 30 percent of the 1981 production. The average carryover considered "healthy" by manufacturers is 15 to 20 percent.

Pesticide producers planned to increase overall capacity by only 0.4 percent in 1983. For herbicides, the planned increase is 0.5 percent and 0.25 percent for insecticides.2/ This compares to annual increases of two to four percent for herbicides, and zero to seven percent for insecticides during the five-year period 1978-1982.

3.2.2 Metallo-Organic Pesticide Manufacturers

Subcategory 2 includes plants which manufacture metallo-organic pesticide compounds. The most common metallo-organic compounds contain

---

1/U.S. Department of Agriculture, Inputs--Outlook and Situation, Economic Research Service, IOS-1, June 1983.

2/Ibid.

Table 3-4. Profile of Pesticide Chemicals Plants

Pesticides Manufactured	Number of Plants
Herbicides only	
Anilides-cyclic	3
Triazines-cyclic	2
Hydrazides-cyclic	3
Benzoics-cyclic	3
Phenoxies-cyclic	4
Dinitrophenols and anilines-cyclic	1
Ureas-cyclic	1
Miscellaneous herbicides	7
SUBTOTAL	24
*Herbicides and other pesticides	23
TOTAL PLANTS PRODUCING HERBICIDES	47
Insecticides only	
Aldrin-cyclic	3
Organophosphorus-cyclic	3
Carbamates-cyclic	2
Chloro-organic-cyclic	2
Nematicides-cyclic	1
Rodenticides-cyclic	2
Attractants and repellants-cyclic	2
Synergists-cyclic	2
Organophosphorus-cyclic	4
Miscellaneous insecticides	18
SUBTOTAL	39
*Insecticides and other pesticides	27
TOTAL PLANTS PRODUCING INSECTICIDES	66
Fungicides only	
Polychloro-aromatics-cyclic	4
Chloroalkyl amides	1
Miscellaneous fungicides	7
SUBTOTAL	12
*Fungicides and other pesticides	30
Total plants producing fungicides	42
Total Number of Plants	114

Source: U.S. EPA, 1977 308 Survey of Pesticide Active Ingredient Manufacturers and Meta Systems Inc calculations.

* Included in the total count of 114 plants are 39 which produce pesticides in more than one of the three major subcategories and are counted (more than once) in each appropriate subcategory.

(e.g., cyclic intermediates, miscellaneous end-use chemicals and chemical products). For purposes of describing the industry in this chapter, the ITC statistics on pesticides and related products are used. For the impact assessment, all pesticide chemicals produced by the 119 plants are included regardless of their ITC classification. (More detailed information on the major pesticide groups is presented later in this chapter). The large inventory carryovers are attributable to several factors, including weather conditions during the 1982 planting season that affected herbicide use, and lower than usual insect infestations combined with more selective insecticide applications based on scouting techniques to locate infestations. Large carryovers again occurred going into 1983. Production was further depressed in 1983 by the payment-in-kind (PIK) program implemented by the U.S. Department of Agriculture. The PIK program reduced crop acreage, particularly for corn (down by 22 million acres) which is a major user of pesticides. As a result, 1983 pesticide production was expected to decline to one billion pounds as shown in Table 3-3.

Pesticide active ingredients are generally manufactured in plants which also produce other organic chemicals including pharmaceuticals, plastics, and resins. Approximately 85 percent of the plants produce no more than four pesticides, while almost 50 percent produce only one. Pesticides generally are not produced throughout the year. Of the 114 plants identified by the EPA 308 Survey as producers of pesticide active ingredients, 55 also formulate and package the pesticide products. Thus, about one-half the pesticide active ingredient manufacturing plants are vertically integrated operations. About three-quarters of the plants (87) produce chemicals other than pesticides.

The plants in the industry also vary widely in size. Based on the 308 Survey the Agency conducted in 1977, pesticide production for a number of plants was worth more than $75 million, and 12 of the 114 manufacturing plants identified by EPA accounted for slightly more than 50 percent of the total value of production. In contrast, almost half of the plants had an annual market value for all pesticide chemicals of less than $5 million.

3.2.1.1 Plant Production by Pesticide Type

Table 3-4 identifies the different subgroups within the major pesticide groups for the 114 plants which manufacture active ingredients according to the 308 Survey. Herbicides can be subdivided into anilides, triazines, hydrazides, benzoics, phenoxies, dinitrophenol/anilines, ureas, and miscellaneous. The major herbicides in the anilide group are alachlor, used extensively on soybeans and corn, and propachlor which is used on sorghum. The most important herbicide in the triazine group is atrazine, which dominates the corn market. The phenoxies group includes 2,4-D, the use of which has been restricted.

Table 3-3. Total U.S. Pesticide Active Ingredient Production*

Year	Production Million Pounds	Value Million $ Current**	Value Million $ Constant+	Average Unit Value*** $/lb. Current	Average Unit Value*** $/lb. Constant	Deflator+
1967	1,050	987	987	0.94	0.94	1.000
1968	1,192	1,137	1,089	0.95	0.91	1.044
1969	1,104	1,113	1,013	1.01	0.92	1.099
1970	1,034	1,074	928	1.04	0.90	1.157
1971	1,136	1,248	1,027	1.10	0.91	1.215
1972	1,157	1,295	1,023	1.12	0.89	1.266
1973	1,417	1,964	1,351	1.39	0.96	1.454
1975	1,603	2,871	1,090	1.79	1.19	1.504
1976	1,364	2,867	1,656	2.03	1.21	1.672
1977	1,387	3,119	1,762	2.25	1.27	1.772
1978	1,417	3,289	1,727	2.32	1.22	1.904
1979	1,430	3,706	1,792	2.59	1.25	2.068
1980	1,467	4,246	1,880	2.89	1.28	2.258
1981	1,429	5,196	2,104	3.64	1.47	2.470
1982	1,113	4,279	1,635	3.84	1.47	2.616
1983++	1,013	3,890	1,430	3.94	1.41	2.726
Average Annual Growth (%)						
1967-1974	10.3	4.6	5.7	0.3		
1974-1982	-3.0	10.2	13.5	5.5		

Source: U.S. International Trade Commission, Synthetic Organic Chemicals, 1982 and prior issues, and Meta Systems Inc calculations.

* Herbicides, insecticides, and fungicides.

** Value is the sum of the value of herbicides, insecticides and fungicides tabulated in Appendix 3-D.

*** Average unit value is total value divided by total production.

\+ Constant 1967 dollars value is calculated using the GNP deflator (1976 - 1.00) from U.S. Department of Commerce, Bureau of Economic Analysis.

++ Estimate by Meta Systems Inc

Table 3-2. Geographic Location of Pesticide Active Ingredient Manufacturing Plants by EPA Region

Region/State	Number of Plants	Percent of Total
Region I Total	5	4.4
Maine	3	
Connecticut	1	
Rhode Island	1	
Region II Total	15	13.2
New York	3	
New Jersey	12	
Region III Total	8	7.0
Pennsylvania	1	
West Virginia	6	
Maryland	1	
Region IV Total	27	23.7
Kentucky	2	
Tennessee	8	
North Carolina	2	
South Carolina	2	
Mississippi	2	
Alabama	7	
Georgia	4	
Region V Total	16	14.0
Minnesota	1	
Illinois	5	
Michigan	6	
Indiana	2	
Ohio	2	
Region VI Total	16	14.0
Texas	10	
Louisiana	6	
Region VII Total	8	7.0
Iowa	1	
Kansas	2	
Missouri	5	
Region VIII Total	2	1.8
Colorado	2	
Region IX Total	15	13.2
California	8	
Nevada	1	
Arizona	6	
Region X Total	2	1.8
Washington	1	
Oregon	1	
Total	114	100.0

Source: U.S. EPA, 1977 308 Survey of Pesticide Active Ingredient Manufacturers and Meta Systems Inc calculations.

Table 3-1. Number of Pesticide Active Ingredient Manufacturers by Employment Size

Plant Size Number of Employees	No. of Plants In Range	Percent of Total Plants	Plant Pesticide Value in 1977 ($ millions)	Percent of Total Value of Shipments
1-24	25	21.9	60.150	2.1
25-49	20	17.5	87.754	3.0
50-99	10	8.8	50.062	1.7
100-199	18	15.8	417.252	14.2
200-299	3	2.6	106.696	3.6
300-399	8	7.0	371.792	12.7
400-499	2	1.8	96.950	3.3
500-999	14	12.3	980.767	33.4
over 1000	14	12.3	766.002	26.1
Total	114	100.0	2,937.425	100.0

Source: U.S. EPA, 1977 308 Survey of Pesticide Active Ingredient Manufacturers, and Meta Systems Inc calculations.

fungicides, act therapeutically to reverse a disease. They are effective at lower concentrations than other fungicides. In addition, they require less frequent application and therefore remain effective throughout more of the crop growth season.

3.2 Plant Characteristics

3.2.1 Manufacturers of Pesticide Active Ingredients

According to EPA 308 data, there are 114 [1/] plants, owned by 81 companies in the U.S. that manufacture pesticide chemicals active ingredients. In 1977, these 114 plants employed a total of about 70 thousand workers (including those employees not involved in pesticide chemicals manufacturing). The distribution of pesticide active ingredient manufacturing plants by number of employees is shown in Table 3-1.

The plants are dispersed throughout the country, with concentrations in the eastern and southern states. Thirty-one states are represented, with New Jersey and Texas having the greatest numbers of plants (12 and 10, respectively). Plant locations by state are presented in Table 3-2.

According to a report by the International Trade Commission (ITC), U.S. pesticide manufacturers produced 1.1 billion pounds of pesticide active ingredient chemicals in 1982 valued at about $4.3 billion.[2/] The ITC information provides a good profile of pesticide production because data are collected from all pesticide manufacturers on an annual basis. The ITC classifies the production information by three major pesticide groups (herbicides, insecticides, and fungicides) covered by this regulation.

Production had been running about 1.4 billion pounds annually from the mid-1970's through 1981. However, inventory carryover from prior years was large and production declined in 1982. Table 3-3 shows historical data on U.S. production and value of pesticide active ingredients.[3/] The pesticides manufactured by the approximately 119 plants affected by this regulation include chemicals in other ITC classifications as well

---

[1] Of the 117 plants identified by EPA in 1977, three plants no longer manufacture pesticides. An additional 5 plants have started production since the 308 Survey was done.

[2/] U.S. International Trade Commission, Synthetic Organic Chemicals, 1982 and prior issues, Washington, DC.

[3/] Data presented in Table 3-3 are compilations for a group of chemicals classified as "Pesticides and Related Products," by the ITC. Synthetic Organic Chemicals, ITC, various issues.

- defoliants and desiccants: chemicals that cause plants to either drop their foliage or hasten the drying of plant tissue, which aids in harvesting crops such as cotton and potatoes; and

- plant growth regulators: chemicals primarily used for tobacco production and for some fruit production.

In most data compilations that are prepared by public agencies, fumigants, rodenticides, and miticides are included under insecticides, while plant growth regulators are included under herbicides.

3.1.2.1 Herbicides

Herbicides constitute the newest and most important group of pesticides. Herbicides are used to prevent or control the growth of undesirable plants and are of two types--selective and non-selective. Selective herbicides are designed to be effective against specific plants and therefore usually have a wide range of agricultural applications. Non-specific types primarily are used in non-agricultural situations where removal of all vegetation is desired.

Herbicides can also be classified according to their time of application: pre-plant herbicides are applied before/during crop planting; pre-emergence herbicides are used after crop planting but prior to plant emergence; and post-emergence herbicides are applied after the crops have emerged.

3.1.2.2 Insecticides

Insecticides kill by contact with, or ingestion by, the insect. Insecticides can be used to eradicate a specific pest, such as the boll weevil, or a broad spectrum of insects.

3.1.2.3 Fungicides

Fungicides represent a relatively minor group of pesticides. Fungicides are used to control fungi and bacteria on living and non-living plants and on other materials. There are two types of fungicides which function differently in their methods of control. Eradicant fungicides kill by contact, and are applied following an infestation. Protectants are applied prior to contamination and thus, are used preventively. The majority of fungicide chemicals are protectants. A more recently developed type of fungicide--and one that offers growth potential to the industry--is the systemic fungicide. These fungicides, unlike the contact pesticide products are classified in SIC 2879, (Pesticides and Agricultural Chemicals Producers, Not Elsewhere Classified). In 1982, there were about 35,000 formulated products registered under the Federal Insecticide, Fungicide and Rodenticide Act.[1/]

Prior to 1970, the formulation of technical-grade pesticides was carried out by a variety of independent firms and agricultural cooperatives. Formulating firms bought pesticides from the basic manufacturers and formulated and packaged the products for sale. In the mid-1970's, there was an overall domestic shortage of chemicals, and during this period many of the pesticide active ingredient manufacturers integrated forward to formulate/package their own chemicals captively. Although the chemical shortage is now over, most of the pesticide active ingredient manufacturers continue to formulate/package pesticide products. The estimate in the Kline Guide is that 80 percent of the formulated pesticide industry is controlled by technical-grade producers.[2/]

3.1.2 Product Characteristics

The most common categorization of pesticides is by the type of pest they treat, such as weeds, insects, and fungal diseases. Three classes of products--herbicides, insecticides, and fungicides--comprise the majority of the domestic pesticide production. In simple terms, herbicides are used to control, prevent, or eliminate weeds; insecticides are used to control or eliminate insects; and fungicides are used to control or destroy fungi and bacteria. In addition to these three major product classes, smaller product classes include the following:

- fumigants: space fumigants are used as gases or vapors in enclosed areas, soil fumigants are cultivated into the soil to control nematodes, fungi, insects, weeds or combinations of these pests;
- nematicides: chemicals used in soils or in water to control worms such as pinworm, trichina, and Guinea worm;
- miticides: chemicals used primarily on fruits and vegetables to control very small organisms which are similar to ticks;
- rodenticides: chemicals used to control rats and mice:

[1/]EPA, Office of Pesticide Programs, Economic Analysis Branch, Pesticide Industry Sales and Usage, 1982 Market Estimate, December 1982.

[2/]C. H. Kline & Co., The Kline Guide to the Chemicals Industry, Fourth Edition, Industrial Marketing Guide, IMG 13-80, 1980.

3. INDUSTRY CHARACTERISTICS

3.1 Overview

This chapter describes the characteristics of plants and companies in the pesticides industry, and the determinants of demand and supply for the industry. The primary characteristics include the number, size, and location of plants and companies, degree of integration and industry concentration, and financial performance. The primary determinants of demand are the nature of the end-use markets, the nature of competitive products and technology, and the magnitude of imports and exports. The industry characteristics and market structure are pertinent to determining industry behavior when faced with additional pollution control requirements. This information is used to estimate the baseline characteristics of the industry during the 1980's which are described in Chapter 4, and to estimate the potential economic impacts of the effluent regulations which are described in Chapter 6.

3.1.1 Industry Coverage

The pesticide industry is two-tiered, encompassing at one level, the manufacturers of pesticide chemicals (active ingredients), and at a second level, the formulator/packagers who combine the active ingredients with substances such as diluents, inorganic carriers, stabilizers, emulsifiers, and aerosol propellants and package them in plastic, glass, paperboard, or metal containers for application in the field. Many of the firms making the pesticide active chemical ingredients are also formulator/packagers, although there are also numerous independent formulator/packagers.

The two levels of pesticide production share a domestic market and final product characteristics, but their manufacturing processes and immediate products are different. Because of this, they are treated separately in the discussions of plant characteristics and imports/exports, but jointly in the discussion of the domestic market.

Pesticide active ingredients are primarily synthetic organic chemicals that are covered in SIC 28694 (Pesticide and Other Organic Agricultural Chemicals, Except Preparation), which is part of SIC 2869, (Industrial Organic Chemicals, Not Elsewhere Classified). The formulator/packagers of with annual sales of $10 million or less, and small pesticide formulator/ packager firms are defined as firms with annual sales of $7.0 million or less. The impacts analyzed include the number of plants with compliance costs, the number of plants failing the NPV test, and the number of closures.

2.9 Foreign Trade

The industry-wide impact of this regulation on foreign trade is measured in terms of the price increases resulting from the regulation. Foreign trade is an important aspect for the pesticide industry, both in terms of selling abroad and competition at home from foreign producers. As foreign producers become more developed, the ability to compete in terms of price becomes more important. In addition to the industry-wide analysis, specific pesticides identified by public comments were studied in detail as to the proportion of production imported and exported and domestic producers' abilities to compete with foreign producers. Often information on the competitive position was scarce and these case studies include information from various proprietary sources. Therefore, they cannot be reproduced here.

2.10 New Sources

The new source limitations, both NSPS and PSNS, are the same as the BAT and PSES limitations respectively. There are no incremental costs nor economic impacts attributable to this regulation. The impacts are assumed to be the same as those for existing sources, and no barriers to entry are anticipated as a result of the compliance costs.

As in the case of manufacturing plants, information on the financial health of the company and the degree to which formulating/packaging operations are integrated into the overall company operations is assessed, for those plants considered to be closure candidates based on the NPV analysis. Company-level financial data are collected about the owners of PFP plants known to be indirect dischargers on the basis of the 308 Survey, since these data are needed for the closure analysis. The degree to which formulating/packaging is integrated into the overall business is measured by comparing the results of the PFP 308 Survey to that of the 308 Survey of pesticide manufacturers. Additional sources of information about the plant, its non-pesticide products, and its owner are: the SRI Directory of Chemicals Producers, which lists all the products produced at specific chemical facilities; corporate annual reports; and industry literature.[1] The analysis of financial conditions and integration is the same as that described earlier for pesticide manufacturers.

For PFP plants, net present value is calculated twice; once with treatment costs included and once without treatment costs. If the plant fails the net present value test without inclusion of the treatment costs, then it is assumed to be a baseline closure candidate regardless of this regulation. If a plant does not fail the net present value test without treatment costs, but does fail with the costs included, then this potential plant closure is considered attributable to the added costs of the regulation.

The results of the plant-specific analysis of the 28 plants that comprise the representative sample are extrapolated to the indirect discharger industry segment on the basis of ratios derived for the PFP plants in the sample. The number of plants likely to close is estimated and characteristics of those closure candidates are assumed to be the same as the closure candidates in the sample.

2.8 Small Business Analysis

An analysis is conducted to determine whether small firms bear disproportionate impacts under the promulgated effluent guidelines; (i.e., Regulatory Flexibility Analysis). The small firms of primary concern in this analysis are those firms with limited resources and/or those that would face barriers to entry due to the regulations. The relevant measure, as in the case of pollution control guarantee assistance, is the financial ability of the firm to raise the necessary capital and to assume the resulting carrying costs. Therefore the criterion for a small business is the sales of the parent firm. Small pesticide active ingredient firms are defined as firms

---

[1] 1979 Directory of Chemical Producers: United States, SRI International, 1979.

2.7.3 Formulator/Packagers

In order to identify potential closure candidates, the same net present value analysis described above is applied to all indirect discharge PFP plants for which 1983 308 Survey data are available. Most of the data required for the net present value analysis are available directly from the 308 Survey, and industry ratios are not required for the indirect discharge PFP subcategory. The analysis assumes that compliance costs incurred by indirect discharge PFP plants are not passed on to consumers. This is a conservative, yet reasonable and appropriate assumption for the following reasons. Since a relatively small number of plants will incur costs, they will not be able to pass on these costs. The market has already adjusted to the treatment costs incurred by direct dischargers under previous regulations and these direct discharge plants are not expected to increase their prices in response to treatment costs incurred by indirect dischargers. Even if some cost pass-through is assumed, it is not possible to estimate demand elasticities because insufficient time series data are available for the wide variety of formulated/packaged products. Therefore a change in production levels can not be estimated.

Since the 1983 PFP 308 Survey includes questions about revenues and expenses, after-tax operating income (U) is directly estimated from the 308 Survey responses. Pre-tax operating income is equal to: market value of pesticide products minus operating costs, interest and depreciation. The tax rate is assumed to be the statutory rate of 0.46. Therefore:

$$U = (1 - .46)(\text{pre-tax operating income})$$

Since the 308 Survey does not ask for the value of current assets, current assets are assumed to be equal to 34.9 percent of sales. This ratio is calculated from FINSTAT[1/] data for firms in SIC 2879, Pesticides and Agricultural Chemicals. These data are considered representative of the firms in this industry since they are in the same SIC group and the Dun and Bradstreet data base contains a large proportion of the companies. The book value of plant and equipment is taken directly from the 1983 308 Survey.

The NPV analysis is done on 36 PFP plants. If any of the values, other than sales, which are needed in the NPV analysis are not reported by a plant, they are estimated by applying ratios calculated from the other plants responding to the 308 Survey.

1/ FINSTAT DATA BASE, prepared by Social and Scientific Systems Inc. for the Small Business Administration (derived from Dun and Bradstreet Financial Profiles data base) and made available to EPA by the Small Business Administration.

If the potential closure candidate manufactures high-profit products, then its pre-tax operating income is recalculated based on value of production and the profitability category for each product. If the ratio of pretax operating income to sales is higher than average (.213), the net present value ratio is recalculated for the plant, using the higher estimate of operating income. The remaining plants, including any for which it was not possible to estimate a profit rate, are considered as possible closure candidates.

Finally, two additional factors are considered in analyzing plants that remain as possible closures. One is the size and financial strength of the parent company. A large, well-financed company is better able to raise the capital necessary for treatment facilities and better able to carry a facility with reduced profits for a few years if the long-term outlook for the products produced is favorable. The second factor is the degree to which the plant is integrated into the overall operations of the parent company. If the plant is a captive operation using the firm's raw materials and/or is the supplier for other plants owned by the firm, the company is less likely to close the plant. A plant which fails the net present value test but has a ratio near the cut-off value is considered a border-line closure candidate. A border-line closure candidate with a financially strong owner and/or that is highly integrated into the overall corporate structure is not considered a closure candidate.

In some cases, a plant which is a potential closure candidate may close the pesticide product line while continuing to operate the rest of the facility. This is more likely to occur if pesticide production is a small part of the plant's total production. The specific information needed to judge whether the plant will close or just the product line is not readily available. However, information on the number of days of pesticide production and whether other products besides pesticides are produced at this site are available. If pesticide production goes on for only a small part of the year (e.g. less than one-third) and other products are produced, then the predicted closure is assumed to effect the pesticide product line only while the plant continues its other operations.

2.7.2. Metallo-Organics

The analysis proceeds through the same steps applied to other manufacturers of pesticide active ingredients, with one difference. First, 1982 sales are not estimated by revising the 1977 production levels and applying 1982 prices. Instead, metallo-organic pesticide chemical sales for this plant is derived from the response of the company during the public comment period following the proposal of regulations. The net present value analysis employs the same industry wide ratios used for the pesticide active ingredient manufacturing plants (Subcategory 1). If the plant appears to be a potential closure candidate based on the NPV test, then additional factors: such as the profitability of its products, the financial strength of the parent company, and the importance of pesticide metallo-organic chemical manufacturing to the parent company, are assessed.

In order to calculate the net present value ratio, estimates of the after tax real operating income and the liquidation value of the facility are required (as described in Section 2.7 above). Much of the information needed for the NPV test is not available for individual plants that manufacture active ingredients. Therefore, the values are estimated using representative ratios for the industry combined with estimates of individual plant sales. The calculation of these ratios is discussed in Appendix 2-C. The ratios are based on financial data from the pesticide operations of seven major pesticide producers. Since the ratios represent pesticide production rather than total production for these companies, they are considered representative of the industry and appropriate to estimating operating income from pesticide production at specific plants. A sensitivity analysis using the lowest operating income to sales ratio instead of the average is discussed in Chapter 8: Limits to the Analysis.

Individual company and product operating margins vary, while the analysis assumes an average value. Therefore, each plant which fails the net present value test is examined to determine if the operating income estimate based on the industry average is appropriate for the pesticides produced by that plant. If the plant's operating income is higher than that estimated on the basis of the industry averages, then it may not be a potential closure candidate. Specific operating margins are not available for individual pesticides. However, profitability is a function of several factors; two of which are considered important for this analysis. First, a patented product is very likely to have a higher operating margin than a non-patented product, particularly a commodity pesticide. The second factor is whether or not a pesticide is highly differentiated from other products. Even if a product is patented, its operating margin will not be particularly high if there are other products that can be substituted for it.

Three profitability categories are used to characterize pesticides; low, medium, and high. The categories of profitability--defined by operating margin--are:[1]

Low (10-20 percent of sales)

Medium (20-40 percent of sales)

High (40 percent of sales or more)

If a product is not patented, it is placed in the low profitability group. If a product is patented and has few or no substitutes, then it is placed in the high profitability group. If it is patented but does face competition, it is assigned to the medium profit group.

---

[1] The ranges are established by Meta Systems Inc based on discussion with industry experts.

Applying these simplifications, the test reduces to:

$$\frac{\bar{U}}{\bar{L}_o} \geq \bar{r}$$

where: $\bar{r}$ = real after-tax cost of capital
$\bar{U}$ = real operating income
$\bar{L}_o$ = current liquidation value in real terms

The equation states that if the rate of return on the liquidation value (U/L_o) is greater than or equal to the real cost of capital, then the plant will remain in operation. The analysis presented in this report uses the ratio form of the net present value test. The real cost of capital is estimated to be 7.5 percent for plants manufacturing pesticide active ingredients that are owned by large firms. (See appendix 2-C.) Since this is based on information from large firms only and in order to take into account instances where small firms may have to pay a premium when borrowing money, the cost of capital for small firms is estimated to be 9.5 percent. Since PFP plants tend to be owned by smaller companies, and they are downstream production to pesticide manufacturers, the cost of capital for PFP plants is also estimated to be 9.5 percent.

2.7.1 Manufacturers of Pesticide Active Ingredients

At proposal and for the Notice of Availability, the Agency began its analysis of the impacts associated with Subcategory 1 by using a screening analysis. The Agency examined the ratio of annual compliance costs to sales (ACC/S) and if this ratio was less than four percent at proposal and one percent at the Notice, the Agency assumed these plants would not be significantly affected. At the Notice the Agency performed a Net Present Value (NPV) Analysis only on plants with an ACC/S less than one percent. The Agency now has eliminated the screening and simply performs the NPV analysis on all plants.

The closure analysis for plants that manufacture pesticide active ingredients has two steps. First, the net present value ratio is calculated for all plants. Second, plants which appear to be potential closures under the net present value test are analyzed in further detail as to the relative profitability of their products, the importance of pesticides to their company, and the financial strength of their owners. Each of these steps, including the assumptions involved, are discussed in detail in the following paragraphs.

The net present value ratio is calculated based on the estimated 1982 value of production at each plant, after treatment costs are incurred. The value of production is equal to the new price (based on average cost increase) multiplied by the new quantity (based on the percentage price increase and the elasticity).