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Economic Impact Analysis of Proposed Effluent Limitations Guidelines and Standards for the Pesticide Formulating, Packaging, and Repackaging Industry

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Executive Summary

Introduction

This Economic Impact Analysis (EIA) assesses the economic impact of proposed guidelines and standards under the Clean Water Act for the Pesticide Formulating, Packaging, and Repackaging (PFPR) subcategories of the Pesticide Chemicals Point Source Category (40 CFR 355). The proposed guidelines and standards will apply to an estimated 3,900 facilities that formulate, package, and repackage pesticide chemicals. For the regulation, EPA divided the existing PFPR subcategory into two subcategories: (1) Subcategory C: Pesticide Chemicals Formulating, Packaging, and Repackaging; and (2) Subcategory E: Repackaging of Agricultural Chemicals Performed at Refilling Establishments. This regulation includes limitations for Best Practicable Control Technology (BPT), Best Conventional Pollutant Control Technology (BCT), Best Available Technology Economically Achievable (BAT), New Source Performance Standards (NSPS) and Pretreatment Standards for Existing and New Sources (PSES and PSNS). Because BCT and BAT requirements match the established BPT requirements, no additional costs are expected for compliance with the BCT and BAT limitations. Accordingly, this EIA focuses on analyzing alternative PSES options.

This executive summary reviews the major elements of the EIA, including: (1) facility impacts analysis for PSES regulatory options and selection of preferred options; (2) Regulatory Flexibility Analysis; (3) analysis of additional impact categories — community level impacts, international trade effects, firm-level impacts, and the effects on construction of new PFPR facilities; (4) analysis of compliance cost-savings from pollution prevention, and assessment of potential labor needs generated by the regulation; and (5) analysis of extending the proposed PFPR regulation to encompass additional pesticide active ingredients (PAIs) beyond those originally studied for regulation.

Analysis of Facility Impacts for PSES Regulatory Options

The main source of technical and financial data for the EIA is the *Pesticide Formulating, Packaging, and Repackaging Facility Survey for 1988*, which requested data from a sample of 708 facilities representing 3,241 facilities that hold product registrations containing one or more of 272 PAIs. The facility impact analysis included a pre-compliance test to identify facilities that are financially weak independent of the PFPR regulation. Approximately 20 percent of facilities failed this test and were removed from the impact analysis. To assess facility impacts, the pre-compliance financial statements were adjusted to reflect the estimated capital and operating costs of alternative regulatory options. Financial tests based on cash-flow, return on assets, and the ratio of compliance cost to facility revenue

were used to identify facility impacts in terms of facility closures — which entail a full loss of facility employment — or moderate impacts, which include product line conversions to non-PFPR activities or compliance costs exceeding 5 percent of revenue. Product line conversions were conservatively assumed to involve loss of all PFPR-related employment in a facility.

In developing this regulatory proposal, EPA defined and analyzed several PSES regulatory options for the Subcategory C and Subcategory E facilities. These options and the findings from the facility-level impact analysis are summarized below.

Subcategory C Facilities

For Subcategory C facilities, EPA initially considered 5 PSES options. Options 1 and 2 are not zero discharge options but involve treatment of wastewater and discharge to POTWs. Options 3, 4, and 5 are zero discharge options but involve different compliance methods with differing costs and impact.

Option 1 consists of end-of-pipe treatment for all wastewaters through the Universal Treatment System[1] and discharge to POTWs.

Option 2 adds pollution prevention by recycling wastewaters from cleaning the interiors of formulating and packaging equipment, and raw material and shipping containers into the product to recover product value in the wastewaters. Other wastewaters are still expected to be treated through the Universal Treatment System and discharged to POTWs.

Option 3 employs the same technology and pollution prevention practices as Option 2 but achieves zero discharge of all process wastewater by recycling the wastewater back to the facility after treatment through the Universal Treatment System.

Option 4 incorporates the pollution prevention aspects of Options 2 and 3, but instead of treatment, adds off-site disposal to an incinerator for the rest of the wastewater.

Option 5 assumes disposal of all wastewater through off-site incineration.

EPA analyzed the compliance costs and industry impacts for these options based on facility and compliance cost data assuming use and control of a set of 272 PAIs. EPA later extended the regulatory cost analysis to include discharge limitations on all additional PAIs. The following discussion is based on the analysis of 272 PAIs. The analyses for the Subcategory C PSES options showed total annualized compliance costs ranging from a low of $27.9 million for Options 2 and 3 to a high of $360.2 million for Option 5. Options 2 and 3, which have the least impacts, are each expected to result in one facility

[1]The Universal Treatment System consists of chemical emulsion breaking, hydrolysis, chemical oxidation, sulfide precipitation and activated carbon filtration treatment technologies.

closure and 170 moderate impacts. EPA estimated the greatest impacts for Option 5 at 7 facility closures and 217 moderate impacts. Total estimated worst-case job losses range from a low of 426 for Options 2 and 3 to a high of 1,173 for Option 5 (see Table ES-1).[2]

Table ES-1
National Estimate of Economic Impacts on Subcategory C Facilities
(Assuming Zero Cost Pass Through)

	Option 1	Option 2	Option 3	Option 4	Option 5
-Number of Facilities Incurring Costs	578	558	558	558	578
-Compliance Capital Costs ($ MM 1988)	$20.8	$66.1	$66.1	$18.4	$21.0
-Total Annualized Compliance Costs ($ MM 1988)	$32.6	$27.9	$27.9	$286.5	$360.2
-Facility Closures	9	1	1	7	7
-Moderate Economic Impacts	171	170	170	193	217
-Estimated Worst-Case Job Losses (FTEs)	437	426	426	1,113	1,173
-Total Pollutant Removals (lbs)	111,653	111,683	111,996	111,996	111,996
-Toxic-Weighted Pollutant Removals (lbs-equivalent)	12,127,075	12,127,666	12,134,051	12,134,051	12,134,051

From this analysis, EPA initially considered Option 3 as the basis for PSES regulation of Subcategory C facilities. Together with Option 2, Option 3 has the lowest compliance costs and impacts of the options analyzed. However, by achieving zero discharge, Option 3 more strongly promotes Clean Water Act objectives than Option 2. Moreover, Option 3 embodies Best Available Technology Economically Achievable (BAT), incorporating the best practices of pollution prevention, recycle/reuse, and water conservation applicable to this subcategory. Options 4 and 5 also achieve zero discharge, but at a much higher cost than Option 3. EPA also found that Option 3 is the most cost-effective of the five options. From these findings, EPA concluded that Option 3 was economically achievable. However, in the Regulatory Flexibility Analysis, discussed below, EPA found that Option 3 would disproportionately affect certain PFPR facilities and modified the option to mitigate these impacts.

Subcategory E Facilities

EPA developed and analyzed two zero discharge options for Subcategory E Facilities: Option 1 achieves zero discharge by storage of wastewater collected from secondary containment structures for use as make-up water in pesticide applications; Option 2 achieves zero discharge by collection of wastewater

[2]Job losses are considered "worst case" because EPA assumed that line conversions would result in loss of all PFPR-related employment in a facility, which may not occur.

from secondary containment followed by contract hauling for off-site incineration. Only 19 of 1,122 Subcategory E facilities were found to not already be meeting zero discharge. EPA estimates that the 19 remaining facilities could comply with Option 1 at zero annual cost and with Option 2 at a total annual cost of only $1,837. Neither option imposes any facility impacts and both were deemed economically achievable. EPA selected Option 1 as the basis for the PSES regulation for Subcategory E facilities.

Regulatory Flexibility Analysis

EPA performed a Regulatory Flexibility Analysis to understand whether Option 3 for Subcategory C facilities would disproportionately affect small business-owned facilities and whether the regulatory option should be modified. Because no impacts were found for the Subcategory E options, EPA did not perform a Regulatory Flexibility Analysis for the preferred Option 1.

In performing the Regulatory Flexibility Analysis for Option 3, EPA had to balance the traditional concerns of a Regulatory Flexibility Analysis — moderation of impacts among small-business entities — with the broader regulatory objectives of the Clean Water Act. In particular, because small business concerns largely comprise the PFPR industry, EPA needed to analyze other facility characteristics in addition to business size classification to understand the characteristics of facilities impacted by Option 3. These additional characteristics included principal PFPR market from which facilities derive business, PFPR revenue as a percent of total facility revenue, and usage of pesticide active ingredients.

From this analysis, EPA found that Option 3 would disproportionately affect certain facilities that: (1) are owned primarily by a small business; (2) participate to a large degree in the institutional/ commercial market; (3) receive a relatively low share of total revenue from PFPR activities; and (4) often use relatively low toxicity "sanitizer" PAIs to produce sanitizer products. Taking these distinguishing characteristics into account, EPA defined a modification to Option 3, namely **Option 3/S**, as the preferred regulatory alternative. Option 3/S is the same as Option 3 except that it exempts certain non-interior wastewater streams from the zero discharge requirement. Specifically, for those facilities that formulate, package, or repackage designated sanitizer PAIs and whose sanitizer production is less than 265,000 pounds per year, *the zero discharge requirement would not apply to non-interior wastewater streams that contain only designated sanitizer PAIs.*[3] These non-interior wastewater streams include exterior

[3]See Table 8 of the proposed regulation or Section 12 of the Technical Development Document (*Development Document for Best Available Technology, Pretreatment Technology, and New Source Performance Technology for the Pesticide Formulating, Packaging, and Repackaging Industry: Proposed*) for a list of the sanitizer active ingredients that are eligible for exemption from the zero discharge requirement under this regulation.

equipment and floor wash, leak and spill cleanup, safety equipment rinsate, contaminated precipitation run-off, laboratory wastewater, air pollution control wastewater, and DOT test bath water. The zero discharge requirement would apply to the interior wastewater streams of these facilities including discharge from cleaning the interiors of drum/shipping containers, bulk containers, and other equipment.

In comparison to Option 3, Option 3/S imposes lower costs and fewer facility impacts, particularly among small business-owned facilities operating in the institutional/commercial market. Total annualized compliance costs under Option 3/S were estimated at $26.1 million, or $1.8 million less than under Option 3. Moreover, under Option 3/S, moderate impacts fell by 20 percent, from 170 to 136 facilities (1 facility was assessed as a closure under both options). EPA estimated total job losses at 355 FTEs under Option 3/S, or 71 fewer job losses than under Option 3. Among small businesses, total facility impacts fell by 22 percent, from 150 to 116.

Because Option 3/S exempts certain discharge streams containing only sanitizer PAIs from the zero discharge requirement, EPA expects that pollutant removals would be slightly lower under Option 3/S than under Option 3. EPA estimates that Option 3/S would remove 111,793 pounds of discharges annually, or 203 pounds less than the amount removed by Option 3. However, when the discharges are adjusted for relative toxicity, EPA estimates that Option 3/S would remove only 19 fewer toxic-weighted pounds than the total of 12,134,501 toxic-weighted pounds removed under Option 3. The small difference in toxic-weighted pounds reflects the generally low toxicity of sanitizer PAIs. Taking into account both the substantial relief to small business-owned facilities provided by Option 3/S *and* the very modest loss in pollution reduction benefits, EPA selected this option as the preferred regulatory option for PSES limitations to be applied to Subcategory C PFPR facilities.

Other Impacts

EPA also performed additional impact analyses for the proposed PSES regulation — community employment, foreign trade effects, firm-level financial performance, and entry of new sources into the PFPR industry — and assessed possible offsets to the regulation's costs and economic impacts — compliance cost-savings from pollution prevention and labor needs generated by the regulation. The findings from these analyses are summarized below.

Community Employment Impacts

Community impacts were assessed on the basis of the employment loss expected to result from facility closures or PFPR line conversions, taking into account both primary employment effects in the PFPR industry and secondary employment effects in other affected industries. Although the community impact analysis used highly conservative assumptions, no Metropolitan Statistical Areas in which impacted sample facilities are located were found to incur employment losses exceeding one percent of total employment, the threshold of significant impact.

Foreign Trade Impacts

EPA assessed foreign trade impacts in terms of the change in net exports of pesticide products stemming from lost production in impacted facilities. EPA analyzed foreign trade impacts under two cases. The more realistic, proportional case, which accounts for the relative competitiveness of U.S. and foreign producers, indicated that Option 3/S would lead to a decline in the net trade balance of $9.2 million or less than one percent of the average pesticides trade balance value over the period 1980-1990. The severely unrealistic, worst case analysis found that the loss in the net trade balance for pesticides under Option 3/S would be about 4 percent. In view of the minor impacts, particularly under the proportional case analysis, EPA concluded that Option 3/S will not significantly impair the international trade position in pesticides.

Firm-Level Impacts

The firm-level impact analysis used a test based on change in pre-tax return on assets (ROA) to assess whether the financial performance of firms owning PFPR facilities will be significantly affected by compliance requirements. Because of sample design issues, the results from this analysis apply only to 308 firms that own sample facilities and cannot be extrapolated to the PFPR facility population. The analysis accounts for compliance costs both in sample facilities and in other PFPR facilities not included in the sample. Also, a pre-compliance test was used to identify firms that are financially weak independent of regulatory requirements: 66 firms failed this test. EPA found that only 5 of the remaining 242 firms would incur adverse financial impacts as a result of regulatory compliance. EPA judges that this modest frequency of impacts should not pose a significant burden to the PFPR industry.

Effects of Regulatory Compliance on New Sources

For Subcategory C facilities, EPA proposes to establish *New Source Performance Standards* (NSPS) and *Pretreatment Standards for New Sources* (PSNS) as zero discharge. The economic impact

analysis for existing sources found that zero discharge (as embodied in Option 3) would be economically achievable for existing sources. Because new sources can include compliance equipment and related processes in plant designs before construction and generally at lower cost than for retrofit applications, EPA believes that new sources will be able to comply at costs that are similar to or less than those for existing sources. Accordingly, EPA concludes that a zero discharge requirement for new source direct dischargers would be economically achievable and would not be a barrier to entry.

Although EPA proposes to exempt certain sanitizer PAI waste streams from the PSES zero discharge requirement for existing facilities, EPA does not propose to extend this exemption to new facilities under PSNS. EPA's proposal to exempt the designated waste streams in existing facilities is based on the substantial reduction in impacts among small business-owned facilities coupled with a very small increase in pollutant loadings. EPA does not have sufficient information for new sources subject to PSNS to conclude that the size and economic conditions of those new sources, the impacts on those new sources, and the associated loadings of toxic pollutants, would justify a similar exemption.

For Subcategory E facilities, EPA proposes NSPS/PSNS equal to the proposed BAT/PSES limitations for existing sources. Because EPA found that compliance with the proposed option is economically achievable for existing facilities, EPA also determined that compliance with NSPS/PSNS will be economically achievable and not a barrier to entry for new sources.

Cost Savings from Pollution Prevention

In its regulatory analysis, EPA found that incorporating pollution prevention as an element of compliance strategy was economically advantageous. Although the regulatory cost analysis accounted for an estimated $4.7 million in cost savings from reduced waste management and disposal costs, certain additional cost savings — from reduced water use and sewer discharge, recovery and reuse of PAIs in wastewaters, reduced permitting-related costs, and reduced insurance and cost of capital — were not recognized. EPA quantified the potential savings from reduced water use and sewer charge, and recovery and reuse of PAIs; the remaining savings categories were qualitatively assessed. From this analysis, EPA estimated national aggregate annual benefits of $116,000 from reduced water use and sewer charge, and $628,100 from recovery and reuse of PAIs. Although permitting cost savings were not estimated on a facility-specific basis, EPA identified possible savings amounts *per facility* varying from a few hundred dollars a year for some POTW-related charges to tens of thousands of dollars for direct discharge permits. In aggregate, such savings might amount to as much as $2 million annually. EPA was also

unable to quantify savings in insurance premiums and reduced cost of capital. However, discussions with industry and a literature review indicate that these factors may also provide financial benefits for firms that choose pollution prevention as a means of complying with the proposed PFPR regulation.

Labor Requirements of Compliance

The manufacturing, installation, and operation of equipment and processes for complying with the PFPR regulation will require labor resources. To the extent that these labor requirements translate into employment increases in complying firms, the regulation may generate employment benefits that partially offset employment losses in impacted facilities. Accordingly, EPA estimated the labor requirements of compliance taking into account both primary labor needs for manufacturing, installing and operating compliance equipment and secondary requirements in other affected industries. From this analysis, EPA estimated an annual *primary* labor requirement of 100 full-time equivalent positions with corresponding payments to labor of $3.4 million (1988 dollars). Taking into account both primary and secondary employment effects, EPA estimated that the total labor requirements of the Option 3/S rule would range from 269 to 400 full-time equivalent positions.

Compliance Effects Including PAIs Not on the Original List of 272 PAIs Studied for Regulation

After analyzing the compliance costs and pollutant removals for Option 3/S, EPA decided to include under regulation all additional PAIs (except sodium hypochlorite) beyond the 272 PAIs on which the initial options analysis and selection were based. EPA conducted additional analyses including these *additional non-272 PAIs*. To distinguish the analysis and findings for the regulatory option including coverage of the additional non-272 PAIs from the analysis of Option 3/S based on only the 272 PAIs, this document refers to the regulation *including coverage of the additional non-272 PAIs* as **Option 3/S′**.[4]

EPA estimated the costs and impacts of Option 3/S′ separately for: (1) facilities that use the original 272 PAIs and that may also use the additional non-272 PAIs; and (2) facilities that use only the additional non-272 PAIs. Costs and impacts for the first set of facilities were analyzed on a facility-specific basis using the same facility impact assessment methodology outlined at the beginning of this summary. In this effort, EPA used data on the usage of the non-272 PAIs from the FATES database to supplement the data developed and analyzed on the basis of the 272 PAIs. Costs and impacts for the

[4]The Federal Register Notice for this regulation refers to the regulatory option with expanded PAI coverage as *Option 3/S.1*.

second set of facilities, which use non-272 PAIs only, were estimated by extrapolating aggregate results from the analysis of facilities using only the original set of 272 PAIs. These separately estimated costs and impacts were combined to yield the aggregate values for Option 3/S′.

Under Option 3/S′, EPA estimated that 869 Subcategory C facilities will incur total annualized costs of $56.1 million, compared to $26.1 million under Option 3/S. The associated facility impacts amount to 2 facility closures and 250 moderate impacts, compared to 1 facility closure and 136 moderate impacts under Option 3/S. Worst case job losses were estimated at 688 full-time equivalent positions, or 333 more than estimated for Option 3/S. Although these analyses show additional economic impacts as a result of including the additional non-272 PAIs under regulation, EPA found that the selected option remains economically achievable. Moreover, by including the additional PAIs under regulation, Option 3/S′ promotes more strongly the pollution reduction objectives of the Clean Water Act. Overall, Option 3/S′ achieves substantially greater pollutant removals, approximately 310,000 pounds annually, than both the initially selected Option 3 and the revised Option 3/S (both achieve about 112,000 pounds)[5]. In addition, because Option 3/S′ retains the exemption for certain sanitizer PAI waste streams, it results in relatively minor impacts among the small business-owned, sanitizer facilities that EPA had found to incur disproportionate impacts under a uniform zero discharge requirement. The exemption for these waste streams excludes from compliance requirements a very small quantity of pollutant discharges containing the exempted sanitizer PAIs, 1,036 pounds annually. Because the sanitizer PAIs generally have relatively low toxicity, the estimated residual discharges amount to only 196 toxic-weighted pounds annually when adjusted for relative toxicity. These residual discharges are an insignificant fraction of the pre-compliance amount of 34 million toxic-weighted pounds. On balance, EPA considers Option 3/S′ the superior alternative among the regulatory options considered.

EPA also performed the additional impact analyses — community employment, foreign trade, and firm-level — summarized above, including consideration of the additional non-272 PAIs. None of these additional analyses found that impacts are likely to be significant as a result of including under regulation the additional PAIs.

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[5]The *toxic-weighted* removals for these options are estimated as follows: Option 3/S′, 33,747,863 pound-equivalents; Option 3/S, 12,134,031 pound-equivalents; and Option 3, 12,134,051 pound-equivalents.

Chapter 1
Introduction and Overview

1.0 Overview and Definitions

The Federal Water Pollution Control Act Amendments of 1972 established a comprehensive program to "restore and maintain the chemical, physical, and biological integrity of the Nation's waters" (Section 101(a)). To implement these amendments, the U.S. Environmental Protection Agency (EPA) issues effluent limitations guidelines and standards for categories of industrial dischargers. The regulations that the EPA establishes are:

- *Best Practicable Control Technology Currently Available* (BPT). These rules apply to existing industrial direct dischargers, and generally cover discharge of conventional pollutants.[1]

- *Best Available Technology Economically Achievable* (BAT). These rules apply to existing industrial direct dischargers and the control of priority and non-conventional pollutant discharges.

- *Best Conventional Pollutant Control Technology* (BCT). BCT rules are an additional level of control beyond BPT for conventional pollutants.

- *Pretreatment Standards for Existing Sources* (PSES). These rules apply to existing indirect dischargers (i.e., facilities whose discharges enter Publicly Owned Treatment Works, or POTWs). They generally cover discharge of toxic and non-conventional pollutants that pass through the POTW or interfere with its operation. They are analogous to the BAT controls.

- *New Source Performance Standards* (NSPS). These rules apply to new industrial direct dischargers and cover all pollutant categories.

- *Pretreatment Standards for New Sources* (PSNS). These rules apply to new indirect dischargers and generally cover discharge of toxic and non-conventional pollutants that pass through the POTW or interfere with its operation.

This Economic Impact Analysis (EIA) assesses the economic impact of proposed effluent limitations guidelines and standards for the Pesticide Formulating, Packaging, and Repackaging (PFPR) subcategories of the Pesticide Chemicals Point Source Category (40 CFR 355). This rulemaking proposes

[1]Conventional pollutants are defined as biochemical oxygen demand (BOD), total suspected solids (TSS), oil and grease, and pH. Other pollutants may also be regulated at the BPT level.

limitations for Best Practicable Control Technology (BPT), Best Conventional Pollutant Control Technology (BCT), Best Available Technology Economically Achievable (BAT), New Source Performance Standards (NSPS) and Pretreatment Standards for Existing and New Sources (PSES and PSNS).

BPT limitations were promulgated for three subcategories of the pesticide chemicals point source category in 1978. Two of the three subcategories regulated the pesticide manufacturing of active ingredients, while the third regulated the formulating and packaging of pesticide products. On September 28, 1993, additional effluent limitations guidelines and standards were issued for the pesticide manufacturing subcategories.

The promulgated BPT regulation required zero direct discharge for pesticide chemicals formulating and packaging facilities. In 1985, EPA promulgated zero discharge pretreatment standards (along with BAT limitations and new source standards to implement the BPT requirements). This regulation was challenged by industry, and EPA voluntarily withdrew the regulation in 1986.

The proposed regulation analyzed in this document will apply to facilities that formulate, package, and repackage pesticide chemicals. An estimated 3,900 facilities engage in this activity nationwide. About 2,400 of these facilities engage in PFPR activities involving the 272 PAIs originally considered for regulation, and therefore represent the population of PFPR facilities surveyed. The remaining facilities use only PAIs beyond these 272 PAIs. For the proposed regulation, EPA divided the existing subcategory for these facilities into two subcategories: (1) Subcategory C: Pesticide Chemicals Formulating, Packaging, and Repackaging (hereinafter, Subcategory C or PFPR Facilities); and (2) Subcategory E: Repackaging of Agricultural Chemicals Performed at Refilling Establishments (hereinafter, Subcategory E or Refilling Establishments). This rule is being proposed in accordance with EPA's Effluent Guidelines Plan issued under Section 304(m) of the Clean Water Act.

1.1 Summary of the Proposed Regulation

The regulations proposed in this rulemaking include BPT, BAT and BCT, PSES, and NSPS and PSNS, as summarized below.

Best Practicable Control Technology (BPT)

For the current Subcategory C (PFPR facilities), EPA proposes to not amend the existing zero discharge BPT provisions, established in 1978, with the exception of adding the word *repackaging* to the title. This change is being made to clarify the types of operations covered and does not expand the current coverage of the BPT effluent limitations guidelines.

A new Subcategory E is proposed to apply to the repackaging of agricultural chemicals at refilling establishments. Zero discharge limitations apply to this new subcategory.

Best Available Technology Economically Achievable (BAT) and Best Conventional Pollutant Control Technology (BCT)

Because BPT is based on zero discharge of wastewater pollutants and more stringent limitations are not possible, BAT and BCT for both subcategories are set at zero discharge of wastewater pollutants. Because the BAT and BCT limitations are set equivalent to the BPT zero discharge limitation and are based on the same control technologies, no additional costs are required for compliance with BAT or BCT.

Pretreatment Standards for Existing Sources (PSES)

For both Subcategory C, PFPR Facilities, and Subcategory E, Refilling Establishments, the Agency proposes to establish PSES on the basis of zero discharge of wastewater pollutants. The best available technologies identified as a basis for these proposed standards consist of pollution prevention, recycle and reuse of wastewater preceded, where necessary, by treatment of wastewater for recycle and reuse. As noted above, because no additional costs are expected for compliance with BCT or BAT, the primary focus of this economic impact analysis is on the development and analysis of impacts for alternative PSES options.

For PFPR Facilities (Subcategory C), the proposed PSES regulation requires zero discharge of all wastewater streams containing the pesticide active ingredients within the scope of this regulation with one exception. Specifically, in its Regulatory Flexibility Analysis, EPA found that the zero discharge requirement was likely to impose disproportionate impacts among small business-owned facilities that primarily serve the industrial/commercial market and that use certain lower toxicity sanitizer pesticide

active ingredients (PAIs) to formulate, package and repackage sanitizer products.[2] To mitigate expected impacts among these facilities, EPA decided not to impose the zero discharge requirement for certain waste streams in facilities that formulate, package, or repackage sanitizer PAIs and whose sanitizer production is less than 265,000 pounds per year.[3] In these facilities, discharges from non-interior process wastewater sources (e.g., floor wash, exterior equipment cleaning, and laboratory rinsates) *that contain only the designated sanitizer PAIs* are exempt from the zero discharge requirement. All other wastewaters at these facilities — including those from interior sources (e.g., bulk tank rinsate, drum/shipping container rinsate, and interior equipment rinsate) or from non-interior sources that contain PAIs other than the designated sanitizer PAIs — are subject to the zero discharge requirement.

For Refilling Establishments (Subcategory E), the zero discharge technology basis for this proposal is secondary containment of bulk storage areas and loading pads, plus the collection and holding of rinsates, contaminated stormwater, and leaks and spills. EPA's Office of Pesticide Programs is proposing a regulation that will require refilling establishments for agricultural pesticides to build secondary containment structures and loading pads to certain specifications. The Office of Water's regulatory proposal builds on this requirement. Specifically, it requires that the contaminated stormwater, rinsates and leaks and spills that have been collected in secondary containment structures be held until they can be reused (e.g., applied as pesticide on a site compatible with the product label or used as make-up water in application of pesticide chemicals to an appropriate site).

New Source Performance Standards (NSPS) and Pretreatment Standards for New Sources (PSNS)

For both subcategories, NSPS and PSNS are being set based on zero discharge for all new sources. In the case of sanitizer chemical facilities, PSNS is more stringent than PSES by setting zero discharge of wastewater pollutants from both the interior and non-interior process wastewater sources. However, this greater stringency should not present a barrier to entry for new sanitizer chemical facilities.

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[2]For further details, see Chapter 5, Regulatory Flexibility Analysis.

[3]See Table 8 of the regulation or Section 12 of the Technical Development Document (*Development Document for Best Available Technology, Pretreatment Technology, and New Source Performance Technology for the Pesticide Formulating/Packaging/Repackaging Industry: Proposed*) for a list of the sanitizer active ingredients that are eligible for exemption from the zero discharge requirement under this regulation.

1.2 Selection of the Proposed Regulatory Options

In the developing this regulatory proposal, EPA considered several regulatory options for the Subcategory C and Subcategory E facilities.

PFPR Facilities (Subcategory C)

For PFPR Facilities, EPA initially considered five PSES technology options. Of these regulatory options, Options 1 and 2 are not zero discharge options but involve treatment of wastewater and discharge to POTWs. Options 3, 4, and 5 are all zero discharge options but, for the regulatory analysis, assume different methods of compliance with differing costs and impacts:

Option 1 consists of end-of-pipe treatment for the entire wastewater volume now generated by PFPR facilities through the Universal Treatment System[4] and discharge to POTWs.

Option 2 adds pollution prevention by recycling wastewaters generated from cleaning the interiors of formulating and packaging equipment, and raw material and shipping containers into the product to recover product value in the wastewaters. Other wastewaters are still expected to be treated through the Universal Treatment System and discharged to POTWs.

Option 3 is based on the same technology and pollution prevention practices as Option 2 except that zero discharge of all process wastewater would be achieved by recycling the wastewater back to the facility after treatment through the Universal Treatment System.

Option 4 incorporates the pollution prevention aspects of Options 2 and 3, but instead of treatment, adds off-site disposal to an incinerator of the rest of the wastewater.

Option 5 assumes disposal of all wastewater through off-site incineration.

EPA analyzed the compliance costs and industry impacts for these options on the basis of facility and compliance cost data assuming use and control of a set of 272 PAIs. These 272 PAIs are the same

[4]The Universal Treatment System consists of chemical emulsion breaking, hydrolysis, chemical oxidation, sulfide precipitation and activated carbon filtration treatment technologies.

as those PAIs whose discharges were originally considered for regulation under the recently promulgated effluent limitation guideline for the Pesticide Manufacturers Industry. From this analysis, EPA initially considered Option 3 to be the basis for Pretreatment Standards for Existing Sources for PFPR Facilities (Subcategory C). This option provides a PSES limitation that is consistent with requirements for direct dischargers. In addition, the compliance costs and facility impacts estimated for this option were the lowest, with Option 2, of the five options analyzed. However, unlike Option 2, Option 3 more strongly promotes the objectives of the Clean Water Act by achieving zero discharge of specified pollutants from PFPR facilities. Specifically, Option 3 embodies Best Available Technology Economically Achievable (BAT) by incorporating the best practices of pollution prevention, recycle/reuse, and water conservation applicable to this subcategory. Specifically, Option 3 embodies Best Available Technology Economically Achievable (BAT), incorporating the best practices of pollution prevention, recycle/reuse, and water conservation applicable to this subcategory. In addition, Option 3 achieves greater pollutant removals than Options 1 and 2 and the same quantity of removals as Options 4 and 5, but at a much lower cost. EPA also found that Option 3 is also the most cost-effective of the five options. From the economic impact analysis, EPA found that Option 3 was both economically achievable and met the objectives of the Clean Water Act by achieving zero discharge of specified pollutants from PFPR facilities.

In the course of its Regulatory Flexibility Analysis, however, EPA found that the zero discharge requirement of Option 3 would disproportionately affect certain PFPR facilities that produce "sanitizer" products and are primarily owned by small businesses. These small impacted facilities were also found to differ from other PFPR facilities by their relatively high degree of participation in the institutional/commercial market and their relatively low share of total revenue from PFPR activities. On the basis of these distinguishing characteristics, EPA defined a modification to Option 3, namely **Option 3/S**, as the preferred regulatory alternative. **Option 3/S** corresponds to Option 3 except that certain non-interior source wastewater streams are exempted from the regulatory requirements. Specifically, for those facilities that formulate, package, or repackage sanitizer active ingredients and whose sanitizer production is less than 265,000 pounds per year, *the zero discharge requirement would not apply to physically separate, non-interior wastewater streams that contain only designated sanitizer PAIs*. These non-interior wastewater streams include exterior equipment and floor wash, leak and spill cleanup, safety equipment rinsate, contaminated precipitation run-off, laboratory wastewater, air pollution control wastewater, and DOT test bath water. The *zero discharge requirement would apply to the interior wastewater streams*

of these facilities including discharge from cleaning the interiors of drum/shipping containers, bulk containers, and other equipment.

In addition, EPA decided to include under the PSES regulation all additional PAIs beyond the list of 272 PAIs on which the initial options analysis and selection were based. EPA conducted additional economic impact and cost-effectiveness analyses of the selected option including regulation of these additional PAIs, referred to as *additional non-272 PAIs*. To distinguish the analysis and findings for the regulatory option including coverage of the additional non-272 PAIs from the analysis of Option 3/S based on only the 272 PAIs, this document refers to the regulation *including coverage of the additional non-272 PAIs* as Option 3/S′.

Although EPA's analyses indicated somewhat larger economic impacts as a result of including these additional PAIs under regulation, EPA found that the Option 3/S′ regulation remains economically achievable and, by virtue of including the additional PAIs under regulation, would promote more strongly the pollution reduction objectives of the Clean Water Act. Overall, Option 3/S′ achieves a substantially greater reduction in pollutant discharges than both the initially selected Option 3 and the revised Option 3/S, which includes the sanitizer PAI exemption. The total estimated reduction in discharges under Option 3/S′ amounts to approximately 310,000 pounds annually, or approximately 175 percent more than the reduced discharges estimated for the options that regulate only the original 272 PAIs (about 112,000 pounds). Moreover, because Option 3/S′ retains the exemption for certain sanitizer PAI waste streams, it results in relatively minor economic impacts among the small business-owned, sanitizer facilities that EPA had found to incur disproportionate impacts because of the uniform zero discharge requirement. The exemption for these waste streams excludes from compliance requirements very small quantity of pollutant discharges containing the exempted sanitizer PAIs, 1,036 pounds annually. Because the sanitizer PAIs generally have low toxicity, the estimated residual discharges amount to only 196 toxic-weighted pounds annually when the residual discharges are adjusted for relative toxicity. In contrast, EPA estimates that the pre-compliance discharges, adjusted for toxicity, amount to nearly 34 million toxic-weighted pounds annually.[5] Accordingly, the residual discharges, adjusted for toxicity, are an

[5]EPA estimates that the total 310,455 pounds of removals for Option 3/S′ translate into total toxic-weighted removals of 33,747,863 toxic-weighted pounds (see the Cost-Effectiveness Analysis report for information regarding toxic-weighted removal calculations and the unweighted and weighted removals achieved by the various regulatory options).

insignificant fraction of the pre-compliance amount. On balance, EPA considers Option 3/S′ the superior alternative among the regulatory options considered.

Refilling Establishments

For Refilling Establishments (Subcategory E facilities), EPA developed two viable regulatory options, both embodying a zero discharge requirement. Option 1 achieves zero discharge through storage of wastewater collected from secondary containment structures for use as make-up water in pesticide applications. Option 2 achieves zero discharge through collection of wastewater from secondary containment followed by contract hauling for off-site incineration. The Agency proposes Option 1.

1.3 Structure of the Economic Impact Analysis

This EIA describes both the methodology employed to assess impacts of the proposed rules and the results of the analyses. The overall structure of the impact analysis is summarized in Figure 1.1. The two main inputs to the analysis are: (1) data on industry baseline financial and operating conditions, and (2) projected costs of complying with the proposed regulations. The industry baseline financial and operating data are based principally on the *Pesticide Formulating, Packaging, and Repackaging Facility Survey for 1988* conducted under Section 308 of the Clean Water Act.[6] The Survey, which requested facility-level data, was divided into three parts. The Introduction requested general facility information such as facility address and SIC code, as well as information to determine whether analysis of the facility should proceed: for example, business status of the facility and confirmation of the PAIs formulated, packaged, or repackaged by the facility (See Appendix A). Part A of the Survey requested technical data, and Part B requested economic and financial data.

The Survey was sent to a total of 708 facilities. Of these, 610 were randomly selected from 3,241 facilities that were identified in the FIFRA and TSCA Enforcement System (FATES) as holding product registrations containing one or more of the 272 PAIs initially considered for regulation. In addition, EPA sent questionnaires to 92 pesticide manufacturing facilities identified by the Pesticide

[6]Baseline conditions also include certain costs deemed necessary to comply with particular regulations imposed under the Resource Conservation and Recovery Act (RCRA), the effluent guidelines for the Organic Chemicals, Plastics, and Synthetic Fibers (OCPSF) Industry, FIFRA maintenance fee requirements, and effluent guidelines for the pesticide manufacturing industry. Parts of these regulations took effect after the base year of the Survey, and imposed costs on certain PFPR facilities. These costs are included in the analysis.

Manufacturing Census conducted by EPA in 1988, on the premise that they might also conduct PFPR activities. Also, six voluntary or pretest questionnaires were submitted.

The second major input to the analysis is the projected costs of compliance with the regulatory options. These cost estimates were developed by the EPA. Details on the compliance cost estimates can be found in the Technical Development Document for the proposed rule. Additional information on all data sources is presented in Chapter 2.

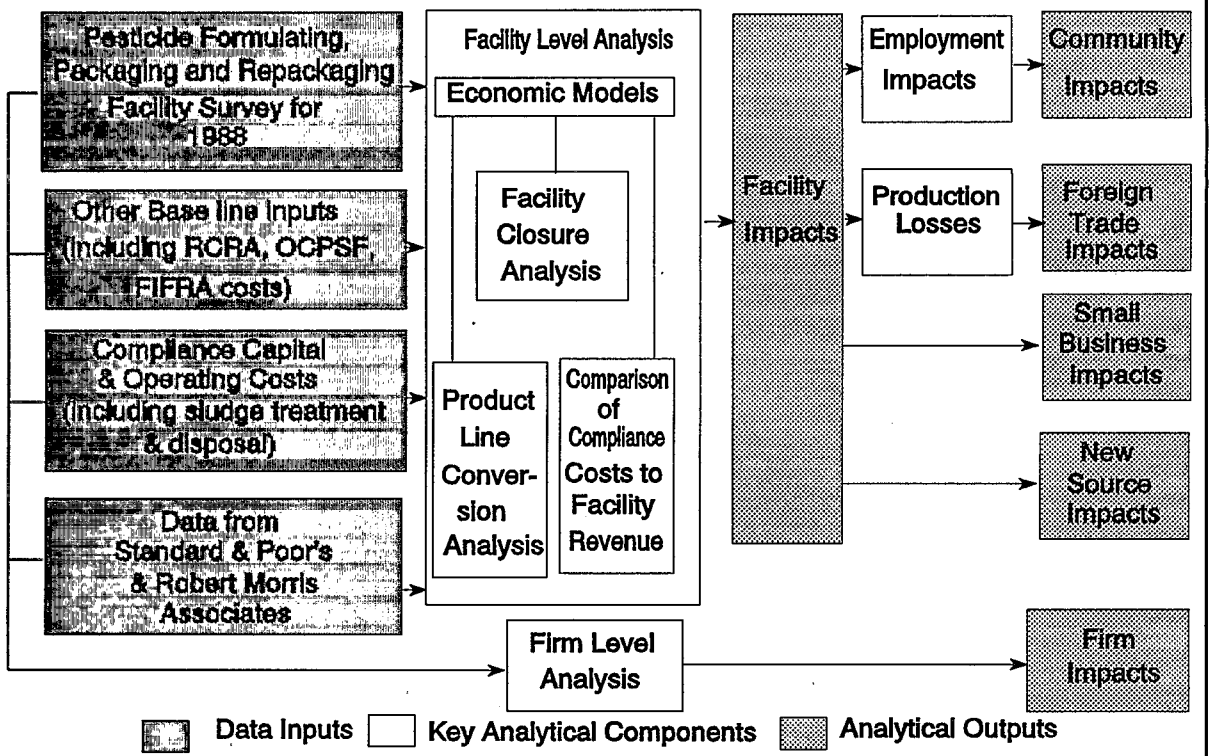
To evaluate the expected impacts of the regulatory options, six measures of impact are examined in the EIA:

- Impacts on facilities that formulate, package, or repackage pesticides containing PAIs covered by the regulation;
- Impacts on PFPR facilities owned by small businesses;
- Employment losses and associated community effects;
- Impacts on the U.S. balance of trade;
- Impacts on firms owning one or more PFPR facilities expected to incur compliance costs; and
- Effects on the construction of new facilities and expansion of existing facilities.

The EIA methodology relies foremost on a facility-level impact analysis. The results from this analysis drive the other components of the EIA (See Figure 1.1.) The facility-level economic model estimates post-compliance revenues, costs, and profits. The post-compliance financial data are then used to analyze three potential effects of the increased costs on facilities: facility closure, conversion of PFPR

product lines to alternate non-pesticide FPR activities, and compliance costs in excess of five percent of facility revenue.[7]

Figure 1.1
Economic Impact Analysis of Pesticides Formulating/Packaging/Repackaging Industry Effluent Limitations Guidelines: Analytic Components



The analysis of facility closure is based on comparing the post-compliance facility cash flow to the baseline cash flow. The product line conversion analysis compares the return on assets (ROA)

[7]In contrast to facility closures and product line conversions, compliance costs in excess of five percent of facility revenue are assumed not to lead to an operational change at a facility. Compliance costs that are less than five percent of facility revenue are commonly judged to be economically achievable (see, for example, the EIAs for effluent limitations for the OCPSF and pesticide manufacturing industries). Compliance costs equal to five percent or more of facility revenue, however, do not *necessarily* indicate a moderate impact.

achieved post-compliance to the ROA that facilities are expected to be able to earn in alternative formulating, packaging, or repackaging activities.

An additional potential impact of the regulation, evaluated using the results of the facility analysis, is the *impact on small businesses*, which is performed in accordance with the requirements of the Regulatory Flexibility Act. This analysis has two steps. First, it is determined whether the regulation is expected to impact a substantial number of small businesses significantly. Impacts are defined as either a facility closure, a product line conversion, or compliance costs equal to five percent or more of facility revenue. Second, if a substantial number of small businesses are projected to sustain significant impacts, alternative regulatory methods that mitigate or eliminate the economic impacts on small businesses are examined. As noted above, the Regulatory Flexibility Analysis provided the basis for developing the preferred regulatory option, which exempts certain waste streams containing only designated sanitizer chemicals from the zero discharge requirement and thus benefits typically small business-owned facilities operating in the institutional/commercial market.

The facility-level impact analysis drives the analysis of other, secondary impacts, including those on local communities and foreign trade. *Community impacts* are assessed on the basis of the employment loss expected to result from facility closures or PFPR line conversions, taking into account both primary employment effects in the PFPR industry and secondary employment effects in linked industries and in consumer-oriented retail and service industries. The significance of the employment loss is evaluated by its effect on total community employment.

Foreign trade impacts may result from changes in the domestic production of pesticides, because pesticides are traded internationally. Changes in the balance of trade are calculated based on both the estimated decreases in exported production and the increases in pesticide imports that result from meeting regulatory requirements. The expected change in net exports (i.e., exports minus imports) is compared with the baseline (1988) trade balance for the entire pesticide industry, and with average year-to-year fluctuations in the pesticide products trade balance, to measure the significance of the change.

EPA also performed a *firm-level impact analysis*, which aims at understanding whether the firms owning PFPR facilities are capable of financing the investments needed to comply with the proposed regulation. Because of sample design issues, the results from this analysis cannot be extrapolated to the

population of PFPR facilities. However, for those firms that own facilities in the PFPR industry Survey, the firm-level analysis accounts for compliance costs both in sample facilities and in other PFPR facilities not included in the sample. The test of financial impact on these firms is based on the change in pre-tax return on assets resulting from compliance with the PFPR regulation.

Finally, impacts of the PSNS and NSPS regulations on *new sources* of pesticide production are evaluated.

In addition to these impact-related analyses, the EIA includes two other analyses pertaining to potential offsets to the costs and economic impacts of the proposed regulations for the PFPR industry. Specifically, EPA analyzed potential *cost-savings from use of pollution prevention* as a means of complying with the proposed regulation. The cost savings from reduced waste management and disposal costs were directly accounted for in estimating the costs of complying with the various regulatory options that incorporate pollution prevention practices. However, certain additional cost savings — from reduced water use, recovery and reuse of PAIs in wastewaters, reduced permitting-related costs, and reduced insurance and cost of capital — were not recognized in the regulatory cost analyses. To the extent possible, EPA quantified these potential additional savings and examined qualitatively the potential savings in categories that were unable to be quantified. In addition, this analysis addresses longer term economic and regulatory environment factors that may cause contract hauling and incineration to be more costly compliance options in the future.

EPA also recognized that the manufacturing, installation, and operation of equipment and processes for complying with the PFPR regulation would generate labor needs. To the extent that these labor needs translate into employment increases in complying firms, the regulation has the potential to generate employment benefits that may partially offset employment losses that are expected to occur in facilities impacted by the rule. Accordingly, EPA analyzed the *labor requirements* for complying with the proposed regulatory option. This analysis is based on the expected contribution from labor in manufacturing, installing and operating compliance equipment and accounts for both primary labor requirements in directly affected industries and secondary labor needs in linked industries and in consumer-oriented retail and service industries.

1.4 Organization of the Economic Impact Analysis Report

The remaining parts of the Economic Impact Analysis Report are organized as follows. The following chapter, Chapter 2, presents a description of the data sources consulted for this EIA. Chapter 3 profiles the pesticide formulating, packaging, and repackaging industry, examining the industry segments involved in pesticide formulating, packaging, and repackaging, and the prevailing market conditions for pesticide products.

Following the background material in Chapters 2 and 3, Chapters 4 through 9 each describe the data and methodology used to estimate one type of potential impact and the resulting impact estimates. The analysis presented in these chapters is based on the 272 PAIs originally studied for regulation. Chapter 4 details the methodology used to estimate facility impacts. As stated above, facility impacts provide the methodological foundation for this EIA. First defined are the markets to be analyzed and the basic model of market structure. Baseline and post-compliance costs and after-tax cash flows are then estimated. This chapter also describes the analyses of facility closures, product line conversions, and compliance costs in excess of five percent of facility revenue.

Chapter 5 presents the small business impact and Regulatory Flexibility Analysis. Chapter 6 describes the methodology for and results of the community impact analysis, based on the results of the facility analysis. Methods for estimating international trade effects, and the expected effects, are described in Chapter 7. Chapter 8 assesses firm-level financial impacts for firms owning one or more PFPR facilities that are expected to incur costs in complying with the proposed regulation. Chapter 9 describes the expected effects of the regulation on new PFPR facilities.

Chapter 10 contains the analysis of potential cost savings to PFPR facilities that use pollution prevention in complying with the proposed regulation. Chapter 11 presents the analysis of the potential labor requirements for complying with the PFPR regulation.

Chapter 12 assesses the economic impacts of including under the proposed PSES regulation the additional PAIs that were not on the original list of 272 PAIs. This chapter applies essentially the same methodologies described in the preceding chapters to estimate the economic impacts of complying with the proposed regulation with its scope of regulatory coverage expanded to include the additional non-272 PAIs. The chapter addresses impacts on PFPR facilities, community employment, the pesticides

international trade balance, and firm financial performance. The chapter also reviews the regulatory flexibility considerations and assesses the compliance labor requirements of expanding the regulation to include the additional PAIs.

The report includes six appendices. The first appendix, Appendix A, contains the Section 308 Survey of pesticide formulating, packaging, and repackaging facilities. The second appendix presents the mapping of PAIs into clusters. Appendix C documents the methodology for calculating price elasticities of demand for PAI clusters. Appendix D presents annualized compliance costs as a percentage of facility revenue for those facilities projected to close in the baseline scenario. Appendix E provides the results of a sensitivity analysis of return on assets used as the basis to estimate product line conversions. Appendix F estimates significant economic impacts assuming partial pass-through of compliance costs.

Chapter 2
Data Sources

This EIA employs data from many sources at differing levels of aggregation. The various sources used are described below.

The *Pesticide Formulating, Packaging, and Repackaging Facility Survey for 1988*, a survey of pesticide formulating, packaging, and repackaging (PFPR) facilities conducted under Section 308 of the Clean Water Act,[1] is the principal source of the facility-level data. EPA sent the questionnaire, requesting both technical and economic information, to a stratified sample of 707 facilities representing 3,241 facilities in the population. Part A of the Survey questionnaire requested the data necessary to perform the technical and treatment cost estimation analysis, including PAI-specific use for 1988. Part B of the Survey questionnaire requested detailed economic and financial data, including balance sheet and income statement information for 1986, 1987, and 1988. Three years of data were collected so that EPA could construct a "typical" year on which to base the impact analysis. A copy of Part B of the Survey is included as Appendix A. A copy of Part A of the Survey can be found in the Public Record. Throughout the remainder of this document, the term "Survey", if not further specified, will refer to Part B of the *Pesticide Formulating, Packaging, and Repackaging Facility Survey for 1988*.

Mandatory reporting of yearly pesticide production is required by the Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA) as part of the pesticide regulation process. Pesticide-producing establishments, including formulating, packaging, or repackaging facilities, are required to provide information to EPA on registered pesticide products, such as product registration numbers, product classification, type and use, and production rates. These data are submitted as part of the "Pesticide Report for Pesticide-Producing Establishments" (EPA Form 3540-16) and are stored in the FIFRA and TSCA (Toxic Substances Control Act) Enforcement System (FATES) database, which is administered by EPA's Office of Prevention, Pesticides and Toxic Substances (OPPTS). Accessing the OPPTS database gave the population data from which the stratified random sample of formulating, packaging, and repackaging facilities was drawn. The databases for the more recent years of 1988-1991 were also

[1]Federal Water Pollution Control Act, 33 U.S.C. 1318.

accessed to identify any changes in the composition of the industry and to evaluate the applicability of the proposed regulation.

The other major data input to the EIA was the estimated compliance costs of the regulation.[2] EPA initially considered compliance costs under five regulatory options: Option 1, a Treat and Discharge Option; Option 2, a Treat and Discharge with Pollution Prevention Option; Option 3, a Zero Discharge Based on Treatment and Reuse with Pollution Prevention Option; Option 4, a Zero Discharge Based on Pollution Prevention and Off-Site Incineration Option; and Option 5, a Zero Discharge Based on Off-Site Incineration Option. EPA concluded that Option 3 provided the best regulatory approach among these five options, but also found that it caused disproportionate impacts in certain small business-owned facilities. On the basis of distinct market, technical, and PAI-use characteristics of these facilities, EPA later defined and analyzed an additional regulatory option for sanitizer chemicals. This option, called Option 3/S, corresponds to Option 3 discussed above, but exempts physically separate, exterior-source wastewater that contains *only sanitizer chemicals* in facilities with less than 265,000 pounds per year of production involving sanitizer PAIs. In addition, EPA decided to extend the coverage of Option 3/S from the 272 PAIs originally studied for regulation to all PAIs (except sodium hypochlorite). This extended option, called Option 3/S′, is based on the same treatment and reuse with pollution prevention technology as Option 3/S.

Two categories of compliance costs associated with pesticide formulating, packaging, and repackaging were evaluated for each option: capital costs and operating and maintenance costs. All compliance cost estimates are presented in 1988 dollars, and are based on the assumption that whenever possible, facilities will build on existing treatment.

The Survey database and the compliance cost estimates provided the basis for all the impact analyses in this EIA, including impacts on facilities, small businesses, communities, foreign trade and new sources. EPA also used data from secondary sources in each of the chapters. The profile of the PFPR industry relied on various issues of *Industrial Outlook*, published by the International Trade Administration of the U.S. Department of Commerce, and the *Census of Manufactures* published by the Bureau of the Census within the Commerce Department. These documents provided aggregate industry

[2]Full details of the compliance cost estimates can be found in the Technical Development Document.

data. The profile also used aggregate import and export data from the United Nations' *International Trade Statistics Yearbook*. *Pesticide Industry Sales and Usage*, published by EPA's Office of Pesticides and Toxic Substances, provided market expenditures and global sales for pesticides.

The facility impact analysis used aggregate financial statistics from Robert Morris Associates' *Annual Statement Studies*, and interest rate data from the *Federal Reserve Bulletin* and Standard and Poor's *Price Index Record*. Historical inflation rates were obtained the *Statistical Abstract of the United States*, published by the Bureau of the Census. Estimated costs that facilities would have incurred after the Survey due to subsequent federal pollution control regulations were obtained from the respective rulemaking packages. These include Resource Conservation and Recovery Act (RCRA) land disposal restrictions (40 CFR 268), effluent limitations for the Organic Chemicals, Plastics and Synthetic Fibers (OCPSF) industry (40 CFR 414), and effluent limitations for the Pesticide Manufacturing Industry (40 CFR 455). In addition, facility-specific costs due to FIFRA maintenance fees were estimated.

Data from EPA's Office of Pesticide Programs (OPP) served as the basis for determining the substitutability among PAIs. In 1980, the OPP defined pesticide markets to ensure that EPA reviewed competing products on roughly the same schedule, so that one pesticide does not have an unfair advantage over another. The pesticide markets were defined as clusters of PAIs that are substitutes for a specific end use. This classification was adapted and used as the basis for defining pesticide markets in this EIA (see Appendix B).

The regulatory flexibility analysis of impacts on small businesses and the firm-level analysis required data from Dun and Bradstreet's *Million Dollar Directory* to calculate the number of employees at the firm level. The community impact analysis relied on population data from *1992 County and City Extra: Annual Metro, City and County Data Book*, published by Brennan Press, and the *1990 Census of Population and Housing*, published by the Bureau of the Census. In addition, to estimate the aggregate community-level employment impacts stemming from PFPR facility employment losses, EPA used industry-specific regional employment multipliers provided by the Bureau of Economic Analysis in the Department of Commerce. These multipliers are documented in *Regional Multipliers: A User Handbook for the Regional Input-Output Modeling System (RIMS II)*, Department of Commerce, 1992. The foreign trade analysis used import data from the OPP and data on the U.S. trade balance from the *International Trade Statistics Yearbook* and the *Statistical Abstract of the United States*.

The chapter on the economic benefits of pollution prevention used secondary price data from the *Annual Market Study* published by Doane Marketing Research, as well as from telephone interviews with pesticide manufacturers and data from the OPP. The OPP maintains PAI-specific price data from a number of proprietary sources. The OPP data were among those used to estimate PAI prices, which in turn were used to estimate the value of the PAIs recovered due to pollution prevention practices. Data from Ernst and Young's *National Water and Wastewater 1992 Rate Survey* were used to calculate savings due to the recycle/reuse of wastewater containing PAIs.

Data sources for the labor requirements analysis chapter include total labor contribution coefficients from the *direct requirements matrix* of the national input-output tables. These coefficients were used to estimate the labor required for manufacturing, installing, and operating the equipment needed to comply with the proposed PFPR regulation and are documented in *The 1982 Benchmark Input-Output Accounts of the United States*, U.S. Department of Commerce, 1991. The purchase price for compliance equipment, and the costs of equipment installation and operation were estimated by EPA project engineers. The labor requirements analysis also used a range of employment multipliers to estimate the aggregate labor requirements that might result from the manufacturing, installation, and operation of compliance equipment. These multipliers were obtained from several sources including internal EPA publications analyzing employment effects of pollution control outlays and a publication of the National Utility Contractors Association, *A Report on Clean Water Investment and Job Creation*, 1992.

Chapter 3
Profile of the Pesticides Formulating, Packaging, and Repackaging Industry

3.0 Introduction

This industry profile describes the services, products, facilities, and firms associated with the formulating, packaging, and repackaging of pesticide active ingredients (PAIs). It is intended to provide insight into industry's reaction to the proposed effluent guidelines through a discussion of historical and current market conditions and the structure and financial condition of the industry. In addition, information on employment, foreign trade, and facility size are provided to aid the reader in understanding the community, foreign trade, and small business impact analyses presented in subsequent chapters.

The six sections of this chapter focus on pesticide formulators, packagers, and repackagers (PFPR), but some of the information presented also pertains to manufacturers of PAIs. Section 3.1 provides an overview of the PFPR industry. Section 3.2 describes the PFPR industry structure and includes a discussion of pesticide markets and foreign trade. Market demand is discussed in Section 3.3. Section 3.4 evaluates the pesticide market years on which the analysis is based to broader market patterns. Section 3.5 presents an analysis of subgroups of PFPR facilities and Section 3.6 concludes with a summary of the information presented in the profile.

3.1 Industry Overview

Description of Pesticide Formulating, Packaging and Repackaging Activities

Classifications of Formulated Pesticide Products

The Federal Insecticide, Fungicide and Rodenticide Act (FIFRA) defines a pesticide as "(1) any substance or mixture of substances intended for preventing, destroying, repelling or mitigating any pest, (2) any substance or mixture of substances intended for use as a plant regulator, defoliant or desiccant." Section 2(t) of FIFRA defines a pest as "(1) any insect, rodent, nematode, fungus, weed, or (2) any other form of terrestrial or aquatic plant or animal life or virus, bacteria, or other microorganism (except viruses, bacteria, or other microorganisms on or in living man or other living animals) which the administrator declares to be a pest under Section 25(c)(1)."

Pesticides are most commonly categorized by the type of pest they treat, such as bacteria, fungi, rodents, weeds, or insects. The majority of domestic pesticide production falls into three classes: herbicides, insecticides, and fungicides. Herbicides are used to control, prevent, or eliminate weeds; insecticides are used to prevent or destroy insects; and fungicides are used to control or eliminate bacteria and fungi. These classifications, as well as some of the less common pesticide classifications, are listed in Table 3.1. Herbicides sales dominated sales of any other pesticide type in U.S. markets as well as worldwide in 1988, with sales comprising 56 percent of the U.S. pesticide market and 42 percent of the world pesticide market. Insecticides ranked second, comprising 24 percent of the U.S. pesticide market and 33 percent of the world pesticide market. Fungicides ranked third in sales in both the U.S. and world pesticide markets, with sales percentages of 12 percent and 19 percent, respectively. Each of these major pesticide classifications was produced and consumed more heavily than all the smaller pesticide product groups combined (see Figure 3.1).[1]

In 1980, EPA's Office of Pesticide Programs (OPP) classified pesticides further into cluster groups based on their major use to ensure that EPA regulated competing pesticides on roughly the same schedule. Six hundred pesticides were classified into 48 clusters according to the major use of the active ingredients. For instance, all herbicides used on corn production were classified into the same cluster. Each cluster therefore contains pesticides that may be roughly substituted for one another in major end use activities.

The Office of Water's *Economic Impact Analysis of Final Effluent Limitations Guidelines and Standards for the Pesticide Manufacturing Industry* classified PAIs as belonging to one or more of these clusters.[2] The Office of Water used OPP's cluster segmentation to define individual markets for groups of pesticides because economic variables, such as demand elasticity, would not be meaningful for a market defined as all pesticides. The Office of Water expanded upon OPP's cluster segmentation in three ways. First, PAIs registered after 1980 were assigned to one of the 48 clusters. Second, the 48 clusters were expanded to 57 clusters, based upon differences in the sensitivity of product demand to changes in

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[1] *Pesticide Industry Sales and Usage: 1988 Market Estimates*, U.S. EPA, Office of Pesticides and Toxic Substances, February 1988.

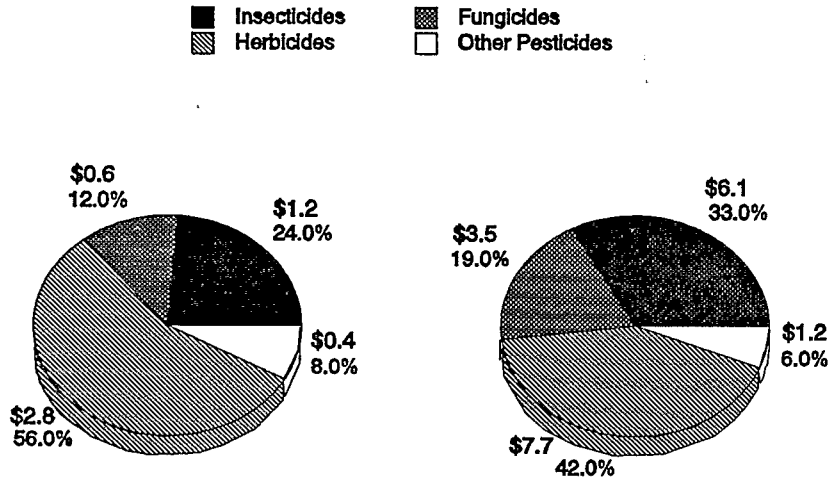
[2] U.S. Environmental Protection Agency, *Economic Impact Analysis of Final Effluent Limitations Guidelines and Standards for the Pesticide Manufacturing Industry*, September 1993.

Table 3.1
Representative Classes of Pesticides and the Pests They Control

Class	Target Pest
Acaricide	Mites, ticks
Algicide	Algae
Attractant	Insects, birds, other animals
Avicide	Birds
Bactericide	Bacteria
Defoliant	Unwanted plant leaves
Dessicant	Unwanted plant tops
Fungicide	Fungi
Growth regulator	Insect and plant growth
Herbicide	Weeds
Industrial Microbiocide	Microorganisms
Insecticide	Insects
Miticide	Mites
Molluscicide	Snails, slugs
Nematicide	Nematodes
Piscicide	Fish
Predacide	Carnivorous animals
Repellents	Insects, birds, other animals
Rodenticide	Rodents
Silvicide	Trees and woody vegetation
Slimicide	Slime molds
Sterliants	Insects, other animals

Source: Minnesota Department of Agriculture, *Rinse and Win Brochure*, 1989.

Figure 3.1
1988 Pesticide Sales in the U.S. and World Markets



U.S. Market (In $ Billions) Total = $4.9 Billion World Market (In $ Billions) Total = $18.5 Billion

Source: *Pesticides Industry Sales and Usage, 1988 Market Estimates,* U.S. EPA, Office of Pesticide Programs, December, 1989

price (see Table 3.2).[3] In addition, although OPP's cluster segmentation assigned each PAI to only one cluster, the Office of Water allowed for a PAI to be assigned to more than one cluster if it had more than one important use.

The data sources for this chapter use assorted classifications in reporting on the PFPR industry. Bureau of the Census data for the PFPR industry fall in two standard industrial classification (SIC) codes: 1) SIC 2879, establishments engaged primarily in the manufacture or formulation of agricultural chemicals not elsewhere classified, and the formulation and preparation of pesticides and 2) SIC 5191, establishments engaged primarily in the distribution of animal feeds, fertilizers, agricultural chemicals,

[3] Clusters were split when (1) there was a wide variety of price elasticities of demand among PAIs within a cluster, and (2) the PAIs among which demand elasticity varied had distinctive uses. For example, the cluster that encompasses herbicides used on fruit trees was split into three clusters: herbicides used on grapes, herbicides used on oranges, and herbicides used on fruit trees (excluding grapes and oranges). See Appendix C of the *Economic Impact Analysis of Final Effluent Limitations Guidelines and Standards for the Pesticide Manufacturing Industry* for further details. Also, one cluster was split since the Pesticide Manufacturing Effluent Limitation Guidelines were promulgated (for a total of 57 clusters) to distinguish the distinct uses of sporicidal vs. non-sporicidal disinfectants.

Table 3.2
Pesticide Clusters

Cluster	Primary Application
	Herbicides used on:
H-1	Broad spectrum of uses
H-2	Corn
H-3	Soybeans, cotton, peanuts, alfalfa
H-4	Sorghum, rice, & small grains
H-5a	Oranges
H-5b	Grapes
H-5c	Fruit trees
H-6	Sugarbeets, beans & peas
H-7	Drainage ditches, rights of way, forestry & ponds
H-8	Turf
H-9a	Vegetables
H-9b	Tobacco
H-10	Unclassified uses
	Insecticides used on/for/as:
I-1a	Cotton
I-1b	Soybeans, peanuts, wheat & tobacco
I-2a	Corn & alfalfa
I-2b	Sorghum
I-3	Fruit, & nut trees, excluding oranges & grapes
I-4a	Oranges
I-4b	Grapes
I-5	Vegetables
I-6	Livestock & domestic animals
I-7	Non-agricultural sites (as repellent)
I-8	Domestic bug control & for food processing plants
I-9	As fumigants & nematicides
I-10	Termite control
I-11	Lawns, ornamentals, & forest trees
I-12	Mosquito larva
I-13	Unclassified uses

Cluster	Primary Application
	Fungicides used on:
F-1	Broad spectrum of uses
F-2a	Fruits & nuts
F-2b	Grapes
F-3	Vegetables
F-4	Oranges
F-5	Seed treatments
F-6	Post-harvest fruit & vegetables
F-7	Grain storage
F-8	Ornamentals
F-9	Turf
F-10	Unclassified uses
	Other Pesticides:
R-1	Industrial preservatives
R-2	Slimicides used in pulp & paper, cooling towers,
R-3	Industrial microbiocides
R-4	Sanitizers used in dairies, food processing,
R-5	Synergists used as insecticide synergists,
R-6	Food preservatives
R-7	Wood preservatives, used for industrial,
R-8a	Sporicidal Disinfectants
R-8b	Non-Sporicidal Disinfectants
R-9	Water disinfectants
R-10	Plant regulators, defoliants, & desiccants
R-11	Preservatives, disinfectants, slimicides
R-12	Molluscides & misc. vertebrate control agents
R-13	Bird chemosterilants, toxicants, & repellants
R-14	Dog &/or cat repellants
R-15	Rodent toxicants, anticoagulants, predator control
U-1	Unclassified uses

pesticides, seeds and other farm supplies, except grains.[4] The *U.N. International Trade Statistics Yearbook* classifies pesticides into disinfectants, insecticides, fungicides, and herbicides for retail sale as either preparations or PAIs. The profile also relies on data from the *U.S. EPA Formulating, Packaging, and Repackaging Survey for 1988* (See Chapter 2). Data from this survey were aggregated to prevent disclosure of confidential business information. For ease of reading, this chapter reports Survey data extrapolated to the entire PFPR population and does not report data for the sample.

Overview of the Services and Products Provided by the Industry

The pesticide industry is vertically integrated into two major segments: pesticide manufacturing and PFPR. Pesticide manufacturers produce PAIs. The PAIs are not directly used in pest control; instead they are combined with solid, liquid and/or gaseous diluents through the process of formulating. The PFPR Survey defines formulation as the process of "mixing, blending, or diluting one or more active ingredients with one or more other pesticide active or inert ingredients, without a chemical reaction that converts one active ingredient to another active ingredient, to obtain a manufacturing use product or an end use product." Packagers prepare pesticide formulations for distribution by packaging the product in plastic, glass, paperboard, or metal containers. Repackagers transfer pesticide products or PAIs, usually from large tanks to smaller containers for use in consumer markets. In the PFPR Survey, packaging is defined as "enclosing or placing formulated pesticide active ingredients into marketable containers," while repackaging is defined as "the direct transference of a single pesticide active ingredient or single formulation from any marketable container to another marketable container without intentionally mixing in any inert, diluents, solvents, or other active ingredients, or other material of any sort." Thus, PFPR involves the conversion of PAIs into easy-to-use products at weaker concentrations packaged for the distributor and/or end user.

Marketable pesticide products are available in solvent-based formulations, water-based formulations, and solid-based formulations. Solvent- and water-based products are applied directly as a liquid or as an aerosol. These wet formulations can take the form of suspensions or emulsions. Solid-based formulations encompass many types of pesticide products. Some are prepared by blending solid active ingredients with inert solids such as clay and sand. Other solid-based pesticide formulations have

[4] SIC 5191 captures the majority of the facilities that are engaged exclusively in the repackaging of pesticide products into refillable containers for agricultural use and, therefore, is used in conjunction with SIC 2879 to define the PFPR industry throughout this profile.

liquid active ingredients absorbed by dry carrier materials. These dry pesticide products can include a wide variety of powders, dusts, granules, and pellets. The chemical nature of the PAI, in part, dictates whether a formulation will be wet or dry. Active ingredients that are not soluble in water or solvents require dry formulations. In addition, consumer preferences can dictate whether pesticide formulations are wet or dry when applied.

Overview of PFPR Production Processes

The PFPR production processes involve the dilution of the highly concentrated PAIs for packaging, potential repackaging, and eventual distribution. Pesticide formulation entails the blending of PAIs with a variety of substances, but does not include processes in which chemical reactions or separations occur. Formulators combine PAIs with inert diluents, inorganic carriers, stabilizers, emulsifiers, aerosol propellants, wetting agents and other pesticide formulations. In addition, formulating operations can include particle size reduction, such as milling and coating processes for granule and treated seed production.

The apparatus used in pesticide formulation is conventional blending equipment. Liquid formulations require tanks equipped with mixers, and solid formulations need blending mills. Secondary equipment includes pumps, hoppers, conveyers, storage tanks, and rotary kilns for curing solid formulations. Solids blending mill capacities vary from several hundred pounds to three tons. Mixing tank capacity for liquid formulations varies from less than 100 gallons to several thousand gallons.[5]

Pesticide packaging generally occurs at the same facility where formulating is conducted. Combining these activities at one location enables facilities to avoid the cost associated with transporting the high volume, dilute formulations. Packaging typically consists of pouring liquid formulations into 55-gallon drums, glass bottles, pails, or other containers for shipping. Solid formulations are usually gravity-collected from hoppers into drums or paper bags for distribution.

Repackaging of pesticides involves transferring formulations from storage tanks to smaller containers for consumer use. Repackagers typically use a bulk storage tank to hold the pesticide

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[5] *Guides to Pollution Prevention: The Pesticide Formulating Industry*, U.S. EPA, Risk Reduction Engineering Laboratory and Center for Environmental Research Information, February 1990.

formulations in inventory. The formulations are moved to "mini-bulk" containers used to transport the product to farmers' fields. The repackaging production process is relatively simple compared to the formulating and packaging segments of the pesticide industry. This fact is reflected by the average market value of production lines for repackaging facilities — about $3,836 — compared to the average market value of production lines for the remainder of the industry — about $197,666.[6]

Regulatory Overview

The Pesticide Formulating, Packaging and Repackaging (PFPR) industry is regulated directly by the Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA), amended in 1988. Other media- or information-based regulations also subject the industry to environmental requirements (e.g. under CERCLA, EPCRA, RCRA, CWA, and CAA).[7]

FIFRA requires all pesticides to be labeled and registered with EPA before they are offered to consumer markets. EPA assigns to each pesticide product a registration number that must appear on the label along with the pesticide active ingredients (PAIs). FIFRA's registration standards are based on avoiding "unreasonable risk" to humans and the environment, taking into account economic, social, and environmental costs and benefits. EPA can refuse to register products that pose a potentially high risk for humans and the environment; it must also approve any changes in the formulation or labeling of a pesticide product.

Reauthorization of FIFRA in 1988 assessed registration maintenance fees for the PFPR industry as well as a one-time reregistration fee for the producers of pesticide active ingredients (PAIs). Annual registration maintenance fees are levied for each individual pesticide product. Each PFPR registrant pays

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[6] Source: U.S. EPA Formulating, Packaging, and Repackaging Survey. The PFPR Survey defines a product line as, "Equipment and interconnecting piping or hoses arranged in a specific sequence to mix, blend, impregnate, or package, or repackage pesticide products. These products contain one or more pesticide active ingredients with other materials to impart specific desirable physical properties for a product or device, or to achieve a desired pesticide active ingredient concentration for a particular product or device, or to package it into marketable containers. The line begins with the opening of shipping containers or the transfer of active ingredient(s) and other materials from a manufacturer or another formulator/packager, or from inventory of bulk storage. The line ends with the packaging or repackaging of a product into marketable containers or into tanks for application."

[7] CERCLA = Comprehensive Environmental Response Compensation and Liability Act; EPCRA = Emergency Planning and Community Right-To-Know Act; RCRA = Resource Conservation and Recovery Act; CWA = Clean Water Act; and CAA = Clean Air Act.

$650 for the first registered pesticide product and $1,300 for every additional product.[8] The maximum limit of maintenance fees for a registrant is $55,000 for the first 50 pesticide products and $95,000 for any number of product registrations.[9,10]

Reregistration fees are a one-time payment for pesticide manufacturers with PAIs that were registered before 1984. The fee is charged on a per PAI basis and may range from $50,000 to $150,000. Reregistration fees are apportioned among producers of each PAI, based on market share.[11]

The Best Practicable Technology (BPT) effluent limitation regulations, authorized under the Clean Water Act, are also of particular relevance to this EIA. BPT standards, established by EPA, are generally based on the average of the best existing performance by facilities in a regulatory category or sub-category that discharge pollutants from a point source to navigable waters. BPT regulations have been promulgated for three segments of the pesticides industry: organic pesticide manufacturers, metallo-organic pesticide manufacturers, and PFPR. EPA considers the following when deriving BPT effluent limitation guidelines: the costs and benefits of effluent reductions, the age of equipment and facilities involved, the process changes required, the processes utilized, engineering aspects of the control technologies, non-water quality environmental impacts, and other factors the EPA Administrator deems appropriate. Under BPT regulations for the PFPR industry, established in 1978, discharge of process wastewater pollutants from PFPR operations is prohibited.

States also have the authority to regulate pesticide products. Most state governments have statutes that regulate pesticides in professional, household, and agricultural markets. Many states have adopted

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[8] U.S. Environmental Protection Agency, Office of Pesticide Programs, *Instructions to Registrants for Filing 1993 Pesticide Registration Maintenance Fees*, 1992.

[9] A "small business" registrant may pay reduced fees under FIFRA. A small business is defined by the Office of Pesticide Programs as any company with 150 or fewer employees and average annual chemical sales of $40 million or less over the three-year period prior to registration. The maximum limits on registration maintenance fees for small businesses is $38,500 for the first 50 products, and $66,500 for any number of products.

[10] Annual maintenance fees may be paid indirectly by organizations other than the pesticide registrant. For example, a trade association which relies on a particular pesticide may voluntarily pay the maintenance fee for that pesticide.

[11] U.S. Environmental Protection Agency, Office of Pesticides Toxic Substances, *Highlights of the 1988 Pesticide Law - The Federal Insecticide, Fungicide, and Rodenticide Act Amendments of 1988*, December, 1988.

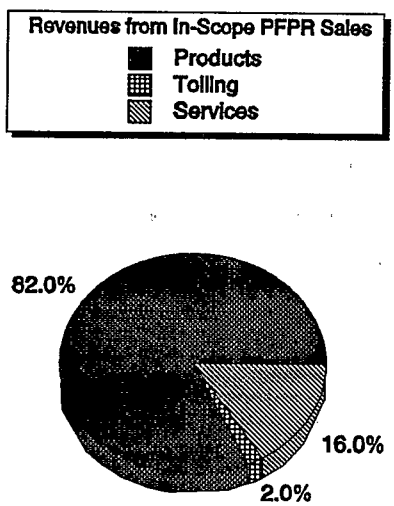
the Uniform State Insecticide, Fungicide, and Rodenticide Act, which requires the registration of pesticides, proper labeling, and penalties for tampering and false branding. Many states also have regulations that set standards for handling, treating, and disposing hazardous substances and wastes, which may impose additional costs on the industry.

3.2 Industry Structure

Markets for Industry Products and Services

The PFPR industry serves its markets by offering both products and services to consumers (see Figure 3.2)[12]. Pesticide products can be classified into three principal markets: agriculture, industrial/institutional/commercial, and home/lawn/garden. Services provided by the PFPR industry include pesticide distribution and application. Additional information on pesticide products and services is provided below.

Figure 3.2
National Estimates of Composition of Facility 272 PAI-Related Revenues
Averaged Across All Facilities (Avg. 1986-1988)



Note: Includes Water Users
Source: Survey

[12]Tolling, or contract work performed for other facilities, may include both products and services.

Pesticide Products

The Survey data show that in 1988 the agricultural market was the largest segment of the industry with an estimated 67 percent of 272 PAI-related pesticide sales nationwide (see Figure 3.3). The home, lawn and garden market comprised the second largest segment of the industry (estimated at 11 percent), followed by the industrial/institutional/commercial market (estimated at 7 percent, 5 percent of which is attributable to the institutional/commercial market, and 2 percent to the industrial market).[13] These three major markets are discussed below.

The agricultural market is diverse in terms of the types and amounts of pesticides used and in pesticide management practices, which vary significantly among regions of the country, states, and sometimes counties. This diversity is an important distinction that separates the agricultural market from the other pesticide markets, which tend to be more homogeneous nationwide. Approximately 62 percent of all agricultural acres are treated with at least one type of pesticide product.[14] Herbicides are used in greater quantities in the agricultural market than any other type of pesticide. In 1989, the herbicides that were used in greatest quantities were Alachlor, Atrazine, and 2,4-D.[15] These pesticides were used primarily on peanuts, corn, soybeans, cotton, and rice. Insecticides were the second most heavily used type of pesticides. In 1989, the insecticides used in greatest quantities were Carbaryl and Terbufos.[16] These pesticides were used primarily on cotton, fruits, vegetables, wheat, and ornamentals. Fungicides are applied to fewer acres than herbicides or insecticides, but are generally applied to high-value fruit and vegetables. In 1989, Maneb was used in the largest quantity among fungicides.[17]

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[13] U.S. Environmental Protection Agency, *U.S. Environmental Protection Agency Pesticide Formulating, Packaging, and Repackaging Facility Survey for 1988.*

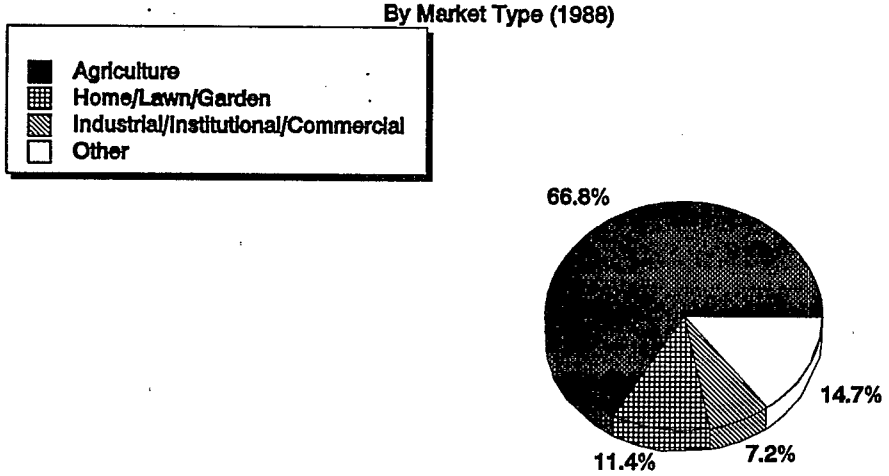
[14] Pimental, D., et al. (1986). Environmental and Economic Impacts of Reducing U.S. Agricultural Pesticide Use. *Pest Management in Agriculture.* CRC Press.

[15] U.S. EPA (1989). *Pesticide Industry Sales and Usage: 1989 Market Estimates.* Office of Pesticides and Toxic Substances, December.

[16] Ibid.

[17] Ibid.

Figure 3.3
National Estimates of Distribution of 272 PAI-Related PFPR Revenue
By Market Type (1988)



Note: Includes both Water-Users and Non-Water Users
Source: Survey

Table 3.3 provides a brief description of the steps taken to move an agricultural PAI through process and distribution channels and then to the end user. The end users may include farmers, government, and commercial applicators. Farmers either purchase and apply pesticide products themselves or pay commercial applicators to apply pesticides to their crops. The government uses agricultural chemicals to control vegetation around highways, roads, railroads, waterways, pipelines, power lines, government buildings, military complexes, and parking lots.

The home/lawn/garden pesticide market includes pesticide products that are commonly used in and around the home. These products include rodenticides, insect repellents, lawn and garden pesticides, disinfectants and other pesticidal cleaners, insecticides to protect pets and eliminate household pests, herbicides, fertilizers with herbicides/insecticides, and insect baits and traps. In general, household pesticides are packaged in containers that are smaller than those used in the other markets and may also be less concentrated. Some household pesticides are seasonal (e.g., lawn and garden products), while others meet a demand that remains fairly constant throughout the year.

Table 3.3
Pesticide Agricultural Production and Distribution[1]

Agent	Purpose
Registrant	Registers the pesticide formulation with EPA. Registration involves a long, expensive R&D process to develop the pesticide, produce the data required for registration, and proceed through the registration process.
Manufacturer	Synthesizes the active ingredient from raw materials.
Formulator/Packager	Produces the pesticide formulation by combining the active ingredient(s) with other substances, including surfactants, clays, powders and solvents; involves mixing or blending operations. Formulation may be done in-house, by independent formulators, or by tollers who formulate the product under contract to the manufacturer.
Distributor	Acts as the "middle man;" buys pesticide from the registrant/manufacturer/formulator and sells to the dealer.
Dealer/Co-op/Repackager	Sells the pesticide to the user.[2]

[1] In many cases several steps are performed by one entity. Large companies might register, manufacture, and formulate their pesticides. Some distributors also formulate several pesticides. Additionally, a single facility might function as a distributor, dealer, and commercial applicator.

[2] A user is defined as a farmer, government, commercial ground applicator, commercial aerial applicator, or home lawn and garden consumer.

Source: Based on a table in: *Pesticide Containers: A Report to Congress*, U.S. EPA, Office of Pesticide Programs, May, 1992.

The main difference between the household market and the other markets is that the end user, the household consumer, purchases household pesticides from a wide variety of common retail establishments (see Figure 3.4). These include grocery, drug, and discount stores, as well as home and garden shops and pet supply companies. The producer of household pesticide products can sell directly to the retail stores or indirectly through a distributor warehouse. Consumer companies, another distribution channel from manufacturers to retail stores, make consumer products, applying their label to the finished good. Like formulators, consumer companies can sell directly to retail establishments or indirectly through food brokers who distribute products to retail stores.

The industrial/institutional/commercial market (I/I/C) includes many products, such as disinfectants, cleaning supplies, and air conditioning biocides, that are generally not perceived as pesticides by the public. In addition, products such as paint and wood preservatives may contain substantial amounts of pesticides. The I/I/C market is estimated to exceed $200 million annually, with approximately 45 percent involving health care institutions.[18]

The I/I/C market differs significantly from the agricultural market in many ways. First, the use of I/I/C products is generally more uniform across the country. Disinfectant uses in various parts of the United States are approximately the same. (Although the use of pesticides for wood preservation and in cooling towers varies somewhat according to the climate.)[19] Also, I/I/C pesticides are generally packaged in smaller quantities than agricultural chemicals. In addition, I/I/C products tend to be less concentrated and therefore less expensive per unit volume of product than agricultural pesticides.

Another major difference between I/I/C and agricultural markets is that fewer manufacturers of pesticides used in the I/I/C market both register and formulate their pesticides; independent formulators/packagers are more predominant in the I/I/C market. In addition, a greater variety of paths exist between the formulators and end users. (See Figure 3.4, which illustrates the distribution channels within the I/I/C and home/lawn/garden markets.)

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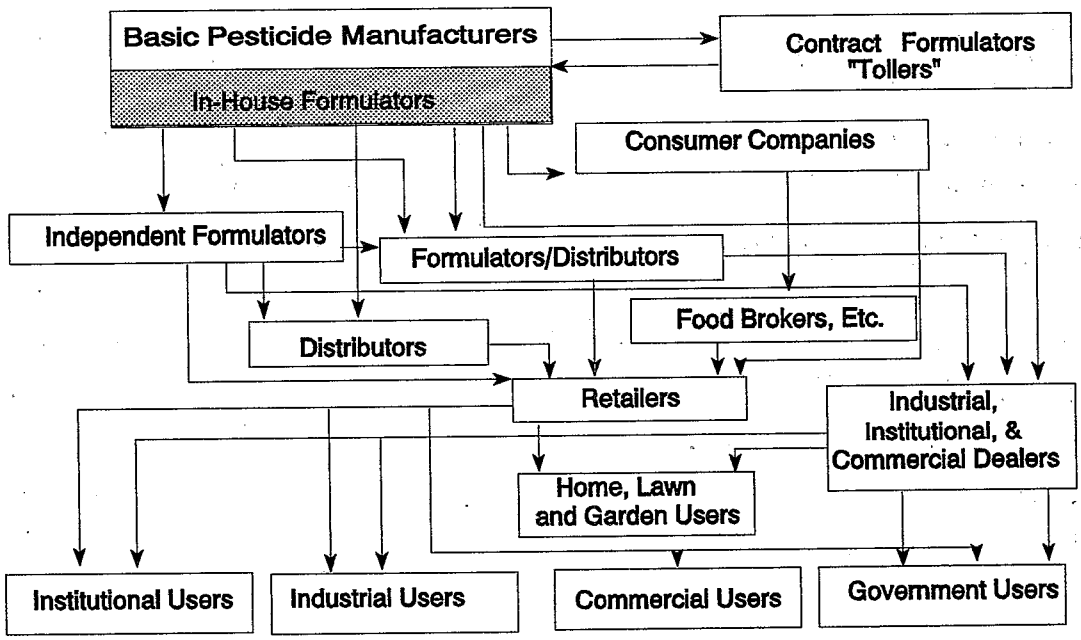
[18] U.S. EPA (1992). *Pesticide Container Report to Congress, Draft.* Office of Pesticides and Toxic Substances, March.

[19] Ibid.

Figure 3.4
Production and Distribution Channels
Industrial/Institutional/Commercial and
Home/Lawn/Garden Markets



Source: Based on a diagram in *Pesticide Containers: A Report to Congress*, U.S. EPA, Office of Pesticide Programs, May, 1992.

The distinction between the industrial and institutional/commercial pesticides is based on the setting in which the pesticide is used. In some cases, the same formulation is used in different types of facilities. Industrial pesticides, such as preservatives, slimicides, or biocides, are typically used in cooling towers, paper and textile mills, oil wells, metalworking facilities, food processing facilities, etc.[20] Typical institutional/commercial end-users include personnel in hospitals, nursing homes, schools, restaurants, hotels, and contract cleaning businesses that serve stores, apartment houses, office

[20] Ibid.

buildings, and garages.[21] Commercial establishments also use pesticides to protect landscaping and to maintain cleanliness and health standards. The federal, state and local governments use I/I/C chemicals on military bases, in hospitals and in other government buildings.

Producers of pesticides used in institutional settings may sell directly to large users (e.g., hospitals), or they may use distributors such as at janitorial supply houses to sell indirectly to smaller users. Institutional distributors usually sell general maintenance products (e.g., cleaning supplies and non-pesticide cleaners, as well as sanitizers and disinfectants). Similarly, producers of industrial and commercial pesticides may sell directly to the end-user or indirectly through a warehouse.[22]

Sanitizers are typically used in the I/I/C market as cleaners, disinfectants, degreasers, and laundry detergents. Many sanitizer products, such as air fresheners and laundry detergents, are sold in low-concentrated formulas to the end-user, who are commonly cleaning services or in-house janitorial/housekeeping staff. The end-user may receive sanitizers directly from the formulator or indirectly from a warehouse.[23]

Pesticide Services

Much of the pesticide application for the three major markets is performed by commercial applicators. Commercial applicators are trained professionals skilled in applying pesticides in an efficient and environmentally safe manner. The National Pest Control Association estimated that in 1990, the commercial applicator industry included 14,250 firms with annual billings of $3.5 billion.[24]

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[21] U.S. EPA, International Sanitary Supply Association, Research Triangle Institute (1989). Meeting Summary. Research Triangle Institute, July.

[22] U.S. EPA, and Mitre Corporation (1983). *The Supply and Use Patterns of Disinfectants and Sanitizers at Selected Sites.* January.

[23] *Shipments of Soaps and Detergents to Rise 3.2% Through 1988, Says U.S. Report,* Soap/Cosmetic/Chemical Specialties for January, 1984, pp.30-34.

[24] National Pest Control Association, Inc. (1991). *Fact Sheet.*

Commercial applicators are contracted by the agricultural industry to apply pesticides to agricultural crops, as well as to food products during storage and transit. In addition to repackaging and distributing pesticide products for the agricultural market, refilling establishments frequently provide application services to farmers. Many refilling establishment dealers will blend pesticide formulations with fertilized water for application to farmers' crops.[25]

In 1985, about 60 percent of the services of the non-agricultural commercial applicator industry were conducted at residences.[26] Household consumers use commercial applicators to manage pests that typically inhabit dwellings, such as termites, cockroaches, and mice, and to rid their lawn and garden of pests. In 1985, 25 percent of the services of the non-agricultural commercial applicator industry were conducted at commercial settings, with 7, 6, and 2 percent of services conducted at institutional, industrial, and government settings, respectively.[27] The I/I/C sectors use the services of commercial applicators to control pests in many settings, including schools, health care facilities, prisons, food processing establishments, hotels, restaurants, factories, warehouses, and military sites. Government entities use the services of commercial applicators to control mosquitos, and to maintain vegetation around roads, and public recreational areas.

Industry Employment

The formulating, packaging, and repackaging of 272 PAIs supported more than 5,000 production workers in 1988, as illustrated in Table 3.4 (national estimates based on Survey data).[28] Facilities with more than $50 million in revenues, while accounting for only an estimated six percent of the number of facilities, employed an estimated 45 percent of the total 272-PAI PFPR production workers. In contrast, facilities with less than $1 million in revenue constituted an estimated 26 percent of the number of facilities but only an estimated three percent of the 272-PAI PFPR production workers in the industry. Table 3.4 provides evidence that PFPR facilities are diversified, with over 80 percent of the production

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[25] Ibid.

[26] Ibid.

[27] Kline & Company, Inc. (1986). PCO Industry Thrives; Hits $2.5 Billion Mark. *Pest Control Technology*, December.

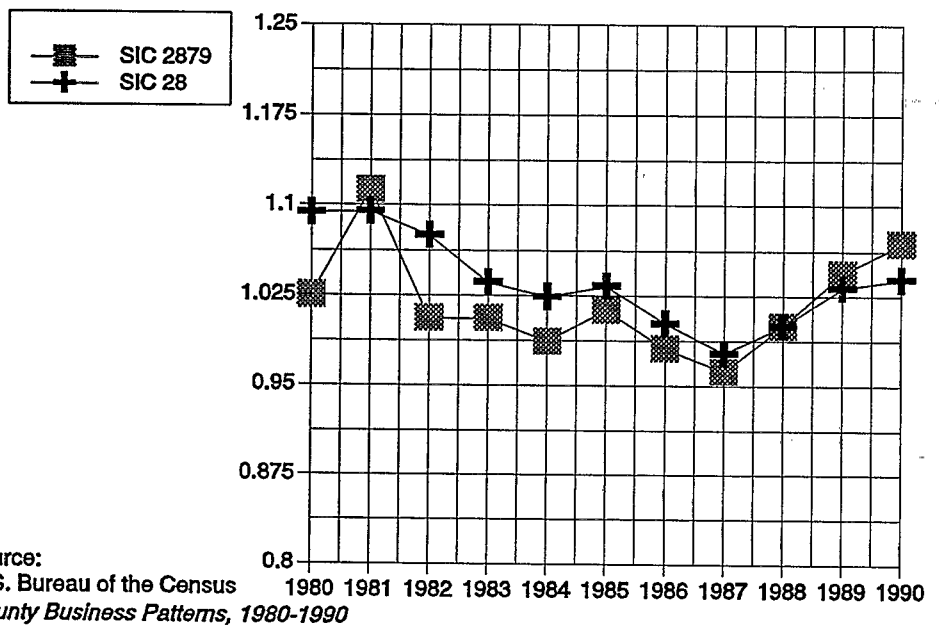
[28] Employment figures are presented in terms of full time equivalents (FTEs). FTEs are calculated by dividing facility annual hours by 2,000.

workers involved in activities other than 272-PAI PFPR in 1988. Production diversity in the PFPR industry is roughly consistent across all facility sizes.

The average number of employees per PFPR facility varies greatly across facility sizes (See Table 3.5). In 1988, facilities with revenues of $50 million or more had an average of 293 total FTEs with 21 PFPR production workers for the 272 PAIs originally considered for this rule (henceforth 272 PAI-related). Facilities with revenues of less than $1 million averaged only eight total FTEs and less than one FTE for 272 PAI-related PFPR production.

Figures 3.5a and 3.5b plot employment trends from 1980 to 1990, for SIC 28 (chemicals and allied products) and SIC 51 (non-durable goods wholesalers) against employment levels for the more specialized industrial categories of SIC 2879 (agricultural chemicals, not elsewhere classified [n.e.c.], and pesticide preparations and formulations), and SIC 5191 (farm supply wholesalers). The employment trends of SIC 28 and SIC 2879 show a fairly close correlation. Employment in SIC 5191, however, did not follow employment trends for the broader industry of SIC 51. SIC 5191 showed a decline in employment from 1980 to 1990 while employment levels for SIC 51 increased over 20 percent during the same time period.

Figure 3.5a
Employment Trends 1980-1990
(1988 Base Year)



Source:
U.S. Bureau of the Census
County Business Patterns, 1980-1990

Table 3.4
Total Facility Employment Characteristics[3]
by Facility Size
(1988 Full-Time Equivalents)

Size of Facility	Number of Population Facilities	% of Total	PFPR Total Revenues (In $ Millions)	% of Total	Total Employment	% of Total	272-related PFPR Production Employment	% of Total	Other Production Employment[1]	% of Total	Non-Production Employment	% of Total
Revs. of $50M and greater	114	6%	4,303.0	79%	33,435	48%	2,340	45%	18,895	52%	12,199	43%
Revs. of $10M to $49.9M	261	15%	682.2	13%	16,199	23%	1,003	20%	8,516	23%	6,679	23%
Revs. of $1M to $9.9M	947	53%	436.7	8%	16,793	24%	1,656	32%	7,165	20%	7,972	28%
Revs. less than $1M	473	26%	31.4	1%	3,733	5%	144	3%	1,856	5%	1,732	6%
Total[2]	1,794	100%	5,453.3	100%	70,159	100%	5,144	100%	36,433	100%	28,583	100%

[1] Other Production Employment includes production workers involved in the manufacturing of PAIs.
[2] The sum of the column may not equal the total due to rounding.
[3] Includes water users.
Source: Survey.

Table 3.5
Average Facility Employment Characteristics[1]
by Facility Size
(1988 Full-Time Equivalents)

Size of Facility	Average PFPR Revenues (In $ Thousands)	Average Total Employment	272 PAI-Related PFPR Production Employment	Average Other Production Employment	Average Non-Production Employment
Revs. of $50M and greater	37,750.7	293	21	166	107
Revs. of $10M to $49.9 M	2,617.0	62	4	33	26
Revs. of $1M to $9.9M	460.9	18	2	8	8
Revs less than $1M	66.5	8	<1	4	4
Average for all facilities	3,038.6	39	3	20	16

Source: Survey.
[1]Includes water users.

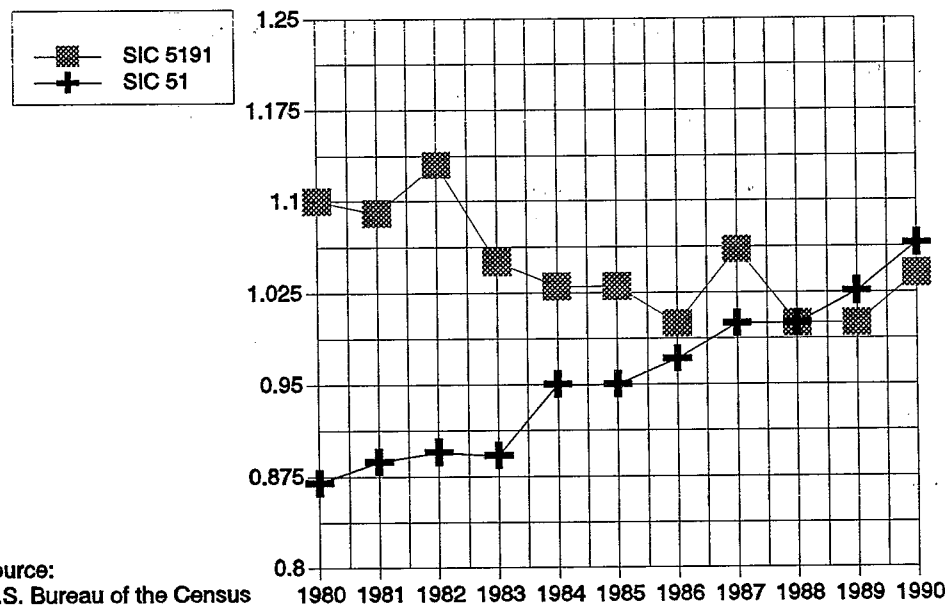
U.S. Trade in International Pesticides Markets

The U.S. pesticide industry participates substantially in the international market for pesticides, including both PAIs and final pesticide products. The volume of international trade in pesticides was approximately $6 billion in 1988 ($1988). Of that amount, the U.S. pesticide industry accounted for over 24 percent of total exports ($1,554 million) and more than 10 percent of total imports ($614 million). Over the ten-year period 1980-1990, domestic exports consistently exceeded imports, contributing a positive trade balance to the U.S. economy averaging over $950 million (See Table 3.6).[29]

Both domestic exports and imports have varied over the past ten years. Imports, however, have shown greater variation, ranging from a low of $187 million in 1989 to a high of $614 million in 1988,

[29] *International Trade Statistics Yearbook*, United Nations, Statistical Office, 1989.

Figure 3.5b
Employment Trends 1980-1990
(1988 Base Year)



Source:
U.S. Bureau of the Census
County Business Patterns, 1980-1990

a range of variation of over 200 percent. Over the same period, domestic exports varied from a low of $1,036 million in 1989 to a high of $1,554 billion in 1988, a range of variation of about 50 percent.

The U.S. industry's participation in the international market for pesticides includes both inter- and intra-company sales and purchases. In particular, a number of firms that manufacture and process PAIs and final pesticide products are multi-national firms with operations in both the United States and other countries. In addition, these multi-national firms include both U.S. and foreign-owned firms. Some amount of the international trade in PAIs and final products involves *intra-firm, trans-national boundary* transfers within the multi-national firms.

3.3 Market Demand and Consumption

Consumption of Pesticide Products — Historical and Current

Consistent with pesticide production data, user expenditures for pesticides are greatest in the agricultural market — about $5.2 billion in 1991 (1988$). The Industrial, Commercial, and Government

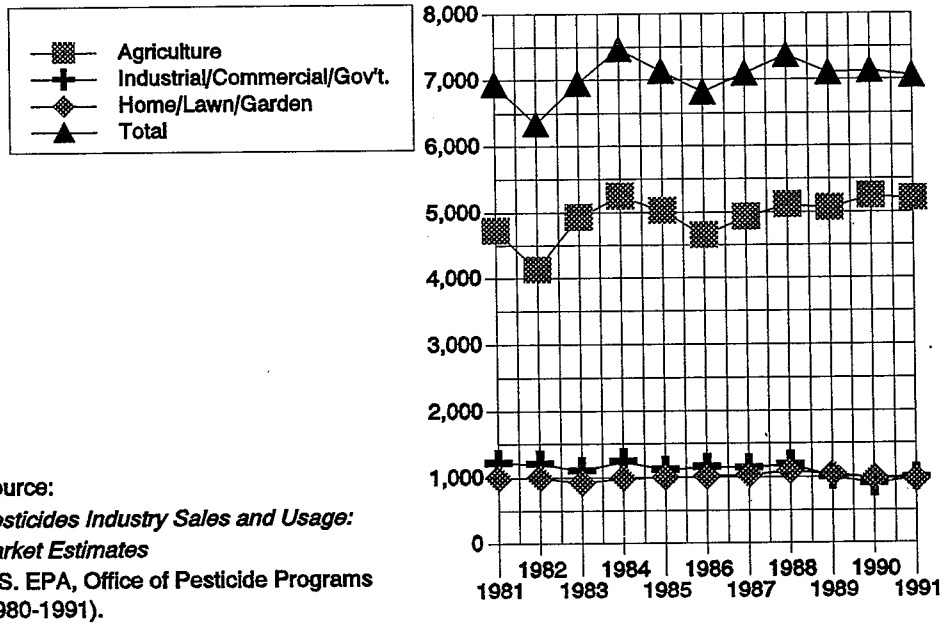
Table 3.6
U.S. Participation in International Markets for Pesticides
Exports, Imports, Trade Balance, and U.S. Share of Total Exports and Imports
(all dollar values in thousands of 1988 dollars)

Year	U.S. Exports	U.S. Share Total Exports	U.S. Imports	U.S. Share Total Imports	U.S. Trade Balance
1980	1,444,467		369,795		1,074,672
1981	1,284,050	26.6%	348,732	9.0%	935,318
1982	1,211,135	27.7%	297,492	8.3%	913,643
1983	1,243,280	27.8%	287,637	7.6%	955,643
1984	1,499,545	29.2%	356,729	8.3%	1,142,816
1985	1,354,907	26.8%	455,252	11.0%	899,655
1986	1,366,117	25.6%	423,276	8.6%	942,841
1987	1,405,878	23.2%	446,536	8.2%	959,342
1988	1,554,136	24.1%	613,752	10.3%	940,384
1989	1,043,371	18.2%	186,594	3.4%	856,777
1990	1,036,597	16.4%	195,209	3.2%	841,388
Average	1,313,044	24.6%	361,909	7.8%	951,134

markets combined (I/C/G)[30] attracted nearly $1 billion in expenditures in 1991 (1988$) as did the H/L/G market (see Figure 3.6 and Table 3.7). Total user expenditures for the three major markets exhibited substantial swings over the period of 1981 to 1991. The peak consumption year was 1984 and the lowest was in 1982. Cumulatively, however, total pesticide expenditures were approximately the same in 1981 and 1991. Pesticide usage for agriculture was the only market of the three with greater consumption in 1991 than in 1981. All of the markets exhibited relative stability, however, in total sales over the decade.

[30] These data are only available aggregated among these markets.

Figure 3.6
User Expenditures for Pesticides by Principal Market
(In Million 1988 $)



Source:
Pesticides Industry Sales and Usage: Market Estimates
U.S. EPA, Office of Pesticide Programs (1980-1991).

Agricultural pesticide purchases reached their lowest level in 1982, the year in which this segment of the market experienced its most dramatic annual decline. Following 1982, agricultural pesticide purchases continued to fluctuate in the second half of the decade, reaching a peak for the 10-year period examined in 1990. In general, the annual changes were less dramatic than the fluctuations that occurred earlier in the decade, thereby reflecting a more stable market.

Although purchase of I/C/G products was second to agriculture for most of the 1980s, the I/C/G market exhibited substantially negative average annual growth over the period examined. Consequently, by the end of the decade, demand for home, lawn and garden products exceeded the demand for I/C/G products. I/C/G product sales were highest in 1984 and lowest in 1991. The decline in I/C/G product sales at the end of the decade probably stems in large part from the recession and weakening of the manufacturing economy that began at that time.

Table 3.7
User Expenditures for Pesticides by Market
(In 1988 $ Millions)

Year	User expenditures for Agriculture	% Annual Change	User expenditures for I/C/G	% Annual Change	User expenditures for Home/Lawn/Garden	% Annual Change	Total	% Annual Change
1981	4,727.3	-2.1%	1,221.7	-1.0%	998.4	-5.4%	6,947.3	-2.4%
1982	4,138.1	-12.5%	1,210.4	-0.9%	996.7	-0.2%	6,345.2	-8.7%
1983	4,931.1	19.2%	1,105.4	-8.7%	919.0	-7.8%	6,955.5	9.6%
1984	5,241.1	6.3%	1,239.2	12.1%	991.4	7.9%	7,471.7	7.4%
1985	5,021.8	-4.2%	1,115.3	-10.0%	1,001.1	1.0%	7,138.2	-4.5%
1986	4,650.1	-7.4%	1,156.0	3.6%	1,014.1	1.3%	6,820.2	-4.5%
1987	4,929.4	6.0%	1,140.3	-1.4%	1,031.5	1.7%	7,101.3	4.1%
1988	5,110.0	3.7%	1,190.0	4.4%	1,080.0	4.7%	7,380.0	3.9%
1989	5,062.1	-0.9%	1,003.1	-15.7%	1,040.4	-3.7%	7,105.6	-3.7%
1990	5,242.8	3.6%	905.6	-9.7%	998.8	-5.0%	7,137.3	0.4%
1991	5,201.5	-0.8%	898.7	-0.8%	962.8	-2.6%	7,063.1	-1.0%
Annual Average Change	---	0.9%	---	-2.3%	---	-0.7%	---	-0.1%

Source: U.S. EPA Pesticide Industry Sales and Usage, 1980-1990 Market Estimates.

Pesticide sales in the home/lawn/garden market declined slightly over the period examined but averaged approximately $1 billion over the entire period. Of the three major markets examined, the home/lawn/garden market exhibited the greatest stability.

Price Elasticity of Demand

Demand elasticity measures the change of quantity demanded by consumers in response to a change in price. The elasticity of demand for pesticide products can therefore be used to project declines in revenues that PFPR firms will experience if they pass compliance costs on to consumers in the form of price increases. Price elasticity of demand is calculated by dividing percentage change in demand by a percentage change in price. Numeric values associated with price elasticities of demand are generally expressed relative to a one percent change in price. For example, an elasticity of -0.5 suggests that a 1 percent increase in price would result in a 0.5 percent decrease in the quantity demanded. High demand elasticity (i.e., a significant reduction in demand resulting from a price increase) may therefore signify a low level of consumer loyalty to the products offered in that particular market, and indicate a substantial decline in revenues should producers choose to pass compliance costs on to consumers.

To assess the price sensitivity for pesticide markets, an estimate of demand elasticity is required at the cluster level. EPA developed a comprehensive approach to estimated cluster elasticities, including:

(1) A review of empirical studies of pesticide production and use;
(2) U.S. Department of Agriculture's analysis of the price elasticity of demand for food commodities;
(3) Feasibility of employing non-chemical, non-biological pest control methods;
(4) An analysis of pesticides' contribution to the cost of producing a commodity, based on estimates of production costs in the farm sector;
(5) Analysis of the marginal productivity of pesticides; and
(6) Expert opinions within EPA's Office of Pesticide Products.

The price elasticities of demand vary substantially among the clusters, since each cluster faces different market forces (Table 3.8). Elasticity of demand varies among the clusters from -0.12 to -1.38. Despite the wide range of demand elasticities among pesticide clusters, 38 of the 47 have relatively inelastic demand: that is, the absolute values of the demand elasticities are less than 1. This finding

Table 3.8
Summary of Estimates of Elasticity of Demand

Cluster	Elasticity Estimate
Herbicides on sugar beets, beans, peas	-0.12
Herbicides on tree fruits (except oranges), sugar cane, nuts	-0.20
Herbicides on tobacco	-0.20
Fungicides on fruit and nuts trees (except oranges)	-0.23
Fungicides for seed treatment	-0.27
Herbicides on vegetables	-0.27
Fungicides on grain in storage	-0.31
Insecticides on vegetables	-0.33
Slimicides	-0.33
Fumigants and nematicides	-0.33
Insecticides on termites	-0.33
Wood preservatives	-0.33
Insect repellents at non-agricultural sites	-0.33
Domestic bug control and food processing plants	-0.33
Mosquito larvacides	-0.33
Fungicides on turf	-0.33
Industrial preservatives	-0.33
Insecticide synergists and surfactants	-0.33
Plant regulators, defoliants, desiccants	-0.33
Sanitizers - dairies, food processing, restaurants, air treatment	-0.33
Insecticides on livestock and domestic animals	-0.33
Industrial microbicides, cutting oils, oil well additives	-0.33
Preservatives, disinfectants, and slimicides	-0.33
Fungicides - ornamentals	-0.33
Insecticides on lawns, ornamentals and forest trees	-0.33
Molluscides & miscellaneous vertebrate control agents	-0.33
Rodent toxicants, anti-coagulants, predator control	-0.33
Unclassified uses	-0.33

Table 3.8
Summary of Estimates of Elasticity of Demand (cont.)

Cluster	Elasticity Estimate
Fungicides on vegetables	-0.38
Fungicides - broad spectrum	-0.40
Herbicides - broad spectrum	-0.48
Insecticides on soybeans, peanuts, wheat, tobacco	-0.56
Herbicides on rights of way, drainage ditches	-0.66
Herbicides on turf	-0.66
Herbicides on soybeans, cotton, peanuts, alfalfa	-0.67
Herbicides on corn	-0.69
Insecticides on corn and alfalfa	-0.69
Insecticides on sorghum	-0.69
Herbicides on sorghum, rice, small grains	-1.00
Fungicides on citrus	-1.00
Herbicides on oranges	-1.00
Insecticides on fruit and nut trees, except oranges and grapes	-1.00
Insecticides on oranges	-1.00
Herbicides - other agricultural uses	-1.00
Insecticides on cotton	-1.06
Fungicides on grapes	-1.38
Herbicides on grapes	-1.38

Source: *Estimates of the Price Elasticity of Demand for Pesticide Clusters*, U.S. EPA and Abt Associates Inc., May 1991. Estimates provided for clusters with costs under the proposed rule.

indicates that demand at a cluster level (although not necessarily at the product level) should not vary significantly with moderate price increases.[31]

[31]For further details on the estimation of pesticide price elasticity of demand see Appendix C of the *Economic Impact Analysis of Proposed Effluent Limitations Guidelines and Standards for the Pesticide Manufacturing Industry.*

3.4 PFPR Industry Performance from 1986 to 1988 Compared to the Historical Trend in the Industry and the Economy in General

EPA examined whether the years encompassed in the Survey — 1986 to 1988 — were "typical" years relative to overall U.S. business conditions and, in particular, to the historical performance of the PFPR industry. If data were gathered for a period in which the economy — and PFPR industry in particular — were in a recession or economic boom, then the economic impact analysis might not reasonably represent the financial burdens associated with the capital requirements and expenses of the proposed effluent guidelines.

To examine this issue, EPA analyzed the condition of the general economy and the PFPR sector of the economy over the 15-year period 1979-1992 (see Table 3.9).[32] In summary, the analysis shows that the general economy was in a relatively stable period of growth during the PFPR survey years, exhibiting neither rapid growth nor declines in performance. Growth in the PFPR industry was less stable than growth in the general economy from 1986 to 1988, exhibiting one year of decline and two years of above average growth. The average value of shipments for SIC 2879 for 1986 through 1988 ($5.82 billion) is similar, however, to the average value of shipments over the 15-year period examined ($5.78 billion) (see Table 3.10). Therefore, the survey years serve as a reasonable base on which to evaluate the achievability of PFPR compliance with an effluent guideline.

Growth in Gross Domestic Product, 1978 to 1991

As shown in Table 3.9, real GDP grew at an average annual rate of 2.1 percent from 1979 to 1992.[33] In 1980, 1982, and 1991, growth from the previous year is negative, with the decline from 1981 to 1982 being the most dramatic experienced by the economy during the 15-year period examined. Following 1982, the economy began its recovery from the recession of 1981-1982. This trend is exhibited in the annual growth of GDP, which rose significantly in 1983 and reached a peak of 6.3 percent in 1984. For the next five years, 1985 to 1989, GDP rose an average of 3.1 percent, showing little year-to-year variation. Beginning in 1990, annual growth was substantially less, with negative growth between 1990 and 1991. During the PFPR survey years, 1986 to 1988, GDP rose an average

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[32] Value of shipments product data for 1990 to 1992 are estimates. Estimates may vary substantially from final numbers. GDP data for 1992 were not available.

[33] GDP data were indexed to 1988 dollars using the GDP price index. Annual growth is defined as the percent change in real GDP from the preceding year.

Table 3.9
Gross Domestic Product vs. Product Shipments for SIC 2879
Comparisons of Annual Growth Rates[1,2]

	Year 1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992
Gross Domestic Product	2.6%	-0.6%	1.7%	-2.2%	3.9%	6.3%	3.1%	3.0%	3.1%	3.9%	2.6%	1.0%	-0.7%	N/A
Value of Product Shipments (2879)	13.2%	3.5%	8.4%	-17.0%	-7.1%	29.7%	-9.8%	-4.6%	8.8%	9.9%	6.8%	-4.0%	-2.3%	-12.0%

Summary Statistics of Annual Growth Rates	Entire Period, 1979-1992				Survey Years, 1986-1988			
	Mean	Max.	Min.	STD[3]	Mean	Max.	Min.	STD[3]
Gross Domestic Product	2.1%	6.3%	-2.2%	2.2%	3.3%	3.9%	3.0%	0.4%
Value of Product Shipments (2879)	1.7%	29.7%	-17.0%	11.8%	4.7%	9.9%	-4.6%	6.6%

1 GDP values were indexed to 1988 dollars using the GDP index. Product shipment values were indexed to 1988 dollars using the Bureau of Labor Statistic's Producer Price Index for agricultural chemicals.

2 SIC 2879 is defined as establishments primarily engaged in the manufacture or formulation of agricultural chemicals not elsewhere classified, and the formulation and preparation of pesticides. The value of product shipments is defined as the value of all products classified in SIC 2879 produced by all industries.

3 STD=standard deviation.

Source: *The Economic Report of the President*, January 1992; *Labstat Series Report*, found in *Producer Price Indexes* (monthly); and the *U.S. Industrial Outlook* (various years).

Note: Value of Product shipments for 1991-1992 are estimates.

Table 3.10
Value of Product Shipments for SIC 2879
in million 1988 $

	Year 1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992
Value of Product Shipments (2879)	$4870	$5513	$5707	$6185	$5133	$4766	$6183	$5577	$5317	$5784	$6360	$6790	$6521	$6369	$5606

Summary Statistics of Annual Growth Rates	Entire Period, 1979-1992				Survey Years, 1986-1988			
	Mean	Max.	Min.	STD[3]	Mean	Max.	Min.	STD[3]
Value of Product Shipments (2879)	$5779	$6790	$4766	$590	$5820	$6360	$5317	$426

[1] Product shipment values were indexed to 1988 dollars using the Bureau of Labor Statistic's Producer Price Index for agricultural chemicals.

[2] SIC 2879 is defined as establishments primarily engaged in the manufacture or formulation of agricultural chemicals not elsewhere classified, and the formulation and preparation of pesticides. The value of product shipments is defined as the value of all products classified in SIC 2879 produced by all industries.

[3] STD=standard deviation.

Source: *Labstat Series Report*, found in *Producer Price Indexes* (monthly); and the *U.S. Industrial Outlook* (various years).

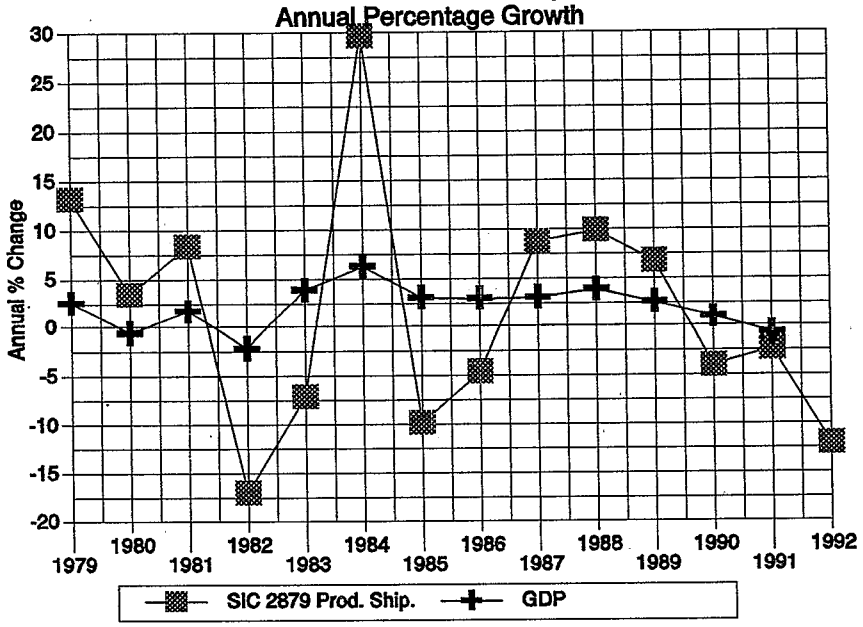
Note: Value of Product shipments for 1990-1992 are estimates.

of 3.3 percent, which is reasonably similar to the 15-year average for the economy. Figure 3.7 illustrates the annual growth in GDP from 1978 to 1991.

Performance of the PFPR Industry Relative to U.S. Business Conditions, 1978 to 1992

To evaluate the performance of the PFPR industry relative to the general economy from 1978 to 1989, EPA obtained value of product shipments data reported in the *U.S. Industrial Outlook.* Value of product shipments data were indexed to 1988 dollars using the Producer Price Index for agricultural chemicals developed by the Bureau of Labor Statistics and annual percentage growth rates were calculated.[34] Figure 3.7 illustrates that the pattern of growth in PFPR shipments generally matches that of the economy as a whole, although with higher volatility.

Figure 3.7
Gross Domestic Product and Product Shipments for SIC 2879
Annual Percentage Growth



Source: *The Economic Report of the President, February 1992; Labstat Series Report,* found in Producer Price Indexes, U.S. Department of Labor, Bureau of Labor Statistics, monthly; and the U.S. industrial Outlook (various years).
Note: Value of Shipments data for 1990-1992 are estimates.

[34] Value of product shipments data were obtained for standard industrial classification (SIC) 2879, which is defined as establishments engaged primarily in the manufacture or formulation of agricultural chemicals not elsewhere classified, and the formulation and preparation of pesticides.

The average growth rate for the PFPR industry for 1978 to 1992 was 1.7 percent, which is somewhat lower than the 2.1 percent experienced by the general economy (see Table 3.9). In addition, from 1981 to 1983 and from 1984 to 1985, the decline in PFPR industry performance, while consistent with the downturn experienced in the general economy, was of much greater magnitude. Variation from the growth trend in the general economy appeared again within the PFPR industry in 1985 and 1986. During the three years encompassed in the Survey data (1986-1988), PFPR shipments growth averaged 4.7 percent, which is somewhat higher than the growth in GDP for the same years (3.3 percent) and higher than the average growth for the PFPR industry from 1978 to 1992 (1.7 percent).

Deviations from the general business trend that occurred in the PFPR industry from 1978 to 1989 can, in part, be explained by specific occurrences in the industry. The decline in the performance of the industry that occurred between 1981 and 1983 was due primarily to the USDA Payment-in-Kind Program, which took 48 million agricultural acres out of production, resulting in a dramatic decline in pesticide sales. Other factors that influenced this decline included more efficient pesticide application techniques and increased pesticide resistance.[35]

The decline that took place from 1981 to 1983 was followed by a surge in the value of product shipments in 1984. This increase was accompanied by a 13 percent rise in pesticide exports.[36] Other factors that influenced this surge include the increase in sales of herbicides and growth-control chemicals (the highest priced subsector of pesticides) as a percent of total pesticide sales and favorable weather conditions.[37] After peaking in 1984, pesticide exports dropped 8.6 percent in 1985, due largely to the strong dollar and the violation of patent laws by foreign competitors.[38] These factors influenced the decline in the value of product shipments experienced by the PFPR industry between 1984 and 1986.

From 1987 to 1989, the PFPR industry exhibited fairly stable and strong growth. Factors that had negative effects on the industry's sales during the middle of the 1980s had in part been addressed.

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[35] As pests increase their resistance to a pesticide product, the product becomes increasingly ineffective, leading to a decline in its use.

[36] United Nation's International Trade Statistics Yearbook.

[37] U.S. Industrial Outlook, 1985.

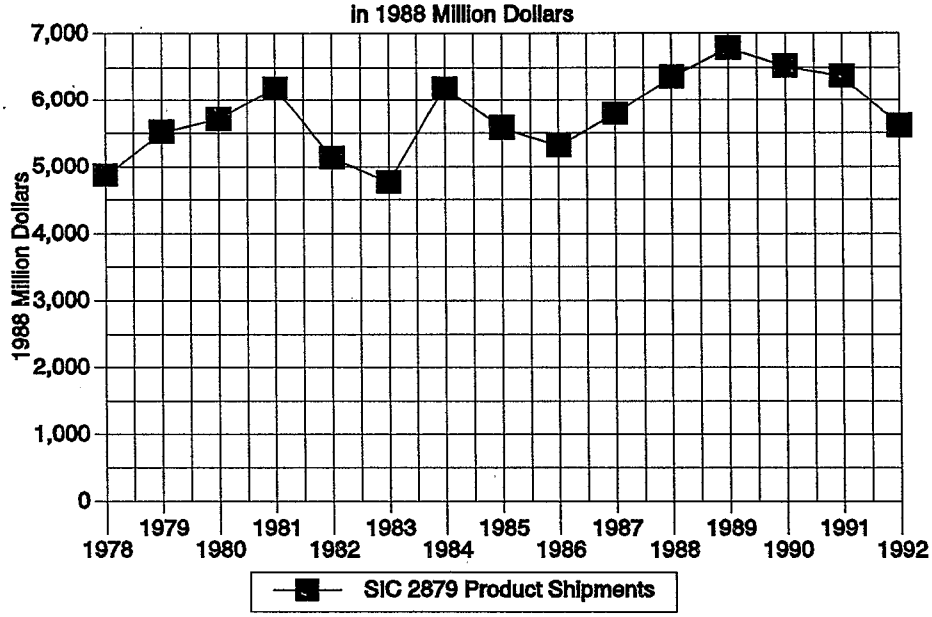
[38] U.S. Industrial Outlook, 1987.

Many of the countries that were involved in the abuse of intellectual property rights had made efforts to control these violations.[39] Also, the extensive consolidation that took place within the industry between 1986 and 1989 gave companies the revenue base needed to fund the rising research and development costs associated with introducing new products to the market. The decline experienced by the industry from 1990 to 1992 is compatible with that experience in the general economy and, therefore, is most likely attributable to a general recessionary trend.

Performance of the PFPR Industry during the PFPR Survey Years, 1986 to 1988

Another gauge of whether the Survey years are biased is to examine the performance of the industry over time compared to performance during the Survey years. If the average profit level during the survey years is similar to typical industry profit levels, the survey years provide a reasonable basis for economic analyses. In the absence of industry-wide profit data, EPA examined the level of revenues in the industry as measured by the real value of product shipments for SIC 2879. These data show that the 3-year average value of product shipments for 1986-1988, $5.82 billion, is similar to the average for the entire 15-year period examined, $5.78 billion (see Table 3.10 and Figure 3.8).

Figure 3.8
Value of Product Shipments for SIC 2879
in 1988 Million Dollars



Source: *Labstat Series Report*, found in *Producer Price Indexes*, Department of Labor, Bureau of Labor Statistics, monthly; and the *U.S. Industrial Outlook* (various years).

[39] U.S. Industrial Outlook, 1992.

3.5 Analysis of Facilities by Water Use Status and By Subgroups

On the basis of the survey data, the following sections characterize PFPR facilities along several important dimensions. The first section presents a summary comparison of water-using and non-water-using facilities. This comparison is limited to only a few data items because the Section 308 survey requested considerably less detailed financial and technical data for non-water-using facilities than for water-using facilities. The second section presents a more detailed look at similarities and differences among 5 important PFPR industry subgroups. Most of the characterizations in this section are based on the more detailed data that apply to *water users only.*

Comparison of Water-Using and Non-Water-Using Facilities

Understanding the financial and market characteristics of water-using and non-water-using PFPR facilities is important in the performance of the EIA because non-water-using facilities will not incur costs for complying with the PFPR effluent guideline. To the extent that non-water users compete in the same PAI and product markets as water users, the competitive behavior of the non-water-using facilities will influence substantially the ability of water-using facilities that do incur compliance costs to recover those costs through price increases to their customers.

From Survey responses, an estimated 610 PFPR facilities (25 percent) do not use water in their 272 PAI-related PFPR operations (referred to hereafter as "non-water-using facilities"). These facilities were not required to complete parts A and B of the Survey, and technical and financial details of their operations are therefore not available. For this reason, much of the data provided in the remainder of this chapter refer only to facilities that use water in their 272 PAI-related PFPR operations (estimated to be 1,794 facilities). The remainder of this section compares water-using and non-water-using facilities on the basis of financial scale and performance, participation in PFPR markets, and facility ownership. From the limited data available on which a comparison may be based, the two groups of facilities have similar financial and market characteristics overall.

Analysis of the survey data indicates that non-water-using facilities have lower revenues (mean value of $3.6 million) than water-using facilities (mean value of $13.4 million) (See Table 3.11.) In addition, the percentage of revenue generated from 272 PAI-related PFPR is very similar for non-water-using facilities (mean value of 14 percent) and water-using facilities (mean value of 15 percent) (The other revenues are from non-272 PAIs, other products, or non-PFPR activities). Although the estimated profit

margin[40] is higher for non-water users (about 11 percent) than for water users (about 5 percent), the estimated median profit margin values for the 2 groups are closer in value (2 and 3 percent).

Table 3.11
Comparative Statistics of Water Using and Non-Water Using Facilities (1986-1988)

	Water Users		Non-Water Users	
	Mean	Median	Mean	Median
Revenue (In Thousands)	13,409	2,374	3,588	1,455
Percent of Revenue from In-Scope PFPR	14.8%	4.2%	13.9%	3.7%
Profit Margin	5.2%	2.3%	11.3%	3.3%
Source: Survey.				

The Survey also requested information on the percentage of revenue generated from 272 PAI-related pesticide sales by market for both water-using and non-water-using facilities. The market descriptions provided in the Survey were:

- Agriculture
- Institutional/commercial[41]
- Industrial use
- Wood preservatives and coatings
- Intermediate pesticide products
- Products used as an additive to a non-pesticide product
- Non-agricultural professional use products
- Consumer home, lawn, and garden

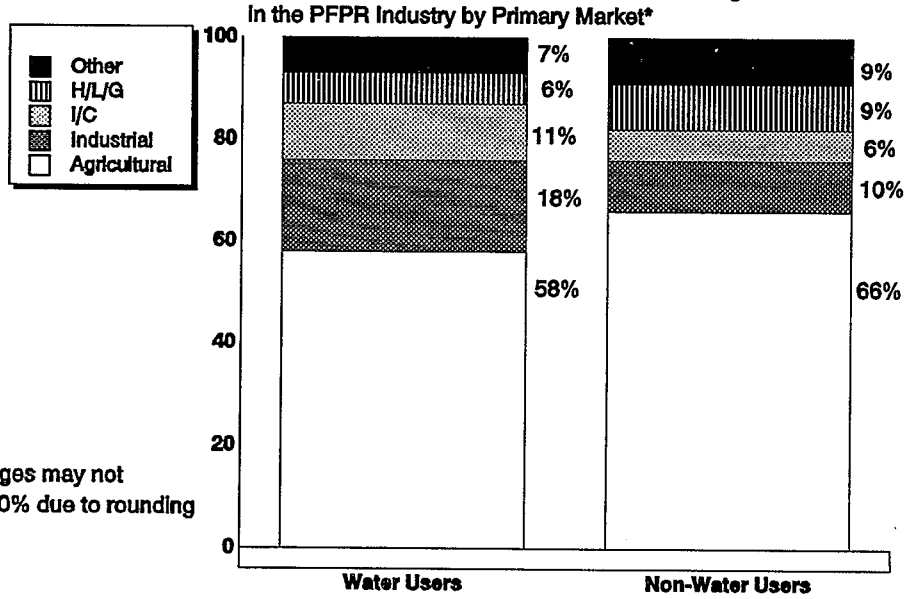
[40] Profit margin is calculated as follows: (total facility revenues - all costs)/total facility revenues.

[41] Henceforth the Institutional/Commercial market is distinguished from the industrial market for analysis regarding the survey data. This was not possible in the general discussion of these markets, as some data were only available aggregated for these two markets.

- Government, for non-institutional use
- Other

For this analysis, EPA defined a facility's primary market as the market from which that facility received at least half of its 272 PAI-related PFPR revenues. The majority of both water-using and non-water-using facilities operate primarily in the agricultural market (See Figure 3.9). Non-water-using facilities participate to a large degree in the agricultural, and home, lawn and garden markets. Competition between water-using and non-water-using facilities is therefore likely to be effective in these markets. In the Institutional/Commercial (I/C) market and the Industrial market, participation by non-water users is less than participation by water users, on a percentage basis. EPA estimates that the I/C market is the primary market for 11 percent of water-using facilities, but only for 6 percent of non-water-using facilities. Similarly, 18 percent of water-using facilities claim that their primary market is the industrial market, whereas only 10 percent of non-water-using facilities state that the industrial market is their primary market. Non-water using facilities are therefore likely to play a less substantial competitive role in these markets in limiting the ability of water-using facilities to pass on compliance costs to their customers.

Figure 3.9
National Estimates of Percent of Water Using Facilities and Non-Water Using Facilities in the PFPR Industry by Primary Market*



* Percentages may not sum to 100% due to rounding

Source: Survey (1986-1988)

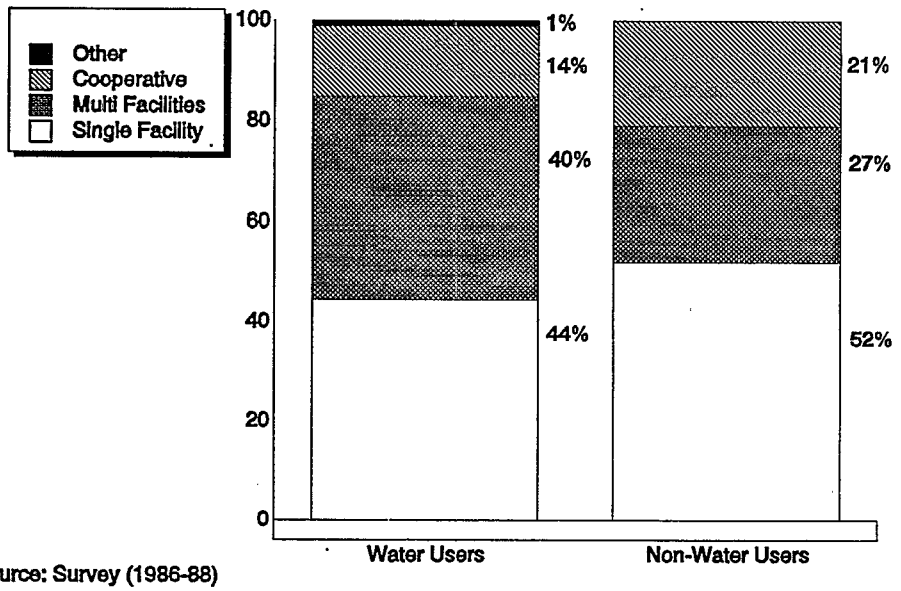
The Survey also requested information on the ownership of the PFPR facilities. The Survey options presented were:

- A single facility enterprise
- A multi-facility company
- A cooperative
- A Federal government agency
- A military or defense organization
- A state government agency
- A local government agency
- Other

The most common ownership type for both water-using and non-water-using facilities is a single facility enterprise: an estimated 44 percent of water-using facilities and 52 percent of non-water-using facilities are estimated to be single facilities (See Figure 3.10). The second most common ownership type is a multi-facility company (40 percent for water users and 27 percent for non-water users.) Most of the remaining facilities participate in a cooperative (14 percent of water users and 27 percent of non-water users).

On balance, these data suggest that, relative to water users, non-water-using facilities are a smaller, but competitively viable, segment of the PFPR industry. EPA technical specialists on PFPR operations report that some PAIs and products require water-based formulation operations. Overall, non-water users will limit somewhat the ability of water users to pass on compliance costs to their customers, because enough PAIs and products can be formulated without water (i.e., either in dry form or with non-water solvents) The only markets in which competition by non-water users is not likely to limit the pass-through of compliance costs are the institutional/commercial and industrial markets.

Figure 3.10
National Estimates of Water-Using Facilities and Non-Water-Using Facilities
In the PFPR Industry by Ownership Characteristics



Source: Survey (1986-88)

Comparison of PFPR Facilities by Major Subgroups

To aid in understanding how a PFPR effluent guideline regulation would likely affect facilities in the PFPR industry, facilities were classified into five groups. These groups differ in terms of such characteristics as markets served, reliance on PFPR as a source of revenue, and primary facility activity. Because an effluent guideline is likely to affect the different subgroups in different ways, it is important to distinguish among these five industry subgroups and understand how the subgroups differ. For example, facilities that are heavily reliant on PFPR operations as a source of revenue will likely face different business decisions when confronted with compliance requirements than those that receive only a small share of revenue from PFPR operations. These facilities likely face the decision of shutting down their entire facility operations if the cost of regulatory compliance imposes an unmanageable financial burden. In contrast, facilities with relatively low reliance on PFPR business as a revenue source should be able to remain in business even if they decide to terminate their PFPR activities or convert those operations to another formulation activity not subject to the PFPR effluent guideline.

The five subgroups were developed, in part, as a result of industry comments to EPA on differentiation among PFPR facilities. In the process of developing this rule, EPA met with interested trade associations including the National Agricultural Chemicals Association (NACA), the National Agricultural Chemical Retailers Association (NACRA), and the Chemical Specialties Manufacturers Association (CSMA). In addition, between 1991 and 1993, EPA conducted site visits to 51 PFPR facilities. These site visits were conducted for several purposes, including strengthening EPA's understanding of the technical and economic activities conducted at the facilities. The five subgroups, together with a review of the basis for defining the subgroup, are as follows:

- ***PFPR facilities that also manufacture PAIs (hereafter, PFPR/Manufacturing Facilities).*** From industry input during the meetings and site visits and industry responses to the Survey, it became apparent that facilities that both manufacture PAIs and perform PFPR processing differ in several respects from other PFPR facilities. Apart from the simple operating difference that these facilities also manufacture PAIs, facilities in this subgroup, as shown below, are generally larger in terms of annual revenue than facilities in other subgroups, are more dependent on PFPR business, and are more likely to be part of a larger, multi-facility firm.

- ***Refilling Establishments.*** Discussions with industry also singled out refilling establishments as a PFPR industry subgroup. Refilling establishments are defined as facilities in which the sole PFPR activity is repackaging pesticide products into refillable containers. These facilities operate almost entirely in the agricultural products market, tend to be relatively small, and generally receive only a small fraction of revenues from PFPR business.

- ***Sanitizer Facilities.*** Further, industry contended that pesticide products used as sanitizers were fundamentally different from other pesticide products, particularly in their concentration and end-use. For this analysis, the Sanitizer Facility subgroup was defined to include any facility that reported at least half of the PAIs it used as being in the Sanitizer PAI Cluster, R-4.[42] Like Refilling Establishments, Sanitizer Facilities tend to be relatively small and generally receive only

[42] For this analysis a sanitizer facility is defined separately for water using and non-water using facilities. For water-using facilities, a sanitizer facility is defined as a facility with one half or more of its pounds of 272-PAI use from Cluster R-4. For non-water using facilities, pounds of PAI use were not available. A sanitizer facility is therefore defined as a facility that uses at least half of the number of 272-PAIs it reports from Cluster R-4.

a small fraction of revenues from PFPR business. In contrast, however, they largely serve a very different market segment, the institutional/commercial market, and were therefore recognized as a different industry subgroup for analyzing regulatory impacts.

- ***Other PFPR Facilities receiving at least of 25 percent of revenues from PFPR business.*** These so-called *Other PFPR Facilities* constitute those facilities whose business is largely in PFPR operations and, by definition, are the "mainstream" PFPR facilities. They participate in all phases of PFPR operations, serve a diverse set of markets, and are typically larger in terms of annual revenues than other PFPR facilities except for the PFPR/Manufacturing Facilities.

- ***Other PFPR Facilities receiving less than 25 percent of revenues from PFPR business.*** These facilities also serve diverse markets and are similar in total revenue to Other PFPR Facilities with at least 25 percent of PFPR revenue. These low-PFPR dependence facilities were separated from the "other" Other Facilities for regulatory analytic purposes, in recognition that facilities with only peripheral participation in the PFPR business will likely face different decisions in responding to regulation than those for which PFPR is the core business (as noted in the example above).

The information provided in the remainder of this section characterizes some of the major financial and operating differences among these facility subgroups. The dimensions on which the five PFPR industry subgroups are characterized are as follows:

- Number of facilities
- Percentage of facilities using water
- Primary facility activity
- Percent of revenue from PFPR
- Mix of formulating, packaging, and repackaging
- Primary pesticide market
- Facility ownership structure
- Capital costs
- Facility employment
- Facility revenue
- Facility profit levels

For many of these data items facilities using water — the characterization of subgroups is based *only on water-using facilities*. Data for *both water-using and non-water-using facilities* are used for the characterizations based on number of facilities and percentage of facilities using water.

Number of facilities

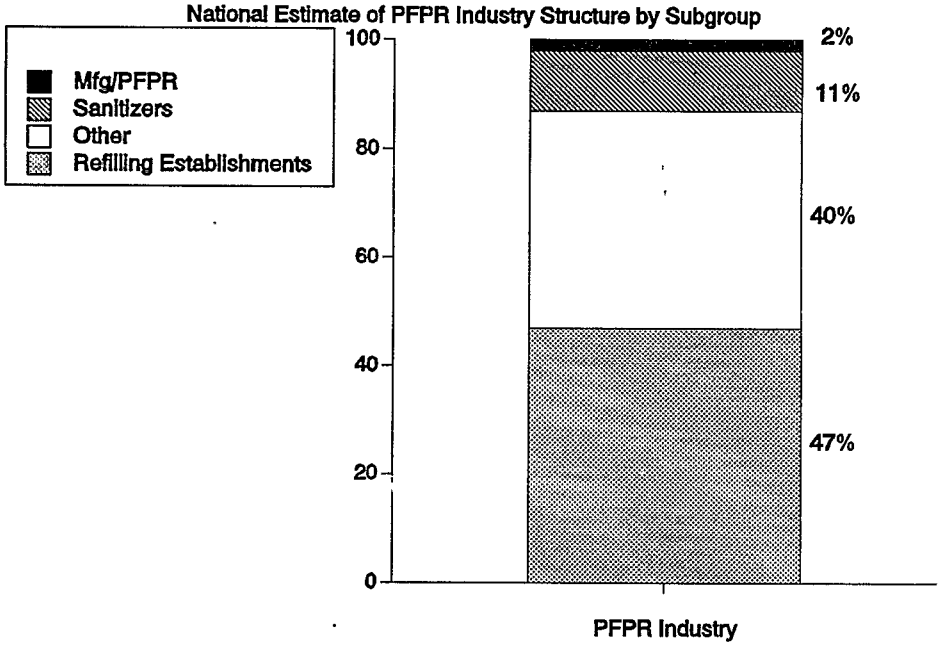
In 1988 (the base year of the Survey), data reported in the FIFRA and TSCA Enforcement System yielded an estimate of about 2,500 PFPR facilities in operation. Nearly half of these facilities (47 percent) are classified as Refilling Establishments (See Figure 3.11). The next largest subgroup in terms of number of facilities is Other PFPR (without differentiation based on share of revenue from PFPR) at 40 percent of total PFPR facilities. PFPR revenue data were requested differently for water-users and non-water users, and therefore it is not possible to calculate comparable PFPR revenue estimates for the two groups. Therefore non-water users cannot be split based on the share of revenue from PFPR as water-users can. Using data for only those facilities that use water, however, the 40 percent of total facilities in the Other PFPR subgroup would split approximately as follows: 27 percent, Other PFPR Facilities *with less than 25 percent of revenue from PFPR*, and 13 percent, Other PFPR Facilities *with at least 25 percent of revenue from PFPR.*

In terms of number of facilities, the remaining two subgroups, Sanitizer Facilities and PFPR/Manufacturers, are much smaller segments of the industry. Sanitizer Facilities constitute an estimated 11 percent of PFPR facilities, while PFPR/Manufacturing Facilities represent only 2 percent of total PFPR facilities.

Percentage of facilities using water

For all industry subgroups, more than a majority of facilities use water in PFPR operations. Beyond this common feature, however, the industry subgroups break into two distinct classes based on whether water is used in PFPR operations. Specifically, nearly all of the PFPR/Manufacturing Facilities and Sanitizer Facilities are estimated to use water in their PFPR activities. In contrast, only about three-fourths of Refilling Establishments and two-thirds of Other PFPR Facilities (again, without differentiation based on share of revenue from PFPR) are estimated to use water (See Figure 3.12).

Figure 3.11
National Estimate of PFPR Industry Structure by Subgroup



Source: Survey, Including Water-Users and Non-Water Users

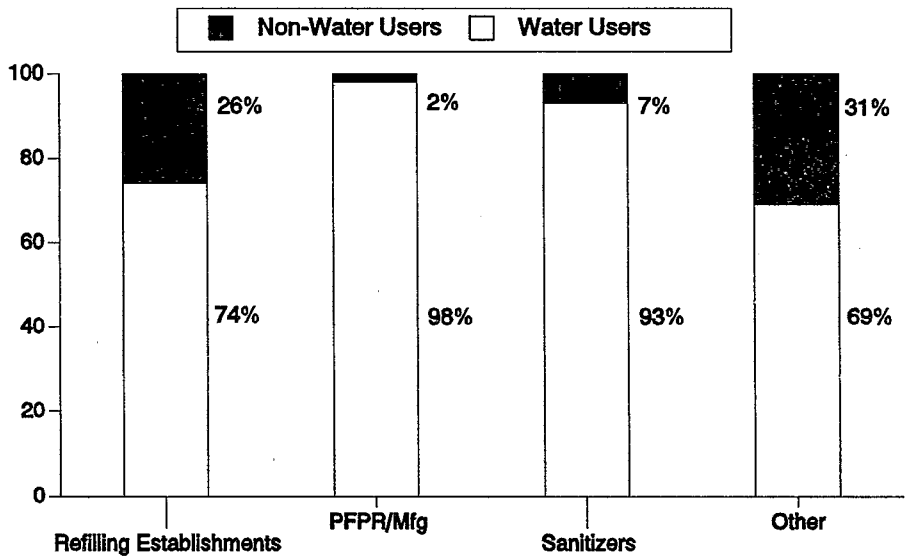
Primary facility activity

The primary Standard Industrial Classification codes reported by facilities in the Survey provide an indication of the different activities in which the different subgroups participate. (The data reported below and for all of the remaining summarizations are for water-using facilities only.)

Over half of the PFPR/Manufacturing Facilities reported a primary SIC of #2879, defined as the "formulation and preparation of ready-to-use agricultural and household pest control chemicals..." (See Table 3.12). About one-quarter of the PFPR/Manufacturing Facilities reported a primary SIC of #2869, defined as "manufacturing industrial organic chemicals, not elsewhere classified...."

In contrast, Refilling Establishments are involved almost exclusively in agricultural industry-related products. Specifically, an estimated 67 percent of Refilling Establishments reported a primary SIC of #5191: "...wholesale distribution of animal feeds, fertilizers, agricultural chemicals, pesticides, seeds, and other farm supplies, except grains". An estimated 13 percent of Refilling Establishments have a primary SIC of #5153: "... buying and/or marketing grain ... and ... beans."

Figure 3.12
National Estimates of Water-Using Facilities and Non-Water-Using Facilities in the PFPR Industry by Subgroup



Source: Survey

The primary SIC codes reported by Sanitizer Facilities indicate their participation in formulating a broad line of non-agricultural products that are distinct from the product codes reported by PFPR/Manufacturing Facilities and Refilling Establishments. An estimated 28 percent of Sanitizer Facilities have a primary SIC of #2842: "...manufacturing furniture, metal, and other polishes; waxes and dressings for fabricated leather...; household, institutional, and industrial plant disinfectants; nonpersonal deodorants, drycleaning preparations, household bleaches, and other sanitation preparations." An estimated 24 percent of Sanitizer Facilities reported their primary SIC as #2841: "...manufacturing soap, synthetic organic detergents, inorganic alkaline detergents...."

Other PFPR Facilities *with less than 25 percent PFPR revenue* participate in widely diverse business classifications, with 33 different primary SIC codes reported by the sampled facilities. These facilities most frequently report an SIC code of #2899: "...manufacturing miscellaneous chemical preparations, not elsewhere classified...." These facilities also frequently report a primary SIC code of #2842 (manufacturing furniture polish, etc.), fully defined above.

Table 3.12
National Estimates of Primary SICs[1] Reported by PFPR Facilities by Subgroup

	PFPR/Mfg	Refilling Establishments	Sanitizers	Other	
				<25%	≥25%
2879	53%				45%
2869	23%				
5191		67%			
5153		13%			
2842			28%	10%	
2841			24%		
2899				27%	
Other	24%	20%	48%	63%	55%
# of 4-digit primary SICs reported	11	16	18	33	23

Note: Includes Water Users.

Source: Survey (1986-88).
1 Includes all SIC production reported by at least 10 percent of facilities in a subgroup.

Finally, the "mainstream" Other PFPR Facilities *with at least 25 percent PFPR revenue* reported the highest participation in SIC group #2879 (formulating and preparing pesticides): 45 percent of facilities listed this SIC code as their primary business classification. This SIC code was also frequently reported by PFPR/Manufacturing Facilities, and was fully defined above.

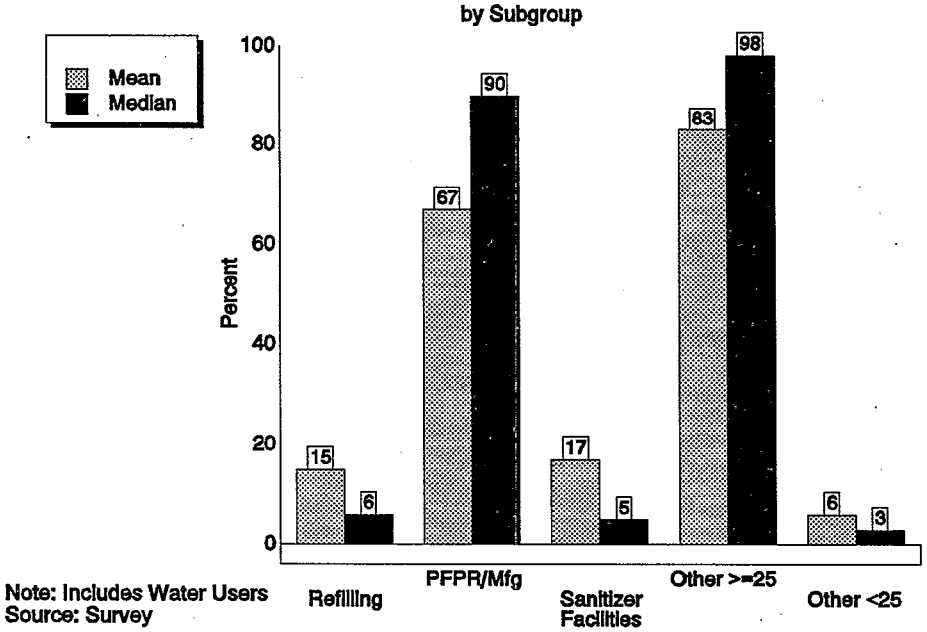
Percent of revenue from PFPR

As discussed in the introduction to this section, the extent to which facilities depend on PFPR business as a revenue source will influence the decisions that facilities face in deciding whether to comply with effluent guideline requirements. Accordingly, understanding how the different industry subgroups vary in their reliance on PFPR revenue is important in structuring the impact analysis. As discussed below, the five subgroups fall into two distinct categories with relatively low reliance on PFPR revenues

exhibited by Refilling Establishments, Sanitizer Facilities, and (by definition) Other PFPR Facilities *with less than 25 percent PFPR revenue*. In contrast, PFPR/Manufacturing Facilities and Other PFPR Facilities *with at least 25 percent PFPR revenue* receive, on average, well more than a majority of their revenue from PFPR activities. Accordingly, it is these two latter subgroups of PFPR facilities that are more likely to consider termination of their entire facility operations when faced with the financial burdens of complying with effluent guidelines.

Two subgroups of facilities obtain a high percentage of their revenue from PFPR: PFPR/Manufacturing Facilities and Other PFPR Facilities *with at least 25 percent PFPR revenue* (See Figure 3.13). The estimated median percentage of revenue from PFPR for PFPR/Manufacturing Facilities is 90 percent. *Other PFPR Facilities with at least 25 percent PFPR revenue* are expected by definition to have a substantial percentage of their revenue from PFPR. The estimated mean and median percentages of revenue from PFPR for this subgroup are, however, dramatically higher than 25 percent, at 83 percent and 98 percent, respectively.

Figure 3.13
National Estimate of Percent of Revenue from PFPR Activities by Subgroup



Note: Includes Water Users
Source: Survey

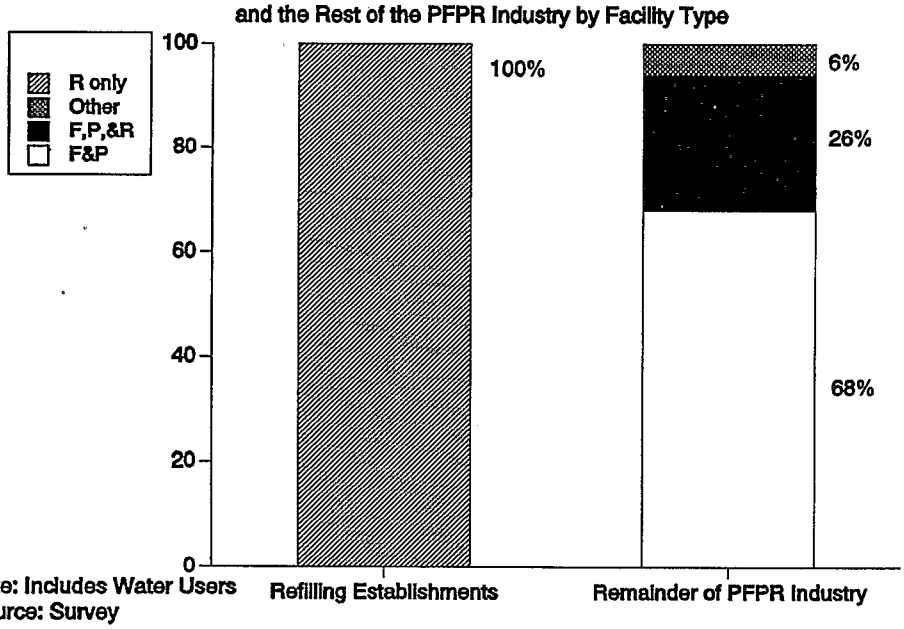
The estimated mean and median percentages of revenue from PFPR for the other three subgroups are all very low. For Refilling Establishments, the estimated mean and median percentages are 15

percent and 6 percent, respectively. For Sanitizer Facilities, the estimated mean PFPR percentage is 17 percent, with a median value of 5 percent. Other PFPR Facilities *with less than 25 percent PFPR revenue* are by definition limited to a low PFPR percentage. The estimated mean and median percentages are substantially lower than 25 percent, however, at 6 percent and 3 percent, respectively.

Mix of formulating, packaging, and repackaging

The particular set of PFPR activities — that is, formulating, packaging, and repackaging — performed by facilities further define the five industry subgroups and highlight the differences among them. Four of the five groups of facilities — the exception being Refilling Establishments — are similar in this respect: the majority of the facilities formulate and package pesticides (about 50 percent to 80 percent) followed by formulating, packaging, and repackaging as the next most frequent combination of activities (about 15 percent to 40 percent). The sole PFPR activity undertaken by Refilling Establishments is the repackaging of pesticides (See Figure 3.14). On this basis, the Refilling Establishments subgroup is markedly different from the other four industry subgroups.

Figure 3.14
National Estimates of Refilling Establishments
and the Rest of the PFPR Industry by Facility Type



Note: Includes Water Users
Source: Survey

Primary pesticide market

As described previously in this section, the Survey requested information on the percentage of revenue generated from 272 PAI-related pesticide revenue by market. For this analysis, EPA defined a facility's primary market as the market from which that facility received at least half of its 272 PAI-related PFPR revenues. Ninety-nine percent of facilities had a primary market.

Three industry subgroups are heavily concentrated in a single market:

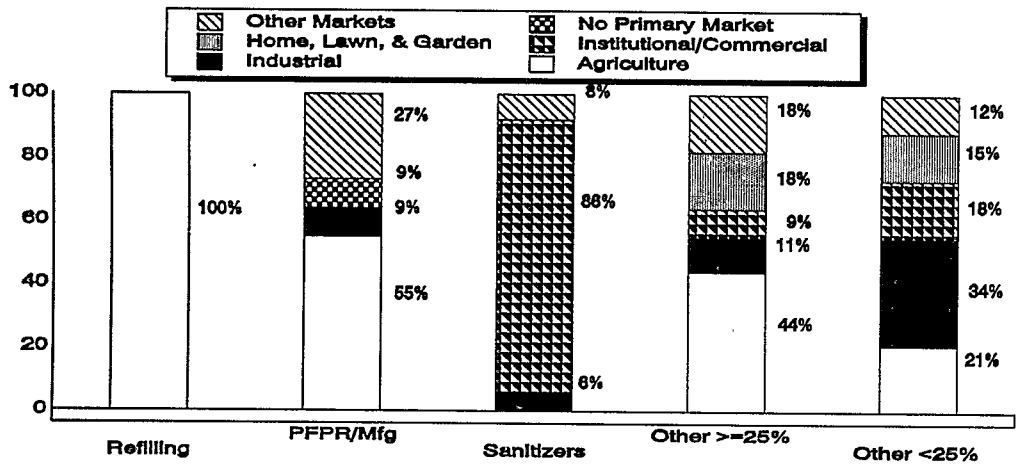
- For *all* **Refilling Establishments**, the primary market is the agricultural market (See Figure 3.15).
- An estimated 86 percent of **Sanitizer Facilities** identify the institutional/commercial market as the primary market.
- Although an estimated 55 percent of **PFPR/Manufacturing Facilities** identify agricultural sales as their primary market, the market participation of these facilities is somewhat more diverse than Refilling Establishments and Sanitizer Facilities, with significant participation levels in "Other," Industrial, and "No Primary Market."

The two Other PFPR facility subgroups participate in a more diverse set of markets. The three most frequent primary markets for Other PFPR Facilities *with at least 25 percent PFPR revenue* are the agricultural market (an estimated 44 percent of facilities), the home, lawn, and garden market (18 percent of facilities), and the industrial market (11 percent of facilities). Other PFPR Facilities *with less than 25 percent PFPR revenue* tended to operate primarily in one of the following four markets: the industrial market (an estimated 34 percent of facilities), the agricultural market (21 percent of facilities), the institutional/commercial market (18 percent of facilities), or the home, lawn, and garden market (15 percent of facilities).

Facility ownership structure

The Survey also requested information on the ownership of the PFPR facilities. Sanitizer Facilities and the two Other PFPR Facility subgroups exhibit similar ownership structures, with about an estimated 60 percent of facilities operating as single facilities and most of the remaining facilities operating as part of a multi-facility company (See Figure 3.16). Nearly 80 percent of

Figure 3.15
National Estimates of Primary* Pesticide Markets
by Subgroup (1988)



* The primary market of a facility, if one existed, was defined as the market from which the facility generated more than 50% of its revenues. Markets that are primary for less than 5% of facilities in a subgroup are included in "other markets."

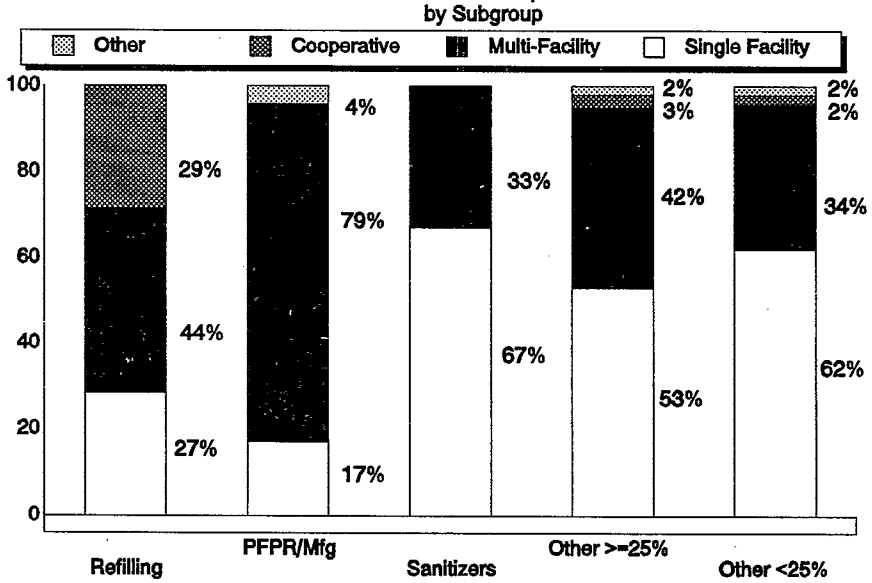
Note: Includes Water Users
Source: Survey
Numbers may not sum to 100% due to rounding.

PFPR/Manufacturing Facilities, on the other hand, are estimated to be owned by multi-facility companies. The dominance of this ownership classification distinguishes the PFPR/Manufacturing Facility from other subgroups, because no other subgroup showed more than a majority of ownership by multi-facility enterprises. Refilling Establishments also show a relatively unique ownership configuration with an estimated 29 percent of these facilities being owned in the form of a cooperative. No more than 3 percent of the facilities in other subgroups identified cooperative as the ownership structure. An estimated 44 percent of the Refilling Establishments are owned as part of a multi-facility company with the remaining 29 percent operating as single entities.

Capital costs

Firms require capital to begin, improve, or expand production. The capital required to enter an industry may be sufficient to impede market entry, thereby decreasing competitiveness within that industry. The ratio of the gross book value of depreciable assets to value added by manufacturing provides a measure of the capital intensity of an industry. The value of the ratio indicates the quantity of capital in dollars required to generate a single dollar of annual value added: the higher the ratio, the higher the capital intensity. Data from the Bureau of the Census indicate that SICs 20-39, which include

Figure 3.16
National Estimates of Ownership Characteristics
by Subgroup



Note: Includes Water Users
Source: Survey

all manufacturing, had a capital intensity ratio of 0.75.[43] SIC 2869, which includes the manufacture of basic pesticides and many other organic chemicals, had a ratio of 1.96, representing a relatively high capital intensity for this segment of the pesticide industry. Comparatively, the formulating/packaging segment of the pesticide industry (SIC 2879), with a ratio value of 0.88, was less capital-intensive than pesticide manufacturers but more capital-intensive than all manufacturing industry.[44] Finally, Refilling Establishments, represented by SIC 51, is the least capital-intensive industry in the comparison with a capital intensity ratio of 0.54.[45,46]

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[43] U.S. Department of Commerce, Bureau of the Census. *1987 Census of Manufacturers, Preliminary Report Industry Series: Industrial Organic Chemicals.* Washington, D.C. July, 1989.

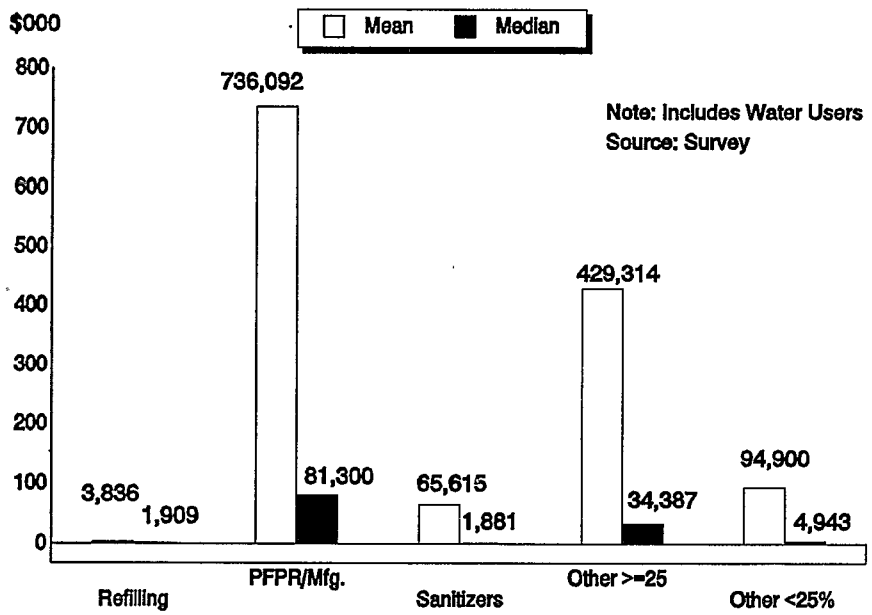
[44] Ibid.

[45] U.S. Department of Commerce, Bureau of the Census. *1987 Census of Wholesalers, Subject Series: Measures of Value Produced, Capital Expenditures, Depreciable Assets, and Operating Expenses.* Washington, D.C. June, 1991.

[46] Note: SIC 51, which represents the wholesaling of non-durable goods, is the most accurate measure of value added for SIC 5191 available. The 1987 value added statistics for SIC 519 (statistics are aggregated in the 1987 Census of Wholesalers Subject Series to the three-digit level) were withheld because the coefficient of variance exceeded acceptable standards established by the Bureau of the Census.

The relative capital intensity of the five subgroups may also be evaluated by looking at the average market value per PFPR production line reported in the Survey (see Figure 3.17). A high market value per production line would suggest that significant capital expenditures are required to enter a segment of the PFPR industry. PFPR/Manufacturing Facilities report the highest market value of production lines with a mean of close to $750,000. Other PFPR Facilities *with at least 25 percent PFPR revenues* report an average value of production lines of over $400,000, while Other PFPR Facilities *with less than 25 percent PFPR revenues* report an average value of less than $100,000. Sanitizer Facilities report still lower value per production line, with an average value per line of less than $70,000. With an average production line value of $3,800, Refilling Establishments have a markedly lower market value per line than the other five industry subgroups. These data are consistent with the depreciable assets to value added ratios reported by the Bureau of the Census.

Figure 3.17
National Estimates of Average Market Value Per PFPR Production Line
by Subgroup



Facility employment

Facility employment also varies substantially among the five industry subgroups. Of the five subgroups, PFPR/Manufacturing Facilities employed the most Full Time Employees (FTEs) per facility, while Refilling Establishments employed the fewest (Table 3.13). On average, PFPR/Manufacturing Facilities employed 271 total FTEs and 18 272 PAI-related PFPR production workers in 1988. In contrast, Refilling Establishments supported an average of only 10 total FTEs and less than one 272 PAI-related PFPR production worker. Sanitizer Facilities had average total employment of 36, yet averaged only one 272 PAI-related PFPR production worker. For both the Refilling Establishment and Sanitizer Facility subgroups, the low ratio of 272 PAI-related PFPR production workers to total employment is consistent with the relative PFPR revenue dependency of these facilities. *Total* employment at Other PFPR Facilities varied little with reliance on PFPR revenue, averaging 53 FTEs for Other PFPR Facilities *with at least 25 percent PFPR revenue* and 64 FTEs for Other PFPR Facilities *with less than 25 percent PFPR revenue*. As would be expected, however, employment of 272 PAI-related production workers varied considerably with the dependence on PFPR revenue. For Other PFPR Facilities *with at least 25 percent PFPR revenue*, 16 of the average 53 total FTEs involved 272 PAI-related production. For Other PFPR Facilities *with less than 25 percent PFPR revenue*, only 1 of the average 64 total FTEs involved 272 PAI-related production.

Facility revenue

The subgroups differ substantially in facility size as indicated by average total facility revenue. PFPR/Manufacturing Facilities have much higher annual facility revenues — the estimated mean is approximately $110 million — than do all other subgroups of facilities (See Figure 3.18). Refilling Establishments and Sanitizer Facilities have relatively low facility revenues, with estimated mean values of $5 million and $11 million, respectively. Other PFPR Facilities have similar average facility revenues, regardless of the percentage of their revenue from PFPR. The estimated mean annual facility revenues for both Other PFPR Facility subgroups are about $18 million.

Facility profit levels

An indication of the competitiveness of an industry can be determined by looking at the range of profitability found in the industry. Because the Survey data do not include costs below the facility level, only total facility profits can be calculated. Profits from PFPR activities or 272 PAI-related PFPR activities cannot be calculated. The profitability of the PFPR industry was assessed on the basis of return

Table 3.13
Average Facility Employment Characteristics by Business Type (1988 Full-Time Equivalents)

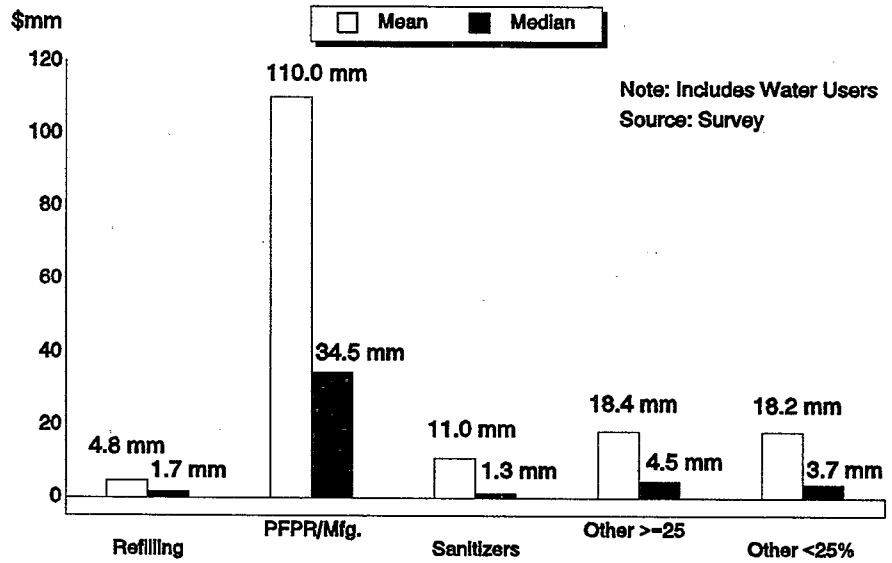
Type of PFPR Facility		Average 272 PAI-Related Revenues (In $ Thousands)[1]	Average Total Employment	272 PAI-Related PFPR Production Employment	Average Other Production Employment	Average Non-Production Employment
Refilling Establishments		155.6	10	<1	5	5
PFPR/ Manufacturing Facilities		66,728.3	271	18	170	83
Sanitizer Facilities		250.5	36	1	22	13
"Other Facilities	≥25 PFPR Rev.	9,031.3	53	16	14	23
	<25 PFPR Rev.	405.7	64	1	35	27
Average for all facilities		3,038.6	39	3	20	16

Source: Survey.
[1] Revenues represent a three year average (1986 - 1988), in 1988 dollars.

on assets (pre-tax facility profits as a percentage of facility assets). Averaged across the survey years of 1986 to 1988, the estimated mean return on assets for the facilities engaged in PFPR activities was 23 percent while the median was almost nine percent (see Table 3.14). The PFPR industry's return on assets at the 95th percentile and 5th percentile was 177 percent and -54 percent, respectively. These data reflect a significant concentration of moderately profitable facilities with a number of facilities reporting both very high profitability levels and very low profitability levels relative to the rest of the PFPR industry. In short, the PFPR industry exhibits a notable range of profitability.

Facility profit levels, measured by the return on assets, are similar for four subgroups, with the exception of Refilling Establishments (See Table 3.14). Over the Survey period, median return on assets are estimated to be 14 percent for Sanitizer Facilities, 13 percent for Other PFPR Facilities *with at least 25 percent PFPR revenue*, 12 percent for Other PFPR Facilities *with less than 25 percent PFPR revenue*, and 11 percent for PFPR/Manufacturing Facilities. In contrast, Refilling Establishments are estimated to have a much lower median return on assets of about 5 percent.

Figure3.18
National Estimates of Facility Revenues
by Subgroup



3.6 Summary

The PFPR industry is a major industry, with an estimated 2,404 facilities active in this business. User expenditures for pesticides are estimated to have been about $7 billion in 1991 (1988$). Although the industry offers pesticide application services, the main output of the industry is pesticide products. These products are sold primarily to the agricultural market, with the institutional/commercial sector and the home/lawn/garden sector also providing major markets. Overall, user expenditures in the PFPR market have not shown a consistent trend of growth or decline over the period 1981 to 1991. Also, the demand for pesticide products is generally expected to be inelastic: that is, demand for pesticide products overall is not expected to decline significantly with moderate price increases.

Much of the data provided in the profile were developed from the Survey administered to the PFPR industry in 1990, covering the years 1986-1988. These years are believed to be representative of the financial performance of the PFPR industry over broader time periods. The assessment of the representativeness of the Survey data is based on the U.S. economic climate from 1986 to 1988 as well as the growth rate and revenues achieved by the PFPR industry over this time period.

Table 3.14
National Estimates of PFPR Return on Assets[1]
By Subgroup
Three Year Average[2]

Subgroup of Facility	Mean	Median	5th Percentile	95th Percentile
Refilling Establishments	6.8%	4.7%	-86.4%	174.4%
PFPR/Mfg. Facilities	27.6	12.5	-15.7	87.6
Sanitizer Facilities	29.9	13.6	-56.3	122.1
Other ≥ 25%	40.1	13.4	-34.1	175.6
Other < 25%	40.4	12.1	-23.0	192.2
Across All Facilities	23.0	8.6	-53.9	176.9

[1] Pretax facility profits as a percentage of total facility assets.
[2] Source: Survey (1986-1988).
Includes Water Users

Based on data from the Survey, an estimated 25 percent of the PFPR industry operated without using water in their 272 PAI-related operations in 1988. These non-water-using facilities appear to be somewhat smaller and less involved in PFPR activities than the water-using facilities. The median profitability between the two groups is similar, however, as are the major markets in which they participate and their ownership structure.

Finally, the PFPR industry consists of five distinct subgroups of facilities: PFPR/Manufacturing Facilities, Refilling Establishments, Sanitizer Facilities, Other PFPR Facilities *with at least 25 percent PFPR revenue,* and Other PFPR Facilities *with less than 25 percent PFPR revenue.* These subgroups of facilities vary in their primary activities, major pesticide markets, ownership structure, capital costs, facility employment levels, facility revenue levels, and facility profit levels. In particular, Refilling Establishments and Sanitizer Facilities have relatively low facility revenues and Refilling Establishments have relatively low profitability.

Chapter 4
Facility Impact Analysis

4.0 Introduction

This chapter presents the methodology used to project impacts of the proposed effluent limitations guidelines and standards at the facility level, and describes the results of the analysis. As discussed in Chapter 1, the facility analysis is the principal building block of the entire economic impact assessment. The facility impact analysis is characterized by the following:

(1) use of economic models to estimate baseline and post-compliance costs and revenues for individual facilities;

(2) separate models of the decision-making process for three groups of pesticide formulating/packaging/repackaging (PFPR) facilities: (1) refilling establishments, (2) PFPR facilities that also manufacture pesticide active ingredients (PAIs) or that receive at least 25 percent of their revenue from PFPR activities, and (3) "other" PFPR facilities;

(3) comparison of annualized compliance cost to facility revenue is used to project significant economic impacts for all three groups of facilities;

(4) application of a discounted cash flow analysis to project closure of PFPR facilities that also manufacture PAIs (PFPR/manufacturing facilities) or that receive at least 25 percent of their revenue from PFPR; and

(5) evaluation of the return on assets at "other" PFPR facilities to project conversion of PFPR operations.

The cost, revenue, and quantity outputs from the first step provide input to the facility closure and PFPR conversion analyses of the subsequent steps. Facility closure is the most severe of the three impacts evaluated, while line conversions and annualized compliance costs in excess of five percent of facility revenue represent more moderate impacts. In contrast to facility closures and product line conversions, compliance costs in excess of five percent of facility revenue are assumed not to be associated with an operational change at a facility. Compliance costs that are less than five percent of facility revenue are commonly judged to be economically achievable. (See, for example, the EIA for effluent guidelines limitations and standards for the OCPSF industry and the pesticide manufacturers industry).

The main body of this economic analysis evaluates the economic impacts of a PSES regulation on facilities discharging to a POTW. A zero direct discharge limit of process wastewater pollutants from PFPR was promulgated under the 1978 pesticide chemicals BPT regulation. Therefore, for most facilities, no costs associated with limitations on direct discharge of pollutants are considered. However, 16 facilities that both manufacture PAIs and PFPR have been combining pesticide manufacturing wastewaters with wastewaters generated from PFPR and discharging these wastewaters directly. These facilities have technically achieved the limits in their NPDES permits, which provide discharge limitations for pollutants generated in the PAI manufacturing process but give no allowance for the pollutants present in the PFPR wastewater. These facilities, however, should already have been complying with the BPT zero discharge requirement for their PFPR wastewaters. The effluent guidelines for direct dischargers in the pesticide manufacturers subcategory were recently revised to impose mass-based limitations on pesticide manufacturing wastewaters. The likely result is that the combined pesticides manufacturing and PFPR facilities will no longer be able to discharge their PFPR wastewaters directly and still meet the limits in their permits. Any additional costs to these facilities of meeting the 1978 BPT zero discharge requirement for PFPR facilities are not attributable to this PFPR rulemaking. Nevertheless, for information purposes, EPA has evaluated the costs to these facilities of achieving zero discharge of their PFPR wastewaters given that they have not been achieving zero discharge to date. The impact evaluation for these facilities addresses only facility-level impacts.

The analysis of facility-level impacts relies heavily on the responses to the survey administered to a portion of the PFPR industry by EPA[1]. As discussed in Chapter 3, EPA sent a questionnaire requesting technical and economic information to 707 PFPR facilities in 1990. The questionnaire consisted of an introduction, a section requesting technical information (Part A), and a section requesting financial and economic data (Part B). Six hundred and ten PFPR facilities were selected from the population of 3,241 facilities thought to be engaged in PFPR activities. The sample facilities were identified largely through the FIFRA and TSCA Enforcement System (FATES) database. The sample was stratified by classifying PFPR products as fungicides, herbicides, insecticides, other products, or combinations thereof. Additional strata were defined by production, measured in pounds. Within each

[1]The Survey was conducted under the authority of Section 308 of the Federal Water Pollution Control Act (the Clean Water Act).

stratum, the population was randomly sampled.[2] In addition, 92 pesticide manufacturing facilities were sent a questionnaire. For ease of reading, the remainder of this report relates data extrapolated to the entire PFPR population and does not report data for the sample unless otherwise indicated.

Questionnaire responses indicated that 2,404 facilities remained in the PFPR business as of 1990 (the year the Survey was conducted). An estimated 1,794 of these facilities both remained in business as of 1990 and use water in their PFPR operations.[3] An estimated 656 of these facilities discharge water directly or indirectly from their PFPR operations. These 656 facilities are therefore the facilities that may be subject to cost increases as a result of the effluent limitations guidelines and standards.

The remainder of this chapter is organized as follows. An economic model of the PFPR industry is developed in Section 4.1. Section 4.2 describes the measures used to assess economic impacts upon PFPR facilities, and Section 4.3 provides the detailed impact calculations. Section 4.4 concludes the chapter with a presentation of the facility impact results.

4.1 Economic Model

Before presenting the specific model used in the analysis to estimate post-compliance costs, prices, and quantities, a brief overview of the conceptual problem is provided.

Generalized Model of the PFPR Industry

The model of the PFPR industry focuses on the short run. The focus on the short run, by definition, limits facilities' and firms' options for responding to increased costs for pollution control and is therefore conservative (i.e., it tends to overstate impacts). For example, in the short run, firms cannot register new products or make major modifications to physical plants. They are free, however, to decrease or increase quantities produced, or change the production mix when faced with new pollution control requirements.

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[2]See the Technical Development Document for additional information on the sample design.

[3]It is possible that facilities producing only solvent-based pesticides discharge solvents to surface waters. In the vast majority of cases, however, solvents are recovered and reused. The proposed rule would therefore not affect these facilities and they are not included in the analysis.

Each facility must decide the quantity of each registered pesticide product to produce, given certain technological and capacity constraints. Different pesticide products may be produced easily at the same facility if, for example, they vary only in concentration. PFPR equipment is typically flexible enough that the facility may use it to produce a variety of products, perhaps with minor adjustments or modifications. A producer may also elect to use a facility at a higher level of capacity (perhaps by adding an additional shift), thereby increasing the production of one or more pesticides.

In addition to incorporating the short-run options, the model must capture the nature of regulatory compliance costs and their effect on production decisions. Ideally, these costs are a function of the production mix. For example, different technological controls may be required if a facility decides to produce pesticide i instead of pesticide j. A facility may also find that the same controls may be used for two different pesticides, so that the incremental control costs of producing pesticide i may be very small as long as pesticide k is also produced.

Given all these considerations, the profit maximizing problem for facility f can be depicted as:

$$\Pi_f = \sum_{i=1}^{n} P_i(Q_i,\ i=1,m) \times Q_{if} - C_{if}(Q_{if}) - EC_{if}$$

where:

Π_f = profit of facility f;

$P_i(Q_i, i=1,m)$ = price of product i, a function of total industry production of product i (Q_i), and industry production of all products competing with product i;

Q_{if} = production of product i by facility f (The sum of the Q_{if}'s, f=1,N equals Q_i);

$C_{if}(Q_{if})$ = total cost to facility f of producing product i; and

EC_{if} = total pollution control costs to facility f required under the proposed option to produce product i.

Each facility in the industry attempts to maximize profits simultaneously. The equilibrium solution is represented by the matrix Q (total industry production), whose typical element Q_{if} represents facility f's production of product i, that solves the profit maximizing problem for all facilities simultaneously.

Data limitations, however, require that the model be simplified. In particular, the entire production choice set (of registered products) available to each facility is unknown. Given this limitation, it is assumed that a facility may respond to a new effluent guideline only by decreasing current production of the pesticides currently produced. This assumption neither allows for the production of new products (i.e., those that were not being manufactured before the guidelines were introduced), nor does it allow one PFPR facility to benefit from the compliance costs and subsequent decrease in pesticide production of another PFPR facility. Note that this assumption is extremely conservative, since it severely limits the options available to each facility and thus overstates the impact of the regulation. A detailed analysis of firm-level pesticide registrations would be necessary to relax this assumption.

Further, given the extremely large number of registered pesticide products, compliance costs cannot be allocated to specific products. Rather, compliance costs are derived in aggregate for PFPR operations.[4] Facility decision making processes are modeled for PFPR operations as a whole, not for individual pesticide products. Built on this generalized model, the applied economic model of the PFPR industry is described below.

Applied Model of the PFPR Industry

The construction of a model of the PFPR industry, and the simulation of the effects of new effluent limitation guidelines and standards, require the following basic steps:

(1) Define the markets to be analyzed;

(2) Determine the basic model of market structure;

(3) Estimate baseline revenue for each facility;

(4) Estimate baseline costs for each facility;

[4]See the Technical Development Document for a complete discussion of the methodology by which compliance costs are estimated.

(5) Adjust baseline costs for other government regulations;

(6) Project facility compliance costs;

(7) Estimate post-compliance prices; and

(8) Calculate post-compliance cash flow for each facility.

These steps are explained below.

Markets to be Analyzed

Although a market is defined by competing products, not all pesticides compete with each other at the consumer level. For example, pesticides used as herbicides on corn do not compete with pesticides used as fungicides on residential gardens. Neither do all pesticides used as herbicides compete with one another. Because pesticides compete with each other individually or in groups rather than as a whole, EPA defined clusters of PAIs based on competition among the end-use pesticide products containing those PAIs.

The classification of PAIs into clusters was done by EPA's Office of Pesticides Programs (OPP) for its regulatory purposes. In 1980, the OPP defined pesticide markets to ensure that EPA regulated competing products on roughly the same schedule, so that one pesticide does not have an unfair advantage over another. As described in Chapter 3, the pesticide markets were defined as clusters of PAIs that are substitutes for a specific end-use. For example, insecticides used on corn represent one market or cluster. The OPP assigned each of the PAIs registered in 1980 to one of 48 separate clusters.[5] With the help of the OPP, EPA's Office of Water made minor adjustments to these pesticide clusters for use in the EIA for effluent limitations for pesticide manufacturers. First, PAIs registered after 1980 were assigned to clusters. In addition, clusters were split when a wide range of price elasticities of demand were estimated to exist within a single cluster and it was possible to further differentiate corresponding PAI uses within the cluster (see Appendix C). Five clusters were split, increasing the number of clusters from 48 to 57.[6]

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[5]In the OPP's classification, each PAI appeared in only a single cluster, since the purpose of the classification was to develop a regulatory schedule for each PAI.

[6]One of these clusters was split after the EIA for pesticide manufacturers was released, to distinguish between the distinct uses for sporicidal and non-sporicidal disinfectants.

Finally, PAIs were allocated to more than one cluster when the PAI was known to be used in substantial quantities for different end uses. The 272 PAIs originally considered for regulation, along with numerous non-272 PAIs, are mapped into the 57 separate clusters, as listed in Appendix B.

It would be preferable to analyze the PFPR industry on a formulated product level, analogous to the PAI-level and cluster-level analyses performed in the pesticide manufacturer effluent limitations EIA. Data limitations, however, and the desire to limit industry response burden, do not allow EPA to analyze the PFPR industry on a formulated product level, for several reasons. First, the PFPR industry formulates PAIs into many thousands of pesticide products, often combining several PAIs with different functions into one product. It is not always possible, therefore, to group formulated pesticide products into individual clusters. Further, industry would have been heavily burdened by supplying cost and price information for each pesticide product. Instead, revenue information was requested in the Survey from the formulating, packaging, or repackaging of all pesticides. (Revenue data did distinguish between revenue from pesticides containing one of the 272 PAIs originally considered for regulation and pesticides containing only other PAIs.) To promote the accuracy and decrease the burden of industry response, cost data were requested only at the level of the facility.[7] Given the difficulties of analyzing business decisions on the basis of individual PAIs or formulated products, most of the analysis is conducted for all PFPR operations or for the entire facility.[8]

Basic Model of Market Structure

Assumptions made about market structure have important implications for empirical modeling. For example, the standard model of supply and demand (i.e., perfect competition) necessarily predicts at least one facility closure if production costs increase. (When the supply curve shifts up to reflect the cost increase, quantity must decrease and the marginal facility must close.) Several factors suggest that markets for pesticide products are highly competitive. First, the production data obtained from FATES and the Survey indicate that, for most clusters, multiple facilities sell pesticide products formulated from PAIs from the cluster. Second, numerous facilities may formulate and package products containing the same PAI. In contrast, among manufacturers, a PAI typically is produced by only one manufacturer who

[7]Industry had indicated that some categories of costs, such as labor expenses, are not tracked at either the PAI or pesticide product level.

[8]Certain sections of the analysis, however, such as the estimates of the price elasticity of demand, are built on the PAI clusters, because no data exist on elasticities for formulated pesticide products.

can sell that PAI to many different PFPR facilities. Finally, the existence of contract tolling in the PFPR industry, where small PFPR facilities may formulate products owned by larger firms to smooth capacity constraints, serves to increase the number of facilities formulating a given product.

At the same time, other factors suggest that the PFPR industry is less than perfectly competitive, exhibiting both elements of product differentiation and monopolistic competition. Specifically, firms tend to produce differentiated products that compete, but that are not perfect substitutes; therefore, product differentiation exists within even closely competitive markets. For example, different pesticides, produced using PAIs within the same cluster, may be differentially effective on a regional basis due to climate differences. Pesticides may also vary in their effectiveness on different varieties of pests and on different varieties of crops. The structure of the pesticide markets can therefore generally be described as competitive with differentiated products. The PFPR industry also has some monopolistic components. In particular, the existence of vertically integrated firms that both manufacture PAIs and formulate products containing those PAIs indicates an aspect of monopolistic competition. In an industry with these characteristics, different prices may exist for similar products within a single market. Firms must compete for customers in terms of both price and the kinds of products they sell. Also, new firms may enter the industry with a new product whose differentiation from its competitors' products may make it profitable.

Baseline Revenue for Each Facility

Baseline revenues, both for the total facility and for only its PFPR operations, are required to evaluate impacts of the regulation. Facility baseline revenue is calculated as the three-year average (1986, 1987, and 1988) of facility revenue as reported in the PFPR Survey (question 8 of Section B). Revenue from PFPR operations is similarly calculated as the three-year average of reported Survey data (question 8 minus question 7 of Section B). These revenues include PFPR of all pesticides, pesticide contract work, and revenue from services that include the provision of pesticide products.

Baseline Costs for Each Facility

Baseline facility and PFPR costs are also required for the analysis. Baseline facility costs are calculated as the three-year average of facility costs as reported in the Survey (question 19 of Part B). In contrast to revenues, facilities were not asked to report costs specific to PFPR operations. Industry comments on the pre-test of the Survey indicated that some costs, such as labor, are not maintained on

a product-specific basis, and that such cost estimates would be very burdensome to generate and of only limited accuracy. The Information Collection Request (ICR) for the final PFPR Survey recognized that "some expenses are difficult to allocate to specific products within a facility." The ICR stated that "information is requested for the entire facility and EPA will allocate expenses to pesticide and non-pesticide product lines in a uniform manner." The analysis therefore assumes a constant profit margin across a facility's operations. PFPR costs are calculated as:

$$PC = FC \times \frac{PR}{FR}$$

where:

PC = three-year average PFPR-related costs;
FC = three-year average facility costs;
PR = three-year average pesticide revenue; and
FR = three-year average facility revenue.

Baseline Cost Adjustments Due to Other Government Regulations

Since 1988 (the Survey base year), the EPA has promulgated three regulations affecting PFPR/manufacturing facilities whose compliance costs are not reflected in the Survey data. These regulations are (1) Resource Conservation and Recovery Act (RCRA) land disposal restrictions (40 CFR 268), (2) effluent limitations for the Organic Chemicals, Plastics, and Synthetic Fibers (OCPSF) industry (40 CFR 414)[9], and (3) effluent limitations for the pesticide manufacturing industry (40 CFR 455). Also, Congress passed the Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA) Amendments of 1988, most of which became effective in December, 1988. The costs associated with the amendments therefore may not be included in the Survey responses. These amendments affected all PFPR facilities. To represent the costs faced by the PFPR industry accurately, the costs associated with each of the above

[9]Although effluent limitations for the OCSPF industry were promulgated in 1987, the rule was not in effect prior to the Survey base year of 1988.

regulations are added to reported facility costs. The regulations and their costs to the PFPR industry are discussed below.[10]

Hazardous and Solid Waste Amendments. The *1984 Hazardous and Solid Waste Amendments* (HSWA) to RCRA had several new provisions, some of which went into effect after 1988. In particular, the Land Disposal Restrictions included in HSWA are likely to have affected manufacturing/PFPR facilities. These regulations prohibit land disposal of hazardous waste until it has been treated to the level achieved by the Best Demonstrated Available Technology.

Congress directed the EPA to write the rules in three stages. Stage 1 regulated solvents and dioxin and was promulgated in 1986. Stage 2, signed July 8, 1987, regulated a group of wastes known as the "California list." For Stage 3, the remaining hazardous wastes were divided into thirds, and signed into regulation on August 17, 1988; June 23, 1989; and May 8, 1990. Each of these rules became effective shortly after promulgation.

Many PFPR/manufacturing facilities generate RCRA-listed wastes as a result of PAI production, and will therefore have incurred costs of complying with the land disposal restrictions. Particularly for the Stage 3 wastes, these costs may not be included in the Survey data. For this reason, the compliance costs estimated for Stage 3 hazardous wastes were added to the baseline fixed costs for manufacturing/PFPR facilities. Because Stages 1 and 2 of the rule became effective by 1987, the costs associated with these stages are assumed to be reflected in the Survey data.

The cost estimates were developed from two sources. The 1986 Survey of Hazardous Waste Generators (GENSUR) conducted by the EPA's Office of Solid Waste (OSW) was used to determine the waste streams for pesticide manufacturing facilities. These data were combined with cost data from the Regulatory Impact Analyses (RIAs) for the land disposal rules. Of the 47 manufacturing/PFPR facilities remaining in the PFPR business as of 1990 that use water, 18 facilities were included in the GENSUR data base. The GENSUR data are organized by facility and waste stream. For each facility and waste stream, the following data were available:

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[10]Regulations not effective until 1988 are added to the costs of each of the Survey years (1986, 1987, 1988). This may overstate 1988 costs in some cases. Conversely, costs resulting from regulations that became effective in 1987 and 1986 are not added to the baseline; therefore, the analysis may understate the costs in those years.

(1) RCRA waste codes (up to 10 codes per waste stream);

(2) Quantity of waste generated on-site and quantity disposed of off-site;

(3) On-site waste management train (up to 10 waste management procedures); and

(4) Off-site disposal train.

For purposes of estimating costs associated with the land disposal restriction rules, the data were first scanned to select only those components dealing with land disposal (i.e., landfill, surface impoundments, and waste piles). The RIAs for the first and last third of the Stage 3 Land Disposal Restrictions included total gallons of waste to be treated and total incremental costs by baseline management practice and RCRA waste code. This allows calculation of unit (per gallon) costs for each RCRA waste by management practice.[11]

For each pesticide manufacturing facility and waste stream, management and RCRA waste codes were matched to the corresponding codes in the RIA to obtain unit costs for each facility, waste stream, and management combination. These unit costs were then multiplied by the appropriate quantities (i.e., gallons of each waste at each facility managed, using each relevant method) to estimate a total cost for each RCRA rule.

Costs of complying with the middle third of the Stage 3 rule were not available in similar detail, because Stage 3 was not considered to be a major rule. The available information included total quantity of covered waste generated and total incremental costs by baseline management practice (i.e., not broken down by RCRA waste code). It was necessary, therefore, to assume that the wastes covered by this rule had the same unit costs. Given the small number of wastes in this group, this assumption is not expected to affect the analysis substantially.

Eighteen PFPR/manufacturing facilities that were in business as of 1990, and use water, were projected to incur costs due to the RCRA rules described above. Total annualized Stage 3 RCRA after-tax costs for these facilities are estimated to be $312,000, in 1988 dollars. Not all of these costs may have been borne by the PFPR/manufacturing facilities, however; a portion may have been passed through

[11]The RIA for the first third examined two alternatives and two scenarios within the first alternative. The costs for Alternative A, Scenario I, were used because this option was closest to the final rule.

to customers in the form of higher prices. Since there exist no readily available data about the portion of costs likely to be passed through to consumers, the analysis assumes that the burden of the cost increase is split evenly between the facilities and the customers. In other words, the facilities are assumed to bear 50 percent of the cost increase.[12] These costs, totalling $156,000, were added to the baseline fixed costs of the affected facilities.

OCPSF Effluent Limitations Guidelines and Standards. The final *OCPSF Effluent Limitations*, issued November 1987, established effluent limitations guidelines and standards for OCPSF process wastewater. Compliance with the rule was required by no later than November, 1990.[13] The regulations for direct dischargers covered about 60 priority pollutants; those for indirect dischargers covered 47 priority pollutants. For purposes of the regulation, OCPSF process wastewater was defined to include establishments, or portions thereof, whose products are classified in any one of five SIC codes: SIC 2821 (plastics and resin materials), SIC 2823 (cellulosic manmade fibers), SIC 2824 (non-cellulosic synthetic fibers), SIC 2865 (tar crudes, cyclic intermediates, dyes and organic pigments) and SIC 2869 (industrial organic chemicals, not elsewhere classified).

Substantial overlap exists between facilities subject to the OCPSF effluent guidelines and the manufacturer/PFPR facilities covered by the PFPR effluent guidelines. Of the 47 manufacturing facilities that are PFPR and use water, 15 also manufacture compounds regulated under the OCPSF rule. The estimated costs to comply with the PFPR rule will be incremental to those of meeting the OCPSF rule. For this reason, OCPSF costs for all manufacturing/PFPR facilities affected by both rules are added to

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[12]Note that if the facilities were assumed to bear the entire cost increase of these regulations (worst case), the analysis would yield two results. First, facilities would be more likely to have a significant impact in the baseline, possibly resulting in fewer facilities impacted by the proposed regulation. Second, facilities not impacted in the baseline would be more likely to have a significant impact post-compliance. The net effect of these two results is indeterminate. Assuming that half of the costs are borne by facilities is therefore a more balanced assumption than assuming that either all or none of the costs are borne by the facilities.

[13]In 1990, the U.S. Fifth Circuit Court of Appeals remanded certain aspects of the rule for further consideration. The Agency promulgated a revised final rule in July, 1993. Revisions were made to certain of the 19 remanded BAT Subpart J pollutants and 11 of the 13 PSES pollutants. Also, PSES were eliminated for 2,4-dimethylphenol and phenol due to adequate treatment at POTWs. Independent of the litigation, the EPA corrected criteria for designating metal- and cyanide-bearing wastewater streams. Facilities subject to these portions of the rule are required to comply as of July 1996, or when their existing permit comes up for renewal, whichever data occur later. Costs were not recalculated for the July, 1993, rule due to the advanced stage of the PFPR analysis. These cost changes would not be expected to affect the conclusions of the analysis.

the economic baseline. Annualized OCPSF after-tax costs for these 15 facilities total $10.8 million, in 1988 dollars. Because no data on the portion of costs likely to be passed through to customers are readily available, the analysis again assumes that the burden of the cost increase is split evenly between the facilities and the customers. The facilities are assumed to bear 50 percent of the cost increase, resulting in total annualized costs borne by the facilities of $5.4 million.

Pesticide Manufacturer effluent limitations guidelines and standards: PAI price increases. Two effects of effluent guidelines for pesticide manufacturers are included in the analysis. First, a portion of the compliance costs resulting from the effluent guidelines are expected to be passed on to the manufacturers' customers — that is, PFPR facilities. The costs to facilities for purchasing certain PAIs are therefore expected to increase. The average price increase for each PAI is calculated as the sum of the increase in price for that PAI at each facility that manufactures the PAI multiplied by the proportion of total production of the PAI at each facility. In other words, the price increase of a PAI is the weighted average of the price increases over all manufacturing facilities producing the PAI, where the weights are each manufacturer's share of total production of that PAI. Algebraically, the equation is:

$$API_i = \frac{\sum_{j=1}^{n} PI_{i,j} \times PQ_{i,j}}{\sum_{j=1}^{n} PQ_{i,j}}$$

where:

API_i	=	the average price increase per pound of PAI, i;
$PI_{i,j}$	=	the price increase per pound of PAI, i, at manufacturing facility, j; and
$PQ_{i,j}$	=	pounds of PAI, i, produced at manufacturing facility, j.

Increases in costs to each PFPR facility are calculated as the amount of each PAI the facility used multiplied by the average price increase for each PAI. The equation is:[14]

[14]This calculation of cost increase assumes that all PAIs are purchased domestically and therefore overstates the impact on PFPR facilities.

$$CI_k = \sum_{i=1}^{n} API_i \times q_{i,k}$$

where:

CI_k = the total PAI cost increase incurred by PFPR facility, k; and

API_i = the average price increase per pound of PAI i,

$q_{i,k}$ = the quantity of PAI i, used by PFPR facility, k.

The resulting total estimated PAI price increases for the 634 PFPR facilities in business as of 1990 that use water and that would be regulated under PSES are $3.4 million per year. Consistent with the handling of the regulatory costs discussed above, half of these costs are assumed to be borne by the facilities.

Pesticide manufacturer effluent limitations guidelines and standards: PFPR facility cost increases. The second effect of the effluent limitations guidelines for pesticide manufacturers is that pesticide manufacturers are expected to bear a portion of the compliance costs. Not all of the compliance costs associated with the pesticide manufacturer effluent limitations are expected to be passed on to PFPR facilities in the form of higher PAI prices. These cost increases are calculated for each pesticide manufacturing facility as follows:

$$C_j = \sum_{i=1}^{n} C_{i,j} \times (1-PP_i)$$

where:

C_j = Annual compliance costs of pesticide manufacturers effluent limitations borne by facility j;

$C_{i,j}$ = Annual compliance costs for PAI, i, at facility j; and

PP_i = Percentage of PAI i compliance costs assumed to be passed through to customers.

Additional annualized after-tax costs totalling $5.6 million are added to the baseline costs for the 47 PFPR/manufacturing facilities in business as of 1990 that use water.

FIFRA amendments. The FIFRA Amendments of 1988 strengthened the EPA's authority in several major areas of pesticide regulation. These new provisions, effective December 24, 1988, affected the costs incurred by PFPR facilities by requiring pesticide re-registration fees and annual maintenance fees. Re-registration fees are levied on manufacturers of PAIs. For each active ingredient intended for use on major food or animal feed crops, registrants are required to pay re-registration fees totalling $150,000. For PAIs not intended for major food or feed uses, registrants are required to pay a fee between $50,000 and $150,000 (EPA, 1988 "Highlights of the 1988 Pesticide Law"). PAI fees are apportioned among registrants of each PAI based on market share. Since this is a one-time fee, however, these costs are not added to the baseline.

In contrast, annual maintenance fees are added to the baseline costs. Unlike the re-registration fee, which is charged to PAI manufacturers, the annual maintenance fee is assessed for each individual pesticide product. The fee amount paid generally increases with the number of registrations held (see Fee Table A, in "Instructions to Registrants for Filing 1993 Pesticide Maintenance Fees"). A multi-facility firm may register the products used by its facilities separately or jointly, at its discretion. Depending on the number of facilities and products, it may be advantageous for the firm to file a single form listing all of its registrations, or to file separate forms for some or all of its facilities. For the first registration, the maintenance fee is $650. Each additional registration costs $1,300, to a maximum of $55,000 for 50 or fewer registrations and $95,000 for any number of registrations.

The FIFRA maintenance fee schedule allows small businesses to pay lower filing fees than other businesses if they hold more than 30 registrations. The definition of "small" used in FIFRA is a registrant that employed 150 or fewer personnel as of December 1, 1992, and during the three-year period ending on December 31, 1991 had an average annual gross revenue from chemical sales that did not exceed $40 million. For purposes of determining whether it is a small business, a registrant must include its own as well as any corporate parents' or subsidiaries' employees and chemical sales. Because the Survey does not include any data on *chemical* sales at the firm level, and no secondary sources supplying this information were identified, the employment criterion alone is used in the analysis to assign lower costs to small entities. If the facility is a single-facility firm, employment data are available from

the Survey. Employment data for multi-facility firms were obtained from *The Million Dollar Directory*.[15] If employment data for a firm were not known, it was assumed not to be a small business, providing a conservatively high estimate of FIFRA maintenance fees.

Data on the number of products containing the original 272 PAIs used at each surveyed facility were obtained from the FATES database and from the Survey. Because the Survey sample does not necessarily contain all facilities of a multi-facility firm, the analysis calculates FIFRA maintenance fees assuming each facility pays the fees for all products it uses. This may have the effect of overstating FIFRA costs to multi-facility firms, since multi-facility firms may combine their registrations. Because Survey respondents were asked to confirm the number of 272 PAI products, not the total number of pesticide products, the estimated FIFRA maintenance costs may understate the actual costs.

Based on the number of registered products reported by each PFPR facility, the analysis includes the annual maintenance fees in baseline costs. The estimated FIFRA maintenance costs are deflated to 1988 dollars using the CPI deflator. Total after-tax FIFRA maintenance fees estimated for the 1,794 PFPR facilities in business as of 1990 that use water are $6.0 million per year. Consistent with the handling of RCRA and OCPSF, half of these costs ($3.0 million) are assumed to be born by the facilities and half are assumed to be passed through to customers in the form of higher prices.

Estimated Facility Compliance Costs

Full details of the methods by which the costs of complying with the regulatory options were estimated can be found in the Technical Development Document. A summary of the cost components and the annualization method are presented below.

Compliance costs were projected at the facility level. For facilities that both manufacture PAIs and perform PFPR operations, the compliance costs are based only on the PFPR operations of the facilities. These costs will be incremental to compliance costs for the manufacturing operations of the facility. The cost estimates for PFPR/manufacturing facilities are based on the assumption that, whenever

[15]See the regulatory flexibility analysis in Chapter 5 for additional information on firm counts and estimating firm-level employment.

possible, facilities will build on existing treatment. Cost estimates for non-manufacturing PFPR facilities are based on the assumption that there is no existing treatment equipment in place.[16]

For the regulatory options considered, two categories of compliance costs were evaluated: capital costs and operating and maintenance costs (including compliance self-monitoring and sludge disposal). The capital costs are one-time "lump sum" costs; the operating and maintenance costs are projected on an annual basis. Capital costs were annualized (assuming that the capital equipment has a productive life of ten years) using the real weighted average cost of capital (discussed below). The equation for calculation of total annualized costs is:

$$ACC = OM + \frac{CPT}{PVF}$$

where:

ACC = annualized compliance costs in 1988 dollars;

OM = estimated annual operating and maintenance costs;

CPT = estimated capital costs;

PVF = present value factor = $\Sigma_{i=1,10}\ 1/(1 + RWACC)^i$; and

RWACC = real weighted average cost of capital.

Annualized compliance costs were added to facility baseline costs to perform the post-compliance analyses.

Cost of capital. The cost of capital is the rate at which a firm obtains funds for financing capital investments. The cost of capital to a particular firm depends on how the investment is financed. One option, equity financing, is taken when a firm issues stock or retains earnings. A second option involves acquiring additional debt, through bonds, notes, or short-term commercial paper. Typically, acquiring debt is the less expensive option. As a firm expands its debt holdings, however, the cost of debt increases, forcing the firm to reach an equilibrium between debt and equity financing. It is assumed in

[16]For the vast majority of facilities, this is a valid assumption. The Survey contained very few non-manufacturing facilities that had an effective treatment system in place for the treatment and removal of PAIs from indirectly discharged wastewater.

this analysis that firms use some combination of debt and equity to finance compliance costs. The measure of a firm's overall cost of financing a capital investment, based on the percentage values of debt and equity used to finance the investment, is termed the weighted average cost of capital (WACC). Thus, the WACC is the average after-tax cost of all funds used to finance a capital investment.

The WACC can be presented in either nominal (i.e., not adjusted for inflation) or real terms (i.e., the nominal WACC is adjusted for inflation). This analysis used the real cost of capital to allow for the use of constant annual compliance costs (i.e., compliance costs that are not inflated over time). The two inputs to calculating the real WACC — nominal WACC and the inflation rate — are discussed below.

Nominal WACC. The nominal WACC was calculated by weighting the cost of equity and the cost of debt by the percentage of the investment expected to be financed by these two methods. The equation used was:

$$WACC = R(E/I) + Y(1-CT)(D/I)$$

where:

WACC	=	nominal weighted average cost of capital;
R	=	after-tax cost of equity;
E	=	amount of investment financed by equity;
I	=	total amount of the investment;
Y	=	pre-tax interest rate on debt;
CT	=	marginal corporate tax rate; and
D	=	amount of investment financed by debt.

The estimates of the nominal WACC vary by firm. The sources of values for the variables in the WACC equation vary, in some cases, based on whether the firm owns a PFPR/manufacturing facility(ies) or a facility(ies) that PFPRs but does not manufacture PAIs. The input sources and values are discussed below.

The percentages of the investment that a firm is assumed to finance through equity (E/I) and debt (D/I) are assumed to match the firm's historical mix of equity and debt investment. The mix of equity

and debt financing was specified in three different ways, depending upon the facility's ownership and business structure. First, *for all public firms,* the mix of debt and equity was gathered from each firm's annual report for 1988. Second, *private firms owning PFPR/manufacturing facilities* were assigned the median debt and equity mix of the public firms owning PFPR/manufacturing facilities in the sample. The median values were 52.2 percent debt financing and 47.8 percent equity financing. Third, *for other private firms,* the debt/equity mix was calculated using the debt/assets and equity/assets ratios from the balance sheet reported by the associated facility in the Survey. If the ratios based on reported data were not bounded by one and zero,[17] the median values of the other private non-manufacturing facilities in the sample were used. These median values are 48.5 percent debt financing and 51.5 percent equity financing. Data for these "other" private firms were not taken as the average of the public firms' data because a sharp distinction is expected between the private and public firms due to size differences. Data from the public firms are not expected to be necessarily representative of data from the private firms.

The after-tax cost of equity (R) is calculated as follows for all public firms:

$$R = i + (RM-1)\beta$$

where:

i = the risk free rate of return = 10.01 percent (calculated from the 1982-1991 average interest rate on 30-year U.S. Treasury Bonds as reported in *Statistical Abstract of the United States*, Bureau of the Census, 1989, 1992);[18]

(Rm-1)= Typical risk premium, or the rate of return on market portfolio less the rate of return on risk free investments = 8.0 percent; and

β = A measure of the risk of an individual firm compared with the market. Beta values are based directly on 1988 *Value Line Investment Survey, Part I Summaries & Indexes* specific to each firm.

For private firms owning PFPR/manufacturing facilities, the cost of equity was calculated as above, except that the beta value was set equal to the median beta value (i.e., equal to 1.175) for the

[17]Negative equity was indicated for one firm undergoing restructuring.

[18]The variable, i, represents the risk free component of the return on equity. Since equity has no maturity date, i is best calculated as the return on *long-term* Treasury Bonds rather than as the return on 10-year Treasury Bonds.

publicly-held firms owning PFPR/manufacturing facilities. For other private firms, cost of equity was estimated using the average return on the stock market from 1982 to 1991, as estimated from the *Standard & Poor's 500 Composite Stock Price Index*, assuming that all dividends are reinvested. This value is 18.08 percent.

For all firms, an estimate of the interest on loans was developed using the 1982-1991 average yield on 10-year Industrial Bonds, which equals 10.68 percent (reported in *Standard & Poor's Security Price Index Record*).[19] The marginal corporate tax rate was assumed to be 34 percent.

Real WACC. Given the nominal WACC, the real WACC is estimated as:

$$RWACC = \frac{1 + WACC}{1 + g} - 1$$

where:

RWACC = the real weighted average cost of capital; and

g = the rate of inflation = 4.02 percent.

This inflation value is the average of the annual percentage changes of the GNP implicit price deflator between 1982 and 1991 (*Statistical Abstract of the United States*, 1992).

Estimated Post-Compliance Prices

Changes in pesticide prices and demand are determined interactively in the market place. Typically, a producer will raise prices based on the expected actions of competitors and the extent to which consumers will decrease demand. Consumers will then respond to the increased prices with a drop in demand based on several factors, including the percent of their production cost contributed by the product and the availability of substitute products. Producers then examine the impact of the price increase and demand decrease on profitability and reevaluate their price. Consumers again react. This iterative process continues until producers believe they have maximized profit.

[19]Because of difficulties in interpreting them, the interest rate data reported in the Survey were not used. See the memorandum to the Administrative Record entitled "Survey Information on Capital Investments".

The main analyses of this EIA are conducted assuming that facilities are unable to pass any costs of the proposed regulation through to customers. This is an extremely conservative assumption that yields maximum projected impacts on PFPR facilities. In fact, this scenario is highly unlikely. For a zero cost pass-through analysis to represent a realistic scenario, either the supply curves for pesticide markets must be perfectly inelastic or the demand curves must be perfectly elastic. A perfectly inelastic supply curve is associated with goods for which there is a fixed supply. This is not the case for pesticide markets. Based on an analysis of the price elasticity of demand for pesticides conducted for the pesticide manufacturer EIA, demand for pesticide is generally inelastic.[20] Because supply curves for the pesticide markets are not known, however, and compliance costs are not estimated in a manner that can necessarily be associated with specific pesticide products, projecting the percentage of the compliance costs that will be passed through to customers is difficult. If the regulation is economically achievable under an assumption of zero cost pass-through, this serves as assurance that it would be economically achievable under a more realistic scenario of partial cost pass-through.

The analyses were also conducted using a price-adjustment rule in which facilities attempt to pass through half of their compliance costs to customers. This assumption, while imprecise, reflects the fact that some cost pass-through is realistically expected. The average percentage increase in price is simply calculated by dividing the annualized compliance costs by the three-year average of revenue from 272 PAI-related PFPR (sum of questions 3, 4, and 5 in Part B of the Survey.) In conjunction with the assumed increase in price, a change in facility revenues is calculated from estimated elasticity values for the mix of facility's pesticide products. The analyses based upon the price-adjustment rule resulted in facility impacts under the proposed option which were unchanged from impacts estimated under the zero cost pass-through assumption. These price-adjustment analyses are discussed in detail in Appendix F.

Post-Compliance Cash Flow

Facility cash flow consists of facility net income plus noncash expenditures. Baseline, or pre-compliance, facility cash flow was estimated based on data from the income statement reported in the Survey. Cash flow was adjusted to account for the estimated costs of complying with Federal pollution control regulations effective after 1988, the base year for the analysis. Post-compliance facility cash flow was calculated by subtracting an adjustment for compliance costs from estimated baseline cash flow.

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[20]Estimates of demand elasticities for PAIs are provided in Appendix C.

4.2 Impact Measures

The following sections present the facility-level impacts evaluated under the baseline and post-compliance scenarios.

Baseline

The baseline economic analysis evaluates each facility's financial operating condition prior to incurring compliance costs for meeting effluent limitations. The purpose of the baseline analysis is to identify PFPR facilities that are currently experiencing or are projected to experience significant financial difficulties *regardless of the promulgation of effluent guidelines*. Attribution of all financial impacts to the effluent limitations rather than to facilities' current financial problems would overstate the burden of effluent limitations.

Facility financial viability is analyzed in the baseline scenario by calculating the three-year after-tax cash flow from the Survey data, incorporating the costs of EPA regulations effective after the Survey was administered.[21] If a facility has lost cash on average over the three-year period, the facility is not expected to remain in operation and post-compliance impacts are not evaluated.

Post-Compliance Impacts

The EIA projects three categories of economic impacts that may result from regulation: facility closure, conversion of PFPR product lines to non-pesticide FPR operations, and compliance costs in excess of five percent of facility revenue. Facility closure is the most severe of the three impacts evaluated, while line conversions and costs in excess of five percent of facility revenue represent more moderate impacts. In contrast to facility closures and product line conversions, *compliance costs in excess of five percent of facility revenue* are not expected to be associated with an operational change at a facility. Compliance costs that are less than five percent of facility revenue are commonly judged to be economically achievable (see, for example, the EIAs for effluent limitations for the OCPSF and pesticide manufacturers industries). In addition, compliance costs equal to five percent of facility

[21] As discussed above, the baseline analysis included the estimated costs associated with four regulations: (1) Resource Conservation and Recovery Act (RCRA) land disposal restrictions, (2) effluent limitations for the OCPSF industry, (3) effluent limitations for the Pesticide Manufacturing Industry, and (4) annual maintenance fees set by EPA under the FIFRA Amendments of 1988.

revenues do not necessarily indicate a significant impact. This measure is counted as a moderate impact under a conservative standard that considers the possibility of such an impact.

The particular impacts evaluated for a facility are a function of the type of PFPR operations conducted at the facility and the percentage of the facility's revenue that is derived from PFPR operations. These characteristics are used as indicators of the options that management will likely consider in response to compliance costs. The grouping of facilities for evaluation of impacts is based, in part, on subcategories defined for this regulation. As previously mentioned, two subcategories are considered under this regulation. In the (remanded) 1985 effluent guidelines for the pesticide industry, all PFPR facilities were classified under Subcategory C. This regulation recognizes another subcategory that previously existed within Subcategory C: Subcategory E, applying to wastewater streams generated by Refilling Establishments. A Refilling Establishment is defined by 40 CFR Part 165 as an establishment at which the sole PFPR activity is the repackaging of pesticide products into refillable containers for the agricultural market. The application of impact measures to these subcategories, as well as the motivation for establishing Subcategory E, are discussed below.

Impact Measures for Facilities Regulated Under Subcategory C

Three impact measures were considered for Subcategory C facilities: (1) facility closures; (2) facility conversions to non-PFPR activities; and (3) compliance costs in excess of five percent of facility revenue.

Facility closures. Two groups of PFPR facilities regulated under Subcategory C would be expected to consider facility closure as a response to effluent limitations: (1) PFPR facilities that also manufacture PAIs; and (2) PFPR facilities earning a significant percentage of their revenue from PFPR activities.

PFPR facilities that also manufacture PAIs (hereafter "PFPR/Manufacturing Facilities") generally obtain a high percentage of their revenue from PFPR activities. Based on responses to the Section 308 Survey, the mean percentage of facility revenue from PFPR activities was 66.5 percent for PFPR/Manufacturing Facilities, with a median value of 90.4 percent. In addition, the manufacturing operations are integrated with the PFPR operations and additional costs may be incurred in manufacturing operations (e.g., tolling costs) if PFPR operations are discontinued.

As discussed in the preceding chapter, Other PFPR Facilities with a substantial percentage of revenue from PFPR operations (and that do not manufacture PAIs) may also consider closing the facility entirely in the face of burdensome compliance costs. This analysis assumes that these Other PFPR Facilities *that obtain at least 25 percent of their revenue from PFPR activities* will consider closing entirely.[22] This fairly low percentage of revenue was chosen so that evaluation of the most severe economic impact — facility closure — includes all facilities that might feasibly consider this alternative.

Facility conversions to non-pesticide Formulating/Packaging/Repackaging activities. Facilities regulated under Subcategory C that do not manufacture PAIs and that obtain less than 25 percent of their revenue from PFPR activities are expected to face different decisions in response to compliance costs. These facilities frequently engage in the formulating and packaging of many non-pesticide products as well as pesticide products. The facilities are typically not dependent on *pesticide* FPR, but include pesticides in the line of many chemical preparations that they formulate, package, and repackage. The production lines are not specific to pesticides, but can FPR a wide range of products. The facilities are therefore likely to consider converting their PFPR lines to the formulation of non-pesticide products rather than closing the facility or the lines if PFPR production is discontinued. Alternatively, some facilities may decide to toll out the pesticide portion of their formulating business, while retaining ownership of the pesticide product. The analysis evaluates whether these facilities would be expected to convert their pesticide lines to other formulating/packaging/repackaging operations as a result of the regulation. Because the conversion of pesticide FPR lines to other FPR operations is not generally expected to result in employment loss, such conversion is considered to be a moderate impact. To ensure that impacts are not overstated, however, EPA presents estimates of employment losses associated with the closure of PFPR lines of facilities expected to convert their PFPR lines. This is a worst case result, and EPA does not believe that such employment losses will actually occur in most cases.

[22]Ideally, the determination of whether management would consider closing a facility entirely would be based on the percentage of profit, rather than revenue, derived from PFPR activities. Because costs were not reported for PFPR activities in the Survey, however, calculation of PFPR profits is not possible.

Ratio of annualized compliance costs to revenue in excess of five percent. As an additional measure of economic effects on facilities regulated under Subcategory C, the annualized compliance costs are compared to facility revenue for each facility. As discussed above, costs in excess of five percent of facility revenue are said to result in a moderate economic impact.

Subcategory E Facilities

For Subcategory E Facilities (or Refilling Establishments), the only economic measure evaluated is compliance costs as a percentage of revenue. As discussed in Chapter 3, Refilling Establishments constitute a distinct set of facilities within the PFPR industry. An estimated 46 percent of the facilities potentially covered by the PFPR regulation are classified as Subcategory E facilities. These facilities do not formulate or package pesticides, but maintain bulk storage tanks for pesticides and distribute the formulated product in refillable containers to farmers. As presented in Chapter 3, most Refilling Establishments surveyed reported a primary SIC code of #5191, which characterizes the establishments as "primarily engaged in the wholesale distribution of animal feeds, fertilizers, agricultural chemicals, pesticides, seeds, and other farm supplies, except grains."[23] In keeping with this line of business, typical ownership of Refilling Establishments differs from that of other PFPR facilities. An estimated 29 percent of Refilling Establishments are owned as a cooperative, e.g., a group of farmers who purchase and distribute pesticides among themselves. In contrast, only two percent of other PFPR facilities have a cooperative form of ownership.

In general, Refilling Establishments have relatively low facility revenue. The estimated mean revenue for Refilling Establishments is $4.8 million per year, in contrast to $16.3 million per year for the remainder of the industry. Also, Refilling Establishments derive only a small percentage of their revenue from pesticide repackaging. The mean percentage of revenue from PFPR activities is 15 percent, with a median value of six percent. Also, the other activities conducted at these facilities do not depend on pesticide packaging. Therefore, for this subcategory, closure of the facility would not be expected in response to compliance costs and no analysis of facility closure is conducted.

[23]In contrast, most Subcategory C facilities reported their primary SIC code as #2842: "Establishments primarily engaged in the manufacture of furniture, metal, and other polishes".

Refilling Establishments have simple production lines, typically consisting of one or more bulk tanks purchased specifically to hold pesticides. The investment in the "production line" is minimal — the average market value of the production line for the Surveyed facilities is $3,800. Alternative uses of the tank are limited and unlikely to provide significant profits. Most owners of Refilling Establishments are therefore not expected to convert their tanks to an alternative use and no analysis of production line conversion is conducted.

The economic returns to Refilling Establishments may, however, be affected by compliance with the proposed regulation. The analysis evaluates the extent of potential impacts by comparing annualized compliance costs to facility revenue. Costs in excess of five percent of the facility's revenue are characterized as a significant economic impact. Table 4.1 presents some of the characteristics that distinguish Refilling Establishments from other PFPR facilities.

Table 4.2 summarizes the impact measures considered in the analysis.

4.3 Calculation of Impacts

This section provides the methods and equations used to analyze facility closure, product line conversion, and compliance costs in excess of five percent of facility revenue.

Facility Closure

A decision to close a facility is typically made at the firm level. The firm holds pesticide registrations and can consider transferring both pesticide and other products among facilities. In general, a facility owner (i.e., a firm) faced with pollution control requirements must decide whether to make the additional investment in pollution control, to change the products produced at the facility (pesticide products as well as non-pesticide products), or to liquidate the facility. Because data on other products to which a facility may convert are unavailable or limited, this analysis assumes that either the pollution control investment is made or the facility is liquidated.

Table 4.1
Estimated National Distribution of Selected Characteristics of Subcategory E Facilities vs. Other PFPR Facilities (Facilities that Use Water)

	Subcategory E Facilities	Subcategory C Facilities*
• Number of Facilities	830	942
• Most Frequently Reported SIC Code	5191 (67 %)	2842 (manufacturing furniture, metal, and other polishes) (14 %)
• Mean Percent of Revenue from PFPR	15 %	28 %
• Facility Revenue		
— mean	$ 4,757,000	$ 16,280,000
— median	$ 1,730,000	$ 3,320,000
• Estimated Market Value of Production Lines		
— mean	$ 3,800	$ 166,000
— median	$ 1,900	$ 6,000
• Ownership Type		
— cooperative	242 (29 %)	15 (2 %)
— single facility	227 (27 %)	569 (60 %)
— multi-facility	361 (43 %)	341 (36 %)
— other	0 (0 %)	17 (2 %)

* Includes only PFPR/Manufacturing and other PFPR facilities regulated under PSES that use water. Omits facilities that are directly discharging PFPR wastewater. Percentages may sum to more than 100 % due to rounding.

The evaluation of whether to close a facility is complex and involves a number of factors including:

(1) Present and expected profitability of the facility;

(2) Required capital investment in pollution control technology equipment;

(3) Expected increase in annual operating costs due to pollution control requirements; and

(4) Expected product price, production costs, and profitability of the facility after pollution control equipment is installed and operating.

Table 4.2 Analysis Methods and Impact Measures by Facility Subcategory		
Subcategory C: PFPR/Manufacturing Facility or Other PFPR Facility with ≥ 25% of revenue from PFPR (380 population facilities)	Subcategory C: Non-manufacturer and < 25% of revenue from PFPR (902 population facilities)	Subcategory E (1,122 population facilities)
1. Cash flow analysis to project facility closure	1. Comparison of ROA for PFPR with alternative asset use to project line conversion	1. Compliance costs compared to revenue
2. Compliance costs compared to revenue	2. Compliance costs compared to revenue	

Compliance Cost Adjustment

The calculation used to estimate whether or not a facility will close is intended to model the decision-making process of the owners of the facility. The calculation compares the pre-compliance profitability of the facility with the post-compliance profitability. Specifically, this calculation entails a comparison of pre-compliance after-tax cash flow to post-compliance after-tax cash flow for the facility. In the majority of cases, a rational owner would not continue operations if a facility's after-tax cash flow is negative.

Facility cash flow consists of facility net income plus noncash expenditures. Baseline, or pre-compliance, facility cash flow was estimated based on data from the income statement reported in the Survey. Cash flow was adjusted to account for the costs of complying with the RCRA land disposal restrictions, OCPSF effluent limitations, pesticide manufacturers effluent limitations, and FIFRA annual maintenance fees. As discussed above, these rules (or portions thereof) were effective after 1988, the base year for the analysis. The compliance costs associated with the rules were therefore not reflected in the Survey data. Specifically, cash flow for a facility was estimated as:

$$CFO = NI + DEP - OC(1-CT)$$

where:

CFO	=	After-tax baseline cash flow;
NI	=	Net income (i.e., after tax profits calculated from the Census);
DEP	=	Depreciation expenses (taken directly from the Census);
OC	=	Cost of compliance with other EPA regulations first effective after 1986 (RCRA land disposal restrictions, OCPSF effluent guidelines, Pesticide Manufacturers effluent guidelines and FIFRA maintenance fees); and
CT	=	Marginal corporate tax rate (assumed to be 34 percent).

Post-Compliance Cash Flow

Facilities for which *baseline* cash flow was negative (i.e., those predicted to be baseline facility closures) were not considered as potential facility closures in the *post-compliance* scenario. For the remaining facilities, however, the *post-compliance* cash flow was evaluated to project facilities that would close due to the regulation.

Under the assumption of zero cost pass through, the calculation of post-compliance cash flow requires only an adjustment for compliance costs. The compliance costs have two components: operating/maintenance costs and capital costs. Full capital costs, funded both by debt and equity are included. An annualized cost of capital is calculated by dividing the estimated capital and land investment by the present value factor. The present value factor is based on the WACC, as discussed in the section on cost of capital.[24] The facility will pay reduced taxes as a result of depreciating capital expenditures.

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[24] The real WACC is used to construct a present value factor (PVF). Multiplying annual costs by a PVF discounts investments over a fixed time period. Correspondingly, dividing present value costs by the PVF gives annualized costs over a fixed period of time. This analysis divided compliance capital and land costs by the PVF to annualize these costs. The analysis uses a ten-year discounting horizon as a conservative estimate of the typical life of the pollution control equipment. The PVF is calculated as:

$$PVF = \sum_{i=1}^{10} \frac{1}{(1 + RWACC)^i}$$

where:

PVF	=	present value factor;
RWACC	=	the real weighted average cost of capital; and

Annual operating and maintenance costs will also be somewhat offset by the corresponding decrease in taxes the facility will pay due to reduced profit. The calculation is as follows:

$$CCadj = (OM \times (1-CT)) + (\frac{1}{PVF} \times CPT) - (\frac{CPT}{10} \times CT)$$

where:

CCadj	=	Compliance cost adjustment to cash flow;
OM	=	Operating and maintenance costs of compliance;
CT	=	Marginal corporate tax rate;
PVF	=	Present value factor; and
CPT	=	Capital costs of compliance.

Post-compliance after-tax cash flow is calculated as baseline after-tax cash flow less the adjustment to cash flow for compliance costs. The equation is:

$$PCCFO = CFO - CCadj$$

where:

PCCFO	=	Post-compliance after-tax cash flow;
CFO	=	Baseline after-tax cash flow; and
CCadj	=	Adjustment to cash flow due to compliance costs.

As previously discussed, a facility with negative after-tax cash flow in the post-compliance scenario was assessed as a closure for the economic impact analysis.

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i = number of years over which costs are discounted.

Product Line Conversion

In theory, conversion of PFPR production lines to alternative non-pesticide FPR activities would be expected to occur at the point that the financial return on the assets employed in an alternative activity exceeds the return from PFPR. The most lucrative alternative activity — and the financial return from that activity — would vary for each facility based on such factors as the local/regional manufacturing activity, capacity availability, and business connections. In general, however, it is expected that alternative FPR opportunities exist in the operations characterized by SIC codes #2899 (chemical preparations) and #2842 (manufacturing furniture, metal, and other polishes). These SIC codes were the most frequently reported primary SIC codes for PFPR facilities obtaining less than 25 percent of their revenue from PFPR.

The analysis of product line conversion is based on comparing the return on assets (ROA) that would be obtained by continuing PFPR in the post-compliance scenario with the ROA obtained from activities classified in SIC 2842 (industry financial data on SIC 2899 are not readily available). The analysis assumes that the ROA achieved by 75 percent of facilities operating in SIC 2842 could reasonably be expected to be achieved by a converted PFPR line. On average over the three-year period 1986-1988, the lowest quartile ROA (defined as earnings before taxes divided by assets) was 2.9 percent for SIC 2842.[25]

The analysis of ROA is conducted in four steps: (1) calculation of baseline ROA; (2) comparison of baseline ROA to 2.9 percent; (3) calculation of post-compliance ROA; and (4) comparison of post-compliance ROA to 2.9 percent. If a facility's baseline ROA is below 2.9 percent, no further line conversion analysis is performed for the facility. If a facility's ROA for PFPR operations falls below 2.9 percent as a result of compliance costs, given that its baseline ROA is above 2.9 percent, the facility is assessed as likely to convert its PFPR production lines to other FPR activities.[26] These steps are discussed below.

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[25]Robert Morris and Associates (1991). *RMA Annual Statement Studies.*

[26]This comparison basis, although reasonable, is far from definitive. In recognition of the lack of data regarding the ROA at which facilities would convert the PFPR lines, a sensitivity analysis of the ROA conversion analysis is presented in Appendix E of the EIA.

Calculate Baseline ROA

ROA is calculated as earnings before taxes (EBT) from PFPR divided by assets associated with PFPR. EBT is calculated as revenue from PFPR minus costs from PFPR (excluding taxes). PFPR revenue is calculated as a three-year average of the sum of Survey questions 3, 4, 5, and 6 in Part B. The PFPR revenue includes revenue from tolling and services, including provision of pesticide products. As previously discussed, the Survey does not provide cost data below the facility level. This report therefore assumes a constant profit margin for all product lines in a facility and calculates costs proportionately to revenue. Algebraically,

$$PC = C \times (PR/TR)$$

where:

PC = PFPR costs net of taxes;

C = Three-year average costs for the entire facility net of taxes (including cost adjustments for post-1988 regulations);

PR = Three-year average revenues from PFPR activities; and

TR = Three-year average total facility revenues.

And,

$$EBT = PR - PC$$

where:

EBT = Earnings before taxes from PFPR operations;

PR = Three-year average revenues from PFPR activities; and

PC = Estimated three-year average PFPR costs net of taxes.

Asset values are also available only for the entire facility. The value of assets associated with PFPR is calculated by assuming constant asset productivity across all product lines. Algebraically,

$$PA = A \times (PR/TR)$$

where:

PA = PFPR assets;

A = Three-year average assets for the entire facility;

PR = Three-year average revenues from PFPR activities; and

TR = Three-year average total facility revenues.

Using the calculated EBT and PA values, baseline ROA for PFPR operations is calculated as follows:

$$ROA = \frac{EBT}{PA}$$

where:

ROA = Baseline pre-tax return on PFPR assets;

EBT = Earnings before taxes from PFPR operations; and

PA = PFPR assets.

If the baseline PFPR ROA of the facility is less than 2.9 percent, no further line conversion analysis is performed on the facility.

Post-Compliance Return on Assets

Under the zero cost pass-through assumption, the numerator of the ROA, (i.e., EBT), is adjusted by subtracting annual operating and maintenance costs, depreciation, and the average annual interest payment due to the debt component of the capital investment calculated over the ten-year assumed life of the investment.[27] The equation is:

[27]The average interest payment is chosen as a typical interest payment.

$$PCROA = \frac{EBT - OM - (CPT/10) - AIP}{PA + CPT}$$

where:

PCROA	=	Post-compliance return on assets;
EBT	=	Earnings before taxes from PFPR operations;
OM	=	Annual operating and maintenance compliance costs;
CPT	=	Compliance capital costs;
AIP	=	Facility's average annual interest payment on the debt component of compliance capital outlays for the life of the investment; and
PA	=	PFPR assets.

Average annual interest payment. The average annual interest payment is calculated as:

$$AIP = \frac{(D \times CPT) \times 0.064}{1 - (1 + 0.064)^{-10}} - \frac{D \times CPT}{10}$$

where:

AIP	=	Average annual interest payment;
D	=	Percent of compliance capital costs assumed to be financed by debt;
CPT	=	Compliance capital costs.

The value of 6.4 percent is the assumed real interest rate and was calculated from the inputs previously described for the WACC. The nominal interest rate is assumed to be 10.68 percent and the inflation rate is assumed to be 4.0 percent. OMB's recommended discount rate of 7.0 percent was also used, with no significant difference in results.

The denominator of the ROA ratio, (i.e., assets), is adjusted by adding the compliance capital outlays to baseline assets to complete the calculation of post-compliance ROA. If the post-compliance PFPR ROA falls below 2.9 percent, given that the baseline ROA was above 2.9 percent, the facility is assessed as likely to convert its PFPR production lines to other non-pesticide FPR activities.

Comparison of Annualized Compliance Costs to Revenue

The annualized compliance costs are compared to three-year average facility revenue as an indication of whether moderate economic impacts are likely. Facility revenue is obtained directly from the Survey (question 8, Part B).

4.4 Facility Impact Results

Using the methodology described above, this section presents the estimated facility impacts of the BPT and proposed PSES regulations.

Impacts under BPT: Baseline and Post-Compliance Analysis

For information purposes, economic impacts were analyzed for the sixteen direct-discharging PFPR/Manufacturing Facilities to comply with existing BPT regulations and were found to be insignificant. None of these sixteen facilities had negative three-year average cash flow in the baseline analysis, therefore none is expected to close in the baseline scenario. Because these sixteen facilities are PFPR/Manufacturing Facilities, they were evaluated for possible post-compliance facility closures. No facility closures are expected under the proposed rule.

Impacts under PSES

Baseline Analysis

The projected baseline facility impacts are shown in Table 4.3. As mentioned above, a baseline impact is said to occur if a facility's average after-tax cash flow for the three years of Survey data is negative. Twenty-two percent of facilities regulated under Subcategory C are estimated to have baseline impacts, while 20 percent of facilities regulated under Subcategory E are estimated to have baseline impacts.

Post-Compliance Analysis of PSES

Subcategory C facilities: initial options. For Subcategory C facilities, EPA initially analyzed the impacts of five possible regulatory options for PSES. The first option considered was end-of-pipe treatment based on the Universal Treatment System for the entire wastewater volume and discharge of

Table 4.3 Projected Population *Baseline* Closures for Facilities that Use Water[1] (Based on 3-year Average Negative Cash Flow)		
	Subcategory C Facilities	**Subcategory E Facilities**
Facility closures:	203	169
Total facilities:	943	830
Percentage of facilities affected:	22%	20%
1. Not including the direct discharging PFPR/manufacturing facilities.		

the entire volume.[28] The second option differentiated between two types of wastewater streams at facilities: (1) "interior" wastewater streams including drum/shipping container rinsate, interior equipment rinsate, and bulk container rinsate; and (2) "other" wastewater streams including exterior equipment and floor wash, leak and spill cleanup, safety equipment rinsate, contaminated precipitation run-off, laboratory wastewater, air pollution control wastewater, and DOT test bath water. The second option was costed for treatment and pollution prevention, based on the wastewater generated from interior wastewater streams being recycled back into the product. (See Chapter 10 for details on the economic benefits to facilities of incorporating pollution prevention measures.)

Options 3, 4, and 5 all result in zero discharge. Option 3 is based on exactly the same technology and pollution prevention practices as the second option but achieves zero discharge of all process wastewater by recycling the wastewater after treatment through the universal treatment system. Option 4 includes the pollution prevention aspects of Options 2 and 3, but achieves zero discharge based on the remaining wastewater being incinerated off-site. Option 5 is based on off-site incineration of all wastewater.

[28]The Universal Treatment System is described fully in the Technical Development Document. Briefly, such a system would have the capability to treat wastewater with hydrolysis, chemical oxidation, and activated carbon depending on the active ingredients needing to be controlled. The Universal Treatment System could also accomplish chemical/thermal emulsion breaking, which controls emulsifiers and surfactants that are added to some pesticide products as inert ingredients.

Of these options, EPA initially selected Option 3 because, as discussed in the Technical Development Document, it represents the performance achievable with the best available treatment technology. EPA's analysis shows that this option is economically achievable and, in fact, results in relatively low economic impacts. The projected facility-level economic impacts associated with each of the regulatory options are discussed below and presented in Table 4.4. As described below, EPA has ultimately decided to propose a variation of Option 3 for PSES.

Impacts of Option 1. Under Option 1, 578 Subcategory C facilities are expected to incur costs. One hundred twenty of these facilities were analyzed for possible facility closure and the remaining 458 were analyzed for line conversions. A comparison of annualized compliance cost to facility revenue was conducted for all Subcategory C facilities. The capital and annualized total costs (which include amortized capital, annual operating and maintenance, and monitoring costs) of complying with Option 1 are expected to be $79.0 million and $32.6 million, respectively. An estimated nine Subcategory C facilities are projected to close due to compliance with Option 1. One hundred seventy-one facilities are expected to incur moderate economic impacts. Total U.S. job losses are projected, in the worst case, to be 437 full-time equivalents (FTEs) as a result of the estimated impacts.

Impacts of Option 2. Under Option 2, 558 Subcategory C facilities are expected to incur costs. One hundred thirteen of these facilities were analyzed for possible facility closure and the remaining 445 were analyzed for line conversions. A comparison of annualized compliance cost to facility revenue was conducted for all Subcategory C facilities. The capital and annualized total costs (which include amortized capital, annual operating and maintenance, and monitoring costs) of complying with Option 2 are expected to be $66.1 and $27.9 million, respectively. One facility is projected to close due to compliance with Option 2. One hundred seventy facilities are expected to incur moderate economic impacts. Total U.S. job losses are projected, in the worst case, to be 426 FTEs as a result of the estimated impacts. The total annualized compliance costs under Option 2 are $4.7 million less than under Option 1, reflecting savings due to waste management disposal savings achieved under Option 2. Additional savings resulting from pollution prevention practices are discussed in Chapter 10.

Impacts of Option 3. Under Option 3, 558 Subcategory C facilities are expected to incur costs. One hundred thirteen of these facilities were analyzed for possible facility closure and the remaining 445 were analyzed for line conversions. A comparison of annualized compliance cost to facility revenue was

conducted for all Subcategory C facilities. The capital and annualized total costs (which include amortized capital, annual operating and maintenance, and monitoring costs) of complying with Option 3 are expected to be $66.1 and $27.9 million, respectively.[29] One facility is projected to close due to compliance with Option 3. One hundred seventy facilities are expected to incur moderate economic impacts. Total U.S. job losses are projected, in the worst case, to be 426 FTEs as a result of the estimated impacts. The total annualized compliance costs under Option 3 are $4.7 million less than under Option 1, reflecting savings due to waste management disposal savings achieved under Option 2. Additional savings resulting from pollution prevention practices are discussed in Chapter 10.

Impacts of Option 4. Under Option 4, 558 Subcategory C facilities are expected to incur costs. One hundred thirteen of these facilities were analyzed for possible facility closure and the remaining 445 were analyzed for line conversions. A comparison of annualized compliance cost to facility revenue was conducted for all Subcategory C facilities. The capital and annualized total costs (which include amortized capital, annual operating and maintenance, and monitoring costs) of complying with Option 4 are expected to be $18.4 and $286.5 million, respectively. Seven Subcategory C facilities are projected to close due to compliance with Option 4. One hundred ninety-three facilities are expected to incur moderate impacts. Total U.S. job losses are projected, in the worst case, to be 1,113 FTEs as a result of the estimated impacts.

Impacts of Option 5. Under Option 5, 578 Subcategory C facilities are expected to incur costs. One hundred twenty of these facilities were analyzed for possible facility closure and the remaining 458 were analyzed for line conversions. A comparison of annualized compliance cost to facility revenue was conducted for all Subcategory C facilities. The capital and annualized total costs (which include amortized capital, annual operating and maintenance, and monitoring costs) of complying with Option 5 are expected to be $21.0 and $360.2 million, respectively. Seven Subcategory C facilities are projected to close due to compliance with Option 5. Two hundred seventeen facilities are expected to incur moderate economic impacts. Total U.S. job losses are projected, in the worst case, to be 1,173 FTEs as a result of the estimated impacts.

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[29]Note that the compliance costs projected for Options 2 and 3 are identical because the costs of reusing wastewater are assumed to approximate the costs of disposing of wastewater.

Table 4.4 summarizes the estimated costs and impacts of these options.

Table 4.4
National Estimates of Economic Impacts upon Subcategory C Facilities
(Assuming Zero Cost Pass-Through)

	Option 1	Option 2	Option 3	Option 4	Option 5
-Facilities Incurring Costs	578	558	558	558	578
-Total Capital Compliance Costs (million of dollars)	$79.0	$66.1	$66.1	$18.4	$21.0
-Total Annualized Compliance Costs (millions of dollars)	$32.6	$27.9	$27.9	$286.5	$360.2
-Facility Closures: (Severe Economic Impacts)	9	1	1	7	7
-Facilities Incurring Moderate Economic Impacts	171	170	170	193	217
-Worst Case Expected Job Losses (FTEs)	437	426	426	1,113	1,173

Identification of differential impacts. As shown above, Option 3 is economically achievable when viewed across all Subcategory C facilities. EPA was aware through discussions with industry, however, that certain segments of the industry exhibit distinctive technical and market characteristics. In particular, industry identified the institutional/commercial market for pesticide products as having unique technical and market characteristics. It was not clear *a priori* that given these characteristics, the regulation would result in a disproportionate economic burden on the facilities in the institutional/commercial market.

As discussed in Chapter 5, in analyzing the regulatory alternatives applicable to Subcategory C facilities pursuant to the Regulatory Flexibility Act, EPA determined that the costs associated with installing treatment systems to recycle non-interior wastewater sources will cause disproportionate economic impacts at certain PFPR facilities but the treatment would remove only a very small amount of toxic pollutants at these facilities. These facilities are distinguished from other PFPR facilities in several ways: they are typically small businesses, participate to a large degree in the

institutional/commercial market, receive a relatively small share of total revenue from PFPR activities, and more often use certain active ingredients to formulate sanitizer products.[30]

On the basis of these distinguishing characteristics, EPA defined a modification to Option 3, namely **Option 3/S**, as the preferred regulatory alternative. **Option 3/S** corresponds to Option 3 except that certain non-interior source wastewater streams are exempted from the regulatory requirements. Specifically, for those facilities that formulate, package, or repackage sanitizer active ingredients and whose sanitizer production is less than 265,000 pounds per year, *the zero discharge requirement would not apply to physically separate, non-interior wastewater streams that contain only designated sanitizer PAIs.*[31] These non-interior wastewater streams include exterior equipment and floor wash, leak and spill cleanup, safety equipment rinsate, contaminated precipitation run-off, laboratory wastewater, air pollution control wastewater, and DOT test bath water. The *zero discharge requirement would apply to the interior wastewater streams of these facilities including discharge from cleaning the interiors of drum/shipping containers, bulk containers, and other equipment.*

Impacts of Option 3/S. Under Option 3/S, 529 Subcategory C facilities are expected to incur costs. One hundred thirteen of these facilities were analyzed for possible facility closure and the remaining 416 were analyzed for line conversions. A comparison of annualized compliance cost to facility revenue was conducted for all Subcategory C facilities. The capital and annualized total costs (which include amortized capital, annual operating and maintenance, and monitoring costs) of complying with Option 3/S are expected to be $63.0 and $26.1 million, respectively. One facility is projected to close due to compliance with Option 3. One hundred thirty-six facilities (20 percent fewer than under Option 3) are expected to incur moderate economic impacts. Total U.S. job losses are projected, in the worst case, to be 355 FTEs as a result of the estimated impacts (17 percent fewer than under Option 3).

Table 4.5 compares the impacts projected under Option 3 and 3/S, providing detail for facilities with wastewater streams containing only sanitizer PAIs, and thus eligible for the sanitizer PAI exemption.

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[30]For further details, see Chapter 5, Regulatory Flexibility Analysis.

[31]See Table 8 of the regulation or Section 12 of the Technical Development Document (*Development Document for Best Available Technology, Pretreatment Technology, and New Source Performance Technology for the Pesticide Formulating/Packaging/Repackaging Industry: Proposed*) for a list of the sanitizer active ingredients that are eligible for exemption from the zero discharge requirement under this regulation.

Table 4.5
National Estimates of Impacts for Subcategory C Facilities Under Option 3 and Option 3/S
(Assuming Zero Cost Pass Through)

	Option 3	Option 3/S
Facilities with *only* wastewater streams containing non-sanitizer pesticide PAIs		
-Facilities Projected to Incur Costs	391	391
-Total Capital Compliance Costs (millions of dollars)	$59.3	$59.3
-Total Annualized Compliance Costs (millions of dollars)	$24.0	$24.0
-Facility Closures: (Severe Economic Impacts)	1	1
-Facilities Incurring Moderate Economic Impacts	119	119
-Worst Case Expected Job Losses (FTEs)	348	348
Facilities with wastewater streams containing only sanitizer PAIs		
-Facilities Projected to Incur Costs	167	138
-Total Capital Compliance Costs (millions of dollars)	$6.8	$3.6
-Total Annualized Compliance Costs (millions of dollars)	$3.9	$2.1
-Facility Closures: (Severe Economic Impacts)	0	0
Facilities Incurring Moderate Economic Impacts	51	17
-Worst Case Expected Job Losses (FTEs)	78	7
All Subcategory C Facilities		
-Facilities Projected to Incur Costs	558	529
-Total Capital Compliance Costs (millions of dollars)	$66.1	$63.0
-Total Annualized Compliance Costs (millions of dollars)	$27.9	$26.1
-Facility Closures: (Severe Economic Impacts)	1	1
-Facilities Incurring Moderate Economic Impacts	170	136
-Worst Case Expected Job Losses (FTEs)	426	355

Subcategory E impacts. For Subcategory E facilities, EPA analyzed the impacts of two possible regulatory options, both based on zero discharge. Option 1 assumes that the contaminated wastewater is used as make-up water in application of pesticide chemicals to the field. Option 2 assumes that the wastewater is contract-hauled for incineration. The Agency is proposing Option 1.

Of the estimated 1,122 Subcategory E facilities that are potentially subject to the regulation, data from the Survey indicate that 98 percent, or 1,103 facilities, are already in compliance. They therefore would not incur any costs to comply with the proposed regulatory option. In addition, the remaining 19 facilities are expected to be able to achieve compliance with the proposed regulation at zero additional cost.

Under Option 2, the same population of facilities (i.e, approximately 19 facilities) are evaluated for compliance costs. The estimated incremental capital and annualized total costs (which include amortized capital, annual operating and maintenance, and monitoring costs) of complying with Option 2 are estimated to be $11,794 and $1,837, respectively. (See Table 4.6) A comparison of annualized compliance cost to facility revenue was conducted for the 19 facilities with costs under Option 2. The estimated mean compliance cost as a percentage of facility revenue would be 0.026 percent and the estimated median value 0.032 percent, with a range from 0.001 percent to 0.048 percent. No facilities had a cost-to-revenue ratio greater than five percent.

Table 4.6
Estimated National Impacts for Subcategory E Facilities

	Option 1	Option 2
-Facilities Incurring Costs	0	19
-Total Capital Compliance Costs	0	$11,794
-Total Annualized Compliance Costs	0	$1,837
-Facility Closures: (Severe Economic Impacts)	0	0
-Moderate Economic Impacts	0	0

Chapter 5
Regulatory Flexibility Analysis

5.0 Introduction

This chapter considers the expected effects of the proposed effluent limitations guidelines and standards for the pesticide formulating, packaging and repackaging (PFPR) industry on small entities pursuant to the Regulatory Flexibility Act. The Regulatory Flexibility Act (Public Law 96-354) calls for the Agency to prepare a Regulatory Flexibility Analysis (RFA) for regulations that are expected to have a significant impact on a substantial number of small entities.[1] The purpose of the Act is to ensure that, while achieving statutory goals, government regulations do not impose disproportionate impacts on small entities.

The Regulatory Flexibility Act also calls for record-keeping and reporting requirements to be indicated, as well as any federal rules that duplicate, overlap, or conflict with the proposed rule. The proposed effluent guideline imposes no reporting and record-keeping requirements. In addition, no known Federal rules duplicate, overlap, or conflict with the proposed rule. However, the PSES guidelines for refilling establishments build upon The Office of Pesticide Programs' proposed regulation that will require refilling establishments of agricultural pesticides to build secondary containment structures and loading pads to certain specifications. Because requirements associated with several regulations became effective since the PFPR Survey was administered, this analysis includes the costs of complying with these regulations to ensure a full accounting of environmental regulatory costs. These regulations include the land disposal restrictions under the Resource Conservation and Recovery Act, effluent limitations for the Organic Chemicals, Plastics and Synthetic Fibers Industry, effluent limitations for the Pesticide Manufacturing Industry, and annual maintenance fees required under the Federal Insecticide, Fungicide and Rodenticide Act Amendments of 1988. The costs of complying with these regulations are accounted for as part of the baseline conditions so that projected costs and impacts are a result of the proposed regulation only.

In performing this analysis, EPA had to balance the traditional concerns of a Regulatory Flexibility Analysis — moderation of impacts among small-business entities — with the broader regulatory

[1] "Small entities" are defined in Section 5.1.

objectives of the Clean Water Act. In particular, because the PFPR industry was found to be heavily dominated by small business concerns, EPA recognized that efforts to moderate economic impacts broadly among small-business entities would require analyzing various characteristics other than entity size to understand which facilities were expected to be impacted under Option 3, the regulatory option originally selected. The Agency therefore analyzed whether subgroups of facilities, defined by major pesticide market, were disproportionately affected and considered whether technical and market factors distinguished any subgroups in ways that would warrant different regulatory approaches for those subgroups. The analysis considered a number of classification criteria — including principal market served, reliance on PFPR activities as a source of revenue, and active ingredients used — in addition to business size classification as the basis for understanding the distribution of impacts under Option 3 for Subcategory C facilities.

This analysis found that adverse impacts most frequently occurred among certain PFPR facilities that may be characterized as follows: they are typically small businesses, participate to a large degree in the institutional/commercial market, receive a relatively small share of revenue from PFPR activities, and often use certain active ingredients to formulate sanitizer products. For example, two-thirds of all impacted facilities in the I/C market use PAI 56, Hyamine 3500, in their PFPR activities. On the basis of the distinguishing characteristics of these affected facilities, EPA defined and analyzed an alternative to Option 3, namely Option 3/S, that reduces the regulatory burden to these facilities. As described in Chapter 4 of this document, the proposed alternative, Option 3/S, exempts certain wastewater streams from Option 3's zero discharge requirements. Specifically, Option 3/S exempts physically separated, non-interior process wastewater streams *that contain only designated sanitizer chemicals* from the zero discharge requirement. All other wastewater streams must meet the Option 3 zero discharge specifications. The Option 3/S alternative was found to mitigate appreciably the impacts within the identified group of affected facilities, including small business-owned facilities, while the number of pounds of pollutants that would not be controlled is very small. The Agency found no other subcategory of facilities that could be provided relief and still meet EPA's stated regulatory objectives under the Clean Water Act.

The following sections of this chapter describe the analysis underlying the definition of Option 3/S, and assess its impacts. Specifically, Section 5.1 discusses the methodology used to identify small entities. Section 5.2 then examines the characteristics of facilities assessed as significantly affected under

Option 3. Section 5.3 defines and analyzes the alternative regulatory option, Option 3/S, which was developed to alleviate some of the disproportionate impacts while maintaining most of the environmental benefits of Option 3. Section 5.4 compares the estimated impacts under Options 3 and 3/S.

5.1 Identifying Small Entities

To perform the Regulatory Flexibility Analysis, EPA needed to identify whether facilities were owned by a small business entity. This effort involved several steps. First, EPA specified the entities that could potentially incur costs of compliance and are therefore subject to impacts of the regulation. Second, the criteria that characterize an entity as "small" were identified based on the Small Business Administration (SBA) business size classification applicable to the PFPR industry. This characterization involved identifying the firm-level ownership of Survey facilities and obtaining or estimating firm-level employment for the firms that own PFPR facilities. These data were then used to specify whether or not facilities are owned by a small business, as defined by SBA.

Identifying Potentially Affected Entities

As previously discussed, the analysis is based on the sample of total PFPR facilities surveyed under authority of section 308 of the Clean Water Act. This sample represents the 1,122 Subcategory E Refilling Establishments and 1,282 Subcategory C PFPR facilities that were in business in 1988. The proposed regulation for Subcategory E Refilling Establishments requires zero discharge of wastewater pollutants based on reuse of contaminated wastewater. As described in Chapter 4, EPA's analysis shows that the Subcategory E regulation will impose only minor capital outlays and no annual compliance costs. Accordingly, EPA expects the Subcategory E regulation to impose no significant economic impacts and did not perform a regulatory flexibility analysis of this regulation. The following analysis, therefore, pertains only to Subcategory C PFPR facilities. The analysis covers 943 Subcategory C PFPR facilities that would be subject to the PSES regulation and that use water in their PFPR operations. It is these facilities that are expected to incur costs of compliance and thus may be significantly affected by the regulation.

Defining "Small Entity"

Because the analysis considered differential impacts according to business-size classification as well as other facility identification criteria, it was necessary to define "small entity" and classify facilities in the PFPR industry survey according to whether they are owned by a small business. The Small Business Administration (SBA) defines small entities in terms of the number of firm employees or firm revenues by Standard Industrial Classification (SIC) code. Pesticide formulating and packaging activities are categorized as SIC 2879. SBA defines a small entity with a SIC code of 2879 as a firm with 500 or fewer employees. No revenue thresholds are given for this SIC code. For this analysis, EPA adopted SBA's small entity definition.

Classifying Facilities into Firms[2]

Because SBA defines small entities in terms of employment at the firm level, EPA next classified facilities according to whether they are part of a single or multi-facility firm, and identified the owning firm for facilities that are part of multi-facility operations. For this classification, EPA relied primarily on the Survey data but used secondary sources when necessary. If a facility indicated on its questionnaire that it was a single entity (question 12 in the Introduction), then the facility was classified as a firm. To identify other firms, facilities were classified according to their FIFRA identification numbers, which are generally held at the firm level, or on the basis of facility Dun and Bradstreet numbers (questions 2 and 3 in the Introduction), parent or parent's parent company names, addresses, and Dun and Bradstreet numbers (questions 13 and 16 in the Introduction).

Estimating Firm Employment

Firm employment was estimated to classify facilities as being owned by either small or other entities as defined by the SBA. For those facilities indicated by their survey data to be single entities, firm employment was calculated by summing formulating, packaging and repackaging employee hours, all other production worker hours, and non-production worker hours as reported in the Survey (question 17 in the Introduction). The sum of these worker hours was divided by 2,000 to yield the full time employee equivalent.

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[2]For this report, the terms "firm" and "entity" are interchangeable.

If the facility was not a single entity, the 1993 *Dun and Bradstreet Million Dollar Directory* was consulted for firm employment data. If a firm was not found in the 1993 directory but had been in the 1992 directory, then 1992 employment data were used.[3] Of the 399 sample firms identified, employment data were not obtained for 62 firms, or approximately 15.5 percent of the sample. For these 62 remaining sample firms, employment was estimated from a regression analysis.[4] The available firm employment data were regressed on 1988 parent firm revenue data as reported in the Survey (question 14 in the Introduction for single entities and question 8A in Section One of Part B for others). The parameter estimate was then applied to the 62 firms to estimate firm employment for these firms. The model specified as:

$$FRMEMP = \alpha\ FRMREV + \epsilon$$

where

FRMEMP	=	firm employment;
FRMREV	=	1988 firm revenue;
α	=	the parameter estimate; and
ϵ	=	the unknown error term.

A total of 283 observations (sample firms for which both employment and revenue data existed) were used in this analysis. The value of α is 0.000004746, significant to 99.99 percent. The adjusted R^2 is 64 percent. This indicates that the parameter estimate will provide reasonably good estimates of firm employment for the 62 firms reporting firm revenue data but lacking firm employment data. This equation yields an average estimate of one full time employee per $210,704 in 1988 firm revenue.

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[3]Where possible, the EIA is based on 1988 data. However, Dun & Bradstreet employment data are available on a subscription basis only for the current year. EPA first assembled firm-level employment data in 1992 and then updated these data in 1993.

[4] Refilling establishments and direct dischargers were included in this part of the analysis so that more data points would be available for the regression analysis to establish employment figures for firms with missing data. A regression analysis was also conducted excluding refilling establishments, however it did not yield a significantly different parameter estimate. The regressions were performed on unweighted sample data. Sample weights were not used for these analyses because the weights apply to facilities but not to firms.

If the estimated number of employees at the firm level was greater than the SBA threshold of 500 employees, then the facility was classified as being owned by a non-small entity. If the estimated number of employees at the firm level was equal to or less than the SBA threshold, then the facility was classified as being owned by a small entity. From this comparison, EPA found that 700, or 74 percent, of the 943 facilities considered in the analysis are owned by small entities.

5.2 Assessing the Distribution of Impacts

Of the five regulatory options initially considered, EPA considered selecting Option 3 because it achieves zero discharge but results in sufficiently low economic impacts to be judged economically achievable. For the Regulatory Flexibility Analysis, EPA examined the impacts of Option 3 to discern whether small business impacts were concentrated among certain classes of facilities according to market or PAI use. In this effort, EPA considered first the extent of small business participation in the PFPR industry, and the extent of impacts among facilities owned by small businesses. However, because a substantial majority of PFPR facilities were found to be owned by small businesses, EPA recognized that the analysis of differential impacts would necessarily include other classification criteria beyond business size. Specifically, EPA analyzed the distribution of impacts according to additional classification criteria, as follows: primary market source of PFPR revenues, percent of facility revenue derived from PFPR activities, and the PAIs most frequently used by the facilities in the PFPR market with the greatest concentration of affected facilities. Throughout this analysis, EPA performed a parallel assessment of the distribution of impacts by business-size of affected facility. From this analysis, EPA defined and analyzed an alternative, Option 3/S, to the initially selected regulatory option, Option 3.

In analyzing the distribution of economic impacts for the Regulatory Flexibility Analysis, EPA drew no distinction between the severe (facility closure) and moderate (facility line conversions or costs of compliance in excess of 5 percent of facility revenues) impact categories as defined in the preceding chapter.[5] All economic impacts were combined for assessing the distribution of impacts by the various facility classification criteria.

[5]Notably, only one facility is projected to incur a severe impact due to compliance under Option 3. This facility is owned by a small entity.

Distribution of Potentially Affected Facilities and Economic Impacts by Entity Size

EPA estimates that a total of 943 PFPR facilities will be subject to the Subcategory C regulation. Of these, 700 (74.2 percent) are estimated to be owned by a small firm and 243 (25.8 percent) are owned by not-small, or other, firms. Within the total set of facilities subject to regulation, the subset of facilities that are expected to incur compliance costs are those in which compliance impacts are possible. Of the estimated 943 PFPR facilities, 558 are expected to incur compliance costs. Of these, 416 (74.6 percent) are owned by small firms and 142 (25.4 percent) are owned by other firms (see Table 5.1). Clearly, a substantial majority of the PFPR facilities that are subject to impacts are owned by small business entities.

EPA also characterized the distribution of economic impacts according to business size classification. Of the 558 facilities that are expected to incur compliance costs, 171 are expected to incur moderate or severe impacts. Of these, 150 or 87.7 percent are owned by small entities, a frequency of impact that exceeds the share of small business-owned facilities in the facility population expected to incur costs as a result of the regulation (74.6 percent) (see Table 5.1).

As a second test of the compliance burdens of Option 3 on small businesses, EPA considered the ratio of expected compliance costs to total facility revenues. This analysis found that the mean ratio of total annual costs of compliance to total facility revenues is higher for facilities owned by small entities, 2.1 percent, than for other entities, 0.3 percent. This ratio further indicates the extent of burden likely to be incurred by small business in complying with Option 3 (see Table 5.1).

EPA determined overall that Option 3 is economically achievable. In particular, only one facility was assessed as a closure and most of the expected economic impacts are associated with line conversions. Even if all the PFPR line conversions close instead of converting to other formulating and packaging activities, EPA estimates that job losses would not exceed 426 full-time equivalent positions nationally. Nevertheless, EPA recognized that these moderate impacts would substantially affect small business entities and was thus concerned with the regulation's burden on small business. At the same time, because a substantial majority of PFPR facilities are owned by small entities, EPA structured its efforts to determine the characteristics of impacted facilities and to define an alternative regulation by using other facility criteria in addition to business size.

Table 5.1 Distribution of Projected Costs and Impacts of Option 3 on Facilities Owned by Small and Other Entities			
	Total	**Facilities Owned By Small Entities**	**Facilities Owned By Other Entities**
Estimated Population of PFPR Facilities Regulated Under Subcategory C	943 (100.0%)	700 (74.2%)	243 (25.8%)
Facilities With Costs of Compliance	558 (100.0%)	416 (74.6%)	142 (25.4%)
Facilities Projected to Incur Impacts	171 (100.0%)	150 (87.7%)	21 (12.3%)
Mean Total Annual Cost of Compliance to Revenue (For Facilities With Costs)	1.6%	2.1%	0.3%
Median Total Annual Cost of Compliance to Revenue (For Facilities With Costs)	0.5%	1.0%	0.2%

Distribution of Economic Impacts by Primary PFPR Market

In analyzing the characteristics of affected facilities, EPA first examined the primary markets from which affected facilities derive 272 PAI-related PFPR revenue. For this analysis, EPA defined a primary market as one from which a facility receives at least fifty percent of its 272 PAI-related PFPR revenue. Impacts were analyzed by market, with market definitions based on responses to Survey question #19 (page I-9 of the Survey). Responses to this question indicated each facility's total 1988 revenues from 272 PAI-related pesticide products by the following markets:

- agricultural
- institutional/commercial
- industrial
- wood preservatives and coatings
- pesticide intermediate products
- products used as an additive to a non-pesticide product
- non-agricultural professional use products
- consumer home, lawn, and garden

- government, for non-institutional use
- other.

This analysis indicated that facilities obtaining at least fifty percent of their 272 PAI-related PFPR revenue from the Institutional/Commercial (I/C) market bore both a large and disproportionately high percentage of the impacts under Option 3. Table 5.2 indicates the distributions by primary market of all facilities projected to incur costs under Option 3, and of those facilities projected to incur significant economic impacts under Option 3. As shown in the table, of the 558 facilities expected to incur costs, 267 (47.8 percent) receive 272 PAI-related PFPR revenue primarily from the I/C market. Moreover, the distribution of significant economic impacts is even more concentrated among facilities primarily reliant on the I/C market for 272 PAI-related PFPR revenue. Of the 171 facilities expected to incur significant economic impacts, 102 (59.8 percent) receive 272 PAI-related pesticide revenue primarily from the I/C market.

Table 5.2 also summarizes primary market information for small business-owned facilities that are expected to incur costs or incur significant economic impacts. Small facilities that are estimated to incur costs or impacts show greater concentration in the I/C market than do facilities as a whole. Specifically, of the 416 small business-owned facilities that are expected to incur costs, 227 or 54.6 percent receive 272 PAI-related PFPR revenue primarily from the I/C market. In comparison, 47.8 percent of all facilities incurring costs under Option 3 receive 272 PAI-related PFPR revenue primarily from the I/C market. Similarly, of the 150 small business-owned facilities expected to incur significant economic impacts, 98 or 65.5 percent receive 272 PAI-related PFPR revenue primarily from the I/C market. Again, the percentage for small business-owned facilities exceeds the value for all facilities of 59.8 percent. Indeed, of the 102 impacted facilities in the I/C market owned by both small and not-small businesses, 98, or 96.1 percent are owned by a small business. This finding underscores the concentration of impacts on small businesses operating in the I/C market.

Distribution of Economic Impacts by Dependence on PFPR Revenue

EPA next examined the distribution of estimated impacts based on facilities' dependence on PFPR revenue. This analysis showed that facilities that are expected to incur economic impacts generally receive only a relatively small percentage of their revenue from PFPR activities. Using the three-year (1986-1988) average ratio of PFPR revenue to total facility revenue as reported in the PFPR Survey, EPA

Table 5.2
Distribution by Primary Market of Facilities Incurring Costs and of Facilities Expected to Incur Significant Economic Impacts Under Option 3

Primary Market	Distribution of Facilities Estimated to Incur Costs Under Option 3		Distribution of Facilities Estimated to Incur Impacts Under Option 3	
	Number and Percent of All Facilities with Costs	Number and Percent of Small Business Facilities with Costs	Number and Percent of All Facilities with Impacts	Number and Percent of Small Business Facilities with Impacts
Agricultural	61 (10.9%)	44 (10.6%)	6 (3.6%)	6 (4.1%)
Institutional/Commercial	267 (47.8%)	227 (54.6%)	102 (59.8%)	98 (65.5%)
Industrial	114 (20.4%)	85 (20.4%)	48 (28.3%)	43 (28.8%)
Wood Preservatives and Coatings	18 (3.2%)	6 (1.4%)	0 (0.0%)	0 (0.0%)
Pesticide Intermediate Products	12 (2.2%)	2 (0.5%)	0 (0.0%)	0 (0.0%)
Additives to Non-Pesticide Products	1 (0.2%)	1 (0.2%)	0 (0.0%)	0 (0.0%)
Non-Agricultural Professional Use Products	15 (2.7%)	6 (1.4%)	7 (4.2%)	0 (0.0%)
Consumer Home, Lawn and Garden	56 (10.0%)	40 (9.6%)	2 (1.3%)	2 (1.5%)
Government, for Non-Institutional Use	6 (1.1%)	0 (0.0%)	5 (2.9%)	0 (0.0%)
Other	1 (0.2%)	1 (0.2%)	0 (0.0%)	0 (0.0%)
No Primary Market	7 (1.3%)	5 (1.2%)	0 (0.0%)	0 (0.0%)
Total	**558 (100.0%)**	**416 (100.0%)**	**171 (100.0%)**	**150 (100.0%)**

A facility's primary market is the PFPR market from which it receives at least 50 percent of its PFPR revenue. Percentages may not sum to 100 percent because of rounding.

estimated that 187 out of the 188 facilities (99.5 percent) assessed as incurring economic impacts under Option 3 receive less than 25 percent of their revenues from PFPR (see Table 5.3). Only one facility that receives more than 25 percent of total facility revenues from PFPR is assessed as likely to incur a

Table 5.3 Dependence on PFPR Revenue of Facilities Incurring Impacts Under Option 3 (by business-size classification and primary market)				
	Facilities With Less Than 25 Percent of Revenue from PFPR Activities		Facilities With At Least 25 Percent of Revenue from PFPR Activities	
Primary Market	All Facilities	Small-Business Owned Facilities	All Facilities	Small-Business Owned Facilities
Agricultural	6	6	0	0
Institutional / Commercial	102	98	0	0
Industrial	48	43	0	0
Wood Preservatives and Coatings	0	0	0	0
Pesticide Intermediate Products	0	0	0	0
Products used as Additives to Non-Pesticide Products	0	0	0	0
Non-Agricultural Professional Use Products	7	0	0	0
Consumer Home, Lawn and Garden	1	1	1	1
Government, for Non-Institutional Use	5	0	0	0
Other	0	0	0	0
No Primary Market	0	0	0	0
Total	**170**	**149**	**1**	**1**
Sum of column may not equal total due to rounding.				

significant economic impact under Option 3. In summary, impacted facilities do not rely predominantly on PFPR revenues to sustain their facilities economically. In fact, on average these facilities derive only 6.7 percent of their total revenue from PFPR activities. This finding further underscores the relatively mild character of the impacts estimated for Option 3.

Again, small business-owned facilities also exhibit the same pattern of low reliance on PFPR activity as a source of business revenue. Of the 161 small business-owned facilities that were assessed as incurring significant economic impacts under Option 3, all but one receive less than 25 percent of total facility revenue from PFPR activity.

Pesticide Active Ingredient Usage by Impacted I/C Facilities

From the foregoing analyses, EPA found that the impacts of Option 3 were expected to occur most among facilities that receive a majority of their PFPR revenue from the Institutional/Commercial market, and that rely to a relatively low extent on PFPR business as a source of revenue. In addition, EPA concluded that economic impacts are concentrated among facilities that are owned by small firms. However, this last observation results largely from the fact that small business-owned facilities represent a substantial majority of facilities in the PFPR industry.

Because certain PAIs may be associated with certain markets and given the concentration of economic impacts among facilities in the I/C market, EPA next examined the PAI usage of these significantly affected facilities in the I/C market to ascertain any particular patterns of PAI usage. From this analysis, EPA found that the PAI used most frequently by the significantly affected facilities that receive a majority of their PFPR revenue in the I/C market is PAI 56, Hyamine 3500: 66.3 percent of the 102 significantly affected facilities in the I/C market use this PAI. No other PAI was used half as frequently among these facilities. Of these 102 facilities, 98 are owned by a small business and these facilities also rely extensively on PAI 56: 69.0 percent of the impacted small-business facilities in the I/C market were found to use Hyamine 3500 in their PFPR activities. Thus, use of PAI 56, Hyamine 3500, is consistently high among both small business-owned impacted facilities and other impacted facilities in the I/C market.

EPA also considered Hyamine 3500's potential contribution to pollution. Using the Agency's toxic weighting factors, which score the toxicity of pollutants on a linear scale relative to copper, EPA found that PAI 56, Hyamine 3500, has a relatively low toxicity value of 0.093. Other PAIs commonly used by impacted facilities primarily in the I/C market were found to be more toxic. The PAI used with the next highest frequency was found to be over 4,300 times as toxic as Hyamine 3500.[6]

[6] A full discussion of toxic weighting factors is provided in the cost-effectiveness report.

Taking into account both the high frequency of use of Hyamine 3500 (PAI 56) by impacted I/C facilities and the comparatively low toxicity of that PAI as a component of effluent waste streams, EPA decided to examine less stringent requirements with respect to PAI 56 in its efforts to moderate the economic impact of Option 3 on the primarily small business-owned facilities in the I/C market.

5.3 Defining an Alternative to Option 3

From the analyses described above, EPA determined that the costs associated with installing treatment systems to recycle non-interior wastewater sources would cause economic impacts at certain PFPR facilities. These facilities are distinguished from other PFPR facilities in several ways: they are typically small businesses in the Institutional/Commercial market, receive a relatively small share of total revenue from PFPR activities, and are apt to use PAI 56 in their PFPR activities. On the basis of these findings, EPA sought to define a regulatory alternative to Option 3 based on PAI 56, Hyamine 3500. However, EPA recognized that isolating PAI 56 as the sole basis for a regulatory exemption might confer a market advantage to Hyamine 3500 relative to other PAIs with which it competes.

In the EIA for the Pesticide Manufacturers effluent guidelines, EPA defined markets of competing PAIs. This market definition is more detailed than the broad markets listed in the Survey. For example, not all pesticides used in the agricultural market compete with each other. Pesticides used as herbicides on corn do not compete with pesticides used as fungicides on apples. Pesticide markets were therefore defined as clusters of PAIs that are substitutes in a specific end-use (e.g., herbicides on corn). The 272 PAIs, or classes of PAIs, on which this impact analysis is based are mapped into 57 separate clusters along with other PAIs with which they compete (see Appendix F).

Hyamine 3500 (PAI 56) is a member of the R-4 cluster which is defined as: "Sanitizers for use in dairies, food processing, restaurants, and air treatment". The other PAIs included in this cluster (from the list of 272 on which this analysis is based) are: Hyamine 2389 (PAI 162), methyl benzethonium chloride (PAI 159), Hyamine 1622 (PAI 105), oxine-sulfate (PAI 51), and HAE (PAI 36). Because the sanitizer PAIs have the same general use, they are roughly substitutable. Accordingly, if a regulatory exemption were defined solely on the basis of Hyamine 3500, the exemption might confer a market advantage to Hyamine 3500 relative to the other PAIs in the R-4 cluster with which it competes. To avoid this result, EPA defined the modification to Option 3, Option 3/S, based on the R-4 cluster instead of on the individual PAI Hyamine 3500.

Specifically, EPA defined a regulatory alternative to Option 3 based on the *physically separated* wastewater streams generated in conjunction with the formulating, packaging, or repackaging of the sanitizer chemicals comprising the R-4 Cluster. This option, called Option 3/S, is the same as Option 3 except for those facilities that formulate, package, or repackage sanitizer active ingredients and whose sanitizer production is less than 265,000 pounds per year. Specifically, in these facilities, non-interior wastewater streams (e.g. from floor wash, exterior equipment cleaning, and laboratory rinsates) *that contain only active ingredients from designated sanitizer chemicals* would be exempt from the Option 3's zero discharge requirement. All other PAI wastewater streams at these facilities, including interior wastewater streams containing sanitizer PAIs and any exterior wastewater streams containing both sanitizer and other PAIs, would be subject to the zero discharge requirement. As is the case for Option 3, the zero discharge requirement for these other wastewater streams can be met through pollution prevention, recycle/reuse, and treatment when necessary. The Option 3 zero discharge requirement would apply to all PAI wastewater streams at any facility whose wastewater streams do not qualify for the sanitizer PAI exemption.

In defining this regulatory alternative, EPA set the 265,000 pounds per year production limit based on analysis of the production volume of facilities that would be expected to avoid adverse impacts as a result of the Option 3/S sanitizer chemical exemption. Specifically, in its facility impact analyses, EPA found that no facility larger than the 265,000 pounds per year sanitizer production limit would avoid a significant impact as a result of the exemption. Accordingly, in an effort to mitigate significant impacts among PFPR facilities owned by small businesses *while retaining as large a share as possible of the pollution reduction benefits of the originally selected Option 3*, EPA decided to limit the Option 3/S sanitizer chemical exemption to only those facilities with less than 265,000 pounds per year of production involving designated sanitizer PAIs.

EPA expects that this regulatory alternative will reduce impacts on the most heavily burdened subgroup of facilities owned by small businesses with only a minimal increase in pollutant releases to the environment.

5.4 Impacts of Option 3/S

Under Option 3/S, which embodies the exemption for R-4 Cluster PAIs contained in physically separated, non-interior wastewater sources, 530 facilities are expected to incur costs of compliance, compared to 558 facilities under Option 3. Of the 530 facilities incurring costs under Option 3/S, 392 (73.4 percent) are owned by a small entity. The number of facilities that are significantly affected (severe and moderate impacts combined) falls from 171 (under Option 3) to 137 under Option 3/S. The number of impacted facilities *owned by small businesses* falls from 150 to 116, or a decrease of 22.7 percent in the number of impacted facilities owned by small entities. Moreover, the percentage of small entity-owned facilities (out of the total of small entity-owned facilities in the PFPR population) that is estimated to incur economic impacts falls from 21.4 percent to 16.6 percent (see Table 5.4, below).

Table 5.4 Distribution of Costs and Impacts Under Options 3 and 3/S

Regulatory Option	Option 3		Option 3/S	
	Total	Small	Total	Small
Number of Facilities in Population	943	700	943	700
Number of Facilities with Costs	558	416	530	392
Number of Facilities with Impacts	171	150	137	116
Percent of Facilities in Population Incurring Impacts	18.1%	21.4%	14.5%	16.6%

At the same time, Option 3/S is expected to result in only a slight increase in pollutant discharges relative to Option 3. EPA estimates that the Option 3/S exemption will result in total additional discharges of 203 pounds annually, but only an additional 19 toxic-weighted pounds[7]. The low ratio of toxic-weighted pounds to unweighted pounds reflects the low toxicity of PAI 56 and other sanitizer PAIs when compared to copper.

Taking into account both the substantial relief to small business-owned facilities provided by Option 3/S *and* the very modest loss in pollution reduction benefits, EPA selected this option as the preferred regulatory option for PSES limitations to be applied to Subcategory C PFPR facilities.

[7] See Chapter 12 for an analysis of combined discharges resulting from the original 272 PAIs and additional non-272 PAIs.

Chapter 5 References

Dun's Marketing Services, Inc. (1993). *Million Dollar Directory*. New Jersey.

The Revised EPA Guidelines for Implementing The Regulatory Flexibility Act. (April 1992).

Chapter 6
Community Impact Analysis

6.0 Introduction

This chapter examines impacts to communities that may result from effluent limitations guidelines and standards for the pesticide formulating, packaging and repackaging (PFPR) industry. Community impacts are evaluated based on estimated employment loss in communities affected by the regulation. Employment losses are estimated, as applicable, for those facilities found to be affected significantly by the proposed regulation. The analysis does not consider potential employment increases at non-impacted facilities. If the employment losses are expected to cause a greater than one percent decline in total employment in the affected community, then the community impact is deemed significant.

This chapter focuses on impacts for the PSES rule applicable to Subcategory C facilities. Employment losses are examined for all five PSES regulatory options considered for Subcategory C facilities initially, plus the proposed Option 3/S, a modification to the initial Option 3. Because EPA selected Option 3/S as the preferred PSES regulatory approach for the Subcategory C facilities, community impacts are examined for this option.

No community impact analysis was undertaken for the PSES regulation proposed for Subcategory E facilities, Refilling Establishments. In the facility-level impact analysis presented in Chapter 4, neither of the two regulatory options considered for Refilling Establishments was found to impose *any* significant economic impacts. Accordingly, with no employment losses anticipated from the PSES regulation for Subcategory E facilities, a community impact analysis is not necessary.

Within the Subcategory C facilities subject to PSES requirements, only facilities that use and discharge water can incur costs and thus be adversely affected by the regulation's requirements. For this reason, the scope of the community impact analysis is restricted to the 651 Subcategory C facilities that use and discharge water and are regulated under PSES.

On the basis of the analysis presented in this chapter, the proposed regulatory option for Subcategory C facilities, Option 3/S, is not expected to cause significant community impacts: community-level employment losses are expected to be well less than one percent.

The remaining sections of this chapter are organized as follows. Section 6.1 presents the methodology for assessing community impacts. Section 6.2 summarizes the estimated employment losses for each regulatory option, and assesses the significance of those losses for Option 3/S.

6.1 Methodology for Assessing Community Impacts

Facility closures, either totally or in part, may result in employment losses. The significance of such employment losses at the community level is measured relative to the community's pre-compliance employment. Typically, a community is defined as the Metropolitan Statistical Area (MSA) in which the facility is located.[1] The MSA is assumed to represent the labor market area within which residents could reasonably commute to work. If the facility is not located within an MSA, then the community is defined on the basis of the county, and county-level employment is used to determine the significance of employment losses. Either way, if the estimated employment loss from facility impacts is greater than one percent of the pre-regulation community employment, the community-level employment impact is considered significant.

EPA considers community employment impacts taking into account both primary impacts and secondary impacts. Primary impacts consist of the employment losses that are expected to occur as a direct result of the regulation. Secondary economic impacts and associated employment losses occur in other businesses than those directly affected by regulation and result from two mechanisms. First, reductions in output at directly affected facilities influence activity and employment levels in linked industries (indirect effects). Second, the losses in employment and employee earnings in both the directly and indirectly affected facilities result in reduced personal consumption expenditures, which may further affect employment levels in the community (induced effects). If the aggregate impacts, including both primary and secondary employment effects, amount to an employment decline of greater than one percent in an affected community, then community impacts are deemed significant.

[1]MSAs are defined by the U.S. Office of Management and Budget.

Estimating Primary Employment Impacts

As presented in Chapter 4, three measures of significant economic impacts at PFPR facilities were evaluated: facility closure, conversion of a PFPR product line, and compliance costs in excess of five percent of facility revenue. Employment losses corresponding to these impact measures are calculated as follows.

Facility Closure

A facility closure is classified as a severe impact. For a projected facility closure, all employment at the associated facility is assumed to be lost. The number of employees at a facility is calculated from data provided in the PFPR Survey (Introduction, question 17). The number of employees is equal to the sum of annual PFPR production worker hours, all other production worker hours, and all non-production worker hours, divided by 2,000.[2] Algebraically,

$$EMP = \frac{FPR + OTH + NPR}{2{,}000}$$

where:

EMP = total facility full-time-equivalent employment;
FPR = total annual worker hours attributable to PFPR production;
OTH = total annual worker hours attributable to other production; and
NPR = total annual non-production worker hours.

Line Conversion

EPA considers a line conversion to be a moderate impact. In general, EPA expects that these facilities would retain some or all of the employment previously associated with PFPR activities. Production might shift to non-pesticide formulating, packaging, or repackaging activities or to pesticides for which compliance is less costly. In contrast, the community impact analysis takes a more conservative, worst-case assessment of the possible employment effects by assuming that the affected facilities close their PFPR production lines entirely, with *all* associated employment assumed lost.

[2](50 weeks/year) × (40 hours/week) = 2,000 hours/year.

Employment losses associated with 272 PAI-related PFPR[3] product line closures are calculated by adding PFPR production worker hours to the portion of non-production worker hours attributable to PFPR production (from the Survey Introduction, question 17). Non-production worker hours associated with PFPR were not reported separately in the Survey. To estimate the non-production worker hours associated with PFPR activities, non-production worker hours were allocated between PFPR activities and non-PFPR activities in the same ratio as production worker hours:

$$PFPREMP = \frac{FPR}{2{,}000} + \frac{\frac{FPR}{FPR + OTH} \times NPR}{2{,}000}$$

where:

PFPREMP = full time equivalent employment attributable to PFPR; and the other variables are as defined above.

Compliance Costs Equal to Five Percent or More of Facility Revenue

Compliance costs equal to five percent or more of facility revenue are also considered by EPA to be a moderate economic impact. As discussed in Chapter 4, this impact measure is not associated with an operational change. Total annual compliance costs that are less than five percent of facility revenue are commonly judged to be economically achievable, but compliance costs equal to five percent or more of facility revenue do not necessarily indicate a significant impact. Accordingly, for this analysis, no employment loss is estimated to occur in conjunction with compliance costs that are at least five percent of facility revenue.

As a practical matter, the assumption that these facilities will incur no employment losses is of little consequence to the analysis of community-level employment impacts. Most facilities that are projected to incur moderate impacts fall in the possible line conversion category, and are therefore assumed to lose all PFPR employment in the community impact analysis. Specifically, under Options

[3] "PFPR employment" in this analysis refers to PFPR employment involving the 272 PAIs originally considered for regulation.

2, 3, and 3/S, fewer than 10 percent of the projected moderate impacts result from compliance costs equal to five percent or more of facility revenue. As a result, at least 90 percent of the moderate impacts under these options are associated with employment loss. Under Option 1, about 88 percent of the moderate impacts are associated with employment loss. Under Options 4 and 5, moderate impacts associated with employment loss constitute 63 percent and 62 percent, respectively.

Estimating Secondary Employment Impacts

Secondary employment impacts are estimated based on multipliers that relate a change in employment in a directly affected industry to aggregate employment change including the employment affects in: (1) linked industries (indirect effects) and (2) consumer businesses whose employment is affected by changes in the earnings and expenditures of the employees in the directly and indirectly affected industries (induced effects). Even when based on highly unlikely, worst-case assumptions, the primary employment losses estimated for the PFPR regulation are very small: under Option 3/S, 355 full-time equivalent job losses are spread over 137 facilities nationally. Given the minimal character of the expected primary losses nationally, EPA expected that aggregate community-level employment impacts — that is, including both primary and secondary impacts — would, in all likelihood, also be minimal.

For this analysis, EPA used a worst-case multiplier scenario to confirm that aggregate community-level employment impacts are not likely to be significant under Option 3/S. Specifically, EPA used a single, worst-case multiplier that is likely to substantially overstate aggregate, community-level effects. This analysis is based on the *highest* state-level multiplier for the relevant industry, and also assumes that all of the employment losses associated with a sample facility impact *and the facilities that it represents in the underlying PFPR population* occur in the location of the sample facility. Even with both of these relatively extreme assumptions, aggregate community-level impacts are estimated to be well less than the one percent threshold of significance.

6.2 Findings From the Community Impact Analysis

As discussed in previous chapters, the main data source for this analysis is the PFPR industry Survey. National estimates of employment losses for each of the six regulatory options were calculated from the sample facility impacts and the sample weights applicable to those observations. Table 6.1 presents the estimates of national employment losses for each option and the number of facilities at which these job losses are expected to occur. As summarized in the table, *worst-case* estimates of national job losses range from a high of 1,173 FTEs under Option 5 to a low of 356 under the proposed option, Option 3/S. The job losses are distributed over a large number of facilities, with an average job loss at any single impacted facility ranging from 2.4 FTEs (Option 1) to 6.2 FTEs (Option 4).

To confirm that Option 3/S would not be expected to result in significant community employment impacts, EPA analyzed aggregate employment effects using two assumptions that are likely to overstate substantially the possible employment impacts in affected communities. The first assumption involves the allocation of the employment losses estimated to occur in *non-sample, impacted* facilities — that is, the facilities in the underlying PFPR facility population that are represented by the sample facilities for which impacts were assessed. As noted in the introduction, community impacts are considered significant if employment losses are estimated to exceed one percent of community employment. If data are available for all facilities in an industry, such changes in MSA employment can be calculated for each facility and location for which a significant impact is assessed. When the impact analysis is based on a sample of the total facilities in an industry, however, the assessment of facility impacts among sample observations applies only to the specific locations containing the affected sample facilities. To extrapolate the impacts from these sample facilities to the population of total facilities requires using sample weights that have been stratified along analytically relevant dimensions (e.g., states or communities for the community impact analysis). The PFPR Survey sample on which this analysis is based, however, was not stratified to provide statistically valid estimates along such dimensions. It is therefore not possible to estimate the geographic distribution of national employment losses at a regionally subaggregated level.

Although a statistically valid analysis of population level employment impacts on a regional or community level cannot be performed, analyses based on assumptions regarding the locational distribution of primary employment impacts can demonstrate that compliance with the proposed regulation is unlikely to have a significant impact on community employment. Under Option 3/S, 115 FTE losses are associated with the 26 *sample* facilities assessed as incurring economic impacts. Further, these 115 FTEs

Table 6.1: Estimated National Employment Losses for Each Regulatory Option					
Regulatory Option	**Number of Facilities with Estimated Employment Losses**	**FTE Loss due to Facility Closures**	**FTE Loss due to Line Conversions**	**Total FTE loss**	**Average FTE Loss per Impacted Facility**
Option 1	179	71	366	437	2.4
Option 2	171	68	358	426	2.5
Option 3	171	68	358	426	2.5
Option 3/S	137	68	287	356	2.6
Option 4	180	736	377	1113	6.2
Option 5	191	736	437	1173	6.1

are distributed over 18 states and 22 MSAs (see Table 6.2). In addition to the 115 employment losses in affected sample facilities, EPA projects an additional 241 employment losses in 110 facilities in unknown states and MSAs for a total of 356 job losses. These additional facility impacts and employment losses are those that are estimated to occur in the PFPR facility population that is represented by sample facilities. It is these 241 FTE losses for which location of employment loss may not be specified for the community impact analysis.

For this analysis, EPA assigned these 241 employment losses *that are not directly accounted for by the affected sample observations* to the known locations of the affected sample facilities in proportion to sample facility weights. Thus, *all of the facilities* that are represented by an affected sample facility, *and their associated employment loss,* are assumed to be located in the same MSA as the affected sample facility. This assumption regarding the locational distribution of facility impacts is expected to overstate employment losses in each MSA, because the *non-sample facility* impacts would likely be distributed among other MSAs that are unknown.

The second assumption involves the multiplier used to estimate the aggregate employment impacts associated with the direct employment losses in impacted PFPR facilities. Specifically, EPA used a worst-case regional impact multiplier from the Regional Input-Output Modeling System developed by the Bureau of Economic Analysis (BEA) within the Department of Commerce. BEA publishes state-level

Table 6.2: Analysis of Community Employment Impacts Assuming Worst-Case Multiplier and Proportional Distribution of Sample-Weighted Employment Losses						
	Primary Impacts Only			Primary and Secondary Impacts		
State	Estimated FTE Loss in Sample Facility MSA	Implicit Sample-Weight	Sample-Weighted FTE Loss	Maximum State Multiplier	Multiplier-Adjusted FTE Loss	Percent Loss in Employment
CA	1.9	5.0	9.7	9.2	89.1	0.0020%
CA	0.2	4.9	0.8	9.2	7.0	0.0006%
CO	0.7	1.2	0.8	9.2	7.4	0.0028%
CT	3.8	4.9	18.6	9.2	171.2	0.0403%
FL	0.0	7.2	0.1	9.2	0.9	0.0006%
GA	0.1	4.9	0.7	9.2	6.6	0.0004%
IA	0.1	5.0	0.3	9.2	2.3	0.0010%
LA	0.1	7.2	0.4	9.2	3.4	0.0006%
MD	0.4	4.0	1.5	9.2	13.5	0.0011%
MN	37.2	4.9	181.0	9.2	1,665.2	0.1181%
MO	56.9	1.2	68.3	9.2	628.8	0.0738%
MO	1.5	4.9	7.1	9.2	65.4	0.0051%
OH	3.7	5.1	18.5	9.2	170.6	0.0217%
OR	0.7	4.9	3.3	9.2	30.1	0.0044%
PA	2.7	7.3	19.5	9.2	179.0	0.0180%
SC	0.8	7.2	5.5	9.2	50.7	0.0148%
TN	1.1	4.9	5.2	9.2	47.5	0.0100%
TN	0.4	4.9	2.1	9.2	18.9	0.0035%
TX	0.3	5.7	1.8	9.2	16.9	0.0023%
TX	1.9	4.0	7.5	9.2	68.8	0.0656%
UT	0.3	7.2	2.2	9.2	19.8	0.0039%
WA	0.1	7.2	1.0	9.2	9.3	0.0008%
Total	114.8	3.1	355.7		3,272.5	

The community-level employment impact values presented in this table provide a worst-case illustration of possible impacts in the MSAs in which those *sample* facilities assessed as incurring economic impacts were located. The employment losses are likely to overstate substantially actual impacts because of the use of a maximum employment impact multiplier and because impacts in unspecified locations are assumed to occur in the same MSA in which the sample facility is located. In fact, the unspecified facility employment impacts are likely to be distributed among these and other unknown MSAs in a way that does not yield as high a concentration of impacts at the sample facility locations as indicated in this analysis.

employment multipliers by industry classifications. For this analysis, EPA used the highest *state-level* employment multiplier applicable to the Chemical and Petroleum Refining Industry, the 2-digit BEA industry that is most likely to include facilities engaged in PFPR business. The highest total employment

impact multiplier reported by BEA is for the state of Texas and has a value of 9.20. Use of this multiplier is likely to exaggerate possible secondary employment impacts for the following reasons:

- Using a *state*, as opposed to *MSA*, multiplier is likely to overstate multiplier effects. The state-level multiplier registers the expected effect throughout the state resulting from changes in activity levels in the subject industry within the state. To the extent that some of these effects occur in locations beyond the MSA in which the primary impacts occur, the state-level multiplier will exaggerate the employment impacts in the MSA.

- The state multiplier value of 9.20 is the highest among those published for the relevant industry. By comparison, the average value of the state-level multipliers for this industry is 4.42 and the minimum value is 2.05. Moreover, only 3 of the 26 *sample* facilities assessed as incurring impacts that could result in job losses are located in Texas. Using the Texas multiplier therefore exaggerates substantially the impacts that will occur in other states.

Still, even with these highly unrealistic assumptions, the analysis shows that Option 3/S is unlikely to result in significant employment impacts at the community level. Specifically, the largest weighted aggregate employment impact under this analysis is associated with an MSA in the state of Minnesota. The estimated sample facility-based employment loss in the MSA is 37.2 FTEs. The sample weight associated with this facility is 4.9, meaning that, in the impact analysis, the facility represents itself *plus* 3.9 other facilities in the underlying PFPR facility population whose locations may not be estimated. Applying the sample weight brings the *primary* employment impact to 181.0. Further, applying the industry impact multiplier for Texas of 9.20 brings the *weighted aggregate* employment impact to 1,665.2 full-time equivalent employment positions. This unrealistically high value exceeds all the other simulated MSA-level impacts by nearly a factor of three. Although this value also yields the highest percentage loss in MSA employment, at 0.1181 percent, it is still less than one-eighth of the one percent significant impact threshold (see Table 6.2). Moreover, if the employment impact for this MSA is calculated on the basis of Minnesota's employment multiplier of 3.4 for the subject industry, the calculated decrease in employment would amount to 615 full-time equivalent positions or a 0.0436 percent employment loss. In all likelihood, this value still substantially overstates the expected employment impacts in the Minnesota MSA because the non-sample facility impacts associated with the affected facility's weight are assigned to the same MSA as the sample facility.

The next highest percentage employment impacts are 0.0738 percent, in Missouri, and 0.0656 percent, in Texas, or approximately 1/14th and 1/15th of the one percent impact threshold, respectively. Thus, even using highly unrealistic assumptions, this analysis finds that Option 3/S would not likely cause a significant loss of employment in any affected MSA.

From this analysis, EPA concludes that the proposed PFPR effluent guideline for Subcategory C facilities, Option 3/S, should not impose a significant burden, as measured by loss of employment, on any community.

Chapter 6 References

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Chapter 7
Foreign Trade Impacts

7.0 Introduction

Products created by pesticide formulators, packagers, and repackagers (PFPR) are traded internationally. Changes in domestic PFPR production resulting from effluent regulations may therefore affect the balance of trade. This chapter considers the potential impacts that compliance with PFPR effluent limitation guidelines may have on foreign trade.

Specifically, this chapter examines the changes in both exports and imports that could occur as a result of a PSES regulation for Subcategory C (PFPR) Facilities. Trade impacts are examined for the six PSES options considered for Subcategory C (PFPR) Facilities, namely: the five options initially considered plus the proposed option, Option 3/S, which is a modification of Option 3. Among these options, the estimated impacts of Option 3 and Option 3/S are examined more closely within the context of the current international pesticide market.

EPA analyzed foreign trade impacts under two cases: a proportional case, which assesses trade impacts based on the relative competitiveness of U.S. and foreign producers in international markets; and a worst case, which makes severely conservative assumptions regarding U.S. competitiveness. Both analyses showed relatively minor trade impacts from the proposed regulatory option, Option 3/S. The proportional case analysis indicated that the net trade balance would decrease about one percent under Option 3/S, or substantially less than the average year-to-year fluctuation in the U.S. pesticide trade balance. The worst case analysis involved very conservative assumptions that are likely to overstate substantially the possible trade impacts, but serves to illustrate the minimal impact that the regulation is expected to have on foreign trade even with these highly adverse assumptions. This analysis found that the loss in the net trade balance for pesticides under Option 3/S would not exceed five percent of the average trade balance in pesticides over the period 1980-1990. Moreover, the calculated loss is less than the average year-to-year change in the pesticides trade balance over this period. For these reasons, EPA expects that the proposed Option 3/S will not significantly impair the international trade position in pesticides.

The following sections of this chapter report the analysis on which this conclusion is based. Section 7.1 describes the methodology used to estimate possible changes in exports and imports resulting from the regulatory options. Section 7.2 summarizes the findings of that analysis, and Section 7.3 assesses the significance of those findings for Option 3 and the proposed option, Option 3/S.

7.1 Methodology for Assessing Foreign Trade Impacts

Compliance with effluent limitation guidelines may affect the U.S. trade balance for pesticide products by reducing exports and increasing imports. Exports may decline because previously exported products are no longer produced, or because production costs and sales prices for domestic producers are increased, thus making domestic products less competitive in foreign markets. Imports may increase as domestic purchasers seek new sources of PFPR products that are no longer offered by affected facilities or that are offered at higher prices.

This analysis focuses on the possible change in exports and imports associated with reductions in output in facilities that may be adversely affected by the PFPR rule. These decreases in exports and increases in imports are derived from facilities that (1) were assessed as a closure or (2) were assessed as a product line conversion. Facilities falling in the third impact category — compliance costs exceeding five percent of facility revenue — are not expected to lose PFPR production and were not considered in this analysis. Facilities that cease or reduce PFPR production may affect the pesticides trade balance in two ways:

First, their former export sales may be lost, all or in part, to foreign producers thereby reducing total domestic exports of pesticide products. The impact on the trade balance will depend on the success of other domestic producers in retaining the export markets formerly served by facilities whose PFPR production declines or ceases as a result of regulation.

Second, their former sales for domestic consumption may be lost, all or in part, to imports thereby increasing total imports of pesticide products. Again, the impact on the trade balance will depend on the success of other domestic producers in retaining those domestic sales markets and preventing import sales from capturing them.

For both effects, foreign and remaining domestic PFPR producers are assumed to compete for the former domestic and export sales markets of those facilities whose PFPR production is lost as a result of regulation. The outcome of the competition between foreign and domestic producers determines the change in the two components of the trade balance: exports and imports. The combination of these two changes — that is, increased imports plus the loss in exports — yields the decline in the net trade balance for pesticide products. The two foreign trade analyses presented in this chapter involve different assumptions regarding the outcome of the competition between foreign and domestic producers. In the proportional case analysis, EPA assumed that domestic producers would remain as competitive in domestic and export sales markets at the margin as they are currently, and therefore would maintain a portion of the markets lost by impacted facilities. In the worst case analysis, EPA made the unrealistically severe assumption that foreign producers would fully capture both the former export and domestic sales of facilities whose PFPR production declines or ceases as a result of regulation. The results of these analyses were then examined relative to the average U.S. pesticide trade balance and the fluctuations that exist within this market.

The Survey provides data on the composition of sales for impacted facilities, including total 272 PAI-related PFPR revenue and the percent of PFPR revenues attributable to exports (in 1988).[1] Facilities that are assessed as closures are assumed to cease producing all PFPR products. In addition, facilities assessed as incurring a product-line conversion are also assumed to cease production of all PFPR products. In some instances, facilities considering a product-line conversion may find it financially advantageous to continue PFPR activities. However, because product-specific revenue and financial performance data are not available, such product-line comparisons were not possible and the analysis conservatively assumes that a line conversion means that all PFPR production at the facility ceases. This assumption is expected to overstate impacts.

Although the analysis does not consider the possible change in exports or imports resulting from product price increases, highly conservative assumptions, particularly in the worst-case analysis, underlie the calculation of net trade effects stemming from output changes in affected facilities. Thus, EPA

[1] For this analysis, "PFPR revenues" refers to revenues from PFPR activities involving the 272 PAIs originally studied for regulation. One impacted facility did not provide a percent of PFPR revenue attributable to exports; for this facility, the weighted average of all facilities regulated under PSES was used.

believes that the assessed trade effects, even without price increases as a variable, provide a conservative assessment of the potential trade impacts of the proposed regulation.

Trade Impacts Under Proportional Case Assumptions

In this analysis, domestic and foreign producers are assumed to compete for the domestic and export sales of facilities that cease PFPR production as a result of the effluent guideline. Domestic and foreign producers share in the market on a proportional basis that corresponds to their average participation in domestic and export markets before regulation. The shares of these markets that are won by foreign producers reflect the long-run success of foreign and domestic producers in competing for domestic and export markets.

Estimating Change in Exports

When a facility ceases PFPR production, the markets that it served, both domestic and export, are assumed to be competed for by other domestic producers and foreign producers. Under the proportional case it is assumed that domestic producers capture the same share of the lost export production as the average share of exports to total domestic production. In other words, domestic producers are assumed to be approximately as competitive at the margin in recovering lost exports as they are on average in achieving export sales out of total production. On the basis of export and domestic shipments data for the 1988-1992 period, the share of pesticide exports expected to be captured by domestic producers is 30.2 percent.[2] Foreign producers are thus assumed to capture 69.8 percent of the former exports from significantly impacted facilities.

The calculation is as follows:

$$EXPDECR_i = \%EXP_i \times FPRREV_i \times (1 - \frac{EXP}{TDP})$$

Where:

$EXPDECR_i$ = The calculated decrease in facility export revenue in 1988 dollars;

$\%EXP_i$ = The percent of PFPR revenue that a facility earned from exports in 1988; and

[2] Based upon 1988-1992, the only years for which these data were available. *(Source: The International Trade Commission)*

$FPRREV_i$	=	The three-year (1986-1988) average facility revenue from PFPR activities in 1988 dollars.
EXP/TDP	=	The average ratio of Exports to Total Domestic Production for pesticide chemicals (30.2 percent)

Estimating Change in Imports

The decline in PFPR production due to compliance may result in increased imports as foreign producers acquire a share of the domestic market formerly served by an impacted facility. In the proportional case, the former sales for domestic consumption are assumed to be split between domestic and foreign producers based on the average ratio of imports to total domestic consumption. That is, foreign producers would be approximately as competitive on the margin as they have been historically in gaining a share of the U.S. market for PFPR products. From data for the 1988-1992 period, foreign producers are assumed to capture 17.9 percent of the domestic market formerly served by impacted facilities.[3] Domestic producers are therefore assumed to retain 82.1 percent of this market.

The calculation is as follows:

$$IMPINCR_i = [FPRREV_i - (\%EXP_i \times FPRREV_i)] \times \frac{IMP}{TDC}$$

Where:

$IMPINCR_i$	=	The annual increase in PFPR imports in 1988 dollars;
$FPRREV_i$	=	The three-year (1986-1988) average facility revenue from PFPR activities in 1988 dollars;
$\%EXP_i$	=	The percent of PFPR revenue that a facility earned from exports in 1988;
IMP/TDC	=	The average ratio of Imports to Total Domestic Consumption (17.9 percent)

[3] Based upon 1988-1992 data, the only years for which these data were available. *(Source: The International Trade Commission).*

Estimating the Change in Net Trade Balance

The deterioration in the net trade balance for pesticide products is calculated by adding the increase in imports and the reduction in exports (expressed as a positive value). The resulting value is the net loss in the domestic trade balance for pesticide products.

Trade Impacts Under Worst-Case Assumptions

Under the worst-case assumptions, foreign producers are assumed to win completely the competition for the former export and domestic sales markets of impacted facilities. That is, the sales for domestic consumption are fully replaced by increased imports and the sales for export are fully replaced by foreign producers. These assumptions maximize the possible adverse trade impact associated with reduced production and sales of PFPR products by significantly impacted facilities.

Estimating Change in Exports

In the worst-case analysis, all PFPR production previously exported by impacted facilities is assumed to be lost to foreign producers. This is a worst-case assumption because it does not allow for other U.S. facilities to acquire a portion of the affected facilities' export sales. The calculated decline in exports is therefore expected to overstate the actual change that would result from compliance. The calculation is as follows:

$$EXPDECR_i = \%EXP_i \times FPRREV_i$$

Where:

$EXPDECR_i$	=	The calculated decrease in facility export revenue in 1988 dollars;
$\%EXP_i$	=	The percent of PFPR revenue that a facility earned from exports in 1988; and
$FPRREV_i$	=	The three-year (1986-1988) average facility revenue from PFPR activities in 1988 dollars.

The total decrease in U.S. exports of pesticide products resulting from compliance is calculated by summing the sample-weighted losses in facility exports over all affected facilities.

Estimating Change in Imports

In the worst-case analysis, all of the former sales for domestic consumption in impacted facilities is assumed to be replaced by imports. This assumption is highly conservative in that it does not allow for domestic producers to replace *any* of the lost domestic sales. In all likelihood, this assumption provides an even greater exaggeration of the potential trade impacts of the PFPR regulation than that applied to exports. This greater exaggeration results from both the larger quantity of product affected (i.e., domestic sales by affected facilities generally exceed their exports) and the extreme improbability that imports would displace all of the former domestic sales of affected facilities. The calculation is as follows:

$$IMPINCR_i = FPRREV_i - (\%EXP_i \times FPRREV_i)$$

Where:

$IMPINCR_i$ = The annual increase in PFPR imports in 1988 dollars;

$FPRREV_i$ = The three-year (1986-1988) average facility revenue from PFPR activities in 1988 dollars; and

$\%EXP_i$ = The percent of PFPR revenue that a facility earned from exports in 1988.

The total increase in pesticide product imports resulting from compliance is calculated by summing the sample-weighted import increases over all affected facilities.

Estimating the Change in Net Trade Balance

Again, adding the increase in imports and the reduction in exports (expressed as a positive value) yields the net loss in the domestic trade balance for pesticide products.

7.2 Estimated Changes in Pesticide Exports and Imports Under Worst-Case and Proportional Case Assumptions

The findings from the analyses outlined above are summarized below.

Proportional Case Assumptions

Using the methodology outlined above, EPA calculated possible changes in the exports and imports of pesticide products resulting from the PSES regulations applicable to Subcategory C (PFPR)

facilities. Under the proportional case assumptions, the decrease in exports is expected to range from $2,685,000 per year under Options 2, 3, and 3/S to $6,256,000 under Options 4 and 5. The increase in imports is expected to range from $6,505,000 under Option 3/S to $35,660,000 under Option 5. The resulting estimated annual decrease in the Net Trade Balance ranges from $9,190,000 under Option 3/S to $41,916,000 under Option 5. Option 3/S, the proposed option, results in the lowest projected decline in trade balance among all of the regulatory options considered (see Table 7.1).

Worst-Case Assumptions

Under the worst-case assumptions, the annual reductions in PFPR exports range from $3,846,000 under Options 2, 3, and 3/S to $8,963,000 under Options 4 and 5. Increases in PFPR imports range from $36,338,000 per year under Option 3/S to $199,219,000 per year under Option 5. The resulting decline in the PFPR trade balance ranges from $40,184,000 per year under Option 3/S to $208,182,000 per year under Option 5. Overall, the deterioration in the net trade balance under the worst-case assumptions is about 4.5 to 5 times as great as the impact amount calculated under the proportional case assumptions. Option 3/S, the proposed regulatory option, achieves the lowest deterioration in the net trade balance among the regulatory options considered (see Table 7.1).

7.3 Significance of the Estimated Decreases in the Net Trade Balance

EPA assessed the significance of these trade impact findings for Options 3 and 3/S.

Proportional Case Assumptions

To assess the significance of the calculated change in the net trade balance, the calculated values for Options 3 and 3/S were considered in the context of the international pesticide market. Two comparisons illustrate the significance of the calculated changes in the international trade balance. First, EPA compared the calculated change in the net trade balance with the actual trade balance values for pesticides over the period 1980-1990. As summarized in Table 7.2, the net trade balance for the period 1980-1990 averaged approximately $950 million. Under Option 3, the decline in the net trade balance would constitute a 1.04 percent decrease in the pesticide trade balance. Under Option 3/S, the proposed regulatory option, the estimated decline in the pesticides trade balance would be less than one percent.

As a second measure of the significance of the calculated losses in the pesticide trade balance, EPA compared the percentage change in the average trade balance implied by the Options 3 and 3/S

Table 7.1 Change in Foreign Trade Balance for Subcategory C PSES Options ($000, 1988)						
Regulatory Option	Proportional Case Assumptions			Worst-Case Assumptions		
	Increase in Imports	Decrease in Exports	Decrease in Trade Balance	Increase in Imports	Decrease in Exports	Decrease in Trade Balance
Option 1	7,188	2,841	10,029	40,155	4,070	44,225
Option 2	7,187	2,685	9,872	40,149	3,846	43,995
Option 3	7,187	2,685	9,872	40,149	3,846	43,995
Option 3/S	6,505	2,685	9,190	36,338	3,846	40,184
Option 4	34,824	6,256	41,080	194,548	8,963	203,511
Option 5	35,660	6,256	41,916	199,219	8,963	208,182

calculations with the actual year-to-year percentage changes in the trade balance that occurred over the ten-year analysis period. Between 1980 and 1990, the pesticide trade balance fluctuated between a low of $841 million and a high of $1,143 million. The year-to-year swings were quite wide: six years showed negative changes over this period ranging from -1.9 percent to -21.3 percent; and four years showed positive changes ranging from 1.7 percent to 19.7 percent. One measure of trade balance volatility is the average of the absolute value of these year-to-year percentage changes, which is 8.0 percent. That is, on a year-to-year basis, and without regard to the direction of change, the average change in the net trade balance for the period 1980-1990 was 8.0 percent. As reported above, the implied declines in the average net trade balance calculated for Options 3 and 3/S are 1.04 percent and 0.97 percent, respectively. Both values are considerably smaller than the 8.0 percent year-to-year fluctuation in the pesticides net trade as observed in recent years (see Table 7.2).

Worst-Case Assumptions

Under the worst-case assumptions, the estimated decrease in the net trade balance in the pesticide industry is more significant than that projected under the proportional case assumptions. However, even these highly unrealistic, worst-case estimates indicate that trade impacts should not be unduly burdensome when viewed in the context of the U.S. trade balance for pesticides. The conservatively calculated loss in the trade balance of $44 million for Option 3 amounts to 4.6 percent of the ten-year average value of $950 million. The $40 million loss calculated for Option 3/S represents only 4.2 percent of the ten-year average. Although these values are higher as a percentage of the 10-year average trade balance than

Table 7.2: U.S. Trade Balance in the Pesticide Market, 1980 -1990			
Year	Trade Balance ($000,000, 1988)	Percent Change	Absolute Percent Change
1980	1,075		
1981	935	-13.0%	13.0%
1982	914	-2.2%	2.2%
1983	955	4.5%	4.5%
1984	1,143	19.7%	19.7%
1985	900	-21.3%	21.3%
1986	943	4.8%	4.8%
1987	959	1.7%	1.7%
1988	940	-2.0%	2.0%
1989	857	-8.8%	8.8%
1990	841	-1.9%	1.9%
Average	951		8.0%
Source: *United Nations International Trade Statistics Yearbook*, 1980-1990.			

those calculated for the proportional case analysis, they still remain well below the average 8.0 percent year-to-year fluctuation observed over the past 10 years.

Taking into account the small effect of the calculated trade balance impacts relative to the existing pesticides trade balance under both the worst-case assumptions and the more realistic proportional case assumptions, EPA judges that Options 3 and 3/S would not be expected to impose a significant impact on the U.S. pesticides trade balance.

Chapter 7 References

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Chapter 8
Assessment of Firm-Level Impacts

8.0 Introduction

The assessment of economic achievability of the PFPR regulation is based primarily on the facility-level impact analysis. EPA, however, also conducted a firm-level analysis, as impacts at the level of the firm may exceed facility level impacts, *particularly when a firm owns more than one facility that will be subject to regulation*. This chapter examines the impact of compliance with the proposed options, Option 3/S for Subcategory C facilities and Option 1 for Subcategory E facilities, on firms owning facilities subject to PFPR effluent guidelines. All firms that own at least one sample facility using water in its PFPR operations are included in the analysis.[1] The analysis involves aggregating financial and compliance cost data for *sample* facilities by firm, and imputing compliance costs for non-sample facilities owned by the firm based on sample facility compliance costs and firm PFPR revenue not attributable to sample facilities. This analysis also considers baseline cost adjustments from other regulatory requirements for both sample and non-sample facilities owned by the firm. Because of sample design considerations, the findings from the firm-level analysis, which is based on *facilities* in the sample survey, cannot be extrapolated on a statistically valid basis to the population level of PFPR industry firms.

Firm-level impacts are evaluated based on estimated post-compliance pre-tax return on assets (ROA) relative to a threshold ROA based on current industry performance. Pre-tax ROA is a measure of the profitability of a firm's capital assets, independent of the effects of taxes. This financial measure provides information regarding the competitive position of the firm within the industry, as well as operating margin and asset management capability. If a firm cannot sustain a competitive ROA when baseline costs and compliance costs are considered, then the firm will likely have difficulty financing the capital outlays for complying with the regulation.

After grouping sample facilities by owning firm, EPA initially considered 308 firms that own at least one water using sample facility. However, 66 of these firms were found to have a baseline ROA

[1] Facilities which do not use water in their PFPR operations were not required to indicate percent of firm revenue attributable to PFPR operations in 1988, making this analysis impossible for firms represented in the sample by only facilities which do not use water in their PFPR operations.

of less than the threshold level, and therefore were not considered for impacts from compliance with the regulatory option. The remaining 242 firms were analyzed for impacts.

From this analysis, EPA found that only 5 of the 242 firms analyzed would be expected to incur significant financial impacts as a result of the proposed PFPR regulations. The Agency judges that these firm-level impacts should not pose a significant burden to the PFPR industry.

The remaining sections of this chapter are organized as follows. Section 8.1 presents the methodology for calculating baseline and post-compliance ROA for the 242 firms, and Section 8.2 summarizes the projected firm-level economic impacts.

8.1 Methodology for Assessing Firm-Level Impacts

The assessment of firm-level impacts involves two separate analyses. First, EPA assessed firm-level financial performance in the baseline, or before application of the PFPR regulatory requirements. Firms that were found financially weak in this analysis were excluded from the second analysis. In the second analysis, firm-level financial performance was assessed taking into account PFPR regulatory requirements.

Analysis 1: Baseline Analysis of Firm-Level Financial Performance

The baseline analysis evaluates each firm's financial operating condition before considering the compliance costs of the PFPR regulation. This analysis identifies firms that are expected to be financially weak relative to the overall industry independent of regulatory requirements. Firms that have a baseline ROA less than the threshold value are not considered for compliance impacts because their financial weakness results from current circumstances.

The analysis of firm-level impacts is based on pre-tax ROA, which is defined as pre-tax income or earnings before taxes (EBT) divided by total firm assets. In the facility-level impact analysis, pre-tax ROA was calculated at the facility level using data from the PFPR industry Survey. In the firm-level analysis, however, the relevant income statement and balance sheet data for calculating pre-tax ROA necessarily are from firm-level financial statements. EPA first assembled the necessary financial statement data for calculating pre-tax ROA for the year 1988. EPA then adjusted these data to reflect ongoing environmental regulatory compliance requirements as previously described in the facility-level

analysis. The ROA with baseline adjustments was then compared to the industry threshold to evaluate financial performance on a pre-compliance basis. The steps in this analysis are summarized below.

Assembling Facilities by Common Firm Ownership and Obtaining Data for Calculating Unadjusted ROA

In the same way as discussed for the analysis of small business impacts (Chapter 5), EPA identified the ownership of facilities in the PFPR industry Survey and grouped facilities by firm for performing the firm-level analysis. All firms with at least one water-using facility in the Survey were considered for the analysis of firm-level impacts. From this grouping, EPA identified 308 firms. These firms fell in three general categories that are relevant for understanding the data sources and development of the unadjusted baseline ROA for the analysis:

1. Public-reporting firms. After grouping facilities, EPA found that 97 of the sample facilities (92 of which use water in their PFPR operations) were owned by 36 public-reporting firms. Firm-level financial data to calculate the unadjusted ROA for these firms were obtained from annual reports or Standard and Poor's *S&P Reports*.

2. Private single-facility firms. From Survey data, EPA found that 180 facilities were private (i.e., non-public-reporting), single-facility firms. In the Survey, these facilities reported being single-facility firms and also reported firm-level revenues equal to facility-level revenues. Total firm assets for 1988 was taken directly from the PFPR Survey, and EBT was calculated using facility-level income statement data from the Survey[2].

3. Multiple facility private firms. The remaining 129 facilities (127 of which use water in their PFPR operations) were grouped into 92 multiple facility private firms. Because the needed EBT and assets data were unavailable for these firms, EPA estimated the unadjusted values using industry-wide ratios developed from the Robert Morris Associates (RMA) publication *Annual Statement Studies*. Specifically, EPA calculated an industry aggregate sales-to-assets ratio and pre-tax profit as a percentage of total sales for use in imputing a firm-level, unadjusted ROA for these firms. The 1988 median ratio of sales

[2] EBT = Total Facility Revenue - Total Costs and Expenses + Taxes.

to assets was averaged over all RMA-reported industries in SIC code 28 (Chemicals and Allied Products), weighted by total value of shipments within each SIC code.[3] The inverse of this value, or the assets-to-sales ratio (calculated as 48.20), was then multiplied by the 1988 firm revenues reported in the Survey to yield 1988 total firm assets, the denominator for the firm-level pre-tax ROA calculation.

EBT was calculated in the same manner using the weighted average of the RMA median 1988 value for pre-tax profit as a percent of sales. The resulting weighted average (4.9187 percent) was multiplied by 1988 firm revenue to yield 1988 EBT, the numerator for the firm-level pre-tax ROA calculation.

This method of imputing an unadjusted ROA means that all multiple facility, non-public-reporting firms start with the same *unadjusted* baseline ROA of 10.2 percent. However, the baseline adjustments for ongoing compliance requirements reduce this value for all firms by varying amounts so that the *adjusted* ROA varies by firm.

Adjusting Baseline ROA for Ongoing Compliance Costs

The estimation of baseline ROA at the firm level is analogous to the calculation of the facility level baseline ROA described in Chapter 4. As in the facility level calculation, environmental compliance costs expected to be incurred by firms after the survey was submitted (1988) were included in the baseline analysis. These include costs from:

1. Resource Conservation and Recovery Act (RCRA) land disposal restrictions;

2. Effluent limitations for the Pesticide Manufacturing Industry, which consists of a) the total annualized cost of compliance with the rule (including capital and operating and maintenance costs), and b) pesticide active ingredient (PAI) price increases to PFPR facilities as a result of the rule;

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[3] 1992 total shipments data were used, as 1988 data were not available for all relevant SIC codes. *(Source: 1992 U.S. Industrial Outlook).* The resulting weighted average sales-to-assets ratio was 0.020745.

3. Effluent limitations for the Organic Chemicals, Plastics and Synthetic Fibers (OCPSF) industry; and

4. The annual product maintenance fees mandated by the 1988 amendments to the Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA).

All PFPR facilities are expected to incur costs from FIFRA and PAI price increases resulting from the Pesticide Manufacturers rule. Half of these costs are expected to be borne by the facility, and the other half is expected to be recovered through product price increases (see Chapter 4). Only facilities that manufacture PAIs are expected to incur costs from RCRA, OCPSF, and the cost of complying with the Pesticide Manufacturers effluent guidelines rule. As in the facility level analysis, EPA expects that half of the RCRA and OCPSF costs will be borne by the facility, while the other half is passed on to consumers through higher PAI prices. The portion of the total annual costs of compliance with the Pesticide Manufacturers rule that is borne by the facility is calculated in the same manner as documented in the EIA for the Pesticide Manufacturers effluent limitations guideline.[4]

The adjustments to firm-level baseline ROA account for additional environmental compliance costs for both PFPR facilities included in the Survey and PFPR facilities owned by a firm but that were not included in the sample. The estimation of costs for these non-sample facilities is based on the estimated firm revenue from PFPR activities that is not accounted for by the sample facilities. These non-sample facilities are expected to incur baseline costs associated only with the FIFRA regulation and PAI price increases resulting from the Pesticide Manufacturers effluent guideline. The other baseline costs pertain only to manufacturing facilities, all of which are included in the sample if they also engage in PFPR activities. Thus, the non-sample PFPR facilities are by definition not manufacturers and are therefore not subject to the other baseline costs.

In addition, some firms included in the analysis own pesticide *manufacturing* facilities that do not engage in PFPR activities, and were therefore excluded from the PFPR industry Survey. However, the identity and ownership of these facilities is known from the analyses that EPA performed for the Pesticide Manufacturers effluent guideline. The costs of the above rules that apply specifically to manufacturing

[4] For details, see Chapter 4 of the Manufacturer's EIA.

facilities (i.e., OCPSF, RCRA, and the annualized cost of compliance with the Pesticide Manufacturers effluent guidelines) are included in the adjustments to baseline values for firms owning such facilities.[5]

Pre-tax ROA, *baseline with adjustments*, is calculated as follows:

$$ROA_{BL} = \frac{EBT - COSTSAMP_{BL} - COSTMFG_{BL} - OTHCOST_{BL}}{ASSET + OCPSFcap}$$

Where:

ROA_{BL}	=	Firm, pre-tax ROA, baseline with adjustments, in 1988;
EBT	=	Unadjusted pre-tax firm earnings in 1988;
$COSTSAMP_{BL}$	=	Annual baseline costs attributable to all sample facilities owned by the firm;
$COSTMFG_{BL}$	=	Annual baseline costs attributable to facilities owned by the firm which manufacture PAIs but do not PFPR;
$OTHCOST_{BL}$	=	Annual baseline costs attributable to facilities which PFPR, and are owned by the firm but not included in the sample;
ASSET	=	Unadjusted firm assets in 1988; and
OCPSFcap	=	The sum of capital costs resulting from the OCPSF rule for all facilities owned by the firm.

The calculation of each of the adjustments to baseline ROA is discussed more fully below.

$COSTSAMP_{BL}$, is the sum of annual baseline costs for sample facilities owned by the firm. As previously mentioned, only facilities that manufacture PAIs are subject to baseline costs for RCRA, OCPSF, and MFGCOMP. Therefore, the costs of these regulations apply only to sample facilities that also manufacture PAIs. The calculation is as follows:

[5] Data for these costs are from the Pesticide Manufacturers' EIA, 1992.

$$COSTSAMP_{BL} = \sum_{i=1}^{n_1} (RCRA_i + OCPSF_i + MFGPAI_i + FIFRA_i + MFGCOMP_i)$$

Where :

$COSTSAMP_{BL}$ = Baseline additional costs for PFPR facilities owned by the firm and in the Survey;

RCRA = Annual costs of RCRA regulation borne by facility i;

OCPSF = Annual costs of OCPSF regulation borne by facility i;

MFGPAI = Annual cost of PAI price increases from Pesticide Manufacturers regulation borne by facility i;

MFGCOMP = Annual costs of compliance with the Pesticide Manufacturers effluent guidelines for facility i; and

FIFRA = Annual costs of FIFRA regulation borne by facility i; and

n_1 = The number of PFPR facilities in the Survey owned by the firm.

Each of these cost elements was calculated as part of the facility-level impact analysis documented in Chapter 4.

$COSTMFG_{BL}$ is the sum of annual baseline costs for non-PFPR facilities that manufacture PAIs. These facilities were not included in the PFPR Survey but were analyzed for the Pesticide Manufacturers rule. Because these facilities are neither subject to the FIFRA regulation, which applies only to final products, nor to the higher PAI prices from the Pesticide Manufacturers rule, these cost elements are excluded from $COSTMFG_{BL}$. The remaining cost elements were taken from EPA calculations for the Pesticide Manufacturers rule. The calculation is as follows:

$$COSTMFG_{BL} = \sum_{i=1}^{n_2} (RCRA_i + OCPSF_i + MFGCOMP_i)$$

Where :

$COSTMFG_{BL}$ = Baseline additional costs for non-PFPR facilities owned by the firm that manufacture PAIs;

RCRA = Annual costs of RCRA regulation borne by *manufacturing* facility i;

OCPSF = Annual costs of OCPSF regulation borne by *manufacturing* facility i;

MFGCOMP = Annual costs of compliance with the Pesticide Manufacturers effluent guidelines for *manufacturing* facility i; and

n_2 = The number of non-PFPR *manufacturing* facilities owned by the firm.

$OTHCOST_{BL}$ is the additional baseline costs that the firm is expected to incur from non-sample facilities engaged in PFPR activities. Only costs associated with FIFRA and PAI price increases from the Pesticide Manufacturers rule are considered in the calculation, as these are the only baseline costs that the non-sample facilities are expected to incur, as explained above. To estimate these costs, EPA extrapolated the baseline cost adjustments that were estimated for each firm's facilities *that are in the Survey* to the calculated PFPR revenue of the firm *that was not covered by the Survey* (this amount is referred to as *PFPR residual revenue*). This calculation assumes that, within a firm, the additions to baseline cost per dollar of residual PFPR revenue are the same as the addition to baseline costs per dollar of PFPR revenue calculated for the firm's facilities in the sample.

To calculate $OTHCOST_{BL}$, EPA first calculated each firm's PFPR revenue *that is not represented by facilities in the Survey* by subtracting the sum of PFPR revenue for each sample facility from the reported total PFPR revenue of the firm. EPA also calculated for each firm the amount of the baseline cost adjustments per dollar of PFPR revenue for the facilities in the Survey. This ratio of additional costs to PFPR revenue was then multiplied by PFPR residual revenue to yield the estimated amount of baseline cost adjustments from each firm's PFPR facilities that are not in the Survey. The formula for the calculation is as follows:

$$OTHCOST_{BL} = \sum_{i=1}^{n_1} \frac{(MFGPAI_i + FIFRA_i)}{FPRREV_i} \times (FRMPFPR - \sum_{i=1}^{n_1} FPRREV_i)$$

Where:

$OTHCOST_{BL}$ = Baseline additional costs that the firm is expected to incur from non-sample PFPR facilities;

FPRREV = Reported 1988 revenues from PFPR for facility i;

FRMPFPR = Expected firm revenues from PFPR in 1988;[6]

MFGPAI = Annual cost of PAI price increases from Pesticide Manufacturers regulation borne by facility i;

FIFRA = Annual costs of FIFRA regulation borne by facility i; and

n_1 = The number of PFPR facilities in the Survey owned by the firm.

The last adjustment needed to calculate firm-level pre-tax ROA in baseline is OCPSFcap, the sum of capital costs associated with the OCPSF rule. This value is added to the total assets value in the denominator of the ROA calculation and pertains only to facilities that manufacture PAIs as explained above. The calculation is as follows:

$$OCPSFcap = \sum_{i=1}^{n_1} OCPSFcap_i + \sum_{i=1}^{n_2} OCPSFcap_i$$

Where:

OCPSFcap = Capital costs of complying with the OCPSF rule for manufacturing facility i;

n_1 = The number of PFPR facilities in the Survey owned by the firm; and

n_2 = The number of non-PFPR *manufacturing* facilities owned by the firm.

Comparing Adjusted Baseline ROA with the Industry Threshold

After applying each of the adjustments to baseline values as described above, EPA compared the adjusted ROA to an industry threshold value to assess the financial performance of firms before consideration of PFPR regulatory requirements. EPA calculated the industry ROA threshold using pre-tax ROA data from Robert Morris Associates (RMA) for 1988. Specifically, EPA calculated the average pre-tax ROA for the lowest-quartile among respondents for all RMA-reported industries in SIC code 28. In computing the average, EPA weighted the lowest-quartile ROA reported for each industry group by the total value of shipments for that SIC code as reported in the 1987 Census of Manufacturers. The resulting threshold ROA is 2.4 percent.

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[6] Calculated by multiplying 1988 firm revenues by percent of firm revenue attributable to PFPR in 1988, as reported in the Survey. If facilities owned by the same firm reported different percentages, EPA conservatively used the highest reported percentage of firm revenue attributed to PFPR activities. Similarly, if facilities owned by the same firm reported different firm revenues, the highest reported firm revenue was used.

EPA compared both the unadjusted and adjusted pre-tax ROA values for each of the 308 firms in the baseline analysis to the threshold ROA value. Of these 308 firms, 63 firms, all of which are non-public-reporting, single facility firms, have an ROA of less than 2.4 percent *before including the baseline cost adjustments described above*. When the baseline cost adjustments are included in the ROA calculation, 3 additional firms fell below the ROA threshold level. These 66 firms are assessed as experiencing financial weakness independent of the proposed effluent guidelines. Accordingly, attributing their economic hardships to the regulation would overstate impacts. These 66 firms with a baseline ROA of less than 2.4 percent were excluded from the remainder of the firm-level analysis.

Analysis 2: Post-Compliance Analysis of Firm-Level Financial Performance

The post-compliance economic analysis evaluates each firm's financial operating condition taking into account the costs of complying with the proposed regulatory options. EPA analyzed the firm-level impact of the proposed regulatory options, Option 3/S for Subcategory C facilities and Option 1 for refilling establishments[7], based on the change in pre-tax ROA. The post-compliance ROA includes both the baseline cost adjustments described above and the costs of compliance under the proposed options. If, as a result of the estimated costs of complying with the PFPR regulation, a firm's pre-tax ROA fell below the 2.4 percent threshold, then the firm was assessed as incurring a financial burden as a result of the proposed PFPR regulation.

The estimation of post-compliance ROA is analogous to the calculation of the *facility-level* post-compliance ROA described in Chapter 4: that is, it takes account of the estimated costs of complying with the proposed PFPR regulation. Like the *firm-level* baseline ROA analysis, however, the firm-level post-compliance analysis accounts for costs that the firm is expected to incur *from non-sample PFPR facilities* owned by the firm. Lacking information on these facilities, EPA again estimated the additional compliance costs to the firm *associated with non-sample PFPR facilities* based on the calculated residual PFPR revenue (i.e., the firm PFPR revenue that is not attributable to the sample PFPR facilities). This calculation assumes that, within a firm, the PFPR compliance costs incurred by non-sample facilities will be the same per dollar of residual PFPR revenue as the compliance costs per dollar of PFPR revenue calculated for the firm's sample facilities. Unlike the estimation of baseline ROA, it was not necessary for EPA to consider non-PFPR manufacturing facilities in this analysis, as these facilities would not be

[7] Facilities are expected to meet regulatory requirements with zero cost under Option 1.

subject to the PFPR regulation. For clarity in this discussion, the baseline cost adjustments described above that affect the numerator in the ROA calculation are combined into one variable, $COST_{BL}$, as follows:

$$COST_{BL} = COSTSAMP_{BL} + COSTMFG_{BL} + OTHCOST_{BL}$$

Post-compliance ROA is calculated as follows:

$$ROA_{PC} = \frac{EBT - COST_{BL} - OMCOMP - (CAPCOMP/10) - INTPMT}{ASSET + OCPSFcap + CAPCOMP}$$

Where:

ROA_{PC} = Estimated firm pre-tax ROA, calculated post-compliance;

EBT = Firm earnings before taxes in 1988;

$COST_{BL}$ = Firm baseline cost adjustments, as defined above;

OMCOMP = Annual firm operating and maintenance costs of complying with the regulatory option;

CAPCOMP = Total firm capital costs of complying with the regulatory option;

ASSET = Unadjusted firm assets in 1988;

OCPSFcap = Total firm capital costs of complying with the OCPSF effluent guideline (a baseline adjustment); and

INTPMT = Average yearly interest payment over 10 years on the capital costs of compliance, calculated as follows:

$$INTPMT = \frac{D \times CAPCOMP \times 0.064}{1-(1.064^{-10})} - \frac{D \times CAPCOMP}{10}$$

Where:

D = Percent of firm's compliance capital outlays financed by debt;

0.064 = The assumed real interest rate of 6.4 percent (see Chapter 4).

The analysis assumes a straight line depreciation schedule over ten years (CAPCOMP/10).

The percent of compliance capital outlays financed by debt, D, was derived differently for public-reporting firms, private single entity firms, and private multiple facility firms. For public-reporting firms, EPA used the ratio of debt to total assets reported in each firms' balance sheet for 1988.[8] For private, single entity firms, the percent of capital financed by debt was calculated using data from the PFPR survey (see Chapter 4). For private, multiple facility firms, EPA averaged the facility-level ratios of debt to total compliance capital used in the facility-level impact analysis. The individual facility values were weighted by each facility's capital cost of compliance.

Calculation of firm-level, post-compliance ROA requires estimates of the compliance capital and operating costs *for the share of a firm's PFPR revenue not covered by Survey facilities*. As noted above, EPA estimated PFPR compliance costs for each firm's residual PFPR revenue by extrapolating the costs calculated for a firm's sample facilities based on the ratio of compliance cost to PFPR revenue. The following discussion describes the separate calculations for the operating and capital costs.

The equation below summarizes the calculation of the firm's annual compliance operating and maintenance costs, OMCOMP. The first part of the equation accounts for operating and maintenance costs among the sample facilities. The second part of the equation accounts for the additional operating and maintenance costs of those facilities associated with the firm's residual PFPR revenue. In a calculation similar to that used for the baseline cost adjustments, these costs are estimated based on the amount of firm PFPR revenue that is not accounted for by the sample facilities *and* the ratio of sample facility compliance operating and maintenance costs to sample facility PFPR revenue. The analysis assumes that the compliance cost-to-revenue ratio among non-sample facilities is the same as that for the sample facilities owned by the firm, in aggregate. The calculation is as follows:

$$OMCOMP = \sum_{i=1}^{n} OMCOMP_i + \sum_{i=1}^{n} \frac{OMCOMP_i}{FPRREV_i} \times (FRMPFPR - \sum_{i=1}^{n} FPRREV_i)$$

[8] For all but two foreign-owned firms, these data were obtained from the firms' 10-K statements. The debt-to-total-assets values for the two foreign-owned firms were calculated using data from *S&P Reports*.

Where:

$OMCOMP_i$ = the annual operating and maintenance costs of complying with the regulation for sample facility i; and other variables are as defined above.

The total capital costs of the regulatory option to the firm, CAPCOMP, are calculated in a parallel manner to OMCOMP. Again, the first part of the equation below accounts for capital costs among the sample facilities while the second part of the equation accounts for the additional compliance capital costs of those facilities associated with the firm's residual PFPR revenue. Also, the analysis again assumes that the compliance capital cost-to-revenue ratio among non-sample facilities is the same as that for the sample facilities owned by the firm, in aggregate. The calculation is as follows:

$$CAPCOMP = \sum_{i=1}^{n} CAPCOMP_i + \sum_{i=1}^{n} \frac{CAPCOMP_i}{FPRREV_i} \times (FRMPFPR - \sum_{i=1}^{n} FPRREV_i)$$

Where:

$CAPCOMP_i$ = the total capital cost of the regulatory option for facility i; and the other variables are as defined above.

8.2 Estimated Firm Impacts

Among the 308 firms initially considered for the analysis, 66 firms, all single entities, had a baseline ROA of less than the established threshold, and were therefore not considered for post-compliance impacts. Of the remaining 242 firms analyzed, EPA found that 5 (2 percent) have a post-compliance ROA less than the 2.4 percent threshold. These firms may experience some financial hardship as a result of complying with the proposed PFPR regulation. Two of these firms are private, multiple facility firms and three are private, single entity firms. All of the private, single entity firms estimated to incur impacts were also found to incur impacts at the facility level. From these findings, EPA judges that firm-level impacts are not expected to be significant. The results of these analyses are summarized in Table 8.1.

Table 8.1: Sample Firm Financial Impacts				
Firm Type	Baseline		Post-Compliance	
	Number of Projected Impacts	Number of Firms Considered	Number of Projected Impacts	Number of Firms Considered
Public-Reporting Firms	0	36	0	36
Private Multi-Facility Firms	0	92	2	92
Private Single Entity Firms	66	180	3	114
Total	66	308	5	242

Chapter 8 References

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Chapter 9
Impacts on New Sources

9.0 Introduction

In this chapter, the effects of the New Source Performance Standards (NSPS) and Pretreatment Standards for New Sources (PSNS) proposed regulations upon new discharge sources are considered. New facilities have the opportunity to incorporate the best available demonstrated technologies, including process changes, in-plant controls, and end-of-pipe treatment technologies, and to use facility site selection to ensure adequate treatment system installation. The impacts of the proposed regulations on new sources are expected to be less burdensome than the impacts of the BAT/PSES regulations on existing sources. Designing a new technology prior to facility construction is typically far less expensive than retrofitting a facility for a new technology. The proposed NSPS and PSNS regulations, and the reasonableness of the associated costs, are discussed below by Subcategory.

9.1 Subcategory C

New Source Performance Standards

EPA is proposing to establish NSPS for Subcategory C as zero discharge, equivalent to BAT requirements for existing sources. Zero discharge represents best available and best demonstrated technology for the pesticide formulating, packaging and repackaging subcategory as a whole. The economic impact analysis shows that this regulatory approach, termed Option 3 in the analysis, would be economically achievable for the industry. EPA believes that new sources will be able to comply at costs that are similar to or less than the costs for existing sources, because new sources can apply control technologies, including dedicated lines and pressurized hoses for equipment cleaning, more efficiently than sources that need to retrofit for those technologies. EPA's analysis concludes that a zero discharge requirement for new source direct dischargers would be economically achievable and would not be a barrier to entry.

Pretreatment Standards for New Sources

EPA is proposing to set PSNS (which cover indirect dischargers) equivalent to NSPS (which cover direct dischargers), i.e., at zero discharge for all PFPR waste streams. For the reasons stated above with respect to NSPS, EPA finds that the PSNS regulations would be economically achievable and not a barrier to entry.

Although EPA has proposed to exempt the non-interior wastestreams of small sanitizer facilities from this zero discharge requirement for existing pretreatment facilities (PSES), EPA is not proposing to include this same exemption for the new source pretreatment facilities (PSNS). The rationale for finding that the exemption for those sanitizer wastestreams is appropriate for existing sources is based on EPA's findings that the impacts on existing small entities would be significantly reduced by the exemption, while the associated additional loading of toxic pollutants would be small. EPA does not have sufficient information about new source pretreatment facilities to conclude that the size and economic condition of those new sources, the impacts on those new sources, and the associated loadings of toxic pollutants, would justify a similar exemption for the non-interior wastestreams for sanitizer facilities.

9.2 Subcategory E

New Source Performance Standards

EPA is proposing NSPS for Subcategory E facilities as equivalent to the zero discharge BAT limitations for existing sources. Since compliance with BAT has been found to be economically achievable for existing facilities, EPA has determined that compliance with NSPS will also be economically achievable and not a barrier to entry for new sources.

Pretreatment Standards for New Sources

EPA is proposing PSES for Subcategory E facilities as equivalent to the zero discharge PSES proposed limitations for existing sources. Since compliance with the proposed option has been found to be economically achievable for existing facilities, EPA has determined that compliance with NSPS will also be economically achievable and not a barrier to entry for new sources.

Chapter 10

Additional Cost Savings From Pollution Prevention Under Option 3/S

10.0 Introduction

Traditionally, the Environmental Protection Agency has evaluated the economic feasibility of effluent limitation guidelines and standards by considering the impacts on an industry of projected compliance costs, for example, the costs of installing and operating a treatment technology. However, facilities may offset some of their compliance costs by achieving regulatory compliance through use of pollution prevention measures. The cost analysis of the proposed PSES regulation for Subcategory C facilities (Option 3/S) assumes that, where possible, facilities will use certain pollution prevention measures to achieve zero discharge. These measures include, for example, recovery and reuse of rinse waters and other wastewaters that contain reusable PAIs. By recovering and reusing the PAIs contained in such wastewaters, facilities may save on the purchase cost of PAIs, water consumption costs, and sewage treatment costs. The cost analyses described in Chapter 4 for the proposed regulation include the costs of implementing such pollution prevention measures and reflect the pollution prevention-related cost savings from reduced waste management and disposal costs. The cost savings *accounted for in the Chapter 4 analysis* amount to $4.7 million on an annualized basis. The regulatory cost analyses, however, do not include certain additional offsetting cost savings that may accrue to facilities from pollution prevention.

To provide a more comprehensive accounting of the costs of achieving compliance with the proposed PFPR regulation, EPA identified and assessed the additional mechanisms by which facilities might achieve cost savings through use of pollution prevention. This chapter describes some of these additional potential savings.

According to Section 6602(b) of the Pollution Prevention Act of 1990, pollution should be prevented at the source whenever feasible. EPA has established pollution prevention as the first priority within an environmental management hierarchy that includes prevention, recycling, treatment, disposal and release. Pollution prevention means "source reduction," or any practice that, as defined by the Pollution Prevention Act (1990):

- Reduces the amount of any hazardous substance, pollutant, or contaminant entering any waste stream or otherwise released into the environment (including fugitive emissions) prior to recycling, treatment, or disposal;

- Reduces the hazards to public health and the environment associated with the release of such substances, pollutants, or contaminants; and

- Increases efficiency in the use of water or other resources.[1]

Pollution prevention is a means for a facility to achieve optimal industrial efficiency by reducing the use and generation of hazardous chemicals prior to treatment, storage, control, out-of-process recycling, and disposal.[2] Changes in processes, reduced generation of hazardous components and reagents, improved housekeeping practices, "in-process" recycling, and reduced water use are all considered effective pollution prevention. Unlike end-of-pipe risk management efforts, pollution prevention can reduce worker, community, and environmental exposure to hazardous materials without transferring pollutants from one medium to another thereby altering the exposure route.

Pollution prevention, recycle, and reuse practices that can be implemented by PFPR facilities fall into three categories:

- Actual production practices (e.g., triple rinsing of shipping containers directly into formulations, scheduling production to minimize frequency of rinsing, storing rinsewaters for future formulations, and dedicating equipment and process lines for specific pesticides);

- Housekeeping practices (e.g., preventative maintenance, use of spill cleanup water in formulations); and

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[1]Habicht, F. Henry II (1992). Memorandum, *EPA Definition of Pollution Prevention*, May 28, 1992.

[2]Anderson, Steven and Herb, Jeanne (1992). "Building Pollution Prevention into Facilitywide Permitting," *Pollution Prevention Review*, Autumn.

- Practices employing equipment that by design promote prevention (e.g., use of low flow hoses, squeegees, and steam cleaners).

The PFPR industry already uses these practices to varying degrees. In some cases, adopting these practices as a means of regulatory compliance can provide various cost savings and qualitative benefits as enumerated below.

The potential cost savings (over and above the $4.7 million discussed in Chapter 4) from using pollution prevention as a method of complying with the proposed PFPR regulation were estimated from responses to the PFPR industry Survey and associated technical and economic analyses. A total of 595 population PFPR facilities are included in this assessment of savings resulting from compliance with the proposed regulation. This subset of facilities includes all PFPR facilities using 272 PAIs that (1) were reported in business as of the date of their survey response, 2) completed all parts of the survey as requested (i.e., are "clean") for both technical and economic information, and 3) are water users who discharge water either directly using the best practicable technology through a National Pollutant Discharge Elimination Discharge System (NPDES) permit, or indirectly into a water body through a publicly owned treatment works (POTW). More specific subsets were identified for particular sections of the analysis.

EPA identified five mechanisms by which facilities may offset some of their regulatory compliance costs through pollution prevention. Two mechanisms are associated with the direct costs of PFPR activities: recovery of PAIs, and recovery of water (reducing water and discharge costs). The other three mechanisms, termed indirect cost savings, arise from reductions in facility and firm costs (or other business-enhancing benefits) that are not directly associated with PFPR processing of PAIs. These indirect cost savings mechanisms include: reductions in permitting costs, reductions in business insurance premiums, and reductions in firm cost of capital.

Using Survey data for PFPR facilities subject to regulation, EPA estimated facility-specific savings for the two direct cost mechanisms listed above. Aggregate annual cost savings from recovery and reuse of PAIs and from reduced water use and discharge were estimated at about $765,000. Although EPA was not able to estimate facility-specific savings for the three indirect cost mechanisms, EPA assessed these opportunities on the basis of discussions with permitting authority and insurance and

finance industry personnel and a review of relevant literature. From these discussions and reviews, EPA concluded that the indirect cost mechanisms would also offer cost-savings opportunities to PFPR industry firms that adopt pollution prevention measures as part of their compliance strategy.

Section 10.1 presents an overview of the two major categories of cost-savings opportunities considered in this analysis: direct and indirect cost savings. Sections 10.2 - 10.6 assess five specific cost-savings mechanisms. The first two are direct cost mechanisms: recovery of PAIs, and recovery of water (reducing water and discharge costs). The other three are indirect cost mechanisms: reductions in permitting costs, reductions in business insurance premiums, and reductions in firm cost of capital. Section 10.7 assesses cost savings from pollution prevention with costs incurred where combustion is the vehicle of regulatory compliance.

10.1 Overview of Compliance Cost Savings Opportunities

Conservative compliance *cost* estimates associated with Option 3/S were presented in the previous chapters as part of the economic impact analysis of this regulation. Although these cost estimates incorporated the cost of implementing pollution prevention measures, the estimates recognized only a part of the potential cost *savings* that would accompany their implementation. Additional cost savings that can accrue through compliance by pollution prevention are detailed in this chapter. For this analysis, EPA categorized potential cost savings as direct or indirect.

Direct cost savings

Direct cost savings arise from changes in the costs of PFPR activities, including off-site costs. EPA identified and analyzed two direct cost savings mechanisms:

- Recovery of PAIs; and
- Recovery of water (reducing water and discharge costs).

During the formulating, packaging, and repackaging of pesticides, various processes can be employed that recover both PAIs and water. In addition, other pollution prevention practices, such as the use of dedicated lines for specific PAIs or products, and recovering spills and using them in product formulations, can nominally increase cost savings. From an analysis of sample facilities' process designs, EPA estimated the potential for PAI and water recovery. The recovered PAIs, water and potential savings in discharge were then costed or estimated from current and historical price data.

Indirect Cost Savings

Indirect cost savings arise from reductions in costs that are not directly associated with pesticide formulating, packaging and repackaging activities. EPA identified and assessed three indirect cost savings mechanisms:

- Reductions in permitting costs;
- Reductions in insurance premiums; and
- Reductions in the cost of capital.

A facility that reduces its discharges by pollution prevention can reduce, and in some cases eliminate, its POTW and NPDES permitting requirements and associated costs. These costs, and potential savings, include both payments to permitting authorities and internal costs such as staff time for preparing permit applications, maintaining compliance monitoring programs, and preparing and submitting permitting compliance reports.

Other indirect cost savings stem from the treatment of the firm by liability and business insurers and the public capital markets. Certain liability and business insurance premiums are based in part on the community and worker safety risks posed by a facility and the risk of non-compliance with environmental and safety regulations. As insurers become more aware of the benefits of managing environmental risks through pollution prevention, policies may offer reduced premiums for facilities with rigorous pollution prevention programs. In addition, reductions in financial and operating risk from pollution prevention programs may reduce the cost of capital for PFPR industry firms. These indirect cost mechanisms are more difficult to quantify than the direct cost mechanisms enumerated above. As a result, EPA was not able to estimate facility-specific savings for the indirect cost mechanisms. Instead, EPA assessed these opportunities on the basis of discussions with permitting authority and insurance and finance industry personnel and a review of relevant literature. From these discussions and reviews, EPA concluded that the indirect cost mechanisms would also offer cost-savings opportunities to PFPR industry firms that adopt pollution prevention measures as part of their compliance strategy. As part of this assessment, EPA estimated a range of potential savings from reductions in permitting costs.

Some additional indirect cost savings may accrue to those facilities that choose pollution prevention over combustion as a method of regulatory compliance. Many facilities may initially find combustion to be the most cost-effective compliance strategy. However, when viewed over a longer time

horizon, pollution prevention may become a less costly option for several reasons. In particular, combustion units face: increased costs and length of time for permitting; increased regulatory attention; possible capacity constraints due to placing a low priority on considering permits for new hazardous waste combustion units; and troublesome community relations. These factors may combine to escalate combustion costs, making it a more expensive compliance method over the long term. EPA discusses these issues at greater length in the final section of this chapter.

10.2 Direct Cost Savings From Recovery and Reuse of PAIs

Residual Pesticide Active Ingredients (PAIs) that remain in the wastewater stream after cleaning of equipment (e.g., interior equipment rinsing) can be recovered in many facilities that currently discharge wastewater, and can be reused in the next batch of formulations requiring that particular PAI or combination of PAIs and inert ingredients. The dedication of lines for specific PAIs and the recovery of wastewater contaminated by only a single PAI facilitate PAI savings. When PAIs are commingled in a waste stream, the wastewater may not be immediately reusable, or may not be reusable at all.

EPA estimated the potential cost savings from recovery and reuse of PAIs from wastewater for 545 facilities. Only water using facilities with compliance costs were analyzed for potential PAI savings. Facilities using a dedicated line or a single contaminant wastewater process are able to reuse the PAIs present in the wastewater, thereby requiring the input of fewer new PAIs. For example, a facility using 10 pounds of PAIs in a formulation with one pound being released into the waste stream would need to use only 9 pounds of new PAIs the next time the same PAI formulation was required *if the facility is able to recover and reuse the one pound of otherwise discharged PAIs*. To estimate the cost savings from reduction in PAI use, EPA estimated the quantity of PAIs that each facility could be expected to recover and reuse. The value of the PAIs recovered was estimated based on PAI-specific prices from the Pesticide Manufacturers effluent guideline or from manufacturers and other secondary sources.

Methodology for Estimating PAI Cost Savings

From engineering analyses of the PFPR industry Survey facilities, EPA estimated that complying facilities would be able to recover and reuse 116 PAIs in the course of complying with the proposed PFPR regulation. The prices per pound for each of these 116 PAIs were gathered from several sources. The EIA for the Pesticide Manufacturers effluent guideline gathered price data for PAIs subject to that rule. In cases where more than one price was reported for a PAI, EPA calculated an average price

weighted by the amount of domestic sales *per price* for each PAI. Some PAI prices were constructed from the revenue received for the final pesticide product at the manufacturing facilities. In addition, chemical product distributors provided some prices. Ten PAIs lacked any pricing data; however, values were estimated for these PAIs by averaging the available PAI prices within clusters of PAI use. The prices for all PAIs were converted to 1988 dollars using the Producers Price Index for chemicals.

To assess the value of savings over the period of compliance with the proposed rule, EPA considered the possibility that PAI prices might increase in the future at a rate greater than the general rate of inflation. However, a review of historical data for the Producers' Price Index (PPI) for chemical products and the Consumer Price Index (CPI) gave no evidence that the PAI prices would be expected to increase at a rate greater than the rate of inflation. Therefore, EPA chose not to adjust PAI prices for increases beyond inflation.

The quantity of PAIs not used in the product and the amount that could be potentially recovered were obtained from the PFPR industry Survey. The recoverable PAI quantities (for each facility, by PAI) were multiplied by the price for each PAI, and summed by PAI to obtain an estimated facility cost savings, as follows:

$$\sum_{i=1}^{n} Q_i \times P_i$$

where:

Q_i = the quantity of PAI i saved;
P_i = the price of PAI i; and
n = the number of PAIs used by the facility.

Estimated PAI Recoveries and Potential Cost Savings

Potential cost savings were estimated for end-of-pipe PAI loadings under Option 3/S. EPA estimates the average amount of PAI loadings per facility (with potential PAI recoveries) at 336 pounds per year, valued at $3,042. Over all facilities, EPA estimates total PAI *loadings* of 118,688 pounds annually with a value of $1,075,332.

Several factors prevent all of the PAI loadings from being recovered and reused, for example: mixed wastewater streams, PAIs caught in filters, and accidental contamination. Engineering analyses indicate that 354 PFPR facilities are currently capable of recovering and reusing 116 PAIs. EPA estimates that facilities may recover, on average, about 220 pounds of PAIs per facility, which represent 77,816 pounds of PAIs per year in aggregate. As a result, about 65 percent of the aggregate PAI loadings are estimated to be recoverable and reusable. At the facility level, on average each facility with PAI savings can expect to recover 57.7 percent of the pounds of PAIs currently being discharged, and 57.6 percent of the dollar value of PAIs currently being discharged.EPA estimated that on average each facility *with PAI savings* would save approximately $1,777 per year, with a total value of $628,065 (in 1988 dollars). On average, these savings represent about 0.65 percent of these facilities' total annual compliance cost. The sample facility with the highest savings is estimated to save $427,000 per year. To the extent that facilities increase recoveries, for example, by further isolating waste streams, these recovery percentages and associated gains from pollution prevention will increase.

Table 10-1
Summary of Estimated PAI Cost Savings Under Proposed Regulatory Option

	Pounds of PAI Recovered	Total Value of PAIs Recovered ($ 1988)
Industry Total (354 facilities)	78,816	$628,065
Average Facility Savings	220	$1,777

To better understand the potential for PAI cost savings from regulatory compliance strategies incorporating pollution prevention, EPA looked more closely at the distribution of cost savings over facilities, and specifically at the characteristics of those facilities achieving the highest savings. Overall, most facilities with savings were estimated to achieve very modest amounts of PAI recoveries and, accordingly, to achieve only modest financial gains from PAI recovery. Over half of the facilities with estimated savings were found to achieve less than 10 pounds of recoveries per year with only a few dollars of associated cost savings.

For a few facilities, PAI recovery and associated cost savings will be much higher. On the whole, these facilities showed few common characteristics with the exception that they tend to be larger PFPR facilities that also manufacture PAIs. To illustrate, the five sample facilities, which represent

approximately 10 facilities in the overall population, that will realize the greatest savings from PAI recovery are diverse in terms of primary market and PAIs used. Three of the facilities receive at least 90 percent of their total facility revenue from PFPR activities, one facility derives about 38 percent of its total facility revenue from PFPR, and one facility depends upon PFPR activities for only about 9 percent of its total revenue. Four out of the five facilities also manufacture pesticides. Two of the facilities share the same primary market: the agricultural market. None of the facilities would experience regulatory relief from the sanitizer exemption. The number of PAIs used by these facilities ranges from one to twenty-five. One PAI, an insecticide, is used by three out of the five facilities and two PAIs, an insecticide and a synergist, are used by two of the facilities. Only one of the sample facilities is a direct discharger; the remainder are indirect dischargers. In sum, these data exhibit little pattern to suggest that only certain types of facilities could be expected to achieve substantial benefits from recovery and reuse of PAIs.

10.3 Cost Savings From Reduced Water Use and Water Discharge

Wastewater from which PAIs have been recovered can be reused with the same line or processes in a PFPR facility from which it was taken. Economic benefits can accrue from the reduced demand for new water as well as from decreased volume of wastewater discharge and associated sewage system costs.

Methodology for Estimating Cost Savings from Reduced Water Use and Water Discharge

The methodology followed by EPA in estimating water-related cost savings involved calculating the potential reductions in water use and discharges by facility and multiplying these values by estimated water and sewer rates. Water and sewer rates were obtained from Ernst & Young's *Water and Wastewater 1992 Survey* of the monthly rates for the 100 largest metropolitan areas. EPA supplemented this rate information with data on water rates for facility locations not covered by the Ernst & Young data. Also, EPA adjusted these rates to reflect expected increases in water and sewer rates at greater than the general rate of inflation.

Estimating Reduced Water Use and Discharge Volumes

The potential cost savings to facilities were calculated separately for water and sewer use. In analyzing sewer cost savings, EPA assumed 100 percent reduction or reuse of water that is currently discharged. However, not all facilities may be able to achieve complete reduction, especially facilities

that do not have dedicated lines. The estimated volume of discharge savings is based on the current volume of POTW and NPDES discharges as reported by facilities in the PFPR industry Survey.

Water cost savings were based on the assumption that water currently discharged to a POTW or under NPDES will be recycled and therefore the amount of new water required for production will be reduced by this amount. The sum of reported POTW and NPDES discharge volumes therefore represents the water volume for calculating water consumption savings as well.

The discharge volume may provide a reasonable estimate of the potential change in water consumption. However, use of the reported discharge volume for calculating the change in water consumption may understate the potential monetary value of water consumption-related savings because of the typical structure of water consumption rates. In particular, as discussed more fully in a later section of this chapter, municipalities are more frequently using increasing block rate structures for water consumption. Under an increasing block structure, the water consumption unit price increases with the volume of consumption per time period. As a result, under an increasing block rate formula, the value of cost savings *for a given volume of reduced water consumption* will increase as the gross quantity of consumption by a facility increases. For example, a facility that saves 5,000 gallons per month out of gross consumption of 50,000 gallons may achieve a higher monetary value of savings than a facility that saves 5,000 gallons out of 10,000 gallons of gross consumption.

The PFPR industry Survey did not require facilities to report either their gross water consumption or the amount of water that remains in the PFPR product. If either of these values were known, it would be possible to calculate more accurately the value of water consumption savings based on the marginal price that would otherwise be charged for the water that is saved through pollution prevention. In the absence of this gross consumption information, this analysis assumes the pre-compliance discharge volume is the gross consumption volume, and the price for valuing water use savings is taken from rate schedules accordingly. To the extent that gross consumption exceeds the discharge volume *and* PFPR facilities face increasing block structures for water use rates, this assumption may understate the unit price being used to value water use savings, thereby understating potential cost savings. Furthermore, the Survey only contained information regarding PFPR water use. If a facility also manufactures PAIs, it may save even greater volumes of water by implementing pollution prevention measures. Therefore potential cost savings may be further understated.

Estimating Rates for Valuing Reduced Water Use and Discharge

Ernst & Young, in *The 1992 Water & Wastewater Rate Survey* reports water and sewer rates for 100 major metropolitan areas. The rates were reported as monthly water and sewer charges based on volume used and discharged. Ernst & Young adjusted the actual water and wastewater rates so that comparisons can be made among cities. Rates were grouped into seven volume categories, beginning with small increments, then shifting to larger increments with larger water consumption volumes.

Although rates for facilities located in rural areas were not included in the Ernst & Young report, a rate analyst from the Denver Water Department stated that urban and rural water and sewer rates in the same region would differ by only small amounts.[3] Accordingly, EPA developed an average rate schedule for each state in which PFPR sample facilities with estimated water savings were located based on the Ernst & Young information for major cities; some states had listings for as many as 9 cities. All of the rates were adjusted to annual rates (i.e., multiplied by twelve). As described below, rates were also adjusted to reflect the amount by which growth in water and sewer rates were estimated to exceed the general rate of inflation. These rates were used to calculate annual cost savings to PFPR facilities that undertake pollution prevention activities.[4]

If water and sewage rates are expected to increase at a rate faster than the general rate of inflation, then using current rates to value reduced water consumption and discharge will understate the potential benefits of pollution prevention to PFPR facilities. Accordingly, EPA reviewed literature and discussed this issue with water and sewer industry specialists to understand whether water and sewage rates could be expected to increase at a rate faster than the general rate of inflation. From this review, EPA identified several factors that are contributing to water and sewer rates' surpassing the general rate

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[3]Montoya, Angela, Telephone Interview of March 21, 1994.

[4] To verify that the Ernst & Young rates would reasonably approximate rural rates, EPA obtained actual water and sewer rates from 9 water and sewer offices in rural areas to compare with the urban rates that were compiled by Ernst and Young. Using these rates, illustrative examples were developed for facilities within the 9 communities. Annual cost savings for water use and sewer discharge for each example were calculated using the state-average rates based on the Ernst & Young survey and the actual rates obtained from rural water and sewer offices. The savings calculated by both methods were not found to vary in a statistically significant way to suggest that the Ernst & Young survey-based rates would either overstate or understate the cost savings from reduced water consumption and discharge.

of inflation. These findings, as summarized in the following paragraphs, lead EPA to adjust the Ernst & Young rates for expected future increases in water and sewer rates.

General trend of water and sewer pricing. Municipalities and towns across the country are reevaluating water rates and structures to account for conservation pressures, increased financial pressures on utilities resulting from regulatory requirements, supply and capacity limitations, and financial management issues.[5] Distinct changes in the water rates and structures in regions across the country have resulted. The changes already realized, as well as ongoing trends, could significantly affect the savings achievable by PFPR facilities that adopt pollution prevention measures to recover and reuse wastewaters.

Rate structures for water pricing. Water and sewer utilities adopt a variety of rate structures to achieve revenue requirements while also promoting other public policy objectives (e.g., water conservation). The three prevalent rate structures include:

1. Declining block rates — prices decrease as consumption increases
2. Uniform rates — prices do not vary with consumption
3. Increasing block rates — prices increase with consumption.

Each of these structures results in significantly different water costs, especially for larger industrial/commercial users. The decision to adopt a particular structure depends on local considerations including: effects on consumers, local usage patterns, water supply, local financial practices, state regulatory environment, conservation, competitiveness with local communities, revenue stability, legality, and simplicity.[6] As a result of these different factors that may affect a community, the ultimate rate structure and cost to consumers vary widely from region to region. Increasingly, communities are moving away from the older declining block structure, which encourages consumption, to the increasing block structure, which encourages water conservation and reduced sewage discharge.

Regional trends in rates and structures. Water and sewer rates vary by region, reflecting localized conditions of water availability and quality. The Northeast is undergoing the most significant

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[5]Duke, Ellen and Montoya, Angela (1993). "Trends in Water Pricing: Results of Ernst and Young's National Rate Survey," *American Water Works Association Journal*, May.

[6]*Ibid.*

shift away from declining rates. In 1992, 44 percent of the utilities used a declining block rate, down from 75 percent in 1986; the utilities reported shifting mainly to uniform rates, although some are moving to increasing block rates. An aging infrastructure that is placing greater demand on the total water system, contamination of the groundwater, and the drought during the 1980s made it difficult for utilities in the Northeast to deliver quantities of water while maintaining quality during peak periods, leading to use of seasonal or excess use charges. The trend away from declining block rates to conservation-oriented rates is expected to continue in the Northeast. The shift in the South away from declining rate structures has been more gradual. However, 25 percent of utilities in the region are using increasing block rates. Because of substantial economic growth, the South faces the challenge of protecting surface and groundwater resources as well as periodic water shortages. These factors have resulted, and will continue to result, in pressures towards increasing block, conservation pricing. Midwestern water users enjoy a relatively plentiful source of water resources through their geographic proximity to the Great Lakes. Like the Northeast, the largest problem in the Midwest is the ability to deliver quality water during peak periods, making excess use and seasonal pricing structures attractive. The region is also increasing its reliance on increasing block rates. In 1986, no facilities used increasing block rates; in 1992, 10 percent used this approach. The West has the greatest proportion of increasing block rates at 32 percent. The water supply is so low in some areas of the West that major cities must rely on "imported" water from other regions. In the West, conservation measures have become imperative. Because the West has experienced significant rate increase in the recent past, the incremental change in water rates in the future is not expected to be as great as in other regions (i.e., Northeast and South).[7]

Projected increases and impact of water rates on the PFPR industry. On the basis of factors such as those delineated in the preceding paragraphs, industry experts indicate that water and sewer rates across the nation are likely to increase at a rate at least as great as the general rate of inflation over the next few years.[8] Moreover, significant variations by region are possible. Although the trend toward conservation pricing has been slower in the Midwest, where a majority of the PFPR facilities are located, the trend is expected to continue and thus affect the PFPR facilities in that region. Industry experts

[7]Duke, Ellen and Montoya, Angela (1993).

[8]Duke, Ellen and Montoya, Angela (1993).

indicate that the Northeast and Southern regions are likely to experience the greatest increase in water rates in the near future[9]; a large number of PFPR facilities are located in the Southern states.

From these considerations, EPA decided to adjust the state-average water and sewer rates by a factor to account for the likelihood that water and sewer rates will increase at a rate exceeding the rate of inflation over a ten-year analysis period. Duke and Montoya (1993) state that in the long term, water and sewer rates for commercial/industrial facilities (across all regions) are likely to increase at a rate somewhat higher than the increase in the Consumer Price Index. EPA estimates that the real rate of price increases could range from 2 to 4 percent. Over a ten-year period, a 2 percent real rate of price increase translates into an average price that is 11 percent higher *in inflation-adjusted terms* than the price at the beginning of the period, while the 4 percent real rate translates into a 22 percent higher average price. For this analysis, EPA calculated water and sewer-based savings using rates increased at both the two and four percent real rates of price increase.

Estimated Cost Savings from Reduced Water Use and Discharge

Water and sewer cost savings were estimated for the 529 Subcategory C facilities estimated to incur costs of complying with the PSES regulation. EPA estimated that 519 facilities could be expected to achieve water and sewer cost savings by use of pollution prevention. For those facilities achieving cost savings, the mean water and sewer savings is estimated at $227 to $251 per year.[10] The maximum annual savings for an individual facility is approximately $13,000. On average, these savings represent about one percent of the total annualized compliance costs for the facilities expected to achieve water and sewer cost savings. However, the maximum percentage of compliance costs estimated to be saved at a specific facility is about 11 percent of total annual compliance costs. On the basis of the individual facility values, EPA estimates national aggregate annual benefits from water and sewer savings of $128,013 to $141,477. In general, the sewer cost component of individual facility savings is approximately two-thirds the water cost savings, although wide variations in pricing do exist. The combined water and sewer cost savings for average and median facilities as well as for industry totals are presented in Table 10-2.

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[9]Montoya, Angela (1994) Telephone Conversation of March 21.

[10]Range results from use of the 2 percent and 4 percent real rates of price increase for water and sewer rates.

Table 10-2 Sewer and Water Cost Savings Summary Table*		
	Weighted Cost Savings (2 percent rate of real price increase)	**Weighted Cost Savings (4 percent rate of real price increase)**
Industry-wide Aggregate	$128,013.24	$141,476.53
Average Facility Savings	$226.72	$250.57
Median Facility Savings	$96.76	$106.94
* Includes facilities with cost savings.		

Most facilities are estimated to achieve relatively modest savings: the estimated median facility cost savings range from $97 to $107 per year. However, some facilities were estimated to achieve substantial savings, both absolutely and as a percentage of total regulatory compliance costs. Specifically, the maximum total cost savings for any one facility is estimated at $12,762 - 12,976. Although cost savings average 0.81 percent of total compliance costs, the analysis found that 10 facilities would be expected to achieve water and sewer cost savings representing between three and eleven percent of their total annual compliance cost. As previously mentioned, these cost savings only represent the savings due to PFPR operations. Some facilities may save additional water and sewer costs by using pollution prevention measures in their manufacturing processes as well.

EPA considered whether the sample facilities with the larger savings values exhibited any particular characteristics. As would be expected, facilities show a greater cost savings the higher the volume of water used. Many of the facilities that captured the highest cost savings are categorized as manufacturers in our survey. The manufacturing category includes facilities that have high water use and discharge volumes because they tend to formulate and package large volumes of PAIs. No regional correlations are apparent. Of the 10 sample facilities with expected water and sewer cost savings exceeding 3 percent of the total compliance cost, 8 primarily serve the institutional market. The remaining two facilities were categorized as a consumer home products facility and an industrial facility.

The actual cost savings from reduced water use and discharge could be higher than estimated. As discussed in the methodology section, the data needed to accurately calculate the cost savings associated with a change in water consumption were unavailable (i.e., the survey did not require facilities to report total water use or the amount of water retained in the product). Because water use is priced in

block rates, the water cost savings based on actual pre- and post-compliance water consumption could result in a much higher cost savings than that calculated by applying a price based only on the amount of water saved, and manufacturing facilities will likely save water in their manufacturing processes as well.

10.4 Indirect Cost Savings from Reduced Costs of Permitting and Fees

PFPR facilities may reduce the costs of obtaining and renewing discharge permits by using pollution prevention measures to comply with the proposed regulatory option. Permitting costs include application fees, annual maintenance fees, renewal fees, costs of preparing engineering reports, and monitoring and reporting costs. A review of permitting information from several states with PFPR facilities showed that permitting costs and payment structures vary considerably from state to state. In general, however, reducing or eliminating discharge volumes through pollution prevention should permit facilities to save on permitting costs. In most cases, facilities would have to retain some form of permit, but would be expected to pay lower permitting costs. In some cases, these savings may be substantial.

Review of Permit-Related Cost Savings Opportunities

To understand the permit-related cost savings that PFPR facilities might achieve, EPA reviewed information on permitting procedures and costs for several states with PFPR facilities.[11] EPA also discussed the opportunity for permit-related cost savings with permitting authority and POTW personnel in several states. From this review, EPA found that the permitting costs and payment structures associated with discharging wastewater vary widely among states and regions. For example, several states vary permit application and maintenance fees based on facility discharge volumes and complexity of discharge streams. Some states indicated that their permit fee structures have been explicitly designed, or are being designed, to promote pollution prevention as a discharge reduction or elimination method. The more common permit-related cost items are as follows:

[11]EPA generally contacted states that are assessed as potentially being impacted, and that represent diverse geographic regions.

Indirect Dischargers

- State Permit Application Fees
- Annual Compliance Costs
- POTW User Fees
- Periodic Monitoring Costs
- Costs of Preparing Permit Applications
- Fines for Exceeding Discharge Limits

Direct Dischargers

- NPDES Fees
- Permit Application Fees
- Annual Compliance Fees
- Fines for Exceeding Discharge Limits
- Periodic Monitoring Costs
- Costs of Preparing Permit Application

From the contacts with state agencies, EPA identified a variety of pricing schemes for each potential permit-related cost. These cost items frequently vary in a way that would allow facilities to reduce expenses by achieving compliance through pollution prevention, as summarized below.

Discharge permits: indirect dischargers. Some states do not require indirect discharge permits; therefore no cost is required for obtaining a permit. Of those that do require permits, the payment structure varies substantially. Several of the ways in which permit costs vary indicate that permit-related cost savings should be available to facilities that comply with the PFPR regulation by means of pollution prevention:

- In some states, the discharge permit fee is based on the complexity of the facility's pretreatment system, which must be inspected and approved. Pollution prevention should at the very least simplify the necessary pretreatment system, and perhaps eliminate the need for a pretreatment system altogether, thus eliminating or reducing this fee component.

- One state, New Jersey, based its application fee on the annual volume of pollutant discharges, while another state, Illinois, based its permit application fee on the amount of water that the

facility is expected to discharge daily. In both cases, achieving zero discharge through pollution prevention would reduce permit costs.

- Florida charged a "zero discharge" fee that was substantially lower in cost than the regular permitting fee and was expected to cover the cost of inspecting the facility's treatment and recycling systems. In some cases, once the facility is proven to be a "zero discharger," the permitting fee is waived for reapplications and renewals. Pennsylvania, in contrast, does not require zero dischargers to obtain a permit.

In all these cases, facilities that comply with the PFPR regulation by means of pollution prevention should be able to reduce or eliminate the permitting fee. Among the states contacted, the fees for a permit application ranged as high as $1.9 million. Accordingly, the possible dollar savings can be substantial. The initial permit is typically valid for a period of 5 years. Renewal fees tend to be less than the original application fee though still substantial.

Discharge permits: direct dischargers. Most states contacted do not have an application fee for direct dischargers. In one state, however, there is a flat application fee that must be paid every five years, and in another state the fee charged is $6,850 upon first applying for the five-year permit, and $2,150 for renewals. A facility that achieved zero discharge through pollution prevention could avoid these charges.

Annual compliance fees: indirect dischargers. One state charges an annual compliance fee, which provides the permitting authority with additional revenues to run its permitting and monitoring programs. At $100 per year, this fee was relatively inexpensive compared to permit application fees. Again, achievement of zero discharge through pollution prevention should eliminate the need to pay this fee.

Annual compliance fees: direct dischargers. The corresponding compliance fee for direct dischargers in the same state described above ranges from $100 to $5,000, depending on the complexity of the facility's treatment system for the discharged water. Pollution prevention may eliminate or substantially reduce this fee amount.

User fees charged by POTWs: indirect dischargers. Most POTWs levy a user fee for industrial dischargers. These fees can be substantial and typically vary with discharge volume, thus providing an opportunity for facilities that comply by pollution prevention to achieve cost savings. For example, in some states contacted, the user fees charged by the POTWs are based on the amount of process water used or discharged, as well as the level of biological oxygen demand (BOD), total suspended solids (TSS), and other pollutants such as ammonia or nitrogen that are found in the discharged wastewater. The range of user fees among the POTWs contacted ranged from $0 to tens of thousands per year, depending on the flow and content of the discharged water.

Monitoring costs: direct and indirect dischargers. Most states contacted did not require facilities to pay an explicit monitoring fee because the POTW user fees were expected to cover that expense. An exception would be if the facility was found to be out of compliance and therefore required extended monitoring. In most such cases, facilities would be charged for that expense. In a few states, facilities are required to pay monitoring fees on a regular basis. The reported costs varied from $500 to $600 per year. Monitoring and analysis when a facility is found to be in violation can cost from $150 to thousands of dollars per incident. Thus, in some but not all cases, facilities would save on monitoring costs by using pollution prevention as the zero discharge compliance method.

Fines for exceeding discharge limits: direct and indirect dischargers. Most states that were contacted fine facilities that exceed their discharge limits. One POTW indicated that depending upon the degree of violation, a facility could pay up to $10,000 in fees per discharge violation. The facility could also be held liable for any damage resulting to the POTW, which could cost tens of thousands of dollars. Excess discharge of pesticide ingredients in particular may disrupt the balance of POTW process bacteria, which may be quite costly to remedy. The risk of such costs would be eliminated by achieving compliance through pollution prevention.

NPDES fees: direct dischargers. The NPDES fees for direct dischargers also vary greatly from state to state. In some states, the NPDES fee was simply a flat amount. However, some states based NPDES fees on the volume of pollutants discharged. One state contacted bases its NPDES fees on two factors: the threat of the discharge to water quality, and the complexity of the discharge. Fees for NPDES permits range from $0 to $73,000 for a five-year permit. In those states in which fees vary with

quantity of discharge or risk imposed by the discharge, use of pollution prevention as a compliance method should enable facilities to reduce or eliminate fee outlays.

In addition to the permit-related savings enumerated above, permitting authority personnel confirmed that state policies are changing in a way to promote use of pollution prevention and that permitting procedures and fee structures are being revised to encourage pollution prevention.

Finally, some permitting authority personnel noted that facilities may not fully eliminate permit-related fees by use of pollution prevention. Indeed, in some states, facilities may be required to keep discharge permits even though they technically become zero-discharge operations. However, permitting authority personnel stated that facilities should generally be able to defray their costs based on the reduced application and maintenance fees frequently charged to zero dischargers and the reduced time for facility personnel to complete applications.

Examples of Possible Permit-Related Savings

Although it is not possible to calculate an expected savings per facility from the information obtained for this study, it is possible to develop illustrative scenarios within the framework of some of the pricing policies of representative states that will illustrate potential cost savings that from use of pollution prevention measures. Several examples based on state-specific permitting fee structures are outlined in the following paragraphs.

Example A: A facility operating in Massachusetts and deemed to be a Category 1[12] Significant Industrial User[13] that discharges wastewater into the Massachusetts Water Resources Authority sewer system. If this facility undertakes pollution prevention measures that eliminate its wastewater discharges, the resulting cost savings to the facility would be:

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[12]A Category 1 SIU facility is "an industrial user subject to Categorical Pretreatment Standards under 40 CFR 403.6 and 40 CFR , Chapter 1."

[13]One criterion for a Significant Industrial User (SIU) is that the facility discharge 25,000 gallons of process wastewater per day.

$1,430 every two years in permitting fees, and

$3,700 per year in monitoring fees[14]

This facility would save an average of **$4,415 each year** in monitoring and permit fees.

Example B: A facility operating in California, classified as a category Ia[15] direct discharge facility. If this facility uses pollution prevention and wastewater recycling measures to eliminate its wastewater discharges, the facility would save **$10,000 each year** in NPDES permit costs.

Example C: If the hypothetical facility described in Example B does not eliminate *all* of its discharge, but reduces it to become a category IIIa[16] facility, then the cost of the facility's NPDES permit would decrease from $10,000 per year to $1,000 per year. The facility would save **$9,000 a year** in NPDES permit fees.

Example D: A facility located in New Jersey is charged $28,000 every five years based upon the volume and toxicity of the loadings discharged to a local POTW, and an annual monitoring fee of $300. After compliance the facility discharges only very dilute amounts of active ingredient from the laundry and showers. As a result the facility is only charged $7,000 every five years and an annual monitoring fee of $300. The facility saves an average of **$4,200 per year** in permit fees.

The examples above indicate some scenarios that could result in substantial cost savings to facilities under current pricing schemes. From the interviews conducted for this study, EPA expects that many states, regions, and POTWs will modify their pricing schemes to further ensure that the permitting process itself does not discourage pollution prevention and, furthermore, many states hope to encourage facilities to engage in pollution prevention. States indicate that they plan to use pricing incentives, shorter

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[14]Assuming the facility is one with "medium monitoring point scores", which are facilities with pretreatment systems which are monitored between two and three times per year, on average.

[15]Category I describes a facility whose discharges "could cause the long-term loss of a designated beneficial use of the receiving water", and a complexity "a" category includes "any major NPDES discharger."

[16]A category III facility describes a facility whose discharges could "degrade water quality without violating water quality objectives, or cause a minor impairment of designated beneficial uses compared with Categories I and II."

permit waiting periods, and a shorter, less complicated permit application to further encourage pollution prevention.

Possible National Savings from Reduced Permitting Costs

Because of the large variation in pricing strategies, it is not possible to estimate accurately the permit-related savings that facilities may achieve through pollution prevention. However, EPA made broad assumptions to illustrate the possible magnitude of permit-related savings that facilities might realize through use of pollution prevention. Because two of the above examples showed annual savings of about $4,000 per year, that amount was used as a benchmark. Assuming that one-third of PFPR facilities incur no savings, one-third save $4,000 per year from reduced permitting costs, and one-third save $8,000 per year (twice the benchmark amount), the aggregate cost savings to the industry would be about $2,800,000 each year.

Overall, PFPR facilities have a substantial opportunity to reduce permit-related costs by undertaking pollution prevention measures. These costs are expected to rise in the future, as states and municipalities modify their permit pricing structures to encourage pollution prevention.

10.5 Indirect Cost Savings from Reduced Insurance Premiums

Although liability and general business insurance policies do not currently incorporate explicit discounts for use of pollution prevention, trends in insurance coverage show that reduced chemicals-related risk should be reflected in reduced insurance premiums. Specifically, the insurance industry has begun to recognize that pollution prevention efforts can reduce a number of business and liability risks. As a result, insurance firm representatives indicate that PFPR facilities with wastewater recycling and zero discharge may be charged lower premiums than facilities that discharge to a POTW. The lower insurance premiums could result from several mechanisms. Although it is not possible to quantify the value of these savings, EPA finds that PFPR facilities should benefit from reduced premiums by using pollution prevention to comply with the proposed PFPR regulation.

Mechanisms by Which Pollution Prevention Reduces Environmental Risk

To understand whether PFPR facilities that use pollution prevention as a compliance method might be charged lower insurance premiums, EPA discussed this issue with several business insurance

representatives. The discussions with industry representatives reveal a trend to incorporate pollution prevention considerations into the underwriting process, potentially resulting in a premium credit.

Over the past decade and a half, the insurance industry has established classification criteria to distinguish increases and decreases in risk in industries using chemicals and with chemical wastes. Ultimately, liability and business insurance premiums are set to reflect the overall environmental risk at industrial facilities and take these risk classification criteria into account. Important factors in evaluating facility environmental risk include:

- Determination of exposure rating
- Assessment of compliance history
- Determination of process/waste constituents
- Determination of the concentration of constituents[17]

Within the risk classification process, pollution prevention as a means of compliance may benefit PFPR facilities through several mechanisms, as follows:

Reduced Use of PAIs Results in Reduced Exposure Risk

PAI recovery and recycling should reduce the volume of PAIs a facility needs to purchase, receive, and manage during the normal PFPR production process. In turn, a reduced volume of pesticide ingredients shipped and handled at a facility can result in lower risk of hazardous exposures for workers and the surrounding community. Insurance industry representatives note, however, that depending on PAI handling and storage practices, exposure risk might not be reduced. And, in some instances, the storage of recovered PAIs for reuse could actually increase business facility risk. Careful management procedures should offset this potential increase in risk. Moreover, if the compliance method used by the facility involves hauling waste to an off-site combustion unit or landfill, transportation of the waste poses a risk that could be avoided by adopting on-site pollution prevention measures.

[17]Aulisi, Andrew of Commerce and Industry Insurance Company. Written correspondence of May 12, 1993.

Elimination of Discharges Results in Lower Risk of Leaks or Accidental Excess Discharges

Facilities that use pollution prevention to eliminate discharges will reduce the risk of accidental discharges of polluting materials. No contaminated wastewater would be released into POTWs, resulting in both a reduced risk of potential accidents or leaks, and a lower risk of excessive discharge into the community. As noted above, excess discharges of PAIs into a POTW can substantially disrupt POTW processes, exposing firms to considerable liability. Reduction in, or elimination of, these risks should result in a lower risk rating for a facility, with the potential for lower insurance premiums.

Reduced Use of PAIs and Elimination of Discharges Reduces the Risk of Exceeding Permit Levels

For those facilities currently discharging to a POTW or directly under a NPDES permit, compliance by pollution prevention may result in reduced insurance premiums because of a reduced risk of being found in violation of discharge limits. With no contaminated wastewater being discharged, the risk of exceeding permit levels (through accidental leak or facility clean-up) decreases substantially. If those same facilities chose to comply by contract hauling and combustion of their wastewater, the risk of noncompliance would remain high. On-site storage of wastes for more than 90 days (or 45 days for facilities storing large volumes of hazardous wastes) instead of reducing waste through pollution prevention measures requires RCRA permitting, which may place facilities in a higher risk category for insurance pricing.[18] In addition, the risk of exposure increases through on-site storage and potential transportation risks.

Outlook for Favorable Consideration of Pollution Prevention by the Insurance Industry

A representative from the Commerce and Industry Insurance Company (a member company of American International Group, Inc.) provided insight into the likelihood that the business insurance industry would grant premium reductions for use of pollution prevention. In evaluating facility risk, the insurance industry relies heavily on the performance record of technologies and processes in managing the risks that insurance policies are purchased to insure against. Currently, pollution prevention technologies and processes are not widely used and not well understood by both process industries (i.e., in this case, the PFPR industry) and the insurance industry. As a result, the insurance industry might not yet view pollution prevention in a favorable light in evaluating facility risk. In some instances, as

[18]Roepe, Wayne. Telephone conversation of March 21, 1994.

noted above, insurance firms might view wastewater recycling and PAI recovery activities as adding to, or at least not reducing, facility operating risks.

However, as various aspects of the pollution prevention process become more accepted and their efficient and effective performance is better established and documented, insurance firms will be more likely to account for the potential risk-reducing benefits of pollution prevention programs in setting insurance premiums. The surface impoundments, holding tanks, underground piping, sludge generation, process modifications, and chemical storage required for wastewater recycling may create risks of operating system failures and pollutant exposures.[19] As these aspects of the pollution prevention process become more widely used, and better understood and proven, the insurance industry will more likely recognize their broader risk-reduction benefits and change facility risk ratings accordingly. Reduced insurance premiums could then result.

10.6 Cost Savings from Reduced Cost of Capital

Compliance by pollution prevention under Option 3/S can provide financial benefits to firms by reducing the cost of capital. Decreases in the amount of pesticides being used can reduce contingent liabilities associated with worker safety and environmental compliance issues, and may also provide preferential recognition and valuation in the public capital markets.

The factors that influence the cost of capital to a firm include: the firm's expected financial performance; the variability of the firm's financial performance; the financial structure of the firm and the associated variability in the performance of the instruments by which the firm's assets are financed; and the relationship of the variability in the firm's own financial performance to that of other firms and competing investment opportunities. These factors determine the overall riskiness of a firm as an investment or lending opportunity. In general, actions that reduce the riskiness or expected variability of a firm's financial performance will reduce its cost of capital. Adoption of pollution prevention measures may reduce the riskiness of the firm's financial performance through:

- Avoidance of contingent liabilities. For similar reasons to those outlined above for reduced insurance costs, use of pollution prevention measures by PFPR facilities can reduce contingent

[19] Aulisi, Andrew of Commerce and Industry Insurance Company. Written correspondence of May 12, 1993.

liabilities that pose a risk for creditors and investors. For example, more efficient use of PAIs and the use of dedicated lines for each PAI and/or product can reduce the overall level of worker exposure to PAIs. In addition, the reduction or reuse of PAIs can reduce or eliminate pollutant discharges, thereby reducing risks to the surrounding community from accidental spills or leakage and also reducing the risk of being found in violation of discharge limits. Risks associated with transporting waste to off-site disposal operations are also eliminated if pollution prevention is chosen as the method of compliance over off-site disposal. Each of these contingencies may pose a financial risk to the firm. In a worst-case scenario, a fine or legal suit in any one of these areas could force a firm into bankruptcy. Elimination or reduction of such contingent liabilities should reduce uncertainty about future financial performance and result in lower required returns by creditors and investors.

- Increased managerial control of the firm. Facilities that prevent pollution associated with PAI use will be better able to control the financial impact of environmental regulations. Firms that limit but continue to discharge effluent are left with the risk of achieving compliance with possibly more stringent environmental requirements in the future. Firms that implement pollution prevention to eliminate discharges are proactively avoiding, and therefore controlling, the possibility of these future compliance costs. The removal of this cost uncertainty should make those firms that adopt pollution prevention less risky to invest in or lend to.

- Preferential recognition and valuation by investors and lenders. Some investors preferentially search for firms that apply effective and proactive pollution prevention programs. For example, some mutual funds include a social/environmental responsibility component in their charter. Firms that are perceived as environmentally responsible may be awarded a higher valuation and lower cost of capital in the public capital markets.

- Improved firm financial performance. Finally, some consumers may favor products of firms that are perceived as environmentally responsible (as defined by the individual consumer). To the extent that a mechanism exists for consumers to be aware that a given firm has undertaken pollution prevention programs, consumers may favor that firm's products over those of its competitors and thus improve the firm's business prospects.

In summary, although it is not possible to quantify the benefits to a firm from reduced cost of capital, EPA believes that these benefits may ultimately play a significant role in improving the financial circumstances of facilities and firms that choose pollution prevention as a means of complying with the proposed PFPR effluent limitation guideline.

10.7 Attaining Compliance Through Pollution Prevention Versus Combustion

In the short term, some facilities may view pollution prevention as a more expensive option than combustion for complying with the proposed PFPR regulation. However, over a longer horizon, several factors may cause combustion, whether on-site or off-site, to become more costly and thereby increase the relative financial attractiveness of pollution prevention. These factors, which are discussed briefly below, stem from issues in the permitting, construction, and environmental regulation of combustion facilities.

Difficulties in Siting a New Combustion Facility

EPA has developed a Draft Strategy for Combustion and Hazardous Waste which sets strategic goals pertaining to combustion facilities. One of the primary goals of this strategy is to "establish a strong preference for source reduction over waste management, and thereby reduce the long-term demand for combustion and other waste management facilities".[20] The Agency proposes to accomplish this goal in part by enhancing public participation in the permitting of incinerators and boilers and industrial furnaces (BIFs), enhancing inspection and enforcement for incinerators and BIFs, and setting stricter emission controls and limits for combustion units. The strategy specifies that "hazardous waste combustion units should be required...to meet the more stringent particulate matter standard that is now applicable to municipal waste combusters".[21] "Hazardous waste combustion units" refers to non-incinerator BIFs, which currently burn a significant volume of hazardous waste, but which, until 1991, faced no RCRA regulation of their air emissions. In addition to the disparity of the air emission requirements, some non-incinerator combustion units enjoy an exemption from RCRA requirements on the waste resulting from their combustion activities. More stringent requirements on BIFs, which are

[20]Draft Strategy for Combustion of Hazardous Waste (1993). EPA, May.

[21]*Ibid.*

currently less expensive alternatives to incineration[22], may ultimately diminish the disparity between the cost of using BIFs and incinerators. Moreover, in the short term, EPA will give low priority to considering requests for additional combustion capacity, and in the long term plans to work with states and hazardous waste generators to *reduce* the amount of process wastes going to combustion units.

Building new combustion capability (e.g., for on-site destruction of PFPR facility wastewaters) could take up to 7 years, in large part because of RCRA permitting requirements, according to hazardous waste disposal experts.[23] Preparing a permit application to show compliance with RCRA is especially difficult for cement kiln operators; some states refuse to issue the air pollution clearances needed to conduct a trial burn as part of the application procedure.[24]

In addition, regulations that restrict and monitor the use of BIFs are likely to emerge in the near future. Additional regulations could mean that BIFs, currently among the least expensive methods for both on- and off-site waste destruction, may become more expensive. In sum, combustion as a method of waste disposal for PFPR operations is likely to become more expensive as combustion units face tighter environmental regulation.

Difficulties and Costs from the RCRA Permitting Process

Permits under the Resource Conservation and Recovery Act are required to operate incinerators (and cement kilns, industrial boilers, and furnaces, if these facilities are to be used for waste destruction). Obtaining *and retaining* these permits is usually a lengthy and expensive process. Community resistance to permit issuance and the potential for litigation also add to the time and cost of obtaining permits. These factors further encumber the development of new combustion capability and are likely to make existing capacity more scarce *relative to demand* and more costly in the future. These market pressures will likely cause the price of combustion services to increase substantially over the next decade. Thus, any short run economic advantage of combustion may vanish within a few years.

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[22]"Outlook for Commercial Hazardous Waste Management Facilities: A Nationwide Perspective," (1992). *The Hazardous Waste Consultant*, March/April.

[23]Gager, Russ (1991). "Hazwaste Landfills Struggle for Growth and Safety," *Hazmat World*, June.

[24]"Outlook for Commercial Hazardous Waste Management Facilities: A National Perspective," (1992). *The Hazardous Waste Consultant*, March/April.

The application process for a new or renewed permit is costly and time-consuming. Similar applications must be filled out for both the state in which the facility operates and for EPA, but only the state requires an application fee. State fees are estimated to average $100,000. In addition, facilities incur other costs for preparing applications. Also, most state applications require that the facility conduct a trial burn to obtain information required in the application. A trial burn is estimated to cost up to $100,000. Permits must typically be renewed at least every 10 years.

Factors that affect the cost of a permit application include:

- Number of units (e.g., incinerators) at the facility;
- Complexity of the waste being burned;
- Commercial versus noncommercial facilities;
- Cost of the trial burn; and
- The extent of community resistance to issuance of new, *and renewal of existing*, permits.

Recently, EPA and states have focused on conducting a risk assessment of the facility to determine the potential harm to the surrounding community. Particular attention is given to facilities operating in urban or agricultural areas.

Other Changes in the Regulatory Environment

Other likely changes in environmental policy and regulation also add to the probability that combustion will become a less economically attractive compliance method in the future. These concerns apply to both on-site and off-site combustion. Facilities that choose contract hauling for off-site combustion as a means of compliance face additional liabilities for the storage and transportation of hazardous wastewaters. On-site combustion can be subject to significant limitations due to: (1) a potential ban on the issuance of permits for new combustion units; (2) lengthy and expensive siting and permitting costs; and (3) increasingly negative community reaction to combustion units. Issues associated with other likely changes in environmental policy and that affect the choice between combustion and pollution prevention are discussed briefly below.

Environmental management policy is increasingly focused on the issue of cross-media transfers of pollutants. For example, contaminated wastewater that is incinerated results in hazardous ash that

needs to be disposed, and the airborne release of some pollutants, despite the best available scrubbers and dry filters. Some PAIs are therefore displaced to other media, resulting in risk to the community and increased risk of exposure to workers and the community during storage and transfer. Requirements for remedial controls on cross-media transfers may cause combustion costs to increase, thus making combustion more expensive. Pollution prevention aims to prevent cross-media transfers and the risks associated with them by reusing and recycling PAIs instead of disposing of them.

Another area of increasing concern that may affect the attractiveness of combustion as a compliance method is the transportation cost and liabilities associated with transporting contaminated waste streams within a site, and even more so off-site. The cost of hazardous waste management and transportation will likely continue to rise in the future and lessen the economic attractiveness of combustion.

In summary, compliance with the proposed PFPR regulation through off-site or on-site combustion presents costs and risks that may not be apparent in the current economic environment. Facilities that select combustion as a compliance strategy may reasonably anticipate increased costs from additional regulations and other environmental policy trends currently at work.

Chapter 10 References

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Chapter 11
Labor Requirements and Potential Employment Benefits of an Effluent Guideline for the Pesticide Formulating, Packaging, and Repackaging Industry

11.0 Introduction

Firms will need to install and operate compliance systems to comply with an effluent limitations guideline for the Pesticides Formulating, Packaging, and Repackaging (PFPR) industry. The manufacture, installation, and operation of these systems will require use of labor resources. To the extent that these labor needs translate into employment increases in affected firms, a PFPR rule has the potential to generate employment benefits. If realized, these employment benefits may partially offset the employment losses that are expected to occur in facilities impacted by the rule. The employment effects that would occur in the manufacture, installation, and operation of treatment systems are termed the "direct" employment benefits of the rule. Because these employment effects are directly attributable to the PFPR rule, they are conceptually parallel to the employment losses that were estimated for the facilities that are expected to incur significant impacts as a result of the PFPR rule.

In addition to direct employment benefits, the PFPR rule may generate other employment benefits through two mechanisms. First, employment effects may occur in the industries that are linked to the industries that manufacture and install compliance equipment; these effects are termed "indirect" employment benefits. For example, a firm that manufactures the pumps, piping and other hardware that comprise a treatment system will purchase intermediate goods and services from other firms and sectors of the economy. Thus, increased economic activity in the firm that manufactures the treatment system components has the potential to increase activity and employment in these linked firms and sectors. Second, the increased payments to labor in the directly and indirectly affected industries will lead to increased purchases from consumer-oriented service and retail businesses, which in turn lead to additional labor demand and employment benefits in those businesses. These effects are termed "induced" employment benefits.

In view of these possible employment benefits, EPA estimated the labor requirements associated with compliance with the proposed PSES effluent guideline for Subcategory C (PFPR) facilities, as represented by Option 3/S. The following discussion summarizes the findings from this effort. Labor requirements — and thus the possible employment benefits — were estimated in two steps. EPA first estimated the direct employment effects associated with the manufacture, installation, and operation of the PFPR compliance equipment. These effects are discussed in Section 11.1. Second, EPA considered

the additional employment effects that might occur through the indirect and induced effect mechanisms outlined above; these effects are discussed in Section 11.2.

On the basis of these analyses, EPA found that the PFPR regulation may yield direct employment requirements of about 100 full-time equivalent positions on a 10-year annualized basis. When the indirect and induced employment effects are included, this value increases to a range of 269 to 400 full-time equivalent positions.

11.1 Estimating the Direct Labor Requirements of the PFPR Rule

As discussed above, an effluent guideline for the PFPR industry will create demand for labor services for manufacturing, installing, and operating compliance equipment. EPA analyzed each of these components of direct labor requirements separately. The sum of the estimated requirements for the three labor categories represents the estimated total direct labor requirement, and thus the potential direct employment benefit, from compliance with the PFPR effluent guideline.

Direct Labor Requirements for Manufacturing Compliance Equipment

EPA estimated the direct labor requirements for manufacturing compliance equipment based on the cost of the equipment and labor's expected contribution to the equipment's value in its manufacture. Labor's contribution was estimated in dollars and was converted to a full-time employment equivalent based on a yearly labor cost. Each component of the calculation is discussed below.

Cost of Compliance Equipment

The cost of compliance equipment was estimated as part of the facility-level impact analysis for the regulatory options. Compliance equipment requirements and associated costs were estimated for each facility in the Survey that was assessed as incurring costs. For the labor requirements analysis, compliance costs and their associated labor requirements were considered only for those facilities *that were not assessed as a baseline closure, or as a closure or line conversion due to compliance*. That is, the analysis considers the labor requirement effects associated only with those facilities that were assessed as likely to comply with the rule and continue PFPR production activities. These costs were weighted according to the number of facilities each sample facility represents in the underlying PFPR industry

population and summed to give an aggregate compliance equipment cost for the PFPR industry. The total estimated capital equipment cost in 1988 dollars for complying with Option 3/S is $41,405,013.[1]

Labor's Expected Contribution to the Equipment's Value

Input-output tables assembled by the Bureau of Economic Analysis in the Department of Commerce provide information on the composition of inputs used to produce the outputs of industries in the U.S. economy.[2] The inputs tallied in the input-output tables include the purchase of intermediate goods, materials and services from other industries as well as the use of labor by the subject industry. In particular, the *direct requirements* matrix identifies the value of each input, including labor, that is required to produce a one dollar value of output for a subject industry. From discussions with PFPR project engineers, the "Heating, Plumbing, and Fabricated Structural Metal Products Industry" (Bureau of Economic Analysis industry classification 40) was identified as the industry with output that most nearly matches the kinds of equipment needed for compliance with the PFPR effluent guideline. From the direct requirements matrix, the labor input, titled *compensation of employees*, accounts for $0.31016 of each dollar of output value from the Heating, Plumbing, and Fabricated Structural Metal Products Industry. Multiplying labor's share of output value (0.31016) times the value of equipment purchases for complying with the PFPR rule ($41,405,013) yields labor's contribution to manufacturing the compliance equipment, measured in terms of gross compensation, $12,842,179 (see Table 11-1).

In the economic impact analysis of the PFPR rule, the manufacture of compliance equipment is considered a one-time event that occurs at the beginning of industry's compliance activities. Accordingly, the labor requirements for manufacturing compliance equipment should be viewed as a one-time requirement. Elsewhere in the PFPR economic impact analysis, the labor effects associated with facility impacts are presented on an annual basis, with the expectation that these job effects would persist over the period of analysis. Accordingly, to assess consistently the possible labor requirement effects from manufacturing compliance equipment, it was necessary to annualize the one-time labor effect. Consistent

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[1] The $41.4 million is the one-time outlay for purchasing the capital equipment estimated to be needed for compliance with the PFPR regulation and is not the *annual* cost of the capital equipment. In the economic impact analysis, the capital outlay is annualized over a 10-year period and the resulting value, which is part of the total annual cost of compliance, is much less than the $41.4 million value.

[2] See *The 1982 Benchmark Input-Output Accounts of the United States*, U.S. Department of Commerce, Bureau of Economic Analysis, December 1991 and "Benchmark Input-Output Accounts for the U.S. Economy, 1982," in *Survey of Current Business*, July 1991, U.S. Department of Commerce, Bureau of Economic Analysis. The 1982 tables are the most current information on the inter-industry input-output structure of the U.S. economy.

Table 11-1
Analysis of Possible Employment Generation Effects of an Effluent Guideline for the PFPR Industry

	Total Weighted Expenditures	Labor Cost Share of Production Value[1]	Labor Cost Component		Direct Labor Requirements[3]	
			one-time basis	annual basis[2]	one-time basis	annual basis
Direct Labor Effects From Compliance Equipment:						
Manufacturing	$41,405,013	31.02%	$12,842,179	$1,828,437	373	53
Installation	$11,560,958	42.23%	$4,882,540	$695,164	142	20
Operation				$916,721		27
Total Direct Labor Effects				$3,440,322		100

Notes:
[1] Source: U.S. Department of Commerce, The 1982 Benchmark Input-Output Accounts of the United States, December 1991.
[2] Annualized over 10 years at the social discount rate of 7 percent.
[3] Number of jobs calculated on the basis of an average hourly labor cost of $17.21 and 2,000 hours per labor-year.

with the annualization procedures elsewhere in the economic impact analysis, the one-time labor compensation value was annualized over a ten-year period at the social discount rate of 7 percent. The resulting annual value of gross labor compensation in manufacturing compliance equipment is $1,828,437.

Conversion to Full-Time Employment Equivalent Basis

To convert the gross payment to labor to a full-time employment equivalent basis, the payment to labor was divided by an estimated yearly labor cost. The yearly labor cost is based on the same labor cost, $17.21 per hour, used in the engineering cost analysis to estimate the cost of operating compliance equipment. The $17.21 per hour is a comprehensive labor cost including an allowance for fringe benefits (e.g., holidays, vacation, and various insurances) and payroll taxes, and was calculated in 1988 dollars. Assuming a 2,000 hour work-year, the gross annual labor cost per full-time employment position is $35,797. On a one-time, one-year basis (i.e., not annualized), the outlay for manufacturing compliance equipment is estimated to require 373 full-time employment positions. On an annualized basis, the $1,828,437 of gross labor cost for manufacturing compliance equipment is estimated to require 53 full-time employment positions.

Direct Labor Requirements for Installing Compliance Equipment

EPA estimated the direct labor requirements for installing compliance equipment in a parallel manner to that used for analyzing the labor requirements for manufacturing compliance equipment. Each component of the calculation is discussed below.

Cost of Installing Compliance Equipment

The cost of installing compliance equipment was estimated in conjunction with estimating the purchase cost of compliance equipment. Specifically, on the basis of the kind, scale, and cost of compliance equipment assessed for a facility, PFPR project engineers estimated an installation cost for the equipment. The estimated installation costs averaged about 28 percent of the purchase cost of the compliance equipment for a total of $11,560,958.

Labor's Expected Contribution to the Equipment's Value

The Bureau of Economic Analysis industry group that EPA used as the basis for estimating labor's share of cost in installing compliance equipment is the "Repair and Maintenance Construction Industry" (Bureau of Economic Analysis industry classification 12). In this industry group, gross payments to labor account for $0.42233 of each dollar of output value, as recorded in the direct requirements matrix for the national input-output tables. Multiplying labor's share of value (0.42233) by the estimated total installation cost ($11,560,958) yields a gross labor cost for compliance equipment installation of $4,882,540. Like the purchase cost of compliance equipment, the installation cost is a one-time outlay and, accordingly, an annualized value was calculated using the 10-year amortization period and the 7 percent social discount rate. The resulting annual value for the labor cost of installing compliance equipment is $695,164.

Conversion to Full-Time Employment Equivalent Basis

Conversion to a full-time employment equivalent basis is based on the same yearly labor cost, $35,797, as used in estimating the labor requirements for the manufacturing of compliance equipment. On a one-time, one-year basis, EPA estimates that 142 full-time equivalent positions would be required for installing the equipment needed to comply with the proposed Option 3/S PFPR effluent guideline. Annualized over 10 years, the corresponding labor requirement for installing compliance equipment is 20 full-time equivalent positions.

Direct Labor Requirements for Operating Compliance Equipment

PFPR project engineers estimated the annual labor hours required to operate compliance equipment as the basis for assessing the annual operating and maintenance costs of the PFPR regulatory options. On a full-time equivalent basis, the estimated annual labor requirement for operating compliance equipment is 27 person-years. This value is assumed to recur annually over the period of analysis. The corresponding total annual estimated payments to labor is $916,721 (1988 dollars).

Total Direct Labor Requirements for Complying with the PFPR Effluent Guideline

Summing the three components yields the total direct labor requirements for complying with the proposed PFPR effluent guideline as represented by Option 3/S. On a full-time equivalent basis, the estimated total annual labor requirement for complying with Option 3/S is 100 person-years. The corresponding total annual estimated payments to labor is $3,440,322 (1988 dollars). To the extent that these labor requirements manifest as net new labor needs in the U.S. economy, the 100 full-time employment equivalents have the potential to offset employment losses that may otherwise occur because of the rule.

11.3 Estimating the Indirect and Induced Labor Requirement Effects of the PFPR Rule

In addition to its direct labor effects, the PFPR effluent guideline may also generate labor requirements through the indirect and induced effect mechanisms described in the introduction to this chapter. The indirect and induced effects associated with an economic activity are analyzed by use of multipliers. Multiplier estimates generally vary with the industry in which the direct economic activities are expected to occur and with the economic characteristics of the location of the direct activities.

A range of multipliers was used in this analysis to illustrate the possible aggregate employment effects of a PFPR effluent guideline. A recent EPA study used multipliers ranging from 3.5 to 3.9 to calculate the possible indirect and induced employment effects of direct activity investments in general water treatment and pollution control.[3] A study of "clean water investments" commissioned by the National Utility Contractors Association (NUCA) documented total employment effect multipliers ranging from 2.8 to 4.0.[4] Using the high and low values for these multipliers, the indicated aggregate

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[3]U.S. Environmental Protection Agency, Office of Water (February 1993). *Job Creation Fact Sheet*, internal document.

[4] Apogee Research, Inc., *A Report on Clean Water Investment and Job Creation*, prepared for National Utility Contractors Association, March 1992.

employment effects associated with the direct labor requirement of 100 full-time positions would range from 280 to 400.

A more conservative assessment of these possible employment effects would recognize that the three categories of labor requirements analyzed above are likely to have different indirect labor demand effects. In particular, the direct labor demands for manufacturing and installing compliance equipment result from additional economic activity in those industries. Accordingly, it is reasonable to expect that the additional economic activity in manufacturing and installing equipment will translate into increased activity in the industries that are linked to the direct effect industries and, hence, lead to additional labor demand in those industries through the indirect effect mechanism. In contrast, the increased labor demand in the PFPR industry for operating compliance equipment does not result from increased economic activity in that industry. As a result, increased labor demand *in the PFPR industry* resulting from the PFPR effluent guideline may not translate into increased labor requirements in the industries that are linked to the PFPR industry. In this case, the appropriate employment multiplier for the *equipment-operations component* of direct labor requirements should exclude the indirect effect mechanism and include only the induced effect mechanism. Multipliers cited in the NUCA study referenced above suggest that a multiplier *based only on the induced effect mechanism* might fall in the range of 2.4 to 2.9. Using this lower multiplier range for the equipment-operations component of direct labor requirements and the higher, 2.8 to 4.0 range for the manufacturing and installation components, the estimated aggregate employment effects of the PFPR effluent guideline would range from 269 to 371 full-time equivalent positions.

Chapter 11 References

Apogee Research, Inc. (March 1992). *A Report on Clean Water Investment and Job Creation*, prepared for National Utility Contractors Association.

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Chapter 12
Assessment of Economic Impacts Of Including Under Regulation Additional PAIs Not On the Original List of 272 PAIs

12.0 Introduction

EPA used facility and compliance cost data based on 272 PAIs to analyze alternative PSES regulatory options for Subcategory C (PFPR) facilities as presented in the preceding chapters. These 272 PAIs are the same as those PAIs whose discharges were originally considered for regulation under the recently promulgated effluent limitation guideline for the Pesticide Manufacturers Industry. As described in the preceding chapters of this EIA, EPA specified 5 PSES regulatory options for Subcategory C facilities and initially selected Option 3 as the preferred option. EPA found that this option was both economically achievable and met the objectives of the Clean Water Act by achieving zero discharge of specified pollutants from PFPR facilities. Subsequent analysis of the distribution of likely economic impacts led EPA to modify Option 3 to mitigate impacts among small business-owned facilities that primarily serve the industrial/commercial market and that use certain lower toxicity sanitizer PAIs to formulate, package and repackage sanitizer products. Specifically, the modified option, Option 3/S, is the same as Option 3 except for those facilities that formulate, package, or repackage sanitizer active ingredients and whose sanitizer production is less than 265,000 pounds per year. In these facilities, discharges from non-interior wastewater sources containing only designated sanitizer chemicals are exempt from the zero discharge requirement.

EPA proposes to include under the proposed regulation all additional PAIs beyond the list of 272 PAIs on which detailed data were gathered in the PFPR industry Survey and on which the detailed analyses presented in preceding chapters are based. Accordingly, EPA estimated the economic impacts of including these additional PAIs under the proposed PSES regulation for Subcategory C facilities, Option 3/S.[1] Although EPA estimates additional economic impacts as a result of including these additional PAIs under regulation, EPA finds that the proposed regulation remains economically achievable overall and, by virtue of including the additional PAIs under regulation, promotes more strongly the pollution reduction objectives of the Clean Water Act.

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[1]In the remainder of this chapter, the additional PAIs not on the original list of 272 PAIs are referred to as the "additional non-272 PAIs" or "non-272 PAIs."

This chapter presents the estimated economic impacts of including these additional PAIs under the proposed PSES regulation for Subcategory C facilities. The regulatory option considered in this chapter is the same as the Option 3/S discussed in the preceding chapters with the exception that its regulatory coverage is broadened to include the additional non-272 PAIs. To distinguish the analysis of the proposed regulation including the non-272 PAIs from the preceding analysis based on only the 272 PAIs, the following discussion refers to the regulation *including coverage of the additional non-272 PAIs* as Option 3/S'.[2]

The rest of this chapter largely parallels the discussion presented in the preceding chapters. Section 12.1 presents the estimated economic impacts on PFPR facilities of regulating the additional non-272 PAIs. Section 12.2 reviews regulatory flexibility considerations of the proposed option. Community impacts of including the additional non-272 PAIs are presented in Section 12.3, with foreign trade effects assessed in Section 12.4. Section 12.5 discusses the estimated impacts on firms owning PFPR facilities. Finally, Section 12.6 describes the labor requirements and possible employment benefits of complying with the proposed option covering the additional non-272 PAIs.

12.1 Estimated Facility Impacts Under Option 3/S'

The analysis was conducted on two separate sets of facilities: (1) facilities that formulate, package, or repackage the original 272 PAIs and that may also use the additional non-272 PAIs[3], and (2) facilities that use only the additional non-272 PAIs in their pesticide formulating, packaging and repackaging activities. These separate analyses were then combined to calculate the aggregate facility-level effects on the PFPR industry.

Facilities Using Both Original 272 PAIs and Additional non-272 PAIs

Compliance cost estimates were developed for the first set of facilities under Option 3/S', which extends regulation to the additional non-272 PAIs. The methodology for analyzing impacts among these facilities is identical to that described in Chapter 4. In addition, EPA used data on the usage of the non-272 PAIs obtained from the FATES database to supplement the data developed and analyzed on the basis

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[2]The Federal Register Notice for this regulation refers to this option as Option 3/S.1.

[3]Sixty-four percent of the facilities that PFPR the 272 PAIs originally considered for regulation also PFPR non-272 PAIs.

of the 272 PAIs. Table 12.1, below, presents the estimated costs and impacts of this regulatory option, Option 3/S′, for facilities using both original 272 PAIs and additional non-272 PAIs, and compares these costs and impacts with those previously presented for Option 3/S.

The compliance costs and impacts for these facilities under Option 3/S′ are somewhat higher than calculated under Option 3/S. As a result of the compliance requirements for the additional PAIs, EPA estimates that 544 Subcategory C facilities using both original 272 PAIs and additional non-272 PAIs will incur costs, an increase of 15 facilities beyond the 529 facilities estimated under Option 3/S. The capital and annualized total costs (which include amortized capital, annual operating and maintenance, and monitoring costs) of complying with Option 3/S′ are estimated to be $102.9 and $40.1 million, respectively. The $40.1 million in total annualized compliance costs represents an increase of $15.0 million above the estimated total annual cost for complying with Option 3/S among these facilities. The associated facility and employment impacts among these facilities are also somewhat larger under Option 3/S′. The estimated number of facility closures, 1, is the same for both Option 3/S and Option 3/S′, while the number of moderate impacts increases from 136 under Option 3/S to 167 under Option 3/S′. The estimated total U.S. job losses remains modest, increasing from 355 FTEs under Option 3/S to 470 FTEs under Option 3/S′. As described in Chapter 4, the job loss estimates are conservative in that the analysis assumes full loss of PFPR-related employment among facilities assessed as line conversions as well as full loss of employment in facility closures.

Facilities Using Only the Additional Non-272 PAIs

To estimate the impact on the second set of facilities — those facilities that formulate, package or repackage *only* the additional non-272 PAIs — EPA assumed that these facilities were similar in several ways to those facilities surveyed and analyzed on the basis of using the 272 PAIs:

- The percentage of water dischargers is the same for both sets of facilities;
- The percentage of facilities using only the non-272 PAIs and that incur compliance costs under Option 3/S′ is the same as that estimated for facilities analyzed as using only the original 272 PAIs under Option 3/S;
- Facilities using only the non-272 PAIs will have the same average compliance cost under Option 3/S′ as estimated for those facilities using only the 272 PAIs under Option 3/S; and

Table 12.1
National Estimates of Costs and Impacts under PSES
Comparison of Option 3/S′ with Option 3/S

	Option 3/S (original 272 PAIs only)	Option 3/S′ (original 272 and non-272 PAIs)
Facilities Not Eligible for Sanitizer PAI Exemption		
•# of Facilities Projected to Incur Costs	391	391
•Total Annualized Compliance Costs (million dollars)	$24.0	$35.1
•Facility Closures (Severe Impacts)	1	1
•Moderate Impacts	119	126
•Expected Job Losses	348	418
Facilities Eligible for Sanitizer PAI Exemption		
•# of Facilities Projected to Incur Costs	138	153
•Total Annualized Compliance Costs (million dollars)	$2.1	$5.0
•Facility Closures (Severe Impacts)	0	0
•Moderate Impacts	17	41
•Expected Job Losses	7	52
All Subcategory C Facilities (except those using only additional non-272 PAIs)		
•# of Facilities Projected to Incur Costs	529	544
•Total Annualized Compliance Costs (million dollars)	$26.1	$40.1
•Facility Closures (Severe Impacts)	1	1
•Moderate Impacts	136	167
•Expected Job Losses	355	470

Note: Based on analysis of only those facilities that use original 272 PAIs or that use both original 272 PAIs and additional non-272 PAIs; excludes facilities that use *only* non-272 PAIs.

- The percentage of facilities using only the non-272 PAIs and that are assessed as closures or

moderate impacts is the same as that estimated for facilities analyzed as using only the original 272 PAIs under Option 3/S.

On the basis of these assumptions, EPA estimated that 424 facilities using only non-272 PAIs will incur compliance costs under Option 3/S′. Of these, 311 are PFPR-only facilities and 13 are PFPR and manufacturing facilities. In addition, EPA estimated that facilities using only non-272 PAIs will incur total annual compliance costs of $16.0 million, of which $10.2 million is in PFPR-only facilities and $5.8 million in PFPR and manufacturing facilities. The corresponding impact estimates are one facility closure and 83 moderate impacts, all of which are estimated to occur among PFPR-only facilities. No impacts are expected among PFPR/manufacturing facilities using only non-272 PAIs (see Table 12.2).

Aggregate Impacts for All Facilities Using Both Original 272 and Additional non-272 PAIs

The aggregate costs and impacts for Option 3/S′ are the combined impacts for both: (1) facilities using both the original 272 PAIs and additional non-272 PAIs; and (2) facilities using only the additional non-272 PAIs. Summing the results for the separately analyzed facility groups, EPA estimated that 869 Subcategory C facilities will incur costs under Option 3/S′ (see Table 12.3). The total annualized costs (which include amortized capital, annual operating and maintenance, and monitoring costs) of complying with Option 3/S′ are estimated at $56.1 million. From this analysis, two Subcategory C facilities were assessed as closures as the result of the Option 3/S′ compliance requirements while 250 facilities were assessed as incurring moderate impacts. In addition, EPA conservatively estimates total job losses in impacted facilities at 688 full-time employment positions.[4] EPA finds that the proposed effluent limitation guideline for Subcategory C facilities, Option 3/S′, which includes coverage of the additional non-272 PAIs, is economically achievable.

Option 3/S′ is estimated to achieve a total of 310,455 pounds of pollutant removals annually or 198,662 pounds more than that achieved by Option 3/S.[5] The residual pollutant loadings under Option 3/S′ are 1,036 pounds or 833 pounds more than under Option 3/S. However, as discussed previously,

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[4]These job-loss estimates are considered conservative because EPA assumes that both facility closures and PFPR line conversions will result in full loss of all PFPR-related employment at affected facilities. EPA believes that this assumption overstates expected employment impacts because line conversions are not likely to cause employment losses in all cases.

[5]The toxic pounds that this represents will be calculated for final.

Table 12.2
Estimated National Impacts for PFPR Facilities Using Only Additional *Non-272* PAIs
(Estimates for "non-272 PAI only" facilities based on extrapolation of results from detailed analysis of facilities using only 272 PAIs)

	Results from Detailed Analysis of Facilities Using Original 272 PAIs	Percentage of Facilities in Preceding Population Group*	Estimates for Facilities Using Only Additional Non-272 PAIs†
Estimated Number of Facilities in Business	2,404		1,475
Estimated Number of Facilities that Use Water	1,794	74.6%	1,101
Estimated Number of Facilities that Discharge	656	36.6%	402
Estimated Number of Facilities that Discharge and Incur Compliance Costs			
- PFPR only	507	77.4%	311
- PFPR and Manufacture	22	3.4%	13
Estimated Total Annual Compliance Cost ($ MM, 1988)			
- PFPR only	$16.7		$10.2
- PFPR and Manufacture	$9.4		$5.8
- Total	$26.1		$16.0‡
Total Annual Compliance Cost, Average per Facility ($, 1988)			
- PFPR only	$32,871		$32,871
- PFPR and Manufacture	$429,065		$429,065
Estimated Number of Facility Impacts			
- PFPR only			
Closures	1	0.2%	1
Moderate Economic Impacts	136	26.8%	83
- PFPR and Manufacture			
Closures	0	0.0%	0
Moderate Economic Impacts	0	0.0%	0

* Percentage calculations are based on findings from detailed analyses of facilities using 272 PAIs. Each percentage value indicates the share of the preceding population group (for facilities using 272 PAIs) that is estimated to fall in that row's named population category. For example, of the 2,404 PFPR facilities using 272 PAIs, 1,794 or 74.6 percent are estimated to use water.

† Within the 1,475 facilities estimated to use only the non-272 PAIs, the estimated number of facilities falling in each population group (e.g., water-users or facilities incurring impacts) is based on applying the relevant percentage from the analysis of PFPR facilities using the 272 PAIs. For example, of the 1,475 facilities using only non-272 PAIs, 74.6 percent or 1,101 facilities are estimated to use water.

‡ The estimates of average facility and total annual compliance cost for non-272 PAI facilities are based on the estimated average facility costs for facilities using only the original 272 PAIs. That is, the average facility annual compliance costs of $32,871 and $429,065, which were calculated from analysis of only the original 272 PAIs, are assumed to apply also for the non-272 PAI facilities. The aggregate annual compliance cost values for facilities using only non-272 PAIs were then calculated by multiplying the average costs per facility by the estimated number of facilities in the relevant non-272 PAI facility category (e.g., 311 PFPR-only facilities x $32,871/per facility = $10.2 million total annual cost for PFPR-only facilities using only non-272 PAIs).

Table 12.3
National Estimates of Costs and Impacts for PSES Option 3/S′
Including Subcategory C Facilities Using Both Original and Additional Non-272 PAIs, and Facilities Using Only Additional Non-272 PAIs
(Assuming Zero Cost Pass-Through)

	Option 3/S′
Facilities Using Both Original 272 PAIs and Additional Non-272 PAIs	
•# of Facilities Projected to Incur Costs	544
•Total Annualized Compliance Costs (million dollars) *	$40.1
•Facility Closures: (Severe Economic Impacts)	1
•Moderate Economic Impacts	167
•Expected Job Losses (FTEs)	470
Facilities Using Only Additional Non-272 PAIs	
•# of Facilities Projected to Incur Costs	325
•Total Annualized Compliance Costs (million dollars)*	$16.0
•Facility Closures: (Severe Economic Impacts)	1
•Moderate Economic Impacts	83
•Expected Job Losses (FTEs)	218
All Facilities	
•# of Facilities Projected to Incur Costs	869
•Total Annualized Compliance Costs (million dollars)*	$56.1
•Facility Closures: (Severe Economic Impacts)	2
•Moderate Economic Impacts	250
•Estimated Worst-Case Job Losses (FTEs)	688

* Total annualized compliance costs are in 1988 dollars.

all of the residual loadings are among the designated sanitizer PAIs, which have relatively low toxicity. As a result, on a toxic-equivalent weighted basis, the estimated residual loadings under Option 3/S′ amount to only 196 toxic-weighted pounds annually. In contrast, EPA estimates that the pre-compliance discharges, adjusted for toxicity, amount to nearly 34 million toxic-weighted pounds annually. Accordingly, the residual discharges, adjusted for toxicity, are an insignificant fraction of the pre-

compliance amount (see the Cost-Effectiveness Analysis report for additional detail on the unweighted and weighted removals achieved by the proposed regulatory option).

12.2 Regulatory Flexibility Considerations of Option 3/S′

For the reasons discussed in the Regulatory Flexibility Analysis presented in Chapter 5, EPA decided to retain the exemption for designated sanitizer PAIs in extending the proposed PFPR regulation to include the additional non-272 PAIs. As documented in Chapter 5, without this exemption, facilities owned by small entities that operate primarily in the institutional/commercial (I/C) market were found to bear disproportionate impacts. To prevent disproportionate impacts from occurring under the revised Option 3/S′ and in recognition that the additional number of toxic pounds of pollutants discharged would be very small, EPA proposes to include designated sanitizer PAIs within the additional non-272 PAIs under the scope of the exemption.

12.3 Community Impacts of Option 3/S′

EPA assessed community impacts under Option 3/S′ in terms of projected employment losses using the same analytic procedure as described in Chapter 6. Even though the assumptions underlying this analysis are more conservative than those underlying the community impacts analysis for regulation of the original 272 PAIs, the estimated maximum MSA-level employment losses are well less than the one-percent threshold considered significant.

The methodology used in this analysis is essentially the same as that used in Chapter 6, with an additional conservative assumption to capture the employment losses estimated for facilities using only the additional non-272 PAIs. As explained in Chapter 6, a statistically valid analysis of population-level employment impacts on a regional or community level cannot be performed because of sample design limitations. However, analyses based on assumptions regarding the locational distribution of primary employment impacts can demonstrate that compliance with the proposed regulation is unlikely to have a significant impact on community employment.

As described in Chapter 6, EPA used conservative assumptions that are likely to overstate possible employment losses in any one MSA. First, EPA assumed that both closure and line conversion impacts would result in the loss of all PFPR-related employment at affected facilities. As stated above, line conversions are not likely to result in a full loss of PFPR-related employment in all cases. Second,

EPA assumed that all of the direct impact employment losses *that are not directly accounted for by the affected sample observations* would occur at the known locations of the affected sample facilities in proportion to sample facility weights. Third, as before, EPA used the maximum state-level multiplier (9.2) for the applicable industry to estimate the secondary employment impacts. Thus, the analytic procedure and assumptions for addressing impacts within those facilities using the original 272 PAIS and the additional non-272 PAIs are identical to those described in Chapter 6.

However, analysis of the employment-related impacts in facilities using *only* the additional non-272 PAIs required a modification to the analytic procedure described in Chapter 6. The impacts in these facilities are not associated with specific sample facilities and are thus conceptually similar to those impacts estimated to occur within the underlying population of PFPR facilities *and not in specific sample facilities* as discussed in Chapter 6. That is, EPA knows none of the locations of these facilities using only non-272 PAIs and assessed as incurring impacts. To account for the estimated impacts in these non-272 PAI-only facilities in the community impact analysis, EPA calculated an impact multiplier that was used to increase the sample facility weights for those sample facilities assessed as incurring impacts. In this way, the weights for impacted sample facilities encompassed the impacts among both classes of facilities considered in this analysis: (1) facilities using the original 272 PAIs and additional non-272 PAIs; and (2) facilities using only the additional non-272 PAIs.

The multiplier developed to account for facilities using only non-272 PAIs was calculated as the ratio of the estimated total of impacted facilities among all PFPR facilities (i.e., both classes of facilities defined in the preceding sentence) to the estimated number of impacted facilities among facilities using the original 272 PAIs and additional non-272 PAIs (i.e., the first class of facilities defined in the preceding sentence). Specifically, as summarized above in Table 12.3, EPA estimated a total of 252 facility impacts under Option 3/S′: 2 facility closures and 250 moderate economic impacts. Of the 252 impacts, 168 are within facilities using the original 272 PAIs and additional non-272 PAIs (1 closure and 167 moderate impacts), and 84 are within facilities using only the additional non-272 PAIs (1 closure and 83 moderate impacts) (see Table 12.3). Thus, the ratio of impacts in all facilities to impacts in facilities using the original 272 PAIs and additional non-272 PAIs is 1.5 (252 / 168 = 1.5). Thus, to account for the estimated impacts in the non-272 PAI-only facilities in the community impact analysis, EPA increased the estimated impacts associated with sample facilities by multiplying the weights of impacted sample facilities by 1.5.

Use of the 1.5 multiplier to account for impacts among facilities using only non-272 PAIs is yet another conservative assumption that is likely to overstate community-level employment impacts. Specifically, use of the multiplier means that MSAs in which sample facilities are located are assumed to incur, in proportion to sample facility weights, the additional employment impacts associated with non-sample facilities among those analyzed using both the original 272 PAIs and non-272 PAIs *and* the employment impacts associated with facilities using only non-272 PAIs. EPA believes that this assumption further exaggerates the impacts calculated for sample facility MSAs, as these impacts would likely be distributed among other MSAs that are unknown.

The analysis of sample facility impacts for Option 3/S′ found that impacts occur among 25 MSAs, which is a modest increase above the 22 MSAs incurring impacts under Option 3/S as discussed in Chapter 6. However, even with the conservative assumptions underlying this analysis, no MSA is expected to incur a significant loss of employment under Option 3/S′. The largest percentage decline in employment calculated for any MSA is only 0.2 percent or well less than the significant impact threshold of one percent. If the impacts in this MSA are assessed on the basis of the state-specific employment multiplier, the percentage employment loss would be only 0.075 percent. Even this amount exaggerates the likely impact because of the assignment of all non-sample facility impacts to the same MSA in which the impacted sample facility(ies) are located.

Accordingly, EPA anticipates no significant community-level impacts under Option 3/S′.

12.4 Foreign Trade Effects Under Option 3/S′

EPA assessed the foreign trade impacts of Option 3/S′ using the same methodology as described in Chapter 7. As described above in the analysis of community impacts, EPA accounted for the impacts in facilities using only non-272 PAIs by increasing the facility weights for impacted sample facilities by a factor of 1.5. As in Chapter 7, EPA analyzed foreign trade impacts under the proportional case, which assesses trade impacts based on the relative competitiveness of U.S. and foreign producers in international markets. From this analysis, EPA estimated that Option 3/S′ would result in a $16,538,000 decrease in the pesticide trade balance, or a decline of 1.74 percent. This 1.74 percent decrease is well less than the average 8 percent year-to-year fluctuation in the pesticides trade balance that occurred between 1980 and 1990. Overall, EPA judges that the foreign trade impacts of the proposed regulation are not likely to be significant.

12.5 Firm-Level Impacts of Option 3/S′

EPA also examined the potential firm-level impacts of Option 3/S′. As in Chapter 8, a firm-level analysis was conducted for all firms which own at least one sample facility that uses water in its PFPR operations, and therefore for which financial data were available. Because of sample design considerations, the findings from the firm-level analysis, which is based on *facilities* in the sample survey, cannot be extrapolated on a statistically valid basis to the population level of PFPR industry firms. In addition, because the impacts and compliance costs incurred by facilities using only the non-272 PAIs cannot be associated with specific sample facilities and owning firms, the firm-level analysis does not include any effects associated with these facilities. However, the firm-level impact analysis does reflect the higher costs among sample facilities of controlling discharges from non-272 PAIs — that is, the higher costs of complying with Option 3/S′ relative to Option 3/S.

The methodology used to calculate firm-level impacts is identical to the methodology used in Chapter 8. Estimated compliance costs under Option 3/S′ were allocated to facilities participating in PFPR activities owned by the firm but not included in the sample. As in Chapter 8, the firm-level financial impact was assessed on the basis of the change in pre-tax return on assets (ROA) and compared with a threshold value based on the lowest quartile data for SIC codes in the 2800 group (Chemicals and Allied Products) of 2.396 percent.[6]

Of the 242 firms considered for impacts under Option 3/S′, 9 firms were found to have a post-compliance ROA of less than 2.396 percent and are therefore assessed as incurring adverse financial impacts as a result of regulatory compliance. Six of these nine firms are private single entities and three are private multi-facility firms. No firm impacts were found among public-reporting firms. EPA judges that these firm-level impacts should not pose a significant burden to the PFPR industry and affirms its conclusion that the PFPR regulations being proposed will be economically achievable by the industry (see Table 12.4).

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[6] The threshold value ROA (2.396 percent) was calculated by weighting the ROA for all available SIC codes in the 2800 group by the total value of shipments of that group.

Table 12.4 Estimated Sample Firm Financial Impacts Under Option 3/S′				
Firm Type	Baseline		Post-Compliance	
	Number of Projected Impacts	Number of Firms Considered	Number of Projected Impacts	Number of Firms Considered
Public-Reporting Firms	0	36	0	36
Private Multi-Facility Firms	0	92	3	92
Private Single Entity Firms	66	180	6	114
Total	66	308	9	242

12.6 Potential Labor Requirements of Complying with Option 3/S′

As discussed in Chapter 11, EPA recognized that the manufacture, installation, and operation of equipment for complying with the Option 3/S′ regulation would require use of labor resources. To the extent that these labor needs translate into employment increases in complying firms, the regulation has the potential to generate employment benefits that may partially offset the employment losses that are expected to occur in facilities impacted by the rule. Using the same methodology as described in Chapter 11, EPA estimated an annual direct labor requirement of 200 full-time equivalent positions for complying with the Option 3/S′ regulation. Of these 200 positions, 139 are estimated to result from compliance with Option 3/S′ among facilities using 272 and non-272 PAIs and 61 are estimated to occur among facilities using only non-272 PAIs. This labor requirement may partially offset the estimated 688 employment losses in impacted PFPR facilities (see Table 12.5).

Table 12.5 National Estimates of Employment Losses and Possible Offsetting Employment Gains Based on Analysis of All Subcategory C Facilities Under PSES Option 3/S′	Estimated Values (Full-Time Equivalents)
Estimated Employment Losses Under Option 3/S′	
Employment Losses from Facility Closures	356
Employment Losses from Line Conversions	209
Total PFPR Facility Employment Losses	688
Estimated Labor Requirements and Possible Offsetting Employment Gains Under Option 3/S′	
Labor Requirements for Manufacturing Compliance Equipment	107
Labor Requirements for Installing Compliance Equipment	41
Labor Requirements for Operating Compliance Equipment	52
Total Labor Requirements for PFPR Regulatory Compliance	200

Appendix A
Pesticide Formulating, Packaging, and Repackaging Facility Survey for 1988

This appendix provides Part B of the *Pesticide Formulating, Packaging, and Repackaging Facility Survey for 1988*, which served as one of the main data sources for the EIA. Part B requested detailed economic and financial data from the facilities, including balance sheet and income statement information for 1986, 1987, and 1988 from water-using facilities.

U.S. ENVIRONMENTAL PROTECTION AGENCY

PESTICIDE FORMULATING, PACKAGING, AND REPACKAGING FACILITY SURVEY FOR 1988

PART B - FINANCIAL AND ECONOMIC INFORMATION

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- drums intro

U.S. ENVIRONMENTAL PROTECTION AGENCY
PESTICIDE FORMULATING, PACKAGING, AND REPACKAGING FACILITY SURVEY FOR 1988

ATTACH LABEL HERE

ID = Facility ID

INTRODUCTION

For the purposes of this survey, a facility is defined as a pesticide producing establishment in which pesticide active ingredients are formulated, packaged, or repackaged. The facility may consist of more than one building, but uses one Establishment Number when reporting pesticide production to EPA on EPA Form 3540-16.

1. Review the information on the label above from your 1988 Pesticides Report for Pesticide-Producing Establishments. Is all the information on the label correct?

add-chg

Yes ..... ☐ 1 *(Skip to Q.3)*
No ..... ☐ 2 *(Continue)*

2. Print ONLY corrections to the label in the space below.

fac-name

Facility name

fac-addr

Mailing address: Street or P.O. Box

fac-city fac-st fac-zip

City State Zip code

FIFRA_ID

FIFRA Establishment Number

3. What is your facility Dun & Bradstreet number?

☐ 9 Not applicable

Dun & Bradstreet Number

DUN_N_B

File - Intro

Enter the four-digit SIC (Standard Industrial Classification) Codes defined by the 1987 Standard Industrial Classification Manual that apply to this facility. In addition to the primary SIC Code, report the secondary and tertiary SIC Codes, if applicable. If secondary or tertiary codes are not applicable, check the box labeled "NA."

a. Primary SIC Code SIC-1

b. Secondary SIC Code ..... SIC-2 ☐ NA

c. Tertiary SIC Code ..... SIC-3 ☐ NA

5. Is this facility's physical location the same as its mailing address?

LOC-SAME

Yes ..... ☐ 1 *(Skip to Q.7)*
No ..... ☐ 2 *(Continue)*

6. Print the street address of the facility's physical location. LOC-ADDR

Physical location: street or industrial park

LOC-CITY | LOC-ST | LOC-ZIP

City | State | Zip code

7. What were the start and end months of your facility's 1988 Pesticides Report for Pesticide-Producing Establishments (EPA Form 3540-16)? (Use 01 = January, 02 = February, etc.)

a. 1988 Pesticide Report Start Month STRT_MTH Start Year STRT_YR

b. 1988 Pesticide Report End Month END_MTH End Year END_YR

Unless fiscal year is specified, all information reported in this questionnaire should be for the same report year as the information provided in your 1988 Pesticides Report for Pesticide-Producing Establishments (EPA Form 3540-16).

P86_CHG

P87_CHG

P88_CHG

File - Intro

REGISTERED PRODUCTS LIST

The yellow, blue, and green pages that follow contain lists of products containing Pesticide Active Ingredients found on Table 1 (pages 5-14). These lists were obtained from your 1988, 1987, and 1986 EPA Pesticides Reports for Pesticide-Producing Establishments (EPA Form 3540-16). Colored paper has been used to differentiate between the years: yellow for 1988, blue for 1987, and green for 1986.

You are REQUIRED to correct ONLY your 1988 list (yellow) according to the instructions provided on that list. You may correct the 1987 (blue) and the 1986 (green) list using the same instructions for both years, but you are not required to do so. All three lists should be used to complete the financial and economic sections of this questionnaire.

You are REQUIRED to complete the Introduction and Part C of this questionnaire even if you discontinued production of all products containing Pesticide Active Ingredients listed on Table 1 (pages 5-14) after December 31, 1988.

8. In 1988, were any of the products listed on the 1988 (yellow) Registered Products List, **formulated** at this facility?

Formulation is the process mixing, blending, or diluting one or more active ingredients with one or more other pesticide active or inert ingredients, without a chemical reaction that converts one active ingredient to another active ingredient, to obtain a manufacturing use product or an end use product.

FORM

Yes ..... ☐ 1
No ..... ☐ 2

9. In 1988, were any of the products listed on the 1988 (yellow) Registered Products List, **packaged** at this facility?

Packaging is enclosing or placing formulated pesticide active ingredients into marketable containers.

PACK

Yes ..... ☐ 1
No ..... ☐ 2

10. In 1988, were any of the products listed on the 1988 (yellow) Registered Products List, **repackaged** at this facility?

Repackaging is the direct transference of a single pesticide active ingredient or single formulation from any marketable container to another marketable container without intentionally mixing in any inerts, diluents, solvents, or other active ingredients, or other materials of any sort.

REPACK

Yes ..... ☐ 1
No ..... ☐ 2

11. Did you answer "Yes" to any of the items in Questions 8, 9, or 10?

YESFPR

Yes ..... ☐ 1 *(Continue)*
No ..... ☐ 2 *(Skip to Part C, Section 3, page C-4 at the end of the questionnaire)*

File - FPR

12. What type of organization best describes the ownership of this facility on the last day of the fiscal year ending in 1988?

(Check only one)

OWNTYPE

- ☐ 1 A single facility enterprise, i.e., the facility and the firm are one and the same ..... *(Skip to Q.17)*
- ☐ 2 A multi-facility company, i.e., your firm owns two or more facilities
- ☐ 3 A co-operative, e.g., a group of farmers who purchase and distribute pesticides among themselves
- ☐ 4 A Federal government agency, except military
- ☐ 5 A military or defense organization
- ☐ 6 A state government agency
- ☐ 7 A local government agency

(Continue to Q.13)

OWNOTH

- ☐ 8 Other *(Specify)* _____

13. Print the name, mailing address, and DUNS (from Dun & Bradstreet) Number of the firm/company or controlling organization.

NAME13

Name of firm

STRT13

Mailing address of firm's headquarters: Street or P.O. Box

CITY13 STATE13 ZIP13

City State Zip Code

DUN13

Firm's Dun & Bradstreet Number

☐ Not applicable — NODUN13

file - FPR

14. What were the total revenues of the firm/company listed in Question 13 for fiscal years ending in 1988, 1987 and 1986?

a. 1988 Revenues ..... $ ____.____.____.____ REV88

b. 1987 Revenues ..... $ ____.____.____.____ REV87

c. 1986 Revenues ..... $ ____.____.____.____ REV86

15. Is the firm identified in Question 13 owned or controlled by another company (i.e., a parent firm.)?

OTHCO

Yes ..... ☐ 1 *(Continue)*
No ..... ☐ 2 *(Skip to Q.17)*

16. Print the name, mailing address, and DUNS (from Dun & Bradstreet) Number of the parent or controlling firm.

NAME16

Name of parent or controlling firm

STRT16

Mailing address of headquarters of parent firm: Street or P.O. Box

CITY16 STATE16 ZIP16

City State Zip code

DUN16 NODUN16

Parent Dun & Bradstreet Number ☐ Not applicable

File - FPR

17 How many employee hours were spent at this facility during each month in the **fiscal year ending** in 1988?

Provide the following information for each month in the **fiscal year ending in 1988:**

- production worker hours spent in formulating, packaging, or repackaging any of the products on the 1988 (yellow) Registered Products List;
- all other production worker hours; and
- total nonproduction worker hours.

Production workers include employees (up through the line-supervisor level) engaged in fabricating, processing, assembling, inspecting, receiving, storing, handling, packing, warehousing, shipping (but not delivering), maintenance, repair, janitorial, and guard services, product development, auxiliary production for plant's own use (e.g., power plant), recordkeeping, and other services closely associated with these production operations at the establishment covered by the report. Supervisory employees above the line-supervisor level are excluded from this category.

Nonproduction workers of the manufacturing establishment include those engaged in the following activities: factory supervision above the line-supervisor level, sales (including driver salespersons), sales delivery (highway truck drivers and their helpers), advertising, credit, collection, installation and servicing of own products, clerical and routine office functions, executive, purchasing, financing, legal, personnel (including cafeteria, medical, etc.), professional, and technical. Also included are employees on the payroll of the manufacturing establishment engaged in the construction of major additions or alterations to the plant and who are utilized as a separate work force.

(The sum of the hours worked in each row should equal the total hours worked for the facility.)

MONTH YR FPRHRS ALLHRS NPHRS

Fiscal Year 1988	Hours production workers spent formulating, packaging, or repackaging products on the 1988 (yellow) Registered Products List	All other production worker hours (including Pesticide Active Ingredient manufacturing)	Total Non-production worker hours
January 198_	_,_ _ _,_ _ _	_,_ _ _,_ _ _	_,_ _ _,_ _ _
February 198_	_,_ _ _,_ _ _	_,_ _ _,_ _ _	_,_ _ _,_ _ _
March 198_	_,_ _ _,_ _ _	_,_ _ _,_ _ _	_,_ _ _,_ _ _
April 198_	_,_ _ _,_ _ _	_,_ _ _,_ _ _	_,_ _ _,_ _ _
May 198_	_,_ _ _,_ _ _	_,_ _ _,_ _ _	_,_ _ _,_ _ _
June 198_	_,_ _ _,_ _ _	_,_ _ _,_ _ _	_,_ _ _,_ _ _
July 198_	_,_ _ _,_ _ _	_,_ _ _,_ _ _	_,_ _ _,_ _ _
August 198_	_,_ _ _,_ _ _	_,_ _ _,_ _ _	_,_ _ _,_ _ _
September 198_	_,_ _ _,_ _ _	_,_ _ _,_ _ _	_,_ _ _,_ _ _
October 198_	_,_ _ _,_ _ _	_,_ _ _,_ _ _	_,_ _ _,_ _ _
November 198_	_,_ _ _,_ _ _	_,_ _ _,_ _ _	_,_ _ _,_ _ _
December 198_	_,_ _ _,_ _ _	_,_ _ _,_ _ _	_,_ _ _,_ _ _
Total	_,_ _ _,_ _ _	_,_ _ _,_ _ _	_,_ _ _,_ _ _

File – Hours

*8. What products and services were provided by your facility in the fiscal year ending in 1988?

		Products on 1988 (yellow) Registered Pesticide Products List		Pesticide products not on 1988 (yellow) Registered Pesticide Products List		Non-pesticide products	
		Yes	No	Yes	No	Yes	No
a.	On-site formulating, mixing or combining chemicals			formpp 1 ☐	2 ☐	1 ☐	2 ☐
b.	On-site packaging products			packpp 1 ☐	2 ☐	1 ☐	2 ☐
c.	On-site repackaging products			rpackpp 1 ☐	2 ☐	1 ☐	2 ☐
d.	On-site distribution and/or wholesaling of products	whsly 1 ☐	2 ☐	whspp 1 ☐	2 ☐	1 ☐	2 ☐
e.	On-site retail sales	rtaily 1 ☐	2 ☐	rtailpp 1 ☐	2 ☐	1 ☐	2 ☐
f.	Off-site application of chemical products/pest control services	apply 1 ☐	2 ☐	apppp 1 ☐	2 ☐	1 ☐	2 ☐
g.	Off-site contract equipment cleaning and maintenance, e.g., the use of pesticides for maintenance of air conditioning equipment	eqcly 1 ☐	2 ☐	eqclpp 1 ☐	2 ☐	1 ☐	2 ☐
h.	Off-site other activity (Specify) othserv	othy 1 ☐	2 ☐	othpp 1 ☐	2 ☐	1 ☐	2 ☐

File - Servmark

19. **Facility 1988 Pesticide Markets**

In the fiscal year ending in 1988, what percentage of your facility's total revenues from pesticide products on the 1988 (yellow) Registered Products List were from the markets listed below? *(Enter "00" if the market is not applicable. Right-justify your answer in the boxes. The percentages should sum to 100%. Do not include pesticides not reported on the 1988 (yellow) Registered Products List.)*

market 1 a. Agriculture, including livestock ..... ___.__ %

2 b. Institutional/commercial use, e.g., janitorial, hospitals, food service establishments ..... ___.__ %

3 c. Industrial use, i.e., products to facilitate and/or maintain an industrial process, such as slimicides used in pulp and paper production and biocides used in cooling towers ..... ___.__ %

4 d. Wood preservatives and coatings ..... ___.__ %

5 e. Products used for formulating pesticides, i.e., intermediate pesticide products ..... ___.__ %

6 f. Products used as an additive to a non-pesticide product, e.g., anti-mold or anti-bacterial agents for cosmetics ..... ___.__ %

7 g. Non-agricultural professional use products, i.e., products where use is restricted to trained professionals ..... ___.__ %

8 h. Consumer home, lawn, and garden ..... ___.__ %

9 i. Government, for non-institutional use, e.g., highway departments, mosquito control districts, public utilities, or military ..... ___.__ %

market 10 j. Other market *(Specify)* _____ ___.__ %

Total 1988 markets for pesticides on the 1988 (yellow) Registered Products List ..... 100 %

20. **Facility 1988 Pesticide Exports**

In the fiscal year ending in 1988, what percentage of your facility's revenues from pesticide products on the 1988 (yellow) Registered Products List, was generated by exports? *(Enter "00" if no products on the 1988 (yellow) Registered Products List were exported. Right-justify your answer in the boxes.)*

EXPREV ___.__ %

File - Serv Mark

32. Did you discontinue production of all products containing pesticide active ingredients listed on Table 1 pages 5-141 after December 31, 1988?

discprod

Yes ..... ☐ 1 *(Skip to Q.34 on page I-24)*
No ..... ☐ 2 *(Continue)*

33a. Did you answer 'Yes' to any of the water uses listed in Questions 21 through 32?

yesuse

Yes ..... ☐ 1 *(You must complete Part A and Part B. Go to page A-1. Do not complete pages I-24 and I-25.)*

No ..... ☐ 2 *(Continue with Q.34 on page I-24)*

H20 use

IF YOU ANSWERED "YES" TO QUESTION 33a, DO NOT COMPLETE THIS TABLE. GO TO PAGE A-1.

Facility Revenues and Costs for All Products and Services

Report the total revenues associated with all pesticide products produced by your facility for your facility's fiscal years ending in 1988, 1987, and 1986. Answer questions for each year. If you don't have revenue and expense information at the facility level, estimate revenues using procedures on page I-26. Check "Yes" or "No" to indicate whether amounts are estimated. Comments on revenue and cost information should be made on page I-28.

34. Does the facility fiscal year correspond to the calendar year?

FISCAL

Yes ..... ☐ 1 *(Skip to Q 36)*
No ..... ☐ 2 *(Continue)*

-1 IN
-1 NA

35. What are the start and end months of the facility fiscal year (e.g., January = 01, December = 12)?

STRTMTH a. Facility fiscal year start month..... ☐☐

END MTH b. Facility fiscal year end month..... ☐☐

-1 IN -1 NA

36. What were the revenues from all pesticide products formulated, packaged, or repackaged and included on any of the Registered Products Lists (following page I-3)? Be sure to check all lists and report the revenues in the fiscal year the product was sold. In using the 1988 list, be sure you have the correct cop

	Fiscal Year 1988	Fiscal Year 1987	Fiscal Year 1986
+IN -1NA	FPRREV88	FPREV87	FPREV86
	$ ☐☐☐,☐☐☐,☐☐☐,☐☐☐	$ ☐☐☐,☐☐☐,☐☐☐,☐☐☐	$ ☐☐☐,☐☐☐,☐☐☐,☐☐☐
	FPR88EST	FPR87EST	FPR86EST
Was the amount estimated?	Yes ☐1 No ☐2	Yes ☐1 No ☐2	Yes ☐1 No ☐2

Revenue

37. What were the revenues from all other products?

	Fiscal Year 1988	Fiscal Year 1987	Fiscal Year 1986
+IN -1NA	OTHREV88	OTHREV87	OTHREV86
	$ ☐☐☐,☐☐☐,☐☐☐,☐☐☐	$ ☐☐☐,☐☐☐,☐☐☐,☐☐☐	$ ☐☐☐,☐☐☐,☐☐☐,☐☐☐
	OTH88EST	OTH87EST	OTH86EST
Was the amount estimated?	Yes ☐1 No ☐2	Yes ☐1 No ☐2	Yes ☐1 No ☐2
	(Go to Fiscal Year 1987)	*(Go to Fiscal Year 1986)*	*(Go to Q 38)*

38. What were the total facility revenues in each fiscal year?

	Fiscal Year 1988	Fiscal Year 1987	Fiscal Year 1986
	totrev88	totrev87	totrev86
	$	$	$
Is the total facility revenue the same as the sum of Questions 3d and 37?	samsum88	samsum87	samsum86
	Yes ☐1 No ☐2	Yes ☐1 No ☐2	Yes ☐1 No ☐2
	(Explain in comments, page I-28)	(Explain in comments, page I-28)	(Explain in comments, page I-28)

+IN
9 NA

record 08

Record 09

39. What are the total facility costs? Include combined facility pesticide and non-pesticide costs such as materials, direct labor, and indirect costs that were incurred during operations, used as operating supplies, or used in repair and maintenance. Include the facility's share of R&D, interest payments, and taxes. Report total delivered cost after discounts, including freight of materials actually used during the year. Include purchases, cost of interplant transfers to the facility, and withdrawals from inventory.

	Fiscal Year 1988	Fiscal Year 1987	Fiscal Year 1986
	totcst88	totcst87	totcst86
	$	$	$
Was the amount estimated?	totb8est	totb7est	totb6est
	Yes ☐1 No ☐2	Yes ☐1 No ☐2	Yes ☐1 No ☐2
	(Go to Fiscal Year 1987)	(Go to Fiscal Year 1986)	(Go to Part C)

+IN
9 NA

Revenue
9/16

Water pollution control equipment: Equipment designed to treat wastewater, prior to reuse, discharge or disposal.

Wet air pollution or odor pollution control system scrubbers: Any equipment using water or water mixtures to control emissions of dusts, odors, volatiles, sprays or other air pollutants.

U.S. ENVIRONMENTAL PROTECTION AGENCY

PESTICIDE FORMULATING, PACKAGING, AND REPACKAGING FACILITY SURVEY FOR 1988

PART C - CONTACT INFORMATION AND CERTIFICATION

ATTACH LABEL HERE

Part C consists of three sections:

Section 1: Technical Information Contact

Section 2: Financial and Economic Information Contact

Section 3: Certification

PESTICIDE FORMULATING. PACKAGING. AND REPACKAGING FACILITY SURVEY FOR 1988

PART B - FINANCIAL AND ECONOMIC INFORMATION

GENERAL INSTRUCTIONS

PURPOSE

The U.S. Environmental Protection Agency (EPA) is establishing wastewater effluent limitations guidelines and standards for the pesticides chemical industry. The EPA is considering 272 pesticide active ingredients, 126 priority pollutants, and other conventional pollutants for regulation. This survey, the **Pesticide Formulating, Packaging, and Repackaging Facility Survey for 1988**, collects data on pesticide formulating, packaging, and repackaging activities; wastewater treatment practices; and financial and economic information for the fiscal years ending in 1988, 1987 and 1986. This fiscal year may or may not coincide with the calendar year.

Part B requests information on ownership, major activities and finances for both this facility and the firm owning this facility. The information will be used by EPA in assessing the economic achievability of effluent guidelines for the pesticide industry. Specifically, EPA needs to determine what proportion of facilities may incur significant adverse economic and financial impacts as a result of the regulation. In addition to determining impacts on the industry as a whole, the Agency will determine if these adverse impacts will be concentrated in a particular type or size of facility.

Among the impact measures to be considered are changes in the facility's cash flow due to additional operating and capital costs that result from compliance with the regulation. Thus, income statement and balance sheet information for the facility is requested. Since the capital cost will be affected by the method and cost of financing, the survey requests information on recent capital investments. Other possible impacts include the closing of a production line or facility, or conversion to other products. Therefore, the survey asks about the value of the plant and equipment, and possible conversion costs.

ADDITIONAL SUBMISSIONS

If you feel that additional information on other facilities you operate will allow EPA to better estimate the combined impact of the regulation on <u>your</u> firm, EPA will accept voluntary submissions for <u>all</u> other facilities that manufacture or formulate, package, or repackage any Table 1 (pages 5 through 14) pesticides within the company.

Voluntary submissions will be used to estimate firm level impacts, but will not be extrapolated to estimate the effects of the regulation on the entire industry.

To receive a blank questionnaire, please contact Ms. Janet K. Goodwin at (202) 382-7152. **Do not use** the questionnaire provided to this facility, as each facility has a unique identification number.

AUTHORITY

Data in this mandatory survey are collected under the authority of Section 308 of the Clean Water Act (33 U.S.C. Section 1318). Late filing or failure otherwise to comply with these instructions may result in criminal fines, civil penalties, and other sanctions as provided by law. Provisions concerning confidentiality of the data collected are explained next.

DATA CONFIDENTIALITY

Regulations governing the confidentiality of business information are contained in 40 CFR Part 2 Subpart B. You may assert a business confidentiality claim covering part or all of the information you may submit, other than effluent data, as described in 40 CFR 2.203(b):

> "(b) Method and time of asserting business confidentiality claim. A business which is submitting information to EPA may assert a business confidentiality claim covering the information by placing on (or attaching to) the information, at the time it is submitted to EPA, a cover sheet, stamped or typed legend, or other suitable form of notice employing language such as 'trade secret,' 'proprietary,' or 'company confidential.' Allegedly confidential portions of otherwise non-confidential documents should be clearly identified by the business, and may be submitted separately to facilitate identification and handling by EPA. If the business desires confidential treatment only until a certain date or until the occurrence of a certain event, the notice should so state."

If no business confidentiality claim accompanies the information when it is received by EPA, EPA may make the information available to the public without further notice to you. Information covered by a claim of confidentiality will be disclosed by EPA only to the extent, and by means of the procedures, set forth in 40 CFR Part 2 Subpart B. In general, submitted information protected by a business confidentiality claim may be disclosed to other employees, officers, or authorized representatives of the United States concerned with carrying out the Clean Water Act, or when relevant to any proceeding under the Act. Effluent data are not eligible for confidential treatment.

QUESTIONS

Questions about Part B - Financial and Economic Information may be directed as follows:

For questions regarding schedule:

Dr. Lynne G. Tudor
U.S. Environmental Protection Agency
Analysis and Evaluation Division WH-586
401 M Street, S.W.
Washington, DC 20460
(202) 382-5834

For questions regarding, or assistance in completing, any item in Part B of the questionnaire, EPA has established a toll-free help line:

EPA Pesticide Formulator/Packager Help Line
Abt Associates Inc.
(800) 343-3019
Ask for Jeremy Wilson (Ext. 5436) or Caty McGuckin (Ext. 5155)

U.S. ENVIRONMENTAL PROTECTION AGENCY

PESTICIDE FORMULATING, PACKAGING, AND REPACKAGING FACILITY SURVEY FOR 1988

PART B - FINANCIAL AND ECONOMIC INFORMATION

ATTACH LABEL HERE

SECTION 1: FACILITY FINANCIAL AND ECONOMIC INFORMATION

Section 1 consists of questions on the finances of this facility. A facility is a pesticide-producing establishment in which pesticide active ingredients are formulated, packaged, or repackaged. Answer the questions in sequence and do not leave any entry blank. Definitions, specific instructions, and spaces for you to comment have been provided. Use the Comments sections on pages B-16 and B-19 to explain your response to any question. Cross-reference each comment with the applicable question number.

To complete the questions in this section, you need copies of the Registered Products List found on yellow, blue, and green pages following page I-3. This information can be obtained from the person at your facility who is responsible for completing Part A, the technical portion of this questionnaire.

1988, 1987, and 1986 Facility Income Statement: Revenues

Report the revenues for this facility from all products for the fiscal years ending in 1988, 1987, and 1986. If the facility did not have revenues associated with a particular source, enter "00" in the boxes. Right-justify your answer. If you don't have revenue information at the facility level, estimate revenues using the procedures described on page B-6. Check "Yes" or "No" to indicate whether amounts are estimated. Comments on revenue and cost information should be made on page B-16. Use brackets to denote negative numbers [-].

1. **Does the facility fiscal year correspond to the calendar year?**

Q1 Yes ..... ☐ 1 *(Skip to Q.3)*
No ..... ☐ 2 *(Continue)*

2. **What are the start and end months of the facility fiscal year (e.g., January = 01, December = 12)?**

Q2A a. Facility fiscal year start month..... ⌊_⌋⌊_⌋
Q2B b. Facility fiscal year end month..... ⌊_⌋⌊_⌋

3. **What were the revenues from all pesticide products formulated, packaged, or repackaged and included on any of the Registered Products Lists (following page I-3)? Be sure to check all lists and report the revenues in the fiscal year the product was sold. In using the 1988 list, be sure you have the corrected copy.**

	Fiscal Year 1988	Fiscal Year 1987	Fiscal Year 1986
	Q3A88 $⌊_⌋,⌊_⌋⌊_⌋⌊_⌋,⌊_⌋⌊_⌋⌊_⌋,⌊_⌋⌊_⌋⌊_⌋	Q3A87 $⌊_⌋,⌊_⌋⌊_⌋⌊_⌋,⌊_⌋⌊_⌋⌊_⌋,⌊_⌋⌊_⌋⌊_⌋	Q3A86 $⌊_⌋,⌊_⌋⌊_⌋⌊_⌋,⌊_⌋⌊_⌋⌊_⌋,⌊_⌋⌊_⌋⌊_⌋
Was the amount estimated?	Q3E88 Yes..... ☐ 1 No..... ☐ 2	Q3E87 Yes..... ☐ 1 No..... ☐ 2	Q3E86 Yes..... ☐ 1 No..... [ ] 2

4. **What were the revenues from contract work or tolling done by this facility for other facilities or firms using pesticides that are included on the Registered Products Lists (following page I-3)? Be sure to check all lists and report the revenues in the fiscal year the product was sold. In using the 1988 list, be sure you have the corrected copy.**

	Fiscal Year 1988	Fiscal Year 1987	Fiscal Year 1986
	Q4A88 $⌊_⌋,⌊_⌋⌊_⌋⌊_⌋,⌊_⌋⌊_⌋⌊_⌋,⌊_⌋⌊_⌋⌊_⌋	Q4A87 $⌊_⌋,⌊_⌋⌊_⌋⌊_⌋,⌊_⌋⌊_⌋⌊_⌋,⌊_⌋⌊_⌋⌊_⌋	Q4A86 ⌊_⌋,⌊_⌋⌊_⌋⌊_⌋,⌊_⌋⌊_⌋⌊_⌋,⌊_⌋⌊_⌋⌊_⌋
Was the amount estimated?	Q4E88 Yes..... ☐ 1 No..... ☐ 2	Q4E87 Yes..... ☐ 1 No..... ☐ 2	Q4E86 Yes..... ☐ 1 No..... [ ] 2
	(Go to Fiscal Year 1987)	*(Go to Fiscal Year 1986)*	*(Go to Q 5)*

5. What were the revenues from services (e.g., application, pest control, or air-conditioning equipment maintenance) that include the provision of pesticide products included on the Registered Products Lists (following page I-3)? Be sure to check all lists and report the revenues in the fiscal year the product was sold. In using the 1988 list, be sure you have the corrected copy.

	Fiscal Year 1988	Fiscal Year 1987	Fiscal Year 1986
	Q5A88 $___,___,___,___	Q5A87 $___,___,___,___	Q5A86 $___,___,___,___
Was the amount estimated?	Q5E88 Yes..... ☐1 No..... ☐2	Q5E87 Yes..... ☐1 No..... ☐2	Q5E86 Yes..... ☐1 No..... ☐2

6. What were the revenues from other formulated, packaged, or repackaged pesticide products that are NOT included on any of the Registered Products Lists (following page I-3)?

	Fiscal Year 1988	Fiscal Year 1987	Fiscal Year 1986
	Q6A88 $___,___,___,___	Q6A87 $___,___,___,___	Q6A86 $___,___,___,___
Was the amount estimated?	Q6E88 Yes..... ☐1 No..... ☐2	Q6E87 Yes..... ☐1 No..... ☐2	Q6E86 Yes..... ☐1 No..... ☐2

7. What were all other revenues not included in Questions 3 through 6?

	Fiscal Year 1988	Fiscal Year 1987	Fiscal Year 1986
	Q7A88 $___,___,___,___	Q7A87 $___,___,___,___	Q7A86 $___,___,___,___
Was the amount estimated?	Q7E88 Yes..... ☐1 No..... ☐2	Q7E87 Yes..... ☐1 No..... ☐2	Q7E86 Yes..... ☐1 No..... ☐2

8. What were total facility revenues in each year?

	Fiscal Year 1988	Fiscal Year 1987	Fiscal Year 1986
	Q8A88 $___,___,___,___	Q8A87 $___,___,___,___	Q8A86 $___,___,___,___
Is the total of all facility revenues in Question 8 the same as the sum of Questions 3 through 7?	Q8T88 Yes..... ☐1 No..... ☐2 ↓ *(Explain in comments, page B-16)*	Q8T87 Yes..... ☐1 No..... ☐2 ↓ *(Explain in comments, page B-16)*	Q8T86 Yes..... ☐1 No..... ☐2 ↓ *(Explain in comments, page B-16)*
	(Go to Fiscal Year 1987)	*(Go to Fiscal Year 1986)*	*(Go to Q.9)*

Estimating Procedures

- **Estimating Revenues.** In some cases, the facility does not sell its products itself and, thus, does not know what revenues are generated (e.g., is part of a multi-facility firm in which two or more facilities contribute to the final products). In such cases, the final revenues the firm realizes from the sale of formulated/packaged/repackaged products should be allocated to the facilities involved in its production and formulating/packaging/repackaging on the basis of each facility's share of operating costs. An example of this allocation procedure is given below.

- **Estimating Expenses.** When certain cost elements (e.g., R&D and Federal taxes) are paid by the division or the firm, the facility's share must be estimated. In this case, base the cost estimate on the facility's share of the division's or the firm's U.S. sales. Use the organizational level closest to the facility for which there are the necessary data. If you do not have facility sales, use the revenue estimate developed above.

Example of Estimating Facility Revenues

Assume that the firm owning this facility also owns two other facilities that perform different aspects of the overall production, formulation and packaging/repackaging process. For example, assume that:

- Facility R manufactures Table 1 active ingredients;
- Facility S formulates these active ingredients into pesticide products; and
- Facility T packages these pesticide products for sale.

Further assume that no sales take place (i.e., no revenues are generated) until the finished products are sold. Hence, revenues for each facility must be estimated. This is done in terms of each facility's share of operating costs relative to the total operating costs of the firm. For this example, assume that the operating costs of pesticide production, formulation, and packaging/repackaging are:

Facility R has operating costs of	$1,000,000
Facility S has operating costs of	$ 500,000
Facility T has operating costs of	$ 500,000
Total operating costs of firm =	$2,000,000

Given this distribution of costs, Facility R would be assigned one-half of the firm's pesticide revenues, Facility S would be assigned one-quarter, and Facility T would be assigned the other one-quarter. Therefore, if the firm had pesticide revenues of $3,000,000, and you were Facility S or Facility T, then your estimated revenues would be $750,000.

(Continue →)

1988, 1987, and 1986 Facility Income Statement: Expenses

Report total facility (pesticide and non-pesticide) combined expenses that were incurred during operations. Amounts must be reported as of the last day of the fiscal year as reported in Question 2. If the facility did not have expenses associated with a particular source, enter "00" in the boxes. Right justify your answer. Use the estimating procedures described on page B-6. Check "Yes" or "No" to indicate whether amounts were estimated. Use brackets to denote negative numbers [-].

9. What were the total costs of all raw materials? *(Include packaging materials, operating supplies, delivered cost, and withdrawal from inventories.)*

	Fiscal Year 1988	Fiscal Year 1987	Fiscal Year 1986
	Q9A88 $	Q9A87 $	Q9A86 $
Was the amount estimated?	Q9E88 Yes ☐1 No ☐2	Q9E87 Yes ☐1 No ☐2	Q9E86 Yes ☐1 No ☐2

10. What were the total costs of all direct labor? *(Include the cost of payroll taxes and fringe benefits.)*

	Fiscal Year 1988	Fiscal Year 1987	Fiscal Year 1986
	Q10A88 $	Q10A87 $	Q10A86 $
Was the amount estimated?	Q10E88 Yes ☐1 No ☐2	Q10E87 Yes ☐1 No ☐2	Q10E86 Yes ☐1 No ☐2

11. What were the costs of all contract work or tolling done for you by others? *(Include the total payments made during the year for such work, including freight in and out.)*

	Fiscal Year 1988	Fiscal Year 1987	Fiscal Year 1986
	Q11A88 $	Q11A87 $	Q11A86 $
Was the amount estimated?	Q11E88 Yes ☐1 No ☐2	Q11E87 Yes ☐1 No ☐2	Q11E86 Yes ☐1 No ☐2

12. What were all other operating expenses not included in Questions 9 through 11? *(Include indirect expenses and repair and maintenance.)*

	Fiscal Year 1988	Fiscal Year 1987	Fiscal Year 1986
	Q12A88 $	Q12A87 $	Q12A86 $
Was the amount estimated?	Q12E88 Yes ☐1 No ☐2	Q12E87 Yes ☐1 No ☐2	Q12E86 Yes ☐1 No ☐2
	(Go to Fiscal Year 1987)	*(Go to Fiscal Year 1986)*	*(Go to Q. 13)*

1988, 1987, and 1986 **Facility** Income Statement: Expenses (continued)

13. What was the depreciation on buildings, plant, equipment, and machinery at your facility?

	Fiscal Year 1988	Fiscal Year 1987	Fiscal Year 1986
	$	$	$
Was the amount estimated?	Yes..... ☐1 No..... ☐2	Yes..... ☐1 No..... ☐2	Yes..... ☐1 No..... ☐2

14. What were the costs from all types of overhead? *(Include rent, nonproduction utilities, selling costs, sales commission, administration and general expenses for your facility.)*

	Fiscal Year 1988	Fiscal Year 1987	Fiscal Year 1986
	$	$	$
Was the amount estimated?	Yes..... ☐1 No..... ☐2	Yes..... ☐1 No..... ☐2	Yes..... ☐1 No..... ☐2

15. What were research and development costs incurred during each year?

	Fiscal Year 1988	Fiscal Year 1987	Fiscal Year 1986
	$	$	$
Was the amount estimated?	Yes..... ☐1 No..... ☐2	Yes..... ☐1 No..... ☐2	Yes..... ☐1 No..... ☐2

16. What were the total interest expenses on all funds during each year?

	Fiscal Year 1988	Fiscal Year 1987	Fiscal Year 1986
	$	$	$
Was the amount estimated?	Yes..... ☐1 No..... ☐2	Yes..... ☐1 No..... ☐2	Yes..... ☐1 No..... ☐2
	(Go to Fiscal Year 1987)	*(Go to Fiscal Year 1986)*	*(Go to Q. 17)*

17. What were the total Federal, State, and local income taxes payable during each year? *(Report taxes, such as property taxes, in response to Question 18.)*

	Fiscal Year 1988	Fiscal Year 1987	Fiscal Year 1986
	$	$	$
Was the amount estimated?	Yes ☐ 1 No ☐ 2	Yes ☐ 1 No ☐ 2	Yes ☐ 1 No ☐ 2

18. What were all other expenses not reported in Questions 9 through 17?

	Fiscal Year 1988	Fiscal Year 1987	Fiscal Year 1986
	$	$	$
Was the amount estimated?	Yes ☐ 1 No ☐ 2	Yes ☐ 1 No ☐ 2	Yes ☐ 1 No ☐ 2

19. What was the total of all costs and expenses?

	Fiscal Year 1988	Fiscal Year 1987	Fiscal Year 1986
	$	$	$
Was the amount estimated?	Yes ☐ 1 No ☐ 2	Yes ☐ 1 No ☐ 2	Yes ☐ 1 No ☐ 2
Is the total of all facility expenses in Question 19 the same as the sum of Questions 9 through 18?	Yes ☐ 1 No ☐ 2 ↓ *(Explain in comments, page B-16)*	Yes ☐ 1 No ☐ 2 ↓ *(Explain in comments, page B-16)*	Yes ☐ 1 No ☐ 2 ↓ *(Explain in comments, page B-16)*
	(Go to Fiscal Year 1987)	*(Go to Fiscal Year 1986)*	*(Go to Q.20)*

1988, 1987, and 1986 Detailed Facility Financial Information - Assets
Current Assets

Report **current assets**, including cash and other assets that are reasonably expected to be converted to cash, sold, or consumed during the year. Amounts must be reported as of the last day of the fiscal years 1988, 1987, and 1986 as reported in Question 2. Estimate amounts using the procedure described on page B-6. Check "Yes" or "No" to indicate whether amounts were estimated.

Current assets include cash and other assets that are reasonably expected to be converted to cash, sold, or consumed during the year.

20. What was the total value of all inventories owned by this facility regardless of where the inventories are held? *(Inventories consist of finished products; products in the process of being formulated, packaged, or repackaged; raw materials; supplies; fuels; etc. Report inventories at cost or market. For inventories at LIFO cost, use the sum of the LIFO amount plus the LIFO reserve.)*

	Fiscal Year 1988	Fiscal Year 1987	Fiscal Year 1986
	Q20A88 $	Q20A87 $	Q20A86 $
Was the amount estimated?	Q20E88 Yes ☐1 No ☐2	Q20E87 Yes ☐1 No ☐2	Q20E86 Yes ☐1 No ☐2

21. What was the total value of all other current assets? *(Include all other current assets such as prepaid expenses like rent, operating supplies, and insurance. Also include cash and accounts receivable.)*

	Fiscal Year 1988	Fiscal Year 1987	Fiscal Year 1986
	Q21A88 $	Q21A87 $	Q21A86 $
Was the amount estimated?	Q21E88 Yes ☐1 No ☐2	Q21E87 Yes ☐1 No ☐2	Q21E86 Yes ☐1 No ☐2

22. What is the total of all current assets?

	Fiscal Year 1988	Fiscal Year 1987	Fiscal Year 1986
	Q22A88 $	Q22A87 $	Q22A86 $
Was the amount estimated?	Q22E88 Yes ☐1 No ☐2	Q22E87 Yes ☐1 No ☐2	Q22E86 Yes ☐1 No ☐2
	(Go to Fiscal Year 1987)	*(Go to Fiscal Year 1986)*	*(Go to Q.23)*

1988, 1987, and 1986 Detailed Facility Financial Information - Assets (continued)
Non-current Assets

Non-current assets include physical items such as property, plant and equipment, and long-term investments and intangibles.

Include:

- original cost of land;
- cost of buildings including expansions and renovations, net of depreciation;
- cost of equipment and machinery net of depreciation;
- cost of intangibles including franchises, patents, trademarks, and copyrights net of accumulated amortization.

23. What is the value of all non-current assets?

	Fiscal Year 1988	Fiscal Year 1987	Fiscal Year 1986
	Q23A88 $,,,	Q23A87 $,,,	Q23A86 $,,,
Was the amount estimated?	Q23E88 Yes ☐1 No ☐2	Q23E87 Yes ☐1 No ☐2	Q23E86 Yes ☐1 No ☐2

24. What is the total of all current and non-current assets?

	Fiscal Year 1988	Fiscal Year 1987	Fiscal Year 1986
	Q24A88 $,,,	Q24A87 $,,,	Q24A86 $,,,
Was the amount estimated?	Q24E88 Yes ☐1 No ☐2	Q24E87 Yes ☐1 No ☐2	Q24E86 Yes ☐1 No ☐2
Is the total of all facility assets in Question 24 the same as the sum of Questions 22 and 23?	Yes ☐1 No ☐2 ↓ *(Explain in comments, page B-16)*	Yes ☐1 No ☐2 ↓ *(Explain in comments, page B-16)*	Yes ☐1 No ☐2 ↓ *(Explain in comments, page B-16)*
	Q24T88	Q24T87	Q24T86
	(Go to Fiscal Year 1987)	*(Go to Fiscal Year 1986)*	*(Go to Q.25)*

1988, 1987, and 1986 Detailed Facility Financial Information - Liabilities and Equity

Report current liabilities that fall due for payment within the report years. Amounts must be reported as of the last day of the fiscal years 1988, 1987, and 1986 as reported in Question 2. If the facility did not have liabilities or equity from a source, enter "00" in the boxes. Right-justify your answer. Estimate amounts using the procedure described on page B-6. Check "Yes" or "No" to indicate whether the amounts were estimated.

Current liabilities fall due for payment within one year. Include accounts payable, accrued expenses and taxes, and the current portion of long-term debt.

25. Current Liabilities. What was the total value of all current liabilities for each report year?

	Fiscal Year 1988	Fiscal Year 1987	Fiscal Year 1986
	Q25A88 $ ___,___,___,___	Q25A87 $ ___,___,___,___	Q25A86 $ ___,___,___,___
Was the amount estimated?	Q25E88 Yes..... ☐1 No..... ☐2	Q25E87 Yes..... ☐1 No..... ☐2	Q25E86 Yes..... ☐1 No..... ☐2

Non-current liabilities and equity fall due beyond one year.

26. Long-Term Debt and Other Non-Current Liabilities. What was the total value of all long-term debt such as bonds, debentures, and bank debt, and all other non-current liabilities including deferred income taxes?

	Fiscal Year 1988	Fiscal Year 1987	Fiscal Year 1986
	Q26A88 $ ___,___,___,___	Q26A87 $ ___,___,___,___	Q26A86 $ ___,___,___,___
Was the amount estimated?	Q26E88 Yes..... ☐1 No..... ☐2	Q26E87 Yes..... ☐1 No..... ☐2	Q26A86 Yes..... ☐1 No..... ☐2

27. Owner Equity. What was the difference between total assets and total liabilities?

The amount reported should include contributed or paid in capital *(preferred and common stock)* and retained earnings.

	Fiscal Year 1988	Fiscal Year 1987	Fiscal Year 1986
	Q27A88 $ ___,___,___,___	Q27A87 $ ___,___,___,___	Q27A86 $ ___,___,___,___
Was the amount estimated?	Q27E88 Yes..... ☐1 No..... ☐2	Q27E87 Yes..... ☐1 No..... ☐2	Q27E86 Yes..... ☐1 No..... ☐2
	(Go to Fiscal Year 1987)	*(Go to Fiscal Year 1986)*	*(Go to Q.28)*

Non-current liabilities and equity (continued)

28. Total Non-current Liabilities and Equity. What was the value of all non-current liabilities and equity?

	Fiscal Year 1988	Fiscal Year 1987	Fiscal Year 1986
	$	$	$
Was the amount estimated?	Yes ☐ 1 No ☐ 2	Yes ☐ 1 No ☐ 2	Yes ☐ 1 No ☐ 2

29. Total Liabilities and Equity. What is the total of all liabilities and equity?

	Fiscal Year 1988	Fiscal Year 1987	Fiscal Year 1986
	$	$	$
Was the amount estimated?	Yes ☐ 1 No ☐ 2	Yes ☐ 1 No ☐ 2	Yes ☐ 1 No ☐ 2
Is the total of all facility liabilities and equity in Question 29 the same as the sum of Questions 25 and 28?	Yes ☐ 1 No ☐ 2 ↓ *(Explain in comments, page B-16)*	Yes ☐ 1 No ☐ 2 ↓ *(Explain in comments, page B-16)*	Yes ☐ 1 No ☐ 2 ↓ *(Explain in comments, page B-16)*
	(Go to Fiscal Year 1987)	*(Go to Fiscal Year 1986)*	*(Go to Q.30)*

30. If you were to discontinue formulating/packaging/repackaging of pesticides included on the 1988 (yellow) Registered Products List, would you be most likely to:

a. Shut down the pesticide formulating/packaging/repackaging lines completely? ..... ☐ 1 *(Skip to Q.32)*

Q30

b. Convert to EPA-registered pesticide products containing active ingredients not listed in Table 1, pages 5 through 14? ..... ☐ 2

c. Convert to non-pesticide products? ..... ☐ 3

d. Convert to EPA-registered pesticide products containing active ingredients not listed in Table 1, pages 5 through 14, and to non-pesticide products? ..... ☐ 4

(Continue)

31. What are the estimated conversion costs of the option reported in Question 30, parts b through d?

Q31

$ ____ , ____ , ____

32. Do you have room to install wastewater treatment equipment on your existing facility site, on property you currently own or lease?

Q32

Yes ..... ☐ 1
No ..... ☐ 2

33. Do you have room to install wastewater treatment equipment away from your existing facility site, on adjacent property you could buy or lease?

Q33

Yes ..... ☐ 1
No ..... ☐ 2

34. Do you own, lease, or rent your facility?

Q34

Lease or rent ..... ☐ 1 *(Continue)*
Own ..... ☐ 2 *(Skip to Q.36)*

35. How long is your lease or rental agreement?

Q35

____ Years *(Continue)*

36. What was the 1988 property tax assessed value of the items listed below? *(Enter "00" if the taxes do not apply. Right-justify your answer in the boxes.)*

State tax assessed value

Q36A a. Land ..... $ |_|_|_|,|_|_|_|,|_|_|_|

Q36B b. Buildings ..... $ |_|_|_|,|_|_|_|,|_|_|_|

Q36C c. Equipment and machinery ..... $ |_|_|_|,|_|_|_|,|_|_|_|

Q36D d. Other *(Specify)* _____ $ |_|_|_|,|_|_|_|,|_|_|_|

_____

Q36E e. Total property tax assessed value ..... $ |_|_|_|,|_|_|_|,|_|_|_|

Local tax assessed value

Q36F f. Land ..... $ |_|_|_|,|_|_|_|,|_|_|_|

Q36G g. Buildings ..... $ |_|_|_|,|_|_|_|,|_|_|_|

Q36H h. Equipment and machinery ..... $ |_|_|_|,|_|_|_|,|_|_|_|

Q36I i. Other *(Specify)* _____ $ |_|_|_|,|_|_|_|,|_|_|_|

_____

Q36J j. Total property tax assessed value ..... $ |_|_|_|,|_|_|_|,|_|_|_|

37. What was the 1988 assessed value of the property, expressed as a percentage of market value (1988 level of assessment)? This information may be included on your tax bill or can be obtained from your state or local tax office. *(Enter "00" if the item is not applicable. Right-justify your answer in the boxes.)*

Q37A a. State assessment percentage ..... |_|_|_|.|_| %

Q37B b. Local assessment percentage ..... |_|_|_|.|_| %

(Go to Section 2)

COMMENTS FOR SECTION 1. *(Please cross-reference your comments by question number.)*

Question Number

Comment 1

Comment 2

Comment 3

Comment 4

Comment 5

Comment 6

Comment 7

Comment 8

SECTION 2: FIRM FINANCIAL INFORMATION

Section 2 requests economic and financial information for the **firm** or organization that owned or controlled this facility on the last day of the fiscal year ending in 1988. If this is a single facility firm, this information should apply to the facility. For multi-facility firms, you may need to contact your company headquarters. Comments on this section may be made on page B-19. Please cross-reference the question in your comment.

1. Report the percentage of the firm's total U.S. revenues, for the fiscal year ending in 1988, generated by each of the activities listed below. *(Enter "00" if the activity was not applicable. Right-justify your answer in the boxes. The sum of all percentages must be 100%).* Note: Question 1 does not apply to government agencies.

Q1A a. Percentage of total firm revenues generated by manufacturing Pesticide Active Ingredients listed on Table 1, pages 5 through 14 ..... |_|_|_|.|_| %

Q1B b. Percentage of total firm revenues generated by formulating, packaging, or repackaging pesticide products containing active ingredients listed on Table 1, pages 5 through 14 ..... |_|_|_|.|_| %

Q1C c. Percentage of total firm revenues generated by all other activities *(Specify)* ..... |_|_|_|.|_| %

_____

Total 1 0 0 %

Q2 2. Did your firm make any capital investment during fiscal years 1985 to 1989? Include both pesticide- and non-pesticide-related investments for any facility owned by this firm.

Yes ..... ☐ 1 *(Continue)*
No ..... ☐ 2 *(Go to Section C)*

1985-1989 Firm Level Capital Investment Information
Dollars and Annual Percentage Rate (APR)

		a. Most recent capital investment	b. Second most recent capital investment	c. Third most recent capital investment
3.	In what year, during the period 1985-1989, was a capital investment made?	Q3A 19 ⌊__⌋ Year	Q3B 19 ⌊__⌋ Year	Q3C 19 ⌊__⌋ Year
4.	Did you use cash as a method of payment?	Q4A Yes ↓ ☐ 1 No ☐ 2 *(Go to Q.5)*	Q4B Yes ↓ ☐ 1 No ☐ 2 *(Go to Q.5)*	Q4C Yes ↓ ☐ 1 No ☐ 2 *(Go to Q.5)*
	a. What was the dollar amount of the cash investment?	Q4AA $⌊__⌋,⌊__⌋,⌊__⌋	Q4AB ⌊__⌋,⌊__⌋,⌊__⌋	Q4AC $⌊__⌋,⌊__⌋,⌊__⌋
5.	Did you use a line of credit as a method of payment?	Q5A Yes ↓ ☐ 1 No ☐ 2 *(Go to Q.6)*	Q5B Yes ↓ ☐ 1 No ☐ 2 *(Go to Q.6)*	Q5C Yes ↓ ☐ 1 No ☐ 2 *(Go to Q.6)*
	a. What was the dollar amount of the investment?	Q5AA $⌊__⌋,⌊__⌋,⌊__⌋	Q5AB $⌊__⌋,⌊__⌋,⌊__⌋	Q5AC $⌊__⌋,⌊__⌋,⌊__⌋
	b. What interest rate did you pay?	Q5BA ⌊__⌋.⌊__⌋ Annual percentage rate	Q5BB ⌊__⌋.⌊__⌋ Annual percentage rate	Q5BC ⌊__⌋.⌊__⌋ Annual percentage rate
6.	Did you otherwise borrow from a bank or other lending institution as a method of payment?	Q6A Yes ↓ ☐ 1 No ☐ 2 *(Go to Q.7)*	Q6B Yes ↓ ☐ 1 No ☐ 2 *(Go to Q.7)*	Q6C Yes ↓ ☐ 1 No ☐ 2 *(Go to Q.7)*
	a. What was the dollar amount of the loan?	Q6AA $⌊__⌋,⌊__⌋,⌊__⌋	Q6AB $⌊__⌋,⌊__⌋,⌊__⌋	Q6AC $⌊__⌋,⌊__⌋,⌊__⌋
	b. What was the interest rate of the loan?	Q6BA ⌊__⌋.⌊__⌋ Annual percentage rate	Q6BB ⌊__⌋.⌊__⌋ Annual percentage rate	Q6BC ⌊__⌋.⌊__⌋ Annual percentage rate
7.	Did you borrow from the parent company as a method of payment?	Q7A Yes ↓ ☐ 1 No ☐ 2 *(Go to Q.8)*	Q7B Yes ↓ ☐ 1 No ☐ 2 *(Go to Q.8)*	Q7C Yes ↓ ☐ 1 No ☐ 2 *(Go to Q.8)*
	a. What was the dollar amount of the loan?	Q7AA $⌊__⌋,⌊__⌋,⌊__⌋	Q7AB $⌊__⌋,⌊__⌋,⌊__⌋	Q7AC $⌊__⌋,⌊__⌋,⌊__⌋
	b. What was the interest rate of the loan?	Q7BA ⌊__⌋.⌊__⌋ Annual percentage rate	Q7BB ⌊__⌋.⌊__⌋ Annual percentage rate	Q7BC ⌊__⌋.⌊__⌋ Annual percentage rate
8.	Did you borrow from another source?	Q8A Yes ↓ ☐ 1 No ☐ 2 *(Go to Q.3b)*	Q8B Yes ↓ ☐ 1 No ☐ 2 *(Go to Q.3c)*	Q8C Yes ↓ ☐ 1 No ☐ 2 *(Go to Section 3)*
	a. What was the dollar amount of the loan?	Q8AA $⌊__⌋,⌊__⌋,⌊__⌋	Q8AB $⌊__⌋,⌊__⌋,⌊__⌋	Q8AC $⌊__⌋,⌊__⌋,⌊__⌋
	b. What was the interest rate of the loan?	Q8BA ⌊__⌋.⌊__⌋ Annual percentage rate	Q8BB ⌊__⌋.⌊__⌋ Annual percentage rate	Q8BC ⌊__⌋.⌊__⌋ Annual percentage rate
		(Continue with Q.3b)	*(Continue with Q.3c)*	*(Go to Part C)*

COMMENTS FOR SECTION 2. *(Please cross-reference your comments by question number.)*

Question Number

Comm1

Comm2

COMM3

Comm4

Comm5

Comm6

Comm7

Comm8

YOU HAVE COMPLETED THE FINANCIAL AND ECONOMIC PORTION OF THIS QUESTIONNAIRE.

CONTINUE WITH PART C.

SECTION 3: CERTIFICATION

1. When the Introduction and Parts A and B have been completed, you must read and sign the certification statement below.

Certification

I certify under penalty of law that this document was prepared under my direction or supervision in accordance with a system designed to assure that qualified personnel properly gather and evaluate the information submitted. Based on my inquiry of the person or persons who manage the system, or those persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge and belief, true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment.

Signature of certifying official _____ Date _____

First name FNAME 1 Last name LNAME 1

Title of certifying official TITLE 1

Mailing Instructions

Thank you for your cooperation.
Please mail your completed questionnaire in the enclosed envelope to:

Ms. Janet K. Goodwin
U.S. Environmental Protection Agency
Industrial Technology Division WH-552
401 M Street, S.W.
Washington, DC 20460
(202) 382-7152

Appendix B
Mapping of Pesticide Active Ingredients into Clusters

This appendix lists the 57 clusters used to define PAI markets in the EIA. As discussed in Chapters 3 and 4, the clusters were developed by EPA's Office of Water based on previous work by EPA's Office of Pesticide Programs (OPP). Individual PAIs are listed by the cluster(s) in which the PAI appears. Chemical Abstract Service (CAS) numbers are provided where applicable. Many of these chemicals have already been regulated in different contexts (see the header of the table for notation indicating whether PAIs are covered by other regulations, as well as the production/marketing status of the PAI).

PESTICIDE CLUSTERS

< > - Denotes pesticides that are not marketed in the U.S.
[ ] - Denotes pesticides that have been cancelled for use in the U.S.
{ } - Denotes pesticides that have been discontinued by manufacturer
| | - Denotes a pesticide whose registration has been withdrawn
( ) - Denotes a Trade or Brand Name
(B) - Denotes biological pesticide
(SB) - Denotes a Office of Water Subcategory B pesticide
(O) - Denotes pesticide manufactured under OCPSF Industry Regulations
(I) - Denotes pesticide manufactured under Inorganic Chemical Industry Regulations
(P) - Denotes pesticide manufactured under Pharmaceutical Industry Regulations
(PM)* - Denotes pesticide covered by Pesticide Manufacturing Industry Regulations (priority pollutant and PAI)
(PM) - Denotes pesticide covered by Pesticide Manufacturing Industry Regulations (priority pollutants only)
△ - Denotes pesticides not produced 1984-1988
▽ - Denotes pesticides not produced 1986-1988
◁ - Denotes pesticides not produced 1984-1985
▷ - Denotes pesticides not produced 1984-1986

F-1 Fungicides
Broad spectrum of uses

205 PCNB 82-68-8 *(PM*)*
32 Thiabendazole (Mertect) 148-79-8 *(PM)*
62 Benomyl 17804-35-2 *(PM*)*
82 Chlorothalonil 1897-45-6 *(PM*)*
87 Mancozeb 8018-01-7 *(PM*)*
96 {Amobam} *(PM)*
149 Malachite Green 12069-69-1 *(PM)*
151 Maneb 12427-38-2 *(PM*)*
190 Organo-Copper *(SB)*
192 Organo-tin Fungicides *(PM*)*
260 Thiophanate Methyl 23564-05-8 *(PM)*
261 Thiram 137-26-8 *(PM)*
Metalaxyl (Ridomil)
Myclobutanil (Systhane, Rally)
Propiconazole (Tilt; CGA-64250; Orbit; Desmel)
Vinclozolin (Ronilan)
Inorganic Pesticides
Calcium Polysulfide (Lime sulfurs) (I)
Inorganic Copper Compounds (I)
Inorganic Sulfur Compounds (I)

F- 2a Fungicides
Fruit and nut trees, except oranges and grapes

268 Ziram 137-30-4 *(PM*)*
164 Quinomethionate (Morestan) 2439-01-2 *(PM)*
134 Ferbam 14484-64-1 *(PM)*
121 Dodine 2439-10-3 *(PM)*
99 {Dichlone} 117-80-6 *(PM)*
74 Captan 133-06-2 *(PM)*
<Dithianon>
Coppers
Glyodin ▵
Iprodione
Triforine
Pharmaceutical Pesticides
Streptomycin *(P)*
Inorganic Pesticides
{Ammonium Polysulfide} *(I)*
Calcium Polysulfide (Lime sulfurs) *(I)*
Inorganic Coppers, cuprus oxide, copper oxide*(I)*
Sodium Polysulfide *(I)*

F- 2b Fungicides
Grapes

134 Ferbam 14484-64-1 *(PM*)*
8 Triadimefon (Bayleton) 43121-43-3 *(PM*)*
<Glyodin>
<Dithianon>
Inorganic Pesticides
Calcium Polysulfide (Lime sulfurs) *(I)*
Sulfur *(I)*

F- 3 Fungicides
Vegetables

228 Propamocarb Hydrochloride (Previcur N) 25606-41-1 *(PM*)*
167 Metiram 9006-42-2 *(PM)*
152 {Niacide} *(PM)*
99 {Dichlone} 117-80-6 *(PM)*
73 [Captafol] 2939-80-2 *(PM*)*
20 Dicloran, DCNA *(PM)* 99-30-9 - Plant closed; only U.S. producer
18 Anilazine (Dyrene) 101-05-3 *(PM)*
9 Hexachlorophene (Nabac) 70-30-4 *(PM)*
Fosetyl-Aluminum (Aliette)
Fluoride Compounds
Inorganic Pesticides
Inorganic Chromium Compounds *(I)*
Coppers, cuprous oxide, copper oxide *(I)*

F- 4 Fungicides
Citrus

267 Zineb (Dithane) 12122-67-7 *(PM)*
Phenolics
211 {Phenyl Phenol} 90-43-7 *(PM)*
Sec-Butylamine *(O)*
Inorganic Coppers, cuprous oxide, copper oxide *(I)*

F- 5 Fungicides
For use as seed treatments

250 {HPMTS} *(PM)*
227 Propionic acid 79-09-4 *(PM)*
120 Metasol DGH *(PM)*
80 Chloroneb 2675-77-6 *(PM*)*
49 Etridiazol (Terrazole, Etrazole, Truban) 2593-15-9 *(PM)*
35 TCMTB (Busan 30A) *(PM*)*
{Chloronitropropane (Lanstan)}
Carboxin
Imazalil (Fungaflor, Fungazil)
Triadimenol (Baytan)
{Fenaminosulf (Lesan)} *(O)*
Sodium Hypochlorite *(I)*

F- 6 Fungicides
Post harvest fruit and vegetables

67 |Biphenyl, Diphenyl| 92-52-4
Imazalil (Fungaflor, Fungazil)
{Isothan}
Sodium Dehydroacetate *(I)*

F- 7 Fungicides
Grain storage

227 Propionic acid 79-09-4 *(PM)*
Isobutyric acid *(O)*
Ammonium Isobutryate

F- 8 Fungicides
Ornamentals

91 {Cycloheximide (Acti-dione)} 66819 *(PM)*
132 Fenarimol (Rubigan) 60168-88-9 *(PM*)*
167 Metiram 9006-42-2 *(PM)*
189 {Organo-Cadmium} *(SB)*

{Dichloroethyl Ether}
{Parinol (Parnon)}
Dodemorph Acetate (Milban)
Fosetyl-Aluminum (Aliette)
Piperalin *(O)*

F- 9 Fungicides
Turf

132 Fenarimol (Rubigan) 60168-88-9 *(PM*)*
100 {Thiophanate Ethyl} 23564-06-9 *(PM)*
91 {Cycloheximide (Acti-dione)} 66819 *(PM)*
Fosetyl-Aluminum (Alliete)
Inorganic Pesticides
Inorganic Cadmium Compounds *(I)*
Nickel Sulfate *(I)*

F-10 Fungicides
Unclassified

{Ditalimfos}
Pseudomonas Fluoescens (Dagger G) *(B)*
{Allyl Alcohol} *(O)*

H- 1 Herbicides
Broad spectrum of uses

138 Glyphosate 38641-90-0 *(PM*)*
16 2,4-D 1702-17-6 *(PM*)*
Monocarbide Dihydrogen Sulfate (ENQUIK, N-tac)
Paraquat
Sodium Chlorate *(I)*

H- 2 Herbicides
Corn

249 Vernolate (Surpass) 1929-77-7 *(PM)*
246 EPTC 759-94-4 *(PM)*
239 Simazine 122-34-9 *(PM*)*
204 Pendimethalin 40487-42-1 *(PM*)*
165 Metolachlor 51218-45-2 *(PM)*
161 Methanearsonic acid *(SB)*
130 Butylate 2008-41-5 *(PM)*
69 Bromoxynil 1689-84-5 *(PM*)*
60 Atrazine 1912-24-9 *(PM*)*
58 Ametryn 834-12-8 *(PM)*
54 Alachlor 15972-60-8 *(PM*)*

32 Cloprop *(PM)*
26 Propachlor 1918-16-7 *(PM*)*
25 Cyanazine (Bladex) 21725-46-2 *(PM*)*
70 <Butachlor> 23184-66-8 *(PM*)*
{Cyprazine (Outfox)}
{Tridiphane (Tandem)}
Nicosulfuron (Thiameturon)
Primisulfuron
Pyridate
TCBC, Trichlorobenzyl Chloride *(O)* ▽

H- 3 Herbicides
Soybeans, cotton, peanuts, alfalfa

272 {Chlorpropham} 101-21-3 *(PM)*
264 Trifluralin 1582-09-8 *(PM*)*
254 Terbacil 5902-51-2 *(PM*)*
249 Vernolate (Surpass) 1929-77-7 *(PM)*
240 Bentazon 25057-89-0 *(PM)*
224 Prometryn 7287-19-6 *(PM*)*
204 Pendimethalin 40487-42-1 *(PM*)*
196 Oxyfluorfen 42874-03-03 *(PM)*
194 Oryzalin 19044-88-3 *(PM)*
178 Benefin, Benfluralin 1861-40-1 *(PM*)*
176 Naptalim (Alanap) 132-66-1 *(PM)*
175 Norflurazon 27314-13-2 *(PM*)*
165 Metolachlor 51218-45-2 *(PM)*
148 Linuron 330-55-2 *(PM*)*
142 Hexazinone 51235-04-2 *(PM)*
135 Fluometuron 2164-17-2 *(PM)*
125 Ethalfluralin (Sonalan) 55283-68-6 *(PM*)*
92 Dalapon 75-99-0 *(PM)*
78 {Chloramben} 1954-81-4 *(PM)*
53 Acifluorfen 62474-59-9 *(PM*)*
45 Metribuzin (Sencor) 21087-64-9 *(PM*)*
39 Pronamide (Kerb) 23950-58-5 *(PM*)*
17 [2,4-DB] - Salts and Esters still produced 94-82-6 *(PM*)*
{Dipropetryn}
{Ethylene Glycol bis Trichloroacetate (Glytac)} *(O)*
{Fluchloralin}
{Nitralin (Planavin)}
{Perfluidone}
{Profluralin (Tolban)}
Chlorimuron Ethyl (Classic)
Clomazone (Command)
Dichlofop Methyl
Dinitramine ▽
Fluazifop-butyl (Fusilade)
Fomesafen (Reflex)
Imazaquin (Scepter)

Imazethapyr (Pursuit)
Lactofen (Cobra)
Mepiquat-Chloride (Pix)
Methazole
Quizalofop-Ethyl (Assure)
Sethoxydim (Poast)

H- 4 Herbicides
Sorghum, rice, small grains

269 Triallate (Far Go) 2303-17-5 *(PM)*
257 {Terbutryn} 886-50-0 *(PM*)*
247 Molinate 2212-61-1 *(PM)*
254 Terbacil 5902-51-2 *(PM*)*
226 {Propazine} 139-40-2 *(PM*)*
170 Napropamide 15299-99-7 *(PM)*
92 Dalapon 75-99-0 *(PM)*
70 <Butachlor> 23184-66-9 *(PM*)*
69 Bromoxynil 1689-84-5 *(PM*)*
68 Bromacil 314-40-9 *(PM*)*
66 {Bifenox} 42576-02-3 *(PM)*
58 Ametryn 834-12-8 *(PM*)*
41 Propanil 709-98-8 *(PM*)*
27 MCPA 94-74-6 *(PM*)*
26 Propachlor 1918-16-7 *(PM*)*
{Barban (Carbyne)}
Bensulfuron Methyl (Londax)
Butralin
Chlorsulfuron (Glean)
Clopyralid (Lontrel)
Difenzoquat Methyl Sulfate (Avenge)
Imazamethabenz-Methyl, AC 222, 293 (Assert)
Isoxaben (EL 107. Prolan)
Metsulfuron Methyl (Ally)
Thifensulfuron-methyl, DPX-M6316 (Harmony, Pi)
Thiobencarb
Tribenuron methyl (Express)

H- 5a Herbicides
Oranges

Glufosinate (Devine) *(B)*

H- 5b Herbicides
Grapes

196 Oxyfluorfen 42874-03-03 *(PM)*

194 Oryzalin 19044-88-3 *(PM)*
170 Napropamide 15299-99-7 *(PM)*

H- 5c Herbicides
Fruits (except oranges and grapes), tree nuts and sugarcane

194 Oryzalin 19044-88-3 *(PM)*
170 Napropamide 15299-99-7 *(PM)*
92 Dalapon 75-99-0 *(PM)*
58 Ametryn 834-12-8 *(PM*)*
44 DNOC 534-52-1 *(PM)*
Asulam
Dichlobenil

H- 6 Herbicides
Sugar beets, beans and peas

256 Terbuthylazine (Gardoprim) 5915-41-3 *(PM*)*
245 Cycloate (Ro-Neet) 1134-23-2 *(PM)*
209 Phenmedipham 13684-63-4 *(PM)*
112 [Dinoseb] 88-85-7 *(PM*)*
95 Desmedipham (Betanex) 13684-56-5 *(PM)*
47 MCPB 94-81-5 *(PM)*
{Diallate}
{Sodium TCA}
Chloridazon ▽
Clopyralid (Lontrel)
Diclop
Diethatyl-Ethyl (Antor)
Ethofumesate
Pyrazon

H- 7 Herbicides
Drainage ditches, rights of way, forestry and ponds

259 Dazomet, DMTT (busamid, Mylome, Nefusan) 533-74-4 *(PM*)*
252 Tebuthiuron 34014-18-1 *(PM)*
251 Bensulide (Betesan) 741-58-2 *(PM)*
239 Simazine 122-34-9 *(PM*)*
238 [Silvex] 93-72-1 *(PM)*
223 Prometon 1610-18-0 *(PM*)*
178 Benefin, Benfluralin 1861-40-1 *(PM*)*
169 Monuron 150-68-5 *(PM)*
168 Monuron TCA 150-68-5 *(PM)*
146 Karbutilate 4849-32-5 *(PM)*
142 Hexazinone 51235-04-2 *(PM)*
123 Endothall 129-67-9 *(PM*)*
119 Diuron 330-54-1 *(PM*)*

110 DCPA 1861-32-1 *(PM*)*
68 Bromacil 314-40-9 *(PM*)*
31 Mecoprop (MCPP) 7085-19-0 *(PM*)*
30 Dichlorprop 120-36-5 *(PM*)*
15 Weedone *(PM)*
14 Chlorfenac 85-34-7 *(PM)*
Aquashade (Dyes and Water)
Dichlobenil
Diquat
Fluridone (Sonar)
Imazapyr
Sulfometuron Methyl (Oust)
AMS, Ammonium Sulfamate *(I)*
Organic Pesticides
Acrolein *(O)*
Amitrole *(O)*

H- 8 Herbicides
Turf

259 Dazomet, DMTT (busamid, Mylome, Nefusan) 533-74-4 *(PM*)*
237 Siduron 1982-49-6 *(PM)*
{Terbutol}
Flurprimidol (Cutless)
Oxadiazon
Inorganic Pesticides
Ferrous Sulfate *(I)*
Potassium Cyanate *(I)*

H- 9a Herbicides
Vegetables

272 {Chlorpropham} 101-21-3 *(PM)*
251 Bensulide (Betesan) 741-58-2 *(PM)*
248 Pebulate (Tillam) 1114-71-2 *(PM)*
176 Naptalam (Alanap) 132-66-1 *(PM)*
174 Norea 18530-56-8 *(PM)*
170 Napropamide 15299-99-7 *(PM)*
115 {Diphenamid} 957-51-7 *(PM)*
110 DCPA 1861-32-1 *(PM*)*
102 Bisethylxanthogen (Herbisan) *(PM)*
83 Chloroxuron 1982-47-4 *(PM)*
39 Pronamide (Kerb) 23950-58-5 *(PM*)*
23 {CDEC (Vegadex)} 95-06-7 *(PM)*
{CDAA (N,N-Diallyl-2-Chloroacetamide)}
Metabromuron ▵
Nitrofen (Tok) ▵

H- 9b Herbicides
Tobacco

248 Pebulate (Tillam) 1114-71-2 *(PM)*
176 Naptalam (Alanap) 132-66-1 *(PM)*
174 Norea 18530-56-8 *(PM)*
170 Napropamide 15299-99-7 *(PM)*
144 Isopropalin 33820-53-0 *(PM*)*
115 {Diphenamid} 957-51-7 *(PM)*
110 DCPA 1861-32-1 *(PM*)*
102 Bisethylxanthogen (Herbisan) *(PM)*
39 Pronamide (Kerb) 23950-58-5 *(PM*)*
23 {CDEC (Vegadex)} 95-06-7 *(PM)*
{CDAA (N,N-Diallyl-2-Chloroacetamide)}
Metabromuron ▵
Nitrofen ▵
Prime +

H-10 Herbicides
Unclassified

215 Picloram 1918-02-1 *(PM)*
98 Dicamba 1918-00-9 *(PM)*
{Erbon}
<Neburon>
Allyl Alcohol}
Fenridazone-Potassium (Hybrex)
Trichlopyr

I- 1a Insecticides/Nematicides
Cotton

262 [Toxaphene] 8001-35-2 *(PM*)*
225 Propargite 2312-35-8 *(PM)*
222 Profenofos (Curacron) 41198-08-7 *(PM)*
214 Phosphamidon 287-99-4*(PM)*
203 Parathion 56-38-2*(PM*)*
199 [EPN (Santox)] 2104-64-5 *(PM)*
197 Sulprofos (Bolstar) 35400-43-2 *(PM*)*
195 Oxamyl 2135-22-0 24 *(PM)*
186 Azinphos-Methyl (Guthion) 86-50-0 *(PM*)*
156 Methomyl 16752-77-5 *(PM*)*
124 [Endrin] 72-20-8 *(PM*)*
108 Dicrotophos (Bidrin) 141-66-2 *(PM)*
107 Parathion Methyl 298-00-0 *(PM*)*
104 Diflubenzuron 35367-38-5 *(PM)*
94 {Demeton (Systox)} 8065-48-3 *(PM*)*
90 Fenvalerate (Pydrin) 51630-58-1 *(PM*)*
63 [Benzene Hexachloride, BHC] 608-73-1 *(PM)*

55 Aldicarb 116-06-3 *(PM*)*
52 Acephate 30560-19-1 *(PM*)*
1 Dicofol (Kelthane, DTMC) 115-32-2 *(PM)*
{Bollex}
{Heliothis Polyhedrosis Virus (Elcar)} *(B)*
Bifenthrin (Talstar)
Chlordimeform Hydrochloride ▽
Cyfluthrin (Baythroid)
Gossyplure
Grandlure Mixture
Lambda Cyhalothrin (Karate)
Monocrotophos (Azodrin) △
Thiodicarb (Larvin)
Tralomethrin (Scout)
[Chlordimeform (Galecron, Fundal)]

I- 1b Insecticides/Nematicides
Soybeans, peanuts, wheat and tobacco

262 [Toxaphene] 8001-35-2 *(PM*)*
208 Permethrin 52645-53-1 *(PM*)*
199 [EPN (Santox)] 2104-64-5 *(PM)*
183 Disulfoton (Disyston) 298-04-4 *(PM*)*
156 Methomyl 16752-77-5 *(PM*)*
127 Ethoprop 13194-48-4 *(PM)*
124 [Endrin] 72-20-8 *(PM*)*
106 Dimethoate 60-51-5 *(PM)*
86 Chlorpyrifos 2921-88-2 *(PM*)*
63 [Benzene Hexachloride, BHC] 608-73-1 *(PM)*
55 Aldicarb 116-06-3 *(PM*)*
{Bollex}
{Heliothis Polyhedrosis Virus (Elcar)} *(B)*
Chlordimeform Hydrochloride ▽
Monocrotophos (Azodrin) △
Tralomethrin (Scout)
[Chlordimeform (Galecron, Fundal)]

I- 2a Insecticides/Nematicides
Corn, alfalfa

255 Terbufos 013071-79-9 *(PM*)*
225 Propargite 2312-35-8 *(PM)*
212 Phorate 298-02 *(PM*)*
208 Permethrin 52645-53-1 *(PM*)*
200 Fonofos 944-22-9 *(PM)*
193 {Orthodichlorobenzene} 95-50-1
182 {Fensulfothion (Dasanit)} 115-90-2 *(PM*)*
150 Malathion 121-75-5 *(PM*)*
111 Trichlorfon (Dylox) 52-68-6 *(PM)*

107 Parathion Methyl 298-00-0 *(PM*)*
86 Chlorpyrifos 2921-88-2 *(PM*)*
76 Carbofuran 1563-66-2 *(PM*)*
75 Carbaryl 63-25-2 *(PM*)*
13 {Landrin 2} 2686-99-9 *(PM)*
TEPP (HETP)▵
{Bufencarb (Bux)}
{Carbophenothion (Trithion)}
{Tefluthrin (Force)}
Formetanate Hydrochloride (Carzol) ◃
Thiodicarb (Larvin)

I- 2b Insecticides/Nematicides
Sorghum

203 Parathion 56-38-2 *(PM*)*
193 {Orthodichlorobenzene} 95-50-1
75 Carbaryl 63-25-2 *(PM*)*
13 {Landrin 2 } 2686-99-9 *(PM)*
{Bufencarb (Bux)}
{Carbophenothion (Trithion)}
{Tefluthrin (Force)}
TEPP (HETP) ▵

I- 3 Insecticides
Fruit (excluding oranges and grapes) and nut trees

225 Propargite 2312-35-8 *(PM)*
214 Phosphamidon 297-99-4 *(PM)*
213 Phosalone 2310-17-0 *(PM)*
203 Parathion 56-38-2 *(PM*)*
195 Oxamyl 2135-22-0 *(PM)*
186 Azinphos-Methyl (Guthion) 86-50-0 *(PM*)*
185 Phosmet (Imidan) 732-11-6 *(PM*)*
156 Methomyl 16752-77-5 *(PM*)*
155 Methidathion 950-37-8 *(PM)*
141 {Cycloprate (Zardex)} 54460-46-7 *(PM)*
129 Chlorobenzilate (Acaraben) 510-15-6 *(PM)*
122 Endosulfan 115-29-7 *(PM)*
107 Parathion Methyl 298-00-0 *(PM*)*
103 Diazinon (Diazitol, Basudin, Dipofene, Spectracide) 333-41-5 *(PM*)*
90 Fenvalerate (Pydrin) 51630-58-1 *(PM*)*
75 Carbaryl 63-25-2 *(PM*)*
59 Amitraz 33089-61-1 *(PM)*
19 Dinocap 39300-45-3 *(PM)*
{Chloropropylate (Acalarate)}
2-Naphthol, Beta-Naphthol *(O)*
Chitin (Clandosan 618)
Dialifor (Torak) ◃

Formetanate Hydrochloride (Carzol) ◁
Ovex (Chlorfensom) △
Petroleum Oils
Tetradifon, Tedion ▽
Tetrasul (Animert V-101) ▽

I- 4 Insecticides/Nematicides
Oranges

173 Naled 300-76-5 *(PM*)*
155 Methidathion 950-37-8 *(PM)*
126 Ethion 563-12-2 *(PM*)*
113 {Dioxathion} 78-34-2 *(PM*)*
75 Carbaryl 63-25-2 *(PM*)*
19 Dinocap 39300-45-3 *(PM)*
1 Dicofol (Kelthane, DTMC) 115-32-2 *(PM)*
Formetanate Hydrochloride (Carzol) ◁
Petroleum Oils
Tetradifon, Tedion ▽
Cryolite (Kryocide) *(I)*

I- 5 Insecticides/Nematicides
Vegetables

235 Rotenone 83-79-4 *(PM)*
214 Phosphamidon 297-99-4 *(PM)*
212 Phorate 298-02 *(PM*)*
195 Oxamyl 2135-22-0 *(PM)*
187 Oxydemeton-Methyl (Metasystox-R) 301-12-2 *(PM)*
183 Disulfoton (Disyston) 298-04-4 *(PM*)*
173 Naled 300-76-5 *(PM*)*
158 Methoxychlor 72-43-5 *(PM*)*
154 Methamidophos 10265-92-6 *(PM*)*
150 Malathion 121-75-5 *(PM*)*
127 Ethoprop 13194-48-4 *(PM)*
122 Endosulfan 115-29-7 *(PM)*
107 Parathion Methyl 298-00-0 *(PM*)*
101 {Ethylan (Perthane)} 72-56-0 *(PM)*
94 {Demeton (Systox)} 8065-48-3 *(PM)*
90 Fenvalerate (Pydrin) 51630-58-1 *(PM*)*
55 Aldicarb 116-06-3 *(PM*)*
22 Mevinphos (Phosdrin) 7786-34-7 *(PM*)*
Chitin (Clandosan 618)
Cryolite (Kryocide)
Cyromazine (Larvadex Premix)
Flucythrinate (Pay Off)
Nicotine
Nicotine Sulfate
Pirimicarb (Pirimor)

Pirimiphos Methyl (Actellic) ▵
Pirimiphos-ethyl (Primicid) ▵
Biological Pesticides
{Sabadilla} *(B)*
Bacillus Thuringiensis (Cutlass) *(B)*
Bacillus Thuringiensis Tenebrionis (Trident) *(B)*
Ryanodine (Ryania) *(B)*

I- 6 Insecticides
Livestock and domestic animals

234 {Ronnel} 299-84-3 *(PM)*
232 Pyrethrum *(PM)*
230 Pyrethrins *(PM)*
220 KN Methyl *(PM*)*
210 Penothiazine *(PM)*
181 Coumaphos (Co-Ral) 56-72-4 *(PM)*
147 Lindane 58-89-9 *(PM)*
131 Famphur 52-85-7 *(PM)*
116 Diphenylamine 122-39-4 *(PM)*
109 Crotoxyphos (Ciodrin) 7700-17-6 *(PM)*
84 Tetrachlorvinphos (Stirofos, Gardona, Rabon) 961-11-5 *(PM*)*
64 Benzyl Benzoate 120-51-4 *(PM)*
59 Amitraz 33089-61-1 *(PM)*
24 Chlorfenvinphos (Supona) 470-90-6 *(PM)*
12 DDVP, Dichlorvos (Vapona) 62-73-7 *(PM*)*
Bomyl ▵
Butonate ▽
Crufomate (Ruelene) ▽
Tabutrex ▽
Organic Pesticides
{Benzene} *(O)*
Bone Oil (Dippel's Oil) *(O)*
Butoxy Polypropylene Glycol (Stabilene, Crag Fly Repellant) *(O)*
Diisobutyl Phenoxyethanol *(O)*
Linseed Oil *(O)*
Muscalure *(O)*
Piperazine Dihydrochloride *(O)*

I- 7 Insecticides
For use as insect repellants at non-agricultural sites

171 Deet 134-62-3 *(PM)*
117 MGK 326 136-45-8 *(PM)*
Citronella, Oil of {Indalone, Dihydropyrone} Camphor
Fish Oil (Fruit Builders Oil)
Organic Pesticides
Ethyl Hexanediol (Turgers 612) *(O)*
{Benzaldehyde} *(O)*

N-Butylacetanilide *(O)*

I- 8 Insecticides
Domestic bug control and in food processing plants

271 Tetramethrin 7696-12-0 *(PM)*
270 D-Phenothrin (Sumithrin) *(PM)*
233 Resmethrin 10453-86-8*(PM)*
232 Pyrethrum 8003-34-7 *(PM)*
231 Pyrethrin II 121-29-9 *(PM*)*
230 Pyrethrin I 121-21-1 *(PM*)*
229 Pyrethrin Coils *(PM)*
202 Para-Dichlorobenzene 106-467
201 Propoxur (Baygon) 114-26-1 *(PM)*
177 MGK Repellant 264 113-48-4 *(PM)*
173 Naled 300-76-5 *(PM*)*
150 Malathion 121-75-5 *(PM*)*
103 Diazinon (Diazitol, Basudin, Dipofene) 333-41-5 *(PM*)*
85 Chlorpyrifos-Methyl 5598-13-0 *(PM)*
65 {Lethane 384} 122-56-1 *(PM)*
65 Lethane 60 301-11-1 *(PM)*
61 Bendiocarb 22781-23-3 *(PM)*
57 Allethrin 584-79-2 *(PM)*
{Isobornyl Thiocyanoacetate (Thanite)}
{Mitin FF}
Bagworm
Chloroethyl Ether
Hydramethylnon (Amdro)
Hydroprene (Altozar)
Isothymyl
MGK Repellant 874 (2-Hydroxyethyl Octyl Sulfide)
N-Ethyl Perfluorooctane
Periplanone-B
Propetamphos
Sulfluramid/GX-071
Inorganic Pesticides
Ammonium Fluosilicate (Dri-Die) *(I)*
Boric Acid *(I)*
Silica Gel *(I)*
Silicon Dioxide *(I)*
Sodium Fluoride (Florocid) *(I)*
Sodium Fluosilicate *(I)*
Zinc Fluosilicate *(I)*
Organic Pesticides
Ethylene Glycol Ether of Pinene (DHS Activator) *(O)*
Napthalene *(O)*

I- 9 Insecticides
Fumigants and nematicides

243 Metam-Sodium (Vapam) 13742-8 *(PM*)*
179 {Sulfotep (Bladafum)} 3689-24-5 *(PM)*
160 Methyl Bromide 74-83-9 *(PM)*
128 Fenamiphos (Nemacur) 22224-92-6 *(PM)*
97 [DBCP, Dibromochloropropane Nematocide] 96-12-8 *(PM)*
81 Chloropicrin 76-06-2 *(PM)*
5 1,3-Dichloropropene 542-75-6 *(PM)*
3 [Ethylene dibromide] 106-93-4 *(PM)*
{Diamidofos (Nellite)}
{Dichloropropane, Propylene Dichloride}
{Fosthietan (Nem-a-Tak)}
Aldoxycarb (Standek)
Carbon Tetrathiocarbonate
Chitin (Clandosan 618)
Isazophos (Triumph, Miral)
Paraformaldehyde
Organic Pesticides
Chloroform *(O)*
Epichlorohydrin *(O)*
Ethyl Formate *(O)*
Ethylene Oxide *(O)*
Ethylene Dichloride, EDC *(O)*
<Perchloroethylene, Tetrachloroethylene> *(O)*
Methylene Chloride *(O)*
Propylene Oxide *(O)*
[Carbon Tetrachloride] *(O)*
Inorganic Pesticides
Aluminum Phosphide (Phostoxin) *(I)*
{Hydrogen Cyanide, Hydrocyanic Acid} *(I)*
Calcium Cyanide (Cyanogas) *(I)*

I-10 Insecticides for termite control

198 Sulprofos Oxon *(PM)*
143 Isofenphos 25311-71-1 *(PM)*
140 [Heptachlor] 76-44-8 *(PM*)*
86 Chlorpyrifos 2921-88-2 *(PM*)*
79 [Chlordane] 57-74-9 *(PM)*
Azadirachtin (Margosan-o-Concentrate) *(B)*
[Aldrin]
[Dieldrin]
Sulfuryl Fluoride (Vikane) *(I)*

I-11 Insecticides/Nematicides Lawns, ornamental and forest trees

184 Fenitrothion 122-14-5 *(PM)*
180 {Aspon} 3244-90-4 *(PM)*
166 {Mexacarbate} 315-18-4 *(PM)*

143 Isofenphos 25311-71-1 *(PM)*
103 Diazinon (Diazitol, Basudin, Dipofene) 333-41-5 *(PM*)*
93 Dienochlor (Pentac, Pentac Aquaflow) 2227-17-0 *(PM)*
77 Carbosulfan (Advantage) 55285-14-8 *(PM)*
48 {Aminocarb (Maticil)} 2032-59-9 *(PM)*
{Bromophos (Nexion)}
{Kinoprene (Enstar)}
Dichlofenthion (Mobilawn) ▵
Dispalure *(O)*
Fluvalinate (Mavrik)
Methyl Eugenol
Biological Pesticides
Bacillus Popillae and B-Lentimorbus *(B)*
Gypchek *(B)*
N-Trap Elm Bark Beetle *(B)*
Nuclear Polyhedrosis Virus of Douglas Fir Russock Moth *(B)*

I-12 Insecticides
For use as mosquito larvacides

253 Temophos 3383-96-8 *(PM)*
157 Methoprene 40596-69-8 *(PM)*
133 Fenthion 55-38-9 *(PM*)*
38 {Landrin I} 2686-99-9 *(PM)*
Arosurf MSF
BT, Butrizol ▷, very low production 1987-88
Dimethrin ▽
Fenoxycarb
Kerosene
Copper Acetoarsenite (Paris Green) *(I)*

I-13 Insecticides
Miscellaneous

{Mobam}
Abamectin (Affirm, Avid)
Clofentizine (Apollo)
Dimetilan (Snip) ▽
Hesythiazox (Savey)
Luretape
Methyl Trithion
Pine Tar
Pro-Drone
[DDT]
Biological Pesticides
Hirsutella Thompsonii (Mycarl) *(B)*
Nosema Locustae Canning (Noloc) *(B)*
Inorganic Pesticides
Lead Arsenate, Basic *(I)*

Lead Arsenate, Acid *(I)*
Potassium Nitrate (Saltpeter) *(I)*
Sodium Arsenate *(I)*

R- 1 Industrial preservatives
Non-public health products used to control algae growth, odor causing bacteria, bacteria causing spoilage, deterioration or fouling of materials.
Plastics, paints, textiles, paper and adhesives.

191 Organo-Mercury *(SB)*
137 Folpet 133-07-3 *(PM)*
88 Copper 8 Quinolinolate 10380-28-6 24*(SB)*
42 Polyphase *(PM)*
11 Dichlorophene 97-23-4 *(PM)*
6 Thenarsazine oxide *(SB)*
Amical
Biobor
Biomet 4
Cetyl Pyridinium Bromide
Fluorosalan v
Mercaptobenzothiazole
Nvosept 95
Pharmaceuticals
Terramycin *(P)*
Phenolics
2-Chlorophenol *(O)*
2,4,5-Trichlorophenol *(O)*
Quaternary Ammonium Compounds
Dodecyl Dimethyl Benzyl Ammonium Chloride
Trans-1,2-bis (Propylsulfonyl) Ethylene
Vancide TH
Vinyzene *(O)*
Visco P-25-F4
[Onyxide]

R- 2 Slimicides
Generally have non public health uses
For use in pulp and paper, cooling towers and sugar mills

259 Dazomet, DMTT (busamid, Mylome, Nefusan) 533-74-4 *(PM*)*
241 Sodium Dimethyl Dithiocarbamate 128-04-1 *(PM*)*
221 {Metasol J-26} 12002-57-2 *(PM)*
219 Busan 40 *(PM*)*
217 Busan 77 *(PM)*
172 Nabam 142-59-6 *(PM*)*
163 Nalco D-2303 *(PM)*
118 Nabonate *(PM*)*
89 Copper EDTA *(SB)*

71 Giv-gard *(PM)*
33 Belclene 310 *(PM)*
21 Busan 90 *(PM)*
1,4-Bis bromoacetoxy)-2-Butene
2,3-Dibromopropionaldehyde (O)
2,4,6 Trichlorophenol
2,6-Bis [(Dimethylamino Methyl] Cyclohexanone *(O)*
3,3,4,4-Tetrachlorotetrahydrothiophene 1,2-dioxide
4-Bromoacetoxymethyl-M-Dioxolane
Bis (Trichloromethyl) Sulfone
Chlorinated Levulinic Acids
Methyl-2-3-Dibromopropionate
Slimitrole
Sulfonated Cresol
XD-1603 (2,2-Dibromo-3-Nitrilopropionamide)
Inorganic Pesticides
Potassium Chromate *(I)*
Sodium Chromate *(I)*

R- 3 Industrial Microbiocides
Cutting oils and oil well additives

28 Octhilinone *(PM)*
Bioban 1487
Busan 1024
CIS-2-Pinanolu
Grotan
Metronidazoleu
Polyethylene Polyamine N-Oleylamine
R-32104

R- 4 Sanitizers
For use in dairies, food processing, restaurants and air treatment

162 Hyamine 2389 *(PM)*
159 Methyl Benzethonium Chloride *(PM)*
105 Hyamine 1622 121-54-0 *(PM)*
56 Hyamine 3500 68424-85-1 *(PM)*
51 Oxine-Sulfate*(PM)*
36 HAE *(PM)*
3,5-Dibromosalicylanilide
4,5-Dibromosalicylanilide
Alkyl Bis (2-Hydroxyethyl) Sodium
Neomycin *(P)*
Oley Trimethyl Ammonium Chloride (Aliquat 21)
Quaternary Ammonium Compounds
Benzalkonium Chloride (BTC)
Inorganic Pesticides
Ammonium Acetate *(I)*

Carbonates: Mg, K, Am, Na *(I)*
HCL *(I)*
Magnesium Silicate *(I)*
Potassium Bromide *(I)*
Potassium Hydroxide *(I)*
Sodium Bisulfite *(I)*
Sodium Bisulfate *(I)*
Sodium Hydroxide *(I)*

Organic Pesticides
Butanoic Anhydride *(O)*
N-Laurel Diethylenetriamin *(O)*
Phenolics
Ortho-benzyl-para-chlorophenol
Ortho-Phenylphenol
Phenol *(O)*

R- 5 Synergists
Used as insecticide synergists, surfactants, chelating agents and carriers

244 {Sulfoxide} 120-62-7 *(PM)*
216 Piperonyl Butoxide 51-03-6 *(PM)*
Arbanol Dee ▽
Biological Pesticides
Bacillus Thuringiensis var Kurstaki
Kurstaki (EG 2348) *(B)*
Kurstaki (EG 2371) *(B)*
Heliotropin (Tropital) ▽
N-Propyl Isome, Propyl Isome
Pentasodium Diethylenetriamine
Sesame Oil (Nematrol)
Turkey Red Oil (Sulfonated Castor Oil)
Inorganic Pesticides
Calcium Sulfate *(I)*
Pentaacetate *(I)*

R- 6 Food preservatives
Food

Organic Pesticides
Acetic Acid *(O)* (Vinegar)
Benzoic Acid *(O)*
Methyl P-Hydroxybenzoate *(O)*
Sorbic Acid *(O)*
Proxel ▽

R- 7 Wood Preservatives
For industrial commercial and marine use

258 (Tetrachlorophenol (Dowicide)) 25167-83-3 *(PM)*
206 PCP, Pentachlorphenol 131-52-2
190 Organo-Copper *(SB)*
188 Organo-Arsenic *(SB)*
Chromic Acid
Cobalt Naphthenate
Inorganic Pesticides
Ammonium Arsenite *(I)*
Arsenic Pentoxide *(I)*
Calcium Arsenate *(I)*
Coal Tar Oils; Tar; Coal Tar Creosote Oils; Coal Tar Distilates; Creosote *(I)*
Potassium Bifluoride *(I)*
Sodium Pyroarsenate *(I)*
Sodium Arsenite *(I)*

R- 8 Disinfectants

Medical, industrial, institutional, household, veterinary, poultry and livestock

The term disinfectants refers to several types of antimicrobial pesticides which are intended to destroy microorganisms (bacteria, fungi, viruses). They are public health products and may require efficacy testing. They fall into two main categories:

R-8a Sporicidal Disinfectants - Also known as sterilizers. They destroy or eliminate all forms of bacteria, fungi and viruses and their spores. This group can be further divided according to whether they are applied to critical or non critical surfaces. Hospital as well as other uses.

Chlorine Dioxide
Other Chlorine releasing agents
Ethelene Oxide
Formaldehyde *(O)*
Glutaraldehyde *(O)* (Cidex, Glutarex, Sonacide; Sporicidin) also used in the Leather Tanning Industry
Ozone
Peracetic acid (decomposes to hydrogen peroxide, acetic acid, and oxygen. More potent than Hydrogen Peroxide.
Peroxygen - Hydrogen Peroxide *(I)*

R-8b - Non sporicidal Disinfectants. May be sporoststic (prevent spore germination or outgrowth or both). These disinfectants destroy or irreversibly inactivate (all, many, some) infectious or other undesirable organisms, but not necessarily their spores.

3,4,5-Tribromosalicylanilide
4-Tert-Amylphenol
Alcohol (ethyl, isopropyl) Also an anticeptic
Aldehydes (other than Glutaraldehyde, e.g. malonaldehyde, succinaldehyde; adipaldehyde)
Alkyl (5-Hydroxy-4-Oxo-2(4H) Pyranyl Methyl)
Bigvanides
Chlorhexidine
Chlorhexidine diacetate
Calcium Hypochlorite *(I)* (Dairy Industry)

Chlorine-B
Furfural *(O)*
Gluconic Acid
Hexahydro-1,3,5-Tris (2-Hydroxypropyl)-S-Triazine ◁
Idophors, also have anticeptic uses
Iodine Compounds
N-Alkyl-N-Ethyl Morpholinium Ethyl Sulfate
Paraformaldehyde (Gas, Farm Uses)
Uniquat CB 50
Organic Pesticides
Phenolics
O-Benzyl-p-Chlorophenol; Ortho-benzyl-para-chlorophenol
211 Ortho-phenylphenol *(PM)*
Propylene Glycol *(O)*
Quaternary Ammonium Compounds - Used on non-critical surfaces.
Alkyl Bis (Hydroxyethyl) Methyl Ammonium Chloride
Dimethyl Ammonium Chloride
Didecyl Decyl Dimethyl Ammonium Chloride
Didecyl Dimethyl Ammonium Chloride
Octyl Decyl Dimethyl Ammonium Chloride

R- 9 Water disinfection - Public Health Uses
Swimming pools. sewage effluents and potable water

Chlorinated Glycorulil
Chlorine
EPIC Liquid Algacide
Inorganic Pesticides
Aluminum Sulfate *(I)*
Calcium Hypochlorite *(I)*
Chlorinated Isocyanurates *(I)*
Chlorine Dioxide *(I)*
Silver *(I)*
Sodium Persulfate *(I)*
Sodium Bromide *(I)*
Quateranary ammonium compounds
Dialkyl Methyl Benzyl Ammonium Chloride

R-10 Plant regulators, defoliants and desiccants
All uses

263 Folex 150-50-5 *(PM)*
236 Tribufos (DEF) 013071-79-9 *(PM*)*
153 Mefluidide 53780-36-2 *(PM)*
145 Propham (IPC) 122-42-9 *(PM)*
72 Cacodylic Acid 75-60-5 *(SB)*
50 Ethoxyquin 91-53-2 *(PM)*
46 CPA (Fruitone) *(PM)*
2 Maleic Hydrazide 123-33-1 *(PM)*

Acoel
Ancymidol
Baguacil
Chloroflurenol
Cycocel
Daminozide
Ethephon
Fluoridamid
Fosamine Ammonium
Indole-3-Butyric Acid
Marstat PN
Mon 4620
Nibroxane
Paclobutrazol (Clipper)
Requat
Sherichem DM
Sodium Chlorate
Thidiazuron
Triacantanol (Triacon)
YEA, Chitosan
Inorganic Pesticides
    Arsenic Acid *(I)*
    Sulfuric Acid *(I)*
Organic Pesticides
    Fatty Alcohols *(O)*
    Octanol (Antak; Flair 85, Offshoot) *(O)*
    {TIBA} *(O)*
    Ethylene *(O)*
    Gibberellic Acid *(O)*
    Hexachloroacetone *(O)*
    Methyl Esters of Fatty Acids *(O)*
    NAA, 1-Naphthalenacetic Acid *(O)*

R-11 Preservatives, disinfectants, slimicides

211 {Phenylphenol (Orthoxenol)} 90-43-7 *(PM)*
7 Dowicil 75 *(PM)*
Dowicil A-40 (2,3,5-Trichloro-4-(Propylsulfonul pyridine)
Nitrapyrin
Omadine-Sodium
Inorganic Pesticides
    Chromic Acid *(I)*
    Lime *(I)*
    Potassium Permanganate *(I)*
    Potassium Iodate *(I)*
Organic Pesticides
    Abietylamine *(O)*
    Chlorobenzene *(O)*
    Hexylene Glycol *(O)*

Phenolics
    Dowicide 31 and 32 (4 and 6-Chloro-2-Phenylphenol)

R-12 Molluscides and Misc. Vertebrate control agents
All uses

192 Organo-tin *(PM*)*
40 Mercaprodimethur, Methiocarb 2032-65-7 *(PM)*
Lamprecid
Magnesium Sulphate (Epsom Salts) *(I)*
Niclosamide (Bayluscide, Bayluscid)
Stirrup M *(O)*

R-13 Bird Chemosterilants, toxicants and repellants
All uses

Ornitrol
Paloja
Inorganic Pesticides
    Copper Oxalate *(I)*
    Zinc Oxide *(I)*
Organic Pesticides
    1,4-benzoquinone (Quinone) *(O)*
    4-Aminopyridine (Avitrol) *(O)*
    Polybutene *(O)*
    Polyethylene *(O)*
    Polyisobutylene *(O)*

R-14 Dog/Cat Repellants
All uses

Ammonium benzoate (Bitrex)
Benzyl diethyl 2,6-xylylcarbamoylmethyl
Blood
Capsaicin
Citral
Citrus Oil
Cresylic Acid
Geranium Oil
Hefty Dog and Cat Repellant
Trichloroethylene
Organic Pesticides
    Allyl Isothiocyanate (Mustard Oil) *(O)*
    Anethole (anise camphor) Cinnamic Aldehyde *(O)*
    Methyl Nonyl Ketone *(O)*
    Pentanethiol *(O)*
    Pyridine *(O)*

Thymol *(P)*

R-15 Rodent toxicants, anticoagulants, predator control
For all uses

265 Warfarin 81-81-2 *(PM)*
242 {Sodium Fluoroacetate, 1080} 62-74-8 *(PM)*
136 [Fluoroacetamide] 144-49-0 *(PM)*
114 Diphacinone 82-66-6 *(PM)*
43 {Fumarin (Bromethalin)} 117-52-2 *(PM)*
37 Chlorophacinone 3691-35-8 *(PM)*
29 Pindone (Pival) 83-26-1 *(PM)*
2-Isovaleryl-1,3-Indandione, Calcium Salt
Alpha-Naphthylthiourea (Antu) *(O)*
Brodifacoum (Talon)
Bromadiolone (Maki)
Bromethalin Bait PAI 43 ???
Phorazetim (Gophacide)
PMP (Valone)
R-55 (tert-butyl dimethyltrithioperoxycarbamate)
Red Squill *(B)*
Strychnine
Strychnine Sulfate
Inorganic Pesticides
Phosphorus *(I)*
Sodium Cynanide *(I)*
Zinc Phosphide *(I)*
Pharmaceutical Pesticides
Cholecalciferol (Quintox)*(P)*
Epibloc *(P)*

U- 1 Unclassified

266 Zetax (Zine MBT) *(PM)*
218 Arylane (Busan 85) *(PM*)*
189 Organo-Cadmium (none registered) *(SB)*
139 {Glyphosine (Polaris)} 2439-99-8 *(PM)*
10 Tetrachlorophene *(PM)*

Appendix C
Methodology for Estimating the Price Elasticity of Demand for Pesticide Clusters

This appendix provides the complete methodology for estimating the price elasticity of demand for pesticide clusters. The price elasticity of demand is used in the EIA to predict the change in demand given an increase in PAI price due to compliance with the proposed effluent guidelines (See Chapter 4 and Appendix F). This methodology is identical to that used in the *Economic Impact Analysis of Final Effluent Limitations Guidelines and Standards for the Pesticide Manufacturing Industry*.

ESTIMATES OF THE PRICE ELASTICITY OF DEMAND FOR PESTICIDE CLUSTERS

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1.0 INTRODUCTION

Purpose of the Analysis

Abt Associates has submitted a draft economic impact assessment (EIA) methodology for assessing the costs of new effluent guidelines for the pesticide industry. The draft EIA methodology relies on the use of price elasticities of demand for pesticide clusters. In this memorandum, demand elasticities for each cluster are estimated based on a review of empirical analyses, the elasticity of demand for food commodities, and a consideration of the factors predicted by microeconomic theory to influence elasticity of demand.

Definition of the Price Elasticity of Demand

In general, the economic concept of elasticity measures the sensitivity of the dependent variable to a change in the value of an independent variable. In particular, the price elasticity of demand measures the sensitivity of consumers to changes in price. (Since this is the elasticity measure of concern for this report we may, for convenience, use the term 'demand elasticity' in place of the term 'price elasticity of demand'.)

The price elasticity of demand estimates the degree to which a change in price results in a change in the quantity demanded. It can be defined as the percentage change in demand divided by the percentage change in price. If consumers cut back their purchases to such a large extent that any price increase reduces total revenue, then demand is said to be elastic, i.e., customers are sensitive to price changes. If consumers cut back their purchases only slightly in response to higher prices, resulting in an increase in revenue, demand is said to be inelastic, i.e., customers are not as sensitive to price changes. The value of the price elasticity of demand is unbounded and may be positive or negative. It is expected, however, that price and demand are negatively correlated, i.e., an increase in price results in a decrease in the quantity demanded. The price elasticity of demand is therefore usually negative.

Four possible values, or ranges of values, of the price elasticity of demand are of particular interest. First, if the absolute value of the elasticity of demand is greater than one, demand is termed elastic. In other words, the percentage change in demand is greater than the percentage change in price. Second, demand is said to be inelastic when the absolute value of the elasticity of demand is less than one but greater than zero. Third, if the value of the elasticity of demand is zero, demand is said to be perfectly inelastic. That is, consumers will continue to purchase a given quantity of a good, despite any changes in price. Finally, if demand and price change by equal percentages, the value of the demand elasticity is exactly one, and demand is said to have unit elasticity. Numeric values are generally expressed relative to

a one percent change in price. For example, an elasticity of -1.5 means that a 1 percent increase in price would result in a 1.5 percent decrease in the quantity demanded.

Measurements of the price elasticity of demand are of use in predicting the incidence of a price increase. As the absolute value of the price elasticity rises, the proportion of the cost increase that can be passed on to consumers declines. If demand is perfectly elastic, no cost pass through is possible.

Market Definition

In order to estimate the price elasticity of demand for pesticides, a clear definition of the markets of concern must be developed. In this analysis, the markets are defined to be 44 separate clusters of pesticides. The clusters are groups of pesticide active ingredients which are close substitutes for a given end-use. For example, insecticides used on vegetables is one of the clusters; herbicides used on turf is another.

The elasticity of demand for pesticides may vary significantly between the clusters, since each cluster faces different market forces. In particular, a distinction may be drawn between the agricultural end-uses and the non-agricultural end-uses. Agricultural sales represent approximately 70 percent of the total expenditures for conventional pesticides in the U.S., with the remainder split about equally between commercial and domestic sales (U.S. EPA, 1988). In contrast to the non-agricultural markets, the basic market structure within which fungicides, herbicides, and insecticides are used agriculturally is somewhat consistent across users and some documentation is available by which to estimate the elasticity of demand. The price elasticity of demand for pesticides used agriculturally will be analyzed first, followed by a discussion of the elasticity of demand for pesticides used in the non-agricultural sector.

2.0 PRICE ELASTICITY OF DEMAND FOR AGRICULTURAL PESTICIDES

Within the agricultural pesticide market there exist several industry sectors including manufacturers, formulators and packagers, distributors, and retailers of pesticides. The primary goal of this analysis is to estimate the elasticity of demand faced by the manufacturers of the active ingredients. However, most studies consider the demand elasticity of the end-user rather than that of the formulator/packager (usually the direct customer of manufacturers). This analysis will assume that the demand elasticity of the formulator/packager is equal to the demand elasticity of the end-user since data on formulator/packager demand elasticity were not located. Assuming competitive markets, the long-run elasticities faced by the manufacturing sector should be similar to the elasticities faced by formulators/packagers.

2.1 Methodology

There is no one recognized source of information for the price elasticity of demand for pesticides; in fact, there is an acknowledged lack of information in this area of study. Abt Associates conducted a thorough search for analyses of the price elasticity of demand for pesticides and also sought expert opinion as to the expected elasticities. The sources considered included literature searches using the following databases from Dialog Information Services: Economic Literature Index, Dissertation Abstracts Online, Agribusiness U.S.A., Agricola, Agris International, and NTIS. A search for subject matter containing the following key words was conducted: price elasticity, or demand, or demand elasticity, and agricultural, or chemical, or pesticide, or herbicide, or fungicide, or insecticide. In addition to the literature search, Abt Associates sought information from the U.S. EPA Office of Pesticide Programs, the U.S. EPA Office of Policy, Planning, and Evaluation, several offices of the U.S. Department of Agriculture, the U.S. International Trade Commission, the Chemical Specialty Manufacturers Association, the National Agricultural Chemical Association, the World Bank, Resources for the Future, the editor of the American Journal of Agricultural Economics, a market research firm, Cornell University, North Carolina State University (Dr. Gerald Carlson), Texas A&M University (Dr. Ron Lacewell), Virginia Polytechnic Institute (Professor George Norton), Iowa State University, Stanford University (Dr. Sandra Archibald), the University of Massachusetts (Professor Joe Moffitt), the University of Arkansas (Professor Mark Cochran), and Harvard University.

The literature search and conversations with the listed expert sources indicated that studies of the price elasticity of demand for pesticides are sparse, and that the existing analyses offer conflicting conclusions and are often controversial. Further, an attempt at compiling expert opinions as to expected elasticities failed; the lack of available research on this issue precluded compact, ready answers that could

be conveyed by telephone. In order to develop the elasticity estimates, Abt Associates developed a five-pronged approach.

First, as described in Section 2.2, Abt Associates considered the relevant empirical studies. Though these studies do not comprehensively answer the question at hand for reasons that are presented below, they do provide estimates of demand elasticity for selected clusters. The second input, and the main source of data from which pesticide elasticities are derived in this analysis, is U.S. Department of Agriculture's (U.S.D.A.) analysis of the price elasticity of demand for food commodities (U.S.D.A., 1985, 1989). The elasticity of demand for farm inputs can be derived from the elasticity of the demand for farm commodities since demand for production inputs must ultimately reflect demand for the end product. Though the two elasticities may not correspond exactly, the elasticity of demand for the food commodities can serve as a reasonable proxy for the elasticity of demand for pesticides in the absence of more relevant data. U.S.D.A.'s estimates of elasticity and the use of these estimates for purposes of this analysis are discussed in Section 2.3.

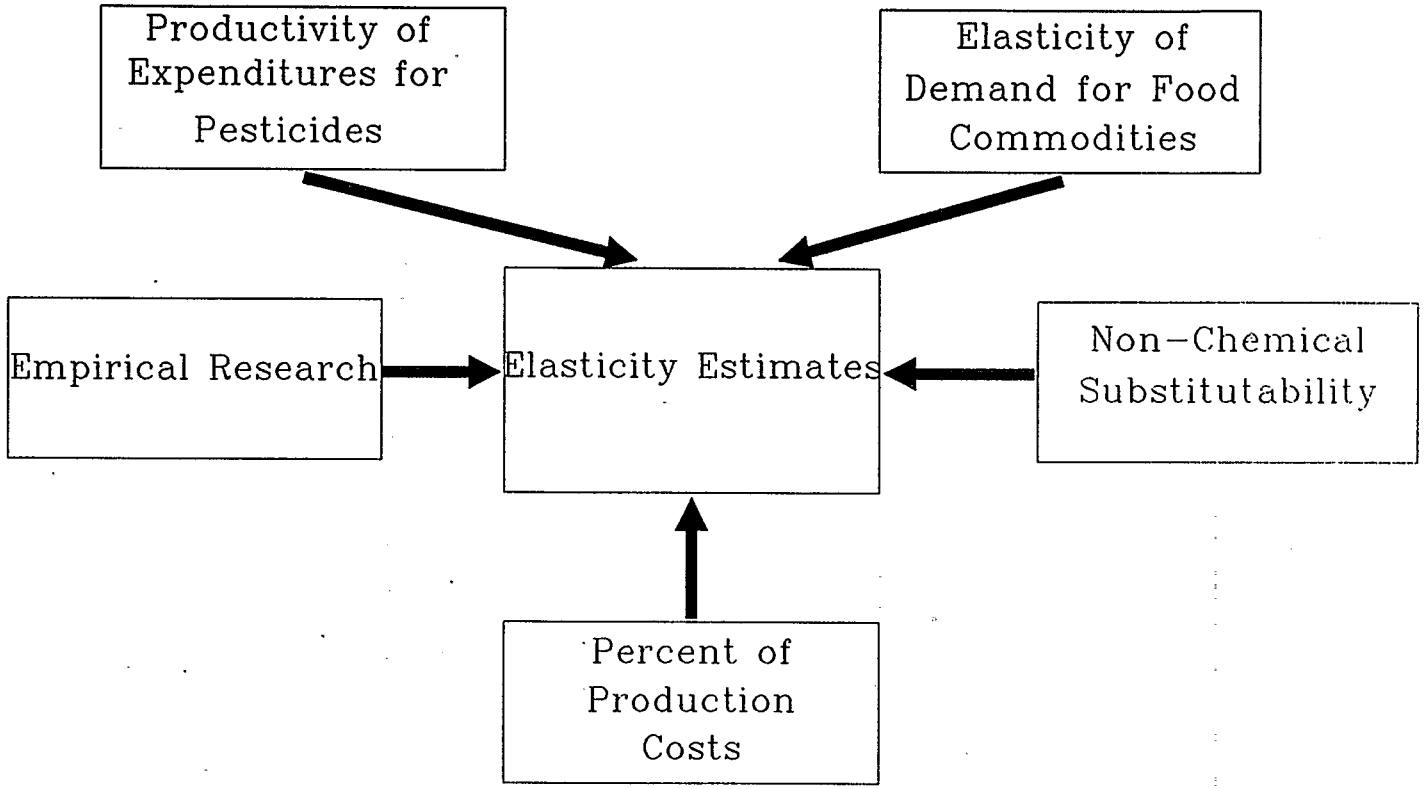
The other three factors used to estimate the elasticity of demand for pesticides are (1) the feasibility of employing non-chemical or non-biological pest control methods, (2) the percent of production cost contributed by the pesticide of interest, and (3) the productivity of expenditures for pesticides. Section 2.4 groups pesticide clusters based on the feasibility of substituting another pest control method for chemical and biological pesticides. The greater the feasibility of substitution, the higher the expected price elasticity of demand. Since the clusters group chemical and biological substitutes, the potential substitutes for a cluster of pesticides are cultural or environmental control technologies, such as crop rotation or the introduction of predatory insects. The rankings of the feasibility of non-chemical substitution for a cluster of pesticides are based on Pimentel et al. (1991).

The analysis of pesticide contribution to the cost of production of a commodity is based on U.S.D.A.'s published estimates of the cost of production in the farm sector (U.S.D.A., 1989a, 1989b, 1988). The greater the contribution to the cost of production, the higher the expected price elasticity of demand. Pesticide contribution to production costs is reported in Section 2.5.

Finally, the productivity of expenditures for pesticides is examined in Section 2.6. In theory, if pesticides are highly productive (i.e., the costs of pest damage without pesticides greatly exceeds the expenses of pesticide application), a prescribed pesticide dosage will be applied regardless of some degree of price variation. In other words, if pesticides are highly productive, the demand for pesticides is likely to be inelastic.

Figure 2.1

Approach to Estimating Price Elasticity of Demand for Pesticides



Section 2.7 combines the information from the empirical studies, the elasticity of demand for food commodities, the substitutability rankings, the data on pesticide contribution to production cost, and the measures of pesticide productivity to estimate the price elasticity of demand for agricultural pesticide clusters. The U.S.D.A. estimates of the elasticity of demand for food commodities are used as the basis for the final elasticity estimates. The other factors are analyzed to determine cases in which the elasticity of demand for food commodities may vary substantially from the elasticity of demand for pesticides applied to the food commodities. In cases where there is a clear indication that the elasticity of demand for the food commodities and the elasticity of demand for the pesticides applied to the food commodities differ, the elasticity estimates are adjusted in the appropriate direction.

Precise quantification of the elasticity of demand, however, is not revealed through the examination of feasibility of substitution, contribution to costs, and productivity of the pesticides. The results only indicate whether demand for the pesticides is likely to be more or less elastic than demand for the relevant food commodities. Therefore, unless there is compelling evidence that the elasticities of demand for food and pesticides applied to food differ substantially, this analysis relies on the estimates of elasticity of demand for food commodities to represent the elasticity of demand for pesticides applied to those food commodities. It should be clear that the resulting elasticity estimates serve as indicators of the approximate magnitude of demand elasticity and not as precise quantifications of these elasticities.

2.2 Review of Empirical Studies of the Price Elasticity of Demand For Pesticides

The empirical analyses of the price elasticity of demand for pesticides can be separated into econometric analyses and other analyses. The econometric analyses of demand elasticity employ several different dependent variables. Variations in the dependent variable influence the resulting demand elasticities. In particular, the dependent variables differ in the level of aggregation of pesticides and in whether pesticides are measured in units of production or units of use.

The level of aggregation of the pesticides may influence demand elasticity by determining the number of close substitutes that are available. According to microeconomic theory, the more narrowly a product is defined, the more substitutes that are likely to be available. For example, more substitutes are available for pork chops than are available for meat.

If a product has many close substitutes, it is likely to be characterized by an elastic demand. Consumers can react to a price increase by switching products without much loss of utility. If a product has a more limited number of substitutes, consumers have little choice but to bear more of the price

increase. For chemical pesticides in general, substitutes include only labor and other non-chemical pest control methods. These are also the only substitutes for fungicides, herbicides, or insecticides since pesticides are generally effective against only either pathogens, weeds, or insects. Since the clusters used in this analysis were chosen to include all close chemical and biological substitutes for an end-use, the only pest control alternatives are non-chemical and non-biological. Substitutes for specific active ingredients, however, may include other active ingredients in addition to the non-chemical, non-biological alternatives.

For the purposes of determining the incidence of the cost increase resulting from new effluent regulations, the ideal price elasticity of demand is that corresponding to each pesticide cluster. However, few of the relevant analyses that Abt Associates located estimate elasticity of demand for clusters of pesticides. Some of the analyses reviewed in this report consider pesticides as a group as the dependent variable; other studies analyze herbicides, fungicides, and insecticides separately or study the demand elasticity for pesticides by crop. Another group looks at specific active ingredients.

In determining the elasticity of demand for clusters of active ingredients, it may at first appear reasonable to bound the elasticity of demand for clusters of pesticides by using the elasticity of demand for pesticides as a group as the lower bound and the elasticity of demand for individual active ingredients as an upper bound. Since pesticides as a group will include all clusters of pesticides, it could be argued that a cluster will exhibit an elasticity no lower than the elasticity of pesticides as a group. However, since the elasticity of pesticides as a group represents an average of the elasticities of clusters it can not serve as a boundary for any one cluster. Similarly, since the elasticities of demand for individual active ingredients within a cluster will vary, the elasticity of any one active ingredient can not act as an upper boundary for the elasticity of the cluster. For purposes of comparison, however, this analysis considers the empirical analyses in two groups: those which consider pesticides as a group and those which consider individual active ingredients.

A second major variation between the regression analyses of demand elasticities reviewed in this report is whether the dependent variable was measured in units of production (e.g., pounds produced per year) or in units of use (e.g., pounds applied per acre per year). Due to potentially significant inventories of pesticides and the dissimilar market structures of pesticide manufacturers and packagers/formulators of pesticides, units of production and use may result in different estimates of elasticity. Further, some studies defined the dependent variable in absolute terms while others used the percent of crop treated. Also, the dependent variable was alternately measured in units of expenditure (e.g., dollars) and units of quantity (e.g., pounds).

Finally, the studies differed in the specification of the model (e.g., simultaneous equations vs. single equation models, inclusion of an independent variable for labor), the time period included, and the region of the country considered. All of the factors discussed above contribute to the difficulty of comparing the empirical studies.

The results of the analyses of elasticity of demand, categorized by their definition of the dependent variable, are described below.

Aggregated dependent variable measured in units of use

Five analyses were located which estimated demand elasticity for pesticides as a group and measured the dependent variable in units of pesticide use. The studies are: Pingali and Carlson (1985), Miranowski (1980), U.S. EPA (1974), Huh (1978), and Burrows (1983). The results of these studies are conflicting. Huh reports demand for herbicides and insecticides used on corn as elastic. Contradicting this result, U.S. EPA (1974) indicates that demand for corn and soybean herbicides and corn insecticides is inelastic. Miranowski also concludes that demand for herbicides used on corn is moderately inelastic when labor is not included in the analysis. However, the price coefficient in his equation is not significantly different from negative one. When Miranowski includes labor in his model, price is insignificant, suggesting that labor is a substitute for herbicides used on corn. Miranowski did not find price to be a significant factor in predicting the level of corn insecticides used. Therefore, his model offers little further insight into the elasticity of demand for insecticides. Burrows also found pesticide price to be insignificant in explaining demand for pesticides and mitacides used on cotton. Finally, Pingali and Carlson estimate that the price elasticity of demand for insecticides and fungicides used in orchards to be significantly different from zero, but not significantly different from negative one.

Pingali and Carlson estimated price elasticity of demand as part of a larger, multidisciplinary study over the 1976-1980 period for forty-seven orchards in Henderson County, North Carolina. To analyze the effect of errors in subjective perception on the demand for pest controls, Pingali and Carlson ran a simultaneous model of pest populations and pest controls. Their model involved a five-equation system with two pest population equations (insect and disease infestation levels), two pesticide equations (insecticides and fungicides), and one pruning status or labor equation.

The variables used in the pesticide equations were obtained from input demand functions developed by Pingali and Carlson. The derived demand functions had four groups of variables: biological, input prices, risk aversion, and human capital. The levels of insecticides and fungicides were given in terms of pounds of active ingredients applied per acre of orchard. The cost per unit of insecticides and fungicides

were given in dollars per pound of active ingredients. A two-stage least squares estimate of the system resulted in a price elasticity of demand for insecticides of -1.39. The fungicide price elasticity of demand was estimated as -0.92. The elasticities of demand for both insecticides and fungicides were found to be significantly less than zero but not significantly different from negative one. The model can therefore be interpreted to confirm a negative correlation between price and demand; it does not, however, indicate with certainty whether demand is elastic or inelastic.

Miranowski (1980) considered alternative pest management systems for corn production with rising energy prices. He used historical data from U.S.D.A. agricultural regions from 1968, 1971, and 1976 to estimate derived demand equations for insecticide and herbicide treatment. Separate weighted least squares regression models for insecticide and herbicide treatment were developed as follows:

$$\ln ST_{i,h} = a_0 + a_1 \ln P_{i,h} + a_2 \ln P_f + a_3 \ln y + a_4 \ln SCA + a5 \ln RE + \ln P_l + e$$

where

$ST_{i,h}$	=	share of corn treated with insecticides (i) or herbicides (h),
$P_{i,h}$	=	price of insecticides (i) or herbicides (h),
P_f	=	price of fuel,
y	=	value of corn output per acre,
SCA	=	share of corn acres in cropland acres,
RE	=	lagged production-oriented research and extension expenditures, and
P_l	=	farm wage rate.

Miranowski obtained data on insecticide and herbicide treatment, as the share of corn acres treated, from the U.S.D.A. annual pesticide surveys for 1968, 1971, and 1976. The input price indices, $P_{i,h}$ and P_f, were derived from data in U.S.D.A.'s Agricultural Prices - Annual Summary (for 1967, 1972, 1977).

Miranowski estimated price elasticity of demand for insecticides as -0.78. However, the coefficient was not significantly different from zero. He reported results of two herbicide demand models, one with and one without the price of labor. When the price of labor is not included in the analysis, the coefficient on herbicide price, -0.75, is significantly less than zero but not significantly different from negative one. Therefore the elasticity of demand may be either elastic or inelastic, but only moderately so.

When the wage rate is held constant, the herbicide price coefficient is 0.03 and becomes insignificant. Though the results of the model with labor held constant may be consistent with inelastic demand for herbicides, the coefficient on labor is positive and significant, suggesting that labor and herbicides are substitutes. The coefficients of the price of pesticides in the two herbicide models suggest that the price of labor and the price of pesticides are co-linear. Since the coefficient for the price of herbicides becomes

insignificant when labor is included in the model, it may be the case that the labor price variable is dominating the herbicide price variable with the result that change in the dependent variable appears to be largely a function of the cost of labor rather than the price of herbicides. However, when labor is absent from the model, the coefficient of the price of pesticides probably includes some of the influence of labor rate changes. The "true" elasticity of demand is therefore likely to fall between the two coefficients of -0.78 and 0.03, still indicating inelastic demand.

Huh (1978) estimated pesticide price elasticity of demand in his doctoral dissertation. Using cross-sectional farm data from Minnesota, Huh modeled pounds of active ingredients of herbicides and insecticides used on corn per farm (Q_T). Exogenous variables included in his final aggregate demand equation were:

x_{2w} = adjusted and weighted price of pesticides (dollars per pound),

x_7 = acres of corn per farm, and

D_5 = a dummy variable for crop rotation plan (0 when farmer did not intend to plant corn again in 1978, 1 when farmer intended to plant some or all of corn in 1978).

The results of the regression analysis were as follows (standard errors are in parentheses):

$$\ln Q_T = 2.212 - \underset{(0.161)}{1.464} \ln X_{2w} + \underset{(0.064)}{1.099} \ln x_7 + \underset{(0.110)}{0.381} D_5 + e$$

The coefficient of the price of pesticides was significantly less than zero and also significantly different from negative one, indicating elastic demand. However, since an independent variable for pesticide substitutes (e.g., labor) was not included, the coefficient on pesticide price may include the effect of changes in labor or other substitute prices and therefore have a bias towards greater elasticity. Huh's model is therefore likely to overstate the elasticity of demand to an unknown degree.

As part of an analysis of farmers' attitude towards alternate crop protection methods, U.S. EPA (1974) described a survey of farmer sensitivity to pesticide price changes. Farmers in Iowa and Illinois responded to the survey as follows:

Percent of Respondents		
Iowa	Illinois	
88	82	(of corn growers) believe all of their corn acres need herbicides each year
62	56	(of corn growers) would not change herbicide use if cost doubled
55	55	(of corn insecticide users) believe all of their corn acres need insecticides
29	39	(of corn growers) believe all of their corn acres need insecticides
77	61	(of corn insecticide users) would not change insecticide use if cost doubled
96	86	(of soybean growers) believe all of their soybean acres need herbicides each year.
72	67	(of soybean growers) would not change herbicide use if cost doubled

The results indicate that the majority of farmers surveyed are insensitive to price changes. Demand for corn and soybean herbicides and corn insecticides appears to be inelastic.

The final study in this category was conducted by Burrows (1983). Burrows tested the hypothesis that integrated pest management (IPM) will significantly reduce pesticide use. He also examined the methodological issue of simultaneity between pesticide use and IPM adoption. Burrows considered only insecticides and mitacides. His data were drawn from a random sample of San Joaquin Valley cotton growers. The observations contain detailed information on output, pesticide and other input use, cost, and revenue for 47 growers spanning a 5 year period from 1970-1974.

Burrows performed a Generalized Least Squares (GLS) procedure for both single and simultaneous equation models. The dependent variable is insecticide and mitacide use measured in sales dollars per acre of cotton grown. Explanatory variables include average pesticide price per pound, an IPM consultant fee per acre, and the expected yield in pounds per acre. Weather and cultural practices are included as proxies for both the size of the pest population and pesticide persistence in the environment. A risk proxy, the ratio of acres planted in cotton to total acres, is used assuming that, for higher ratio values, risk-averse growers

will be likely to use more pesticides as insurance against crop loss. Pesticide price is a quantity-weighted price index.

In both the single and simultaneous models, pesticide prices are insignificant. Burrows explained that this may result from limited degrees of freedom (there are only ten price observations). He also offered an alternative explanation that expenditures may not be sensitive to price when conflicting sources of information - personal experience, pesticide salespersons, IPM consultants, and extension representatives - affect the decision to spray. Another potential explanation is that if the expected rate of return from pesticide use is high, price movements over a modest range would not have much explanatory value. The price elasticity determined by the single equation model is approximately unity, -0.90. The elasticity resulting from the simultaneous version of the model is -1.23. Since the coefficients were not significant, these values are inconclusive.

Aggregated dependent variable measured in units of production

An earlier version of an economic impact assessment of pesticide effluent guidelines analyzed aggregated pesticides and measured the dependent variable in units of production (U.S. EPA, 1985). U.S. EPA found that the price elasticity of demand for pesticides as a group, as well as for fungicides, herbicides, and insecticides was significant and inelastic. EPA estimated pesticide elasticity of demand based on the following log-linear function:

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

where:

$PROD_t$, $PPROD_{t-1}$	=	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 ingredient in year t
IX_t	=	Industrial production index in year t

Elasticities were calculated for herbicides, insecticides, fungicides, and all pesticides. Pesticide production rates were obtained from U.S. International Trade Commission, Synthetic Chemicals. The units of production were not given. Pesticide prices were average prices for each product group and for all pesticides and were calculated from U.S. International Trade Commission, Synthetic Chemicals and converted to real prices using the GNP Deflator. Based on this model, EPA obtained the following results:

Ln of Production of	Intercept	Ln Acres	Ln Real Price	Ln Production Previous Year	Industrial Production Index
Herbicides $R^2 = 0.98$	-12.93 (-3.51)	3.19 (4.02)	-0.67 (-2.49)	0.299 (1.88)	-0.00651 (-3.24)
Insecticides $R^2 = 0.68$	-3.49 (-1.32)	1.53 (2.90)	-0.32 (-2.51)	0.142 (0.57)	
Fungicides $R^2 = 0.35$	-1.46 (-0.47)	1.04 (2.02)	-0.35 (-2.07)	0.05 (0.18)	
All Pesticides $R^2 = 0.89$	-6.42 (-2.26)	1.88 (3.02)	-0.49 (-2.37)	9.427 (1.84)	

T-statistics are given in parentheses. The analysis indicated that demand is inelastic for each of the three pesticide groups as well as for pesticides in general. All price elasticities were significantly less than zero, and significantly lower than one in absolute value, except for the coefficient for herbicides which is not significantly different from negative one. The model, therefore, indicated that the price elasticity of demand for insecticides, fungicides, and all pesticides is inelastic. According to the model, the price elasticity of demand for herbicides is near unity, meaning that demand may be either elastic or inelastic.

The analysis suggested that the demand for herbicides is more elastic than the demand for insecticides or fungicides. EPA explained that during the 1970's herbicides experienced a large increase in application rates and the proportion of acres treated and that "the coefficient on acres in the herbicide equation reflects this". The authors also noted that "one of the reasons the amount of variation explained by the fungicide equation was so low was that a very large proportion of fungicides were used for non-agricultural purposes". The authors were unable to explain why business cycles are important for herbicides and not for the other two product groups. It should be noted that the study did not include a variable for prices of substitutes or final products. If these prices are correlated with pesticide prices, the coefficients may be biased. Finally, the authors did not identify the type of end-use (e.g., agriculture, commercial, domestic) of the pesticides included in their analysis.

Another factor that may influence the results obtained by EPA is that the dependent variable is measured by weight (pounds). This may not accurately reflect price elasticities since more effective and

expensive pesticides may be substituted for pesticides requiring higher doses to be effective. EPA acknowledged this issue, stating that 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 more powerful than conventional pesticides, thus reducing the weight of pesticides required for pest control. EPA asserted, however, that in terms of total insecticide production, these impacts are small.

Active ingredient as dependent variable; measured in units of use

The following three studies examined demand elasticity for specific pesticides and measured demand in units of use: Lacewell and Masch (1972), Carlson (1977), and Carlson (1977a). Lacewell and Masch found that the demand for the herbicide 2,4-D was inelastic. Carlson's price coefficient for 2,4-D was small and negative, but not significant, which may be consistent with price inelasticity. Carlson's significant price coefficients for insecticide active ingredients indicated that demand is elastic in both the short-run and the long-run.

Lacewell and Masch selected a five county area in the Northern High Plains of Texas as the study area to evaluate the effect of a tax vs. a marketing quota farm program on the level of chemicals used in a specific agricultural region. The primary agricultural crops of the area were grain sorghum and wheat. To control weeds in wheat and grain sorghum, herbicides, especially 2,4-D, were utilized.

Using data on land utilization for 1969, Lacewell and Masch constructed a linear programming model for the five county region. For illustrative purposes, the change in the quantity of 2,4-D used in response to changes in the price of 2,4-D was investigated. Requirements for weed control were assumed to be met by one of three weed control alternatives: (1) use of 2,4-D, (2) use of 2,4-D and dicamba, and (3) use of dicamba, other chemicals and additional tillage operations. The price of 2,4-D was increased by increments, using parametric programming, from 52 cents per pound to $37.00 per pound, at which point the model predicted no 2,4-D would be used. In response to a more marginal price increase of 78 percent (from $0.52 to $0.93 per pound), Lacewell and Masch predicted a decrease in use of 2,4-D of 30 percent. This translates to an inelastic demand of approximately -0.38.

Carlson's two articles (1977 and 1977a) used the same log-linear model to examine demand elasticities of particular herbicides and insecticides. Carlson first considered price elasticity of demand for pesticides as part of a study to determine the importance of pest resistance to insecticides in affecting demand for specific compounds. In his second article, Carlson illustrated some advantages and disadvantages of price incentive systems relative to quantity incentive systems for pollution control.

Carlson used individual farm data on insecticide use from several cotton production regions to test hypotheses of decreasing productivity of insecticides and substitutability between chemical types. His original estimation model is

$$Q_t = c_0 + c_1 R_{1t} + c_2 R_{2t} + c_3 e_t + c_4 C_t + E_t$$

where

Q_t = quantity of a given insecticide purchased in year t (pounds of actual material),
R_{1t} = insecticide price deflated by an index of all agricultural input prices,
R_{2t} = substitute insecticide price,
e_t = resistance index,
C_t = agricultural product price index, and
E_t = error term.

The agricultural product price variable, C_t, was not statistically significant and was deleted from the model. A lagged dependent variable was added to account for the assumed effects of delayed adjustments to price changes. Carlson used this model to analyze several of the largest selling groups of insecticides. The specific dependent variables and their price elasticities were as follows (standard errors appear in parentheses):

Dependent Variable	Price elasticity
(A) Domestic and foreign sales of cyclic organophosphate insecticides (1953-1970)	-1.461 (0.796)
(B) Same as (A) except divided by domestic cotton acreage planted	-1.552 (0.780)
(C) Total sales of parathion and methyl parathion (1953-1970)	-1.06 (0.273)
(D) Domestic sales of DDT (1945-1969)	-0.667 (0.397)
(E) Domestic sales of DDT (1953-1969)	-1.091 (0.625)

Insecticide price has the expected negative effect on insecticide purchases. Carlson concludes that sales of the compounds are quite responsive to price, indicating that there are many substitute pest controls in the long run. None of the coefficients, however, are significantly different from negative one, so the model indicates that elasticity of demand is unlikely to be either highly elastic or highly inelastic.

In Carlson's subsequent article (1977a) he reported a slightly different elasticity for the parathion and methyl parathion group and also includes the herbicide 2,4-D in his analysis. Further he reported long-run elasticities for DDT and 2,4-D. The results were as follows:

Dependent Variable	Price elasticity
(F) Domestic sales of parathion, methyl parathion (1953-1969)	-0.945 (0.339)
(G) Domestic sales of 2,4-D (1950-1970, except 1965-68) divided by cropland index	-0.193 (0.349)
(H) Same as (D) except long-run	-1.53
(I) Same as (G) except long-run	-0.594

The analysis indicates that the elasticity of DDT increases substantially from the short-run to the long-run, as would be expected as more substitutes may be developed with time. The coefficient for 2,4-D shows demand to be inelastic, but is insignificant. Though this result may be consistent with inelastic demand, it is inconclusive.

Active ingredient as dependent variable; measured in units of production

Abt Associates located no studies which fit this category.

Summary

Table 2.1 summarizes the empirical studies discussed above; Figure 2.2 displays the empirically-derived elasticity estimates graphically. As can be seen from Figure 2.2, elasticity estimates ranged from approximately zero to -1.5. While most estimates indicate that the demand for pesticides is relatively inelastic, the results are inconclusive. Since the studies used different models and, in particular, different dependent variables, variation in the estimates is expected. The number of studies which considered clusters of pesticides as the dependent variable was insufficient to draw reliable conclusions as to the price elasticity of demand for clusters of pesticides. However, the results of the analyses which did define the dependent variable as a cluster of pesticides will be considered in the final estimations of demand elasticities.

Table 2.1
SUMMARY OF ECONOMETRIC ANALYSES

Study	Model Type	Data Sources	Time period of study	Dependent Variable	Independent Variables	Price Coefficients (standard errors)	R square	Significantly different fro zero?	Significantly different from negative one?
Pingali and Carlson (1985)	5 equation system; Seperate least squares regressions for insecticides and fungicides; log-linear function	Study of 47 orchards in Henderson County, NC	1976-1980	Active ingredient applied per acre of orchard (lbs)	canopy rating disease density insect populations variety of trees spacing humidity temperature rainfall tree age x tree size fruit yield cost/unit insecticide cost/unit fungicide additional labor potential income variance of insect damage variance of disease damage schooling extension publications	insecticides: -1.39 (0.35) fungicides: -0.92 (0.32)		yes yes	no no
inowski (1980)	Separate least squares regressions for insecticides and herbicides; log-linear function	Historical data from USDA agricultural regions	1968,1971, and 1976	Share of corn treated with insecticides or herbicides	price of insecticides or herbicides price of fuel value of corn output per acre share of corn acres in cropland acres lagged production-oriented research and extension expenditures farm wage rate	insecticides: -0.78 (-0.53) herbicides: (wage rate constant) 0.03 (0.30) (wage rate varies) -0.75 (0.18)	0.36 0.77 0.67	no no yes	no yes no

Table 2.1 (cont.)

SUMMARY OF ECONOMETRIC ANALYSES

Study	Model Type	Data Sources	Time period of study	Dependent Variable	Independent Variables	Price Coefficients (standard errors)	R square	Significantly different fro zero?	Significantly different from negative one?
U.S. EPA (1985)	time series; log-linear function	acres - various U.S.D.A. publications real price - U.S. International Trade Commission, Synthetic Chemicals; 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.	Herbicides, Fungicides, and all pesticides: 1967-81. Insecticides: 1967-79	Production of pesticide active ingredients in year t	Acreage of principal crops planted in year t Real unit price for pesticide active ingredients in year t Industrial production index in year t Production of pesticide active ingredients in year t-1	herbicides: -0.67 (0.27) insecticides: -0.32 (0.13) fungicides: -0.35 (0.17) pesticides: -0.49 (.21)	herbicide 0.9 insecticid 0.68 fungicide 0.35 pesticide 0.89	yes yes yes yes	no yes yes yes

Table 2.1 (cont.)
SUMMARY OF ECONOMETRIC ANALYSES

Study	Model Type	Data Sources	Time period of study	Dependent Variable	Independent Variables	Price Coefficients (standard errors)	R square	Significantly different fro zero?	Significantly different from negative one?
Huh (1978)	Step-wise regression for herbicides and insecticides; log-linear function	self-designed and conducted survey of of 130 farms growing corn in Minnesota	1977	Active ingredients of herbicides and insecticides used on corn per farm (lbs)	adjusted and weighted price of pesticides (dollars per pound) acres of corn per farm dummy variable on 78 repeat corn	all herbicides and insecticides: -1.464 (.161)	0.79	yes	yes
Burrows (1983)	Simultaneous and single GLS regressions for insecticides and mitacides	Random sample of San Joaquin Valley cotton growers	1970-1974	Sales dollars per acre	Average pesticide price per pound Consultant fee expected yield farm size risk crop price IPM maximum temperature minimum temperature degree days frost days rain irrigation	single equation: -0.90 simultaneous equation: -1.23	single equation: 0.18 simultaneous equation: -0.18		no no

Table 2.1 (cont.)

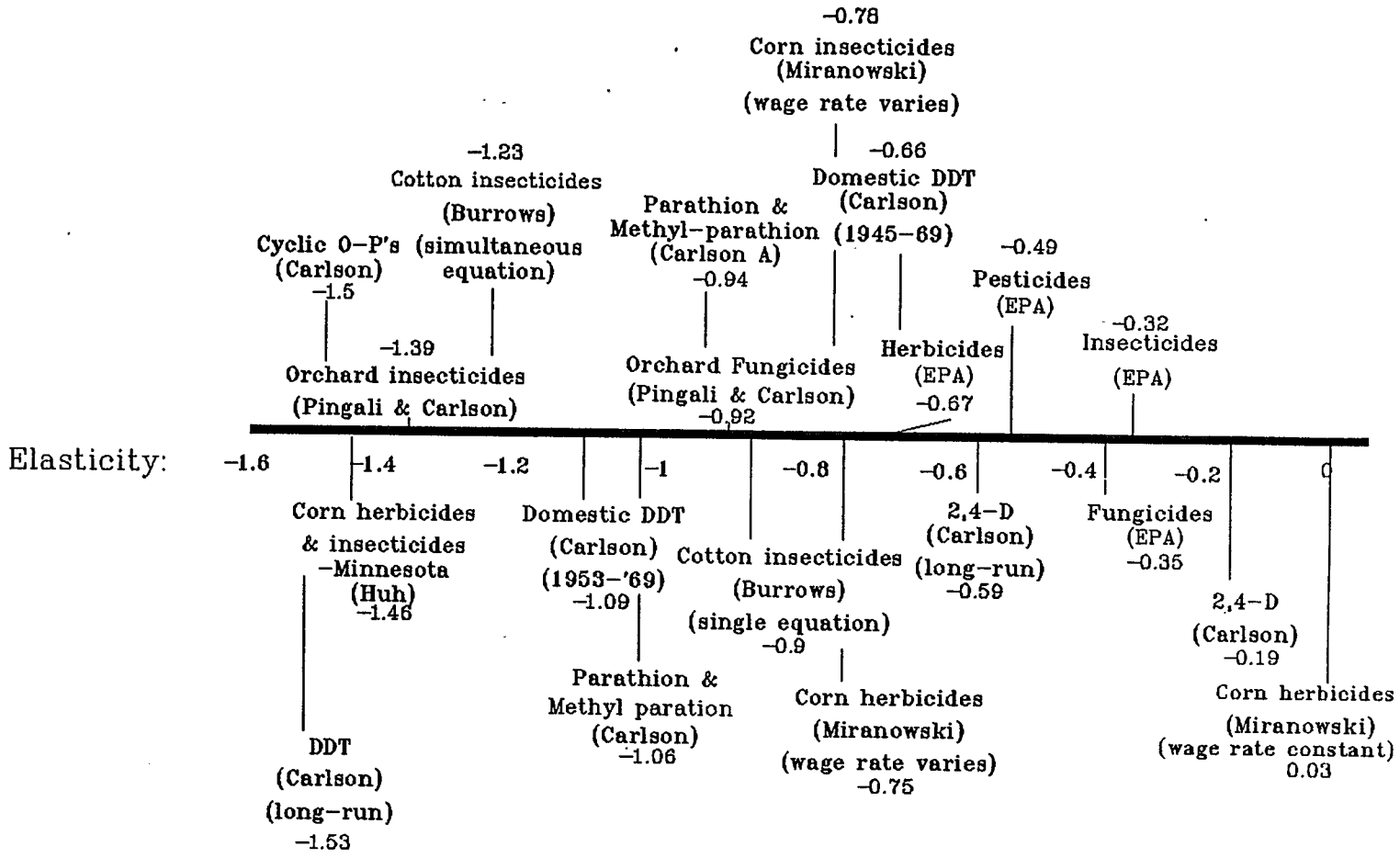
SUMMARY OF ECONOMETRIC ANALYSES

Study	Model Type	Data Sources	Time period of study	Dependent Variable	Independent Variables	Price Coefficients (standard errors)	R square	Significantly different fro zero?	Significantly different from negative one?
Carlson (1977)	log-linear function for specific active ingredients	USDA annual reports	1945-1970	Quantity of active ingredient purchased in a year (lbs):	insecticide price deflated by an index of all agricultural prices	A. -1.461 (0.796)		yes	no
				A.domestic and foreign cyclic organophosphate insecticides (1953-70)	substitute insecticide price	B. -1.552 (0.780)	0.96	yes	no
				B.same as A. except divided by domestic cotton acreage planted	resistance index	C. -1.06 (0.273)		yes	no
				C.parathion and methyl-parathion (1953-70)	agricultural product price index	D. -0.667 (0.397)		yes	no
				D.Domestic DDT (1945-69)		E. -1.091 (0.625)	0.82	yes	no
				E.Domestic DDT (1953-69)		F. -0.945 (0.339)	0.98	yes	no
				F.parathion and methyl-parathion (1953-70) (alternate estimate)		G. -0.193 (0.349)	0.81	no	yes
				G.2,4-D (1950-70 except 1965-68) divided by cropland index		H. -1.53			
				H.Same as D. except long-run		I. -0.594			
				I.Same as G. except long-run					

Figure 2.2

ELASTICITY OF DEMAND

Summary of Econometric Studies



2.3. Price Elasticity of Demand for Food Commodities

Given that the empirical analyses are insufficient to derive estimates of demand elasticity for clusters of pesticides, an alternative method of estimation of the elasticity was developed. The method used in the remainder of Section 2 of this report relies on a consideration of four factors: (1) the price elasticity of demand for food commodities, (2) the availability and relative costs of non-chemical pest management, (3) the contribution of pesticides to the variable cost of farm production, and (4) the productivity of expenditures on pesticides. Though these sources will not reveal precise quantifications of the price elasticity of demand for pesticides, they can be used to indicate whether demand for the pesticides is expected to be elastic or inelastic and to construct approximate estimates of the elasticity of demand.

Since the demand for particular inputs to a product is in part derived from demand for the end product, the demand for pesticides used in the agricultural sector will be influenced by the demand for food. The demand elasticities of food commodities, developed in this section, are used to provide initial estimates of the elasticity of demand for clusters of pesticides.

Estimates of the direct price elasticity for foods at the retail level are taken from the U.S.D.A. report entitled "U.S. Demand for Food: A Complete System of Price and Income Effects" (1985), authored by Kuo S. Huang. Using a constrained maximum likelihood method, Huang developed statistical procedures for estimating a large-scale demand system from time-series data. He then applied his procedures to an estimation of a domestic food demand system including forty food items and one non-food item. The food items, direct-price elasticities, and standard errors of the estimates are listed in Table 2.2. The estimated elasticities ranged from -0.0385 (cabbage) to -1.378 (grapes). Huang noted that an exact t-test for the statistical significance of the elasticity estimates is not applicable, given the assumptions of a maximum likelihood model. For the purposes of his analysis, Huang considered an estimate to be statistically significant if the estimated elasticity was larger than its standard error. While estimated elasticities with relatively large standard errors may imply that the estimates are not statistically precise, only four of the thirty-four commodity elasticity estimates used in this analysis had a standard error greater than the elasticity estimate (butter, other fresh fruits, carrots, and cabbage).

Huang also provided estimates of demand elasticities for the following aggregated food groups: meat, staples, fats, fruits, vegetables, processed fruits and vegetables, and desserts. The direct price elasticities he obtained were negative for all seven food categories, with magnitudes ranging from -0.08 to -0.34. For purposes of the discussion here, however, the individual food items must be reorganized to correspond to the crops included in the clusters.

Table 2.2
ESTIMATED DIRECT-PRICE ELASTICITIES
(USDA, 1985)

Commodity	Direct-Price Elasticity	Standard Error
Beef & veal	-0.6166	0.0483
Pork	-0.7297	0.0327
Other meats	-1.3712	0.2045
Chicken	-0.5308	0.0608
Turkey	-0.6797	0.1332
Eggs	-0.1452	0.0225
Cheese	-0.3319	0.1174
Fluid Milk	-0.2588	0.1205
Evaporated & Dry Milk	-0.8255	0.2642
Wheat Flour	-0.1092	0.1026
Rice	-0.1467	0.1438
Potatoes	-0.3688	0.0689
Butter	-0.167	0.1748
Apples	-0.2015	0.1469
Oranges	-0.9996	0.1465
Bananas	-0.4002	0.1334
Grapes	-1.3780	0.1829
Grapefruits	-0.2191	0.1067
Other Fresh Fruits	-0.2357	0.5471
Lettuce	-0.1371	0.0656
Tomatoes	-0.5584	0.0624
Celery	-0.2516	0.0636
Onions	-0.1964	0.0693
Carrots	-0.0388	0.1816
Cabbage	-0.0385	0.0405
Other Fresh Vegetables	-0.2102	0.1436
Fruit Juice	-0.5612	0.1006
Canned Tomatoes	-0.3811	0.1072
Canned peas	-0.6926	0.1746
Canned Fruit cocktail	-0.7323	0.3677
Dried beans, peas, & nuts	-0.1248	0.0313
Other processed Fruits & vegetable	-0.2089	0.0921
Sugar	-0.0521	0.0172
Ice Cream	-0.1212	0.0848

Source: U.S.D.A. (1985). U.S. Demand for Food: A Complete System of Price and Income Effects. By Kuo S. Huang. National Economics Division, Economic Research Service. Technical Bulletin No. 1714

To estimate an average elasticity for individual crops in a cluster, the elasticities of the included crops are weighted by the quantity of the relevant pesticide applied to that crop, as reported in Pimentel et al. (1991). This weighting factor incorporates the fact that pesticide use varies between crops; the elasticity of demand for a crop with heavy pesticide use will more greatly influence the elasticity of demand for the relevant cluster of pesticides than will the demand for a crop with low pesticide use. The resulting elasticity estimate is not a measure of the elasticity of the entire cluster of crops (unless the cluster consists of only one crop). Rather, it is a measure of the weighted average elasticity of the individual commodities in the cluster. The elasticity of the entire cluster will be lower than the average elasticity of the individual commodities due to the reduction in the number of substitutes. For example, people may easily substitute beef for pork and therefore these individual commodities may have relatively high elasticities. However, substitutes for all meats are less readily available and this category is likely to have a lower elasticity than the average elasticity of individual meats.

Since the elasticity of the demand for food commodities is assumed to represent the elasticity of demand for pesticides, this elasticity will also be overstated. The overestimation of the value of demand elasticity will likely result in an exaggerated estimate of the fraction of cost increases that is borne by the manufacturers. In the absence of more appropriate data, however, this value provides a reasonable best estimate of the demand elasticity for clusters of pesticides.

Table 2.3 displays the average elasticities for the clusters based on Huang's analysis. The elasticity estimates for the clusters represented range from -0.12 (herbicides on sugar beets, beans, and peas) to -1.38 (fungicides on grapes, herbicides on grapes, and insecticides on grapes). This range of values indicates that the demand for the food clusters varies from highly inelastic to somewhat elastic.

While the calculations for most of the clusters are straight-forward, the estimation of elasticity for the six clusters containing crops that serve as animal feed required an intermediate step. The elasticity of demand for corn, sorghum, soybeans, and alfalfa - all crops that are largely used for animal feed - was calculated from Huang's estimates of the elasticity of demand for animal food products.

An average elasticity for animal feed crops can be obtained by weighting the elasticity of each animal product by the amount of that product consumed. Huang provides "the retail weight equivalent of civilian food disappearance", a measure of consumption, for each food item. This weighting calculation yields an elasticity of demand for animal products of -0.55. However, for this weighting method to accurately reflect the elasticity of demand for feed crops, it must be true that a unit of feed yields equal units of all included animal products. This is not the case. The yield rates of dairy products and eggs are substantially higher

Table 2.3

Average Elasticities of Crops Within Clusters

Cluster	Crops	Own-Price Elasticity	Pesticide Use (millions of kgs/yr)	Percent of weight /15	Weighted Elasticity /16
fungicides on fruit & nut trees excluding oranges /1	apples	-0.20	3.50	0.27	-0.05
	grapefruit	-0.22	0.50	0.04	-0.01
	other fresh fruit	-0.24	9.14 /7	0.70	-0.16
	total		13.14	1.00	-0.23
fungicides on oranges	oranges	-1.00	1.50	1.00	-1.00
fungicides on grapes	grapes	-1.38	9.00	1.00	-1.38
fungicides on vegetables /2	lettuce	-0.14	0.04	0.01	-0.00
	tomatoes	-0.56	0.85 /8	0.15	-0.09
	canned tomatoes	-0.38	1.65 /8	0.30	-0.11
	onions	-0.20	0.20	0.04	-0.01
	carrots	-0.04	0.06	0.01	-0.00
	cabbage	-0.04	0.20	0.04	-0.00
	potatoes	-0.37	2.50	0.45	-0.17
	other fresh	-0.21	0.04 /9	0.01	-0.00
	total		5.54	1.00	-0.38
herbicides on sorghum, rice, small grains	rice	-0.15	6.00	0.46	-0.07
	sorghum	-0.69 /3	7.10	0.54	-0.37
	total		13.10 /1	1.00	-0.44

Table 2.3 (cont.)

Average Elasticities of Crops Within Clusters

Cluster	Crops	Own-Price Elasticity	Pesticide Use (millions of kgs/yr)	Percent of weight /15	Weighted Elasticity /16
herbicides on corn	corn	-0.69 /3	111.00	1.00	-0.69
herbicides on soybeans, cotton, peanuts, and alfalfa	soybeans	-0.69 /3	58.00	0.96	-0.66
	(dried beans, peas) & nut	-0.12 /4	2.50	0.04	-0.01
	alfalfa	-0.69 /3	0.10	0.00	-0.00
	total		60.60 /1	1.00	-0.67
herbicides on tree fruits (except oranges), nuts, & sugarcane /	apples	-0.20	6.00	0.89	-0.18
	grapefruit	-0.22	0.05	0.01	-0.00
	other fresh fruit	-0.24	0.51 /7	0.08	-0.02
	(dried beans, peas) & nut	-0.12 /4	0.20 /1	0.03	-0.00
	total		6.76	1.00	-0.20
herbicides on oranges	oranges	-1.00	1.70	1.00	-1.00
herbicides on grapes	grapes	-1.38	0.30	1.00	-1.38
herbicides on sugar beets, beans, & peas	canned peas	-0.69	0.05 /1	0.04	-0.03
	dried beans & peas (& nu	-0.12 /4	0.85 /1	0.65	-0.08
	sugar	-0.05 /5	0.40	0.31	-0.02
	total		1.30	1.00	-0.12

Table 2.3 (cont.)

Average Elasticities of Crops Within Clusters

Cluster	Crops	Own-Price Elasticity	Pesticide Use (millions of kgs/yr)	Percent of weight /15	Weighted Elasticity /16
herbicides on vegetables /2	lettuce	-0.14	0.06	0.04	-0.00
	tomatoes	-0.56	0.03 /8	0.02	-0.01
	canned tomatoes	-0.38	0.07 /8	0.04	-0.01
	onions	-0.20	0.40	0.23	-0.05
	carrots	-0.04	0.03	0.02	-0.00
	cabbage	-0.04	0.20	0.12	-0.00
	potatoes	-0.37	0.80	0.47	-0.17
	other fresh	-0.21	0.12 /9	0.07	-0.01
	total		1.71	1.00	-0.27
insecticides on vegetables /2	lettuce	-0.14	0.06	0.02	-0.00
	tomatoes	-0.56	0.27 /8	0.08	-0.04
	canned tomatoes	-0.38	0.53 /8	0.15	-0.06
	onions	-0.20	0.09	0.03	-0.01
	carrots	-0.04	0.02	0.01	-0.00
	cabbage	-0.04	0.40	0.12	-0.00
	potatoes	-0.37	2.00	0.59	-0.22
	other fresh	-0.21	0.04 /9	0.01	-0.00
	total		3.41	1.00	-0.33
insecticides on oranges	oranges	-1.00	8.50	1.00	-1.00
insecticides on grapes	grapes	-1.38	2.00	1.00	-1.38

Table 2.3 (cont.)

Average Elasticities of Crops Within Clusters

Cluster	Crops	Own-Price Elasticity	Pesticide Use (millions of kgs/yr)	Percent of weight /15	Weighted Elasticity /16
insecticides on soybeans, peanuts, wheat, & tobacco /17	wheat	-0.11 /6	1.00	0.15	-0.02
	(dried beans, peas) & nut	-0.12 /4	0.50	0.08	-0.01
	soybeans	-0.69 /3	5.00	0.77	-0.53
	total		6.50	1.00	-0.56
insecticides on fruit & nut trees excluding oranges & grapes /1	apples	-0.20	7.00	0.53	-0.11
	grapefruit	-0.22	3.00	0.23	-0.05
	other fresh fruit	-0.24	3.10 /7	0.24	-0.06
	(dried beans, peas, &) nu	-0.12 /4	0.02 /1	0.00	-0.00
	total		13.12	1.00	-0.21
insecticides on corn and alfalfa	corn	-0.69 /3	14.00	0.93	-0.64
	alfalfa	-0.69 /3	1.00	0.07	-0.05
	total		15.00	1.00	-0.69
insecticides on sorghum	sorghum	-0.69 /3	1.10	1.00	-0.69

Sources for Table 2.3:

Values for "own-price elasticity" were obtained from U.S.D.A. (1985).
Values for "pesticide Use" were obtained from Pimentel et al. (1991).

Notes to Table 2.3:

/1 The price elasticity of demand for bananas is not included since a separate estimate of the quantity of herbicides applied to bananas is not available. Also, fruit categories are only included if they can be assigned to a single cluster. For example, "fruit juice" is not included since it could include apple and orange juice, and therefore overlap two clusters.

/2 Vegetable categories are only included if they can be assigned to a single cluster. for example, "other processed fruits and vegetables" is not included since the category overlaps two clusters.

/3 Crop is assumed to be fed to animals. See text for explanation of elasticity estimate.

/4 The elasticity estimate is for dried beans, peas, and nuts. No separate elasticity estimates for these foods are available.

/5 The elasticity estimate for sugar does not distinguish between sugar beets and sugar cane.

/6 Elasticity estimate is for wheat flour.

/7 Includes lemons, cherries, peaches, plums, and "other fruit"

/8 According to the 1989 "Agricultural Statistics" published by the U.S. Department of Agriculture, 34 % of all tomato acreage is used to produce for the fresh market and 66% of the acreage is used to produce tomatoes for processing. Pesticide use is split between fresh and processed markets using these percentages. While this split will not be precise since production per acre and pesticide use may vary, it is used as a reasonable approximation.

/9 Includes cucumbers, peppers, sweet potatoes, and "other vegetables".

/10 The category "other grain" is excluded since elasticity estimates are not available. Use of herbicides on "other grains" is relatively minor, at 2.7 million kgs per year.

/11 Since estimates of the elasticity of cotton are not included in the U.S.D.A. report, cotton is not included in the elasticity estimate for the cluster. Herbicide use on cotton, estimate at 8.2 million kg/year, is small compared to herbicide use on soybeans. Therefore, the elasticity estimate for the cluster should not be substantially affected by the absence of an elasticity estimate for cotton.

/12 Includes pecans and "other nuts"

/13 The analysis assumes that half of herbicides used on peas are used on canned peas with the remainder used on dried peas.

/14 Includes all herbicides applied to beans and one-half of herbicides applied to peas.

/15 "Percent of Use" equals "Pesticide use on crop"/"Pesticide use on cluster"

/16 "Weighted Elasticity" equals summation of ("percent of use" multiplied by "own-price elasticity")

/17 Since estimate of the elasticity of demand for tobacco are not included in the U.S.D.A. report, tobacco is not included in the elasticity estimate for this cluster. However, since about 80 percent of the insecticides applied to crops in this cluster are applied to soybeans, peanuts, and wheat, the absence of an elasticity estimate for tobacco should not dramatically affect the elasticity estimate for the cluster.

than the yield rates of meats per unit of food. Therefore, a weighted average of the food elasticities based on consumption would be biased towards the elasticities of dairy products and eggs. That is, the elasticity values for dairy products and eggs would influence the resulting average elasticity more heavily than is appropriate.

As can be seen from Table 2.2, the elasticities of demand for dairy products and eggs are generally lower than the elasticity of demand for meats. Weighting the elasticities by consumption is therefore likely to understate the elasticity of demand for feed crops. To avoid this underestimation, the elasticity of demand for animal feed is calculated based only on the meat products. The resulting estimate of -0.69 is conservative in that it is likely to somewhat overstate the elasticity of demand for animal products, and therefore animal feed. This conservative value, however, still indicates that demand for feed crops is inelastic.

Huang's report analyzed demand elasticity for foods at the retail level. U.S.D.A. has also analyzed the elasticity of demand for farm products by modeling the quantity of the farm product as an input in food processing (U.S.D.A., 1989). The analysis considers eight commodities: beef and veal, pork, poultry, eggs, dairy, processed fruits and vegetables, fresh fruit, and fresh vegetables. U.S.D.A.'s results are consistent with previous findings, and show that all own-price elasticities are negative and less than 1 in absolute values. The authors found that, with the exception of poultry, farm-level demands are nearly as large as the corresponding retail elasticities or somewhat larger than the corresponding retail elasticities. Since specific commodity elasticities are not given and since the findings indicate that farm-level elasticities are similar to retail-level elasticities, this analysis uses the more detailed values for elasticities that are given in Huang's report.

2.4. Feasibility of Non-Chemical Substitution

In order to further delineate variations in the elasticities of demand exhibited by each cluster, one can examine the market characteristics that, according to microeconomic theory, influence the price elasticity of demand. These characteristics include the availability of substitutes for the product, the contribution of the product to the cost of production, and the productivity of expenditures for the product. This section discusses the availability of substitutes for clusters of pesticides. Section 2.5 considers the impact of pesticide contribution to the cost of production while Section 2.6 evaluates the productivity of expenditures for pesticides.

As discussed earlier, demand elasticity is, theoretically, a function of the availability of substitutes, among other factors. If a product has many close substitutes, it is likely to be characterized by an elastic

demand. Substitutes for a pesticide active ingredient include an alternative active ingredient as well as non-chemical substitutes. In constructing pesticide clusters, U.S. EPA's Office of Pesticide Programs (OPP) grouped all active ingredients which are substitutes for each other. The active ingredients included in the clusters are both chemical and biological. Therefore, substitutes for a cluster include only cultural and environmental pest control technologies[1].

Achievable reduction in pesticide use for specific end-uses has been studied by Pimentel et al. (1991). Pimentel considered the costs and benefits of replacing chemical pest control methods with currently available biological, cultural, and environmental pest control technologies. Since both the pesticide clusters, as defined by EPA, include biological pest control methods, the biological alternatives listed by Pimentel are not alternatives to the clusters. However, Abt Associates knows of no analysis which considers only cultural and environmental pest control alternatives. Further, the biological pest control methods constitute only a small minority of the pesticides within the clusters. Pimentel et al.'s analysis is, therefore, used to measure the relative substitutability of the pesticide clusters.

In this report, Pimentel's study is used to develop a general rating of the degree to which pesticide substitution is feasible for each cluster. The greater the feasibility of substitution, the higher the expected elasticity of demand for pesticides in the cluster. The ratings are based on two criteria: (1) the percentage by which non-chemical alternatives can replace pesticides, and (2) the projected net cost of replacing pesticides with a non-chemical pest control method. Based on these criteria, the clusters are grouped into three categories as shown in Tables 2.4, 2.5, and 2.6. Clusters in the "high substitutability" category can, according to Pimentel et al., achieve at least a 40 percent reduction in pesticide use at an additional cost of less than one dollar per hectare. Clusters in the "moderate substitutability" category can achieve at least a 20 percent reduction in pesticide use at a cost no greater than five dollars per hectare. Clusters which do not qualify for either of these categories are listed under the heading "low substitutability".

The clusters defined by OPP often group several of the crops that are listed in Table 2.4, 2.5, and 2.6. To determine ratings for the clusters, the crop-specific ratings were weighted by the pounds of fungicide, herbicide, or insecticide applied to each crop, as was relevant for the cluster. The cluster ratings, as developed by Abt Associates based on Pimentel et al. are as follows:

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[1] Most of the pesticide clusters include at least two active ingredients, indicating that chemical substitutes exist for most active ingredients. The substitutability between active ingredients will vary by region and with meteorological conditions, as well as with specific crops. A comparison of the chemical substitutes available for particular active ingredients is not undertaken in this analysis.

Table 2.4
Non-chemical Substitutability for Pesticides by Cluster
Fungicides

High Substitutability	Moderate Substitutability	Low Substitutability
soybeans	rice	cotton
other vegetables	sugar beets	sweet corn
peaches	lettuce	tobacco
	carrots	peanuts
	potatoes	tomatoes
	onions	
	beans	
	cantaloupe	
	peppers	
	sweet potatoes	
	watermelons	
	apples	
	cherries	
	peas	
	pears	
	plums	
	grapes	
	oranges	
	grapefruit	
	lemons	
	"other" fruit	
	pecans	
	"other" nuts	
	cole	
	cucumbers	

Source: Abt Associates estimates based on Pimentel et al. (1991)

Table 2.5

Non-chemical Substitutability for Pesticides by Cluster

Herbicides

High Substitutability	Moderate Substitutability	Low Substitutability
tobacco	peanuts	corn
potatoes	sorghum	cotton
tomatoes	pasture	wheat
cucumbers	grapes	soybeans
apples	alfalfa	rice
plums	hay	sugar beets
oranges	beans	"other" grain
grapefruits	cherries	lettuce
lemons	peaches	cole
"other" nuts	pears	carrots
	"other" fruit	sweet corn
	pecans	onions
		cantaloupe
		peas
		peppers
		sweet potatoes
		watermelons
		"other" vegetables

Source: Abt Associates estimates based on Pimentel et al. (1991)

Table 2.6

Non-chemical Substitutability for Pesticides by Cluster

Insecticides

High Substitutability	Moderate Substitutability	Low Substitutability
sorghum	cotton	corn
hay	wheat	lettuce
tomatoes	carrots	cole
cherries	onions	potatoes
peaches	cucumbers	sweet corn
pears	beans	cantaloupe
plums	sugar beets	
grapes	peas	
"other" fruit	watermelons	
pecans	"other" vegetables	
"other" nuts	sweet potatoes	
oranges	peppers	
grapefruit	alfalfa	
lemons	soybeans	
	rice	
	tobacco	
	peanuts	
	"other" grains	

Source: Abt Associates estimates based on Pimentel et al. (1991)

Low Substitutability

fungicides for use on vegetables

herbicides for use on corn

herbicides for use on soybeans, cotton, peanuts, alfalfa

herbicides for use on sugar beets, beans, and peas

insecticides for use on corn and alfalfa

insecticides for use on vegetables

Moderate Substitutability

fungicide for use on fruit and nut trees, except oranges and grapes

fungicides for use on oranges

fungicides for use on grapes

herbicides for use on vegetables

herbicides for use on sorghum, rice, small grains

herbicides for use on grapes

insecticides for use on cotton

insecticides for use on soybeans, peanuts, wheat, and tobacco

High Substitutability

herbicides for use on tree fruits (except oranges), nuts, and sugarcane

herbicides for use on oranges

herbicides for use on tobacco

insecticides for use on grapes

insecticides for use on oranges

insecticides for use on fruit and nut trees excluding oranges and grapes

insecticides on sorghum

As discussed earlier, these data can be used to suggest pesticide clusters for which the demand elasticity differs substantially from the demand elasticity for the associated food commodities. Demand for the six pesticide clusters with low substitutability may be inelastic relative to the demand for the associated foods. In the seven cases of high substitutability, the demand for the pesticide cluster may be more elastic than the demand for the associated foods. The feasibility of substitution for pesticide clusters is considered in Section 2.7 in constructing estimates of the elasticity of demand for the pesticide clusters.

2.5. Contribution to the Variable Cost of Production

Economic theory predicts that a producer's sensitivity to price will increase with the percentage of production cost contributed by that input. To further distinguish between the elasticities of demand for the different clusters of pesticides, Abt Associates has considered the extent to which the pesticides in the clusters contribute to production costs.

The U.S.D.A. publishes cost-of-production data summarizing all operator and landlord costs and returns associated with the production of several individual commodities (U.S.D.A., 1989a). The cost estimates separate the cost of chemicals and can be used to determine chemical costs as a percentage of total variable costs of production. Cost of chemicals is included in two categories: "chemicals" and "custom application". Both custom operators and farmers apply pesticides. The category "chemicals" includes agricultural chemical use by farmers and does not include labor spent in chemical application. Many custom operators charge a flat rate and do not provide a cost breakdown between labor and materials. "Custom application" therefore includes operator-applied chemicals, operator labor, and farm operations other than chemical application. The category "custom application" was included in calculations of pesticide contribution to total cost in order to ensure that all chemical costs are included. The estimate of pesticide contribution to the cost of crop production will, however, be overstated. These data are presented in Table 2.7 for the commodities for which the information was available.

The pesticide clusters defined in this analysis separate agricultural chemicals into fungicides, insecticides, and herbicides. The U.S.D.A. report does not separate the costs of chemicals into these categories. In order to divide the cost of chemicals between each of these types of pesticides, Abt Associates estimated total expenditures for each pesticide type for the commodities considered in the U.S.D.A. report. Total expenditures were calculated by multiplying the pounds of fungicide, herbicide, or insecticide applied to a commodity (from Pimentel et al, 1991) by the average price of the relevant pesticide type i.e., fungicides, herbicides, and insecticides (as reported in Synthetic Organic Chemicals, 1988). The chemical contribution to variable cost was then divided between the three pesticide categories based on the percent of expenditures. The percentages of variable production costs for fungicides, herbicides, and insecticides by commodity are listed in Table 2.7.

The crop-specific estimates must be grouped into clusters for purposes of this analysis. An estimate of the contribution of pesticide to variable cost for a cluster is made only if such an estimate is available for individual crops contributing at least 50 percent of the pesticide use for the cluster (based on Pimentel et al., 1991). Eight clusters meet this qualification. These clusters are listed below in descending order of

Table 2.7

Fungicide, Herbicide, and Insecticide Contribution to Variable Costs of Production

Commodity	Chemical Costs as a Percent of Variable Costs[1]	Fungicide Costs as a Percent of Variable Costs[2]	Herbicide Costs as a Percent of Variable Costs[2]	Insecticide Costs as a Percent of Variable Costs[2]
soybeans[3]	37	0	35	3
peanuts[3]	31	12	17	3
cotton[3]	29	0	16	13
sugarbeets[3]	28	0	23	5
sorghum[3]	25	0	22	3
corn[3]	22	0	19	2
rice[3]	20	0	19	1
wheat[3]	18	0	16	2
potatoes[4]	16	7	3	6
barley[3]	16	0	16	0
tobacco[5]	10	0	3	7
oats[3]	9	0	9	0

[1]Equals ("chemicals" + "custom operations")/"total variable cash expenses"

[2]Estimate by Abt Associates using pesticide prices from Synthetic Organic Chemicals, 1988 and pounds applied from Pimentel, D. et al, (in press), "Environmental and Economic Impacts of Reducing U.S. Agricultural Pesticides Use", Pest Management in Agriculture, CRC Press.

[3]Source for percent of production costs - USDA, 1989. "Economics Indicators of the Farm Sector, Costs of Production, 1987". Economic Research Service. February.

[4]Source for percent of production cost- USDA, 1988. "1985 Potato Cost and Returns: Fall Production Areas". Potato facts special edition. Economic Research Service. September.

[5]Source for percent of production cost - USDA, 1989. "Tobacco: Situation and Outlook Report". Economic Research Service. September.

the percent of the pesticide contribution to cost. Based only on contribution to cost, the order also corresponds to expected decreasing price elasticity of demand. The clusters are:

1) Herbicide used on soybeans, cotton, peanuts, alfalfa (33 percent of variable cost)
2) Herbicides used on sorghum, rice, small grains (20%)
3) Herbicides used on corn (19%)
4) Insecticides used on cotton (13%)
5) Insecticides used on soybeans, peanuts, wheat, and tobacco (3%)
6) Herbicides used on tobacco (3%)
7) Insecticides used on sorghum (3%)
8) Insecticides used on corn and alfalfa (2%)

U.S.D.A. did not estimate the cost of production for specialty crops. These data are compiled at the county level and collected by individual states, but are not available on a national level. It is beyond the scope of this study to collect cost of production data from each county in each state for each crop. Abt Associates did, however, obtain cost of production reports for specialty crops of interest from the states that represented a large percentage of the planted acreage of each crop. From these reports it was evident that the pesticide contribution to cost varied significantly between regions. Therefore, it was decided that without a statistically valid national sampling, the county-level data could not accurately be used to represent national cost data. No estimates of the pesticide contribution to variable costs of producing specialty crops are included in this analysis.

The purpose of considering the pesticide contribution to variable cost is to determine whether the demand elasticity for clusters of pesticides is likely to differ substantially from the elasticity of demand for the associated food commodities (calculated is Section 2.3). In particular, for the four pesticide clusters where chemicals contribute over ten percent of total variable cash expenses, farmers may be relatively sensitive to pesticide price changes. Therefore, demand for these pesticide clusters may be more elastic than demand for the associated food commodities. This factor is considered in Section 2.7, along with the other available data, to estimate the elasticity of demand for each of the pesticide clusters.

2.6 Productivity of Expenditures for Pesticides

The productivity of an input refers to the marginal value product of expenditure for the input compared to the cost of the input. When the marginal value product exceeds the input cost, the input is said to be productive. If an input is highly productive, demand for the input is theoretically likely to be

insensitive to small changes in price. Three studies which examined the productivity of expenditures for agricultural pesticides were located and are discussed below.

Headley (1968) estimated partial production elasticities for the following input variables using Cobb-Douglas functions: labor, land and buildings, machinery, fertilizer, pesticides, and "other". He then compared the marginal value production of expenditure for pesticides to the marginal factor cost of pesticides to determine the extent of disequilibrium in the use of pesticides by farmers. The results of Headley's study indicated that the marginal value of a one-dollar expenditure for chemical pesticides is approximately $4.00. Headley noted several limitations of his analysis, including that his conclusions are based on aggregative analysis and may not apply to local situations.

Campbell (1976) considered this same issue for a cross-sectional sample of tree-fruit farms in British Columbia. The statistical techniques used by Campbell include Ordinary Least Squares and Factor Analysis Regression. The data used in fitting Campbell's regression equation were as follows: the dependent variable was the value of output of fruit; the input variables were the values of services of land and buildings and capital equipment, and the values of inputs of irrigation water, labor, fertilizers, and pesticide sprays. Corresponding to Headley's findings, Campbell found that the value of a marginal dollar's worth of pesticides was significantly greater one dollar, indicating a relatively inelastic demand. However, as Headley did, Campbell suggested caution in the interpretation of this result. He noted that it is possible that his statistical procedure introduced an upward bias to the estimate since the sample data exhibited fairly high correlations among some of the independent variables, including pesticides.

According to Lichtenberg and Zilberman (1986), however, the studies of Headley and Campbell are methodologically flawed. Lichtenberg and Zilberman argue that econometric measurements of pesticide productivity that are derived from standard production theory models contain significant upward biases that result in the overestimation of pesticide productivity. The authors claim that the constant elasticity of the marginal effectiveness curve produced by a standard Cobb-Douglas specification will not match the actual behavior of the marginal effectiveness curve. The correct form of the marginal effectiveness curve, according to Lichtenberg and Zilberman, will show an increase in pesticide use in response to pest resistance and a decrease in use only when pest resistance is so widespread that alternative measures are most cost effective. The true marginal effectiveness curve will decline at an increasing rate in the economic region. Lichtenberg and Zilberman cast doubt on the high marginal productivity of pesticides estimated by Campbell and Headley.

Given that these studies do not provide definitive estimates of the productivity of pesticides and do not address the productivity of specific pesticide clusters, we develop simple original estimates of the productivity of pesticide clusters. In this analysis, the productivity of pesticides (specified as either fungicides, herbicides, or insecticides) on individual food commodities is calculated as follows:

$$P = \frac{V \times MP}{C}$$

where:

C = the cost of pesticide treatment for the food commodity (dollars per hectare),

MP = the marginal value product from the pesticide application (percent of total production value),

P = the productivity of the pesticide on the food commodity (dollars per hectare/dollars per hectare), and

V = the production value of the crop (dollars per hectare harvested).

The data sources for the three input parameters were as follows. The production value of the crops was obtained from U.S.D.A. (1989). The cost of pesticide treatment was taken from Pimentel et al. (1991). No source of specific estimates of the marginal value product associated with fungicides, herbicides, and insecticides on crops was located. The analysis therefore relied on the expertise of the U.S. EPA Office of Pesticide Programs (OPP) to estimate the value of this parameter. The OPP stated that it was reasonable to generalize that the marginal product associated with the use of fungicides, herbicides, or insecticides on a crop equaled ten percent of the production value of that crop (telephone communication, Dave Broussard, OPP, 2/91). Since no more precise estimates were available, the analysis adopted this value.

In reality, there will be some variation in the marginal value product of fungicides, herbicides, and insecticides on different crops. To the extent that the marginal value product for a pesticide type on a crop is greater than 10 percent, the analysis will understate productivity and therefore overstate the elasticity of demand. Similarly, if the marginal value product for a pesticide type on a crop is less than 10 percent, the productivity of the pesticide will be overstated and the elasticity of demand will be underestimated.

Weighted averages of the productivity measures for pesticides used on individual crops were calculated to obtain measures of productivity for pesticide clusters. The weighting factor was the quantity of pesticides included in the cluster applied to each crop, as determined by Pimentel et al. (1991). Table 2.8 displays the productivity measures for the pesticide clusters for which the information was available.

Table 2.8

Productivity of Pesticide Clusters

Cluster	Productivity (Dollars of Marginal Product per Dollars of Pesticide Expenditures)
Fungicides on:	
Fruit and nut trees, except oranges and grapes	$ 5.81
Grapes	$ 9.83
Vegetables	$12.37
Oranges	$12.54
Herbicides on:	
Sorghum, rice, small grains	$ 0.88
Corn	$ 1.11
Soybeans, cotton, peanuts, alfalfa	$ 2.68
Sugar beats, beans, peas	$ 2.72
Vegetables	$17.85
Oranges	$17.91
Tree fruits (except oranges), sugar cane, nuts	$19.29
Grapes	$61.43
Insecticides on:	
Cotton	$ 0.72
Sorghum	$ 1.24
Corn, alfalfa	$ 3.69
Vegetables	$ 7.92
Fruit and nut trees, except oranges and grapes	$ 8.51
Soybeans, peanuts, wheat, tobacco	$13.08
Oranges	$15.04
Grapes	$37.80

Note that there is great variation in the productivity estimates. The lowest productivity estimate is $0.72, for insecticides used on cotton; Herbicides used on grapes had the highest productivity, at $61.43. The wide range is due both to variability in the value of production of crops and variability in the cost of applying pesticides to the crop. For example, the value of production of cotton is $487 per hectare while the value of a hectare of grapes is $4,914 per hectare (U.S.D.A., 1989). In addition, the average cost of insecticide application to cotton is about $118 per hectare while the costs of applying herbicides to grapes is $8 per hectare (Pimentel et al., 1991). However, it must again be recognized that due to lack of data, the analysis assumes that the marginal value of production of insecticides on cotton and herbicides on grapes are identical.

The productivity of the clusters is considered in the next section, along with the factors previously discussed, in developing estimates of the elasticity of demand for each pesticide cluster. Demand for the pesticide clusters for which productivity is low can be expected to be elastic relative to the demand for the associated food commodities, ceteris paribus. Similarly, when a cluster of pesticides is highly productive, demand is likely to be inelastic compared with demand for the associated food commodities.

2.7. Conclusions - Agricultural Pesticides

Section 2 of this report estimates the price elasticity of demand for twenty-four pesticide clusters. Estimates of the elasticity of demand for clusters of pesticides are based on the price elasticity of demand for the associated food commodities. However, the elasticity of demand for an input is not solely a function of the demand for the end product (unless input ratios are assumed to be fixed). Therefore, the elasticity estimates are adjusted as warranted by consideration of three factors: (1) the feasibility of substituting non-chemical controls for the pesticide cluster, (2) the contribution of the pesticide cluster to the variable cost of crop production, and (3) the productivity of the pesticide cluster. In addition, the literature estimates of elasticity are considered when appropriate.

Since the effect of these factors is not easily quantified, we use this information to adjust the pesticide elasticities estimated from the demand for crops rather than to attempt to pinpoint the value of demand elasticity. Based on this information, we identify clusters for which the elasticity of the demand for the food commodity is likely to differ substantially from the elasticity of demand for the corresponding cluster of pesticides.

Note that the effect of the factors considered may cancel each other. For example, the feasibility of non-chemical substitution for a cluster of pesticides may be high, indicating that the elasticity of demand may be higher for the cluster of pesticides than for the associated crops. However, if the productivity of

the pesticide cluster is also high, less elastic demand is indicated for the cluster of pesticides than for the associated foods. To decide whether an adjustment to the elasticity of demand for the food commodities is warranted, the net indication of the factors is considered. Factors that indicate relatively elastic demand and factors that indicate relatively inelastic demand cancel each other. If, on net, two factors indicate relatively elastic or inelastic demand, an adjustment to the elasticity estimate is made.

Table 2.9 summarizes the information from the five areas of research: literature estimates, demand elasticities of food commodities, feasibility of substitution, contribution of chemicals to production costs, and productivity estimates. The information is summarized for twenty-one sectors of agricultural pesticide use. Three additional clusters of pesticides are included in the following summary of elasticity of demand for agricultural pesticides: fungicides used on grain storage, fungicides used for seed treatment, and fungicides - post-harvest. Since these clusters differ from the other agricultural pesticide clusters in that the pesticides are not applied to crops in the field, they have not been included in the analysis to this point. However, since the pesticides in these clusters are used agriculturally, elasticity estimates are discussed in this section. The best estimate of elasticity for each of the twenty-four agricultural clusters is discussed below.

a. Fungicides used on vegetables

The elasticity estimate of -0.38 is taken directly from U.S.D.A.'s (1985) estimate of the demand elasticity for retail vegetables, weighted by the amount of fungicides applied to each type of vegetable. No adjustments are made since the substitutability for fungicides on vegetables is low and the marginal productivity of fungicides on vegetables is moderate.

b. Fungicides used on fruit and nuts except oranges

The elasticity of demand for food commodities in this cluster, based on a weighted-average of the elasticity values estimated by U.S.D.A. (1985), is -0.23. No adjustments are made to this value are made to arrive at the elasticity of demand for fungicides applied to these food commodities. No corrections were necessary since the substitutability for fungicides on fruit and nuts except citrus is moderate as is the marginal productivity of fungicides on fruit and nut trees, except oranges. The estimated elasticity of -0.23 indicates less elastic demand than does the analysis of Pingali and Carlson (1985). However, the elasticity estimate of Pingali and Carlson consider only apples and is therefore not directly comparable to the elasticity estimate for the cluster. Both the current estimate and the Pingali and Carlson estimate indicate that demand is inelastic.

Table 2.9
Summary of Elasticity Information

Cluster	Literature Estimates	Elasticity of Food Commodity	Feasibility of Substitution	Fraction of Contribution to Production Costs	Marginal Productivity
Fungicides on:					
vegetables	N.A.	-0.38	low	N.A.	$12.37
fruit & nut trees, except oranges	-0.92 (2)	-0.23	moderate	N.A.	$5.81
oranges	N.A.	-1.00	moderate	N.A.	$12.54
grapes	N.A.	-1.38	moderate	N.A.	$9.83
Herbicides on:					
sorghum, rice, small grains	N.A.	-0.44	moderate	0.20	$0.88
soybeans, cotton, peanuts, alfalfa	inelastic (5)	-0.67	low	0.33	$2.68
corn	0.03, -0.75 (3) -1.46 (4) inelastic (5)	-0.69	low	0.19	$1.11
oranges	N.A.	-1.00	high	N.A.	$17.91
tree fruits, nuts & sugar cane	N.A.	-0.20	high	N.A.	$19.29
grapes	N.A.	-1.38	moderate	N.A.	$61.43
vegetables	N.A.	-0.27	moderate	N.A.	$17.85
tobacco	N.A.	N.A.	high	0.03	$58.60
sugar beets, beans peas	N.A.	-0.12	low	N.A.	$2.72

(1) Burrows (1983), cotton only
(2) Pingali and Carlson (1985), apples only
(3) Miranowski (1980), corn only
(4) Huh (1978), corn insecticides and herbicides
(5) U.S. EPA (1974), corn or soybeans, only

Table 2.9 (cont.)
Summary of Elasticity Information

Cluster	Literature Estimates	Elasticity of Food Commodity	Feasibility of Substitution	Fraction of Contribution to Production Costs	Marginal Productivity
Insecticides on:					
vegetables	N.A.	-0.33	low	N.A.	$7.92
fruit & nut trees exc. oranges	-1.39 (2)	-0.21	high	N.A.	$8.51
oranges	N.A.	-1.00	high	N.A.	$15.04
grapes	N.A.	-1.38	high	N.A.	$37.80
corn, alfalfa	-0.78 (3) -1.46 (4) inelastic (5)	-0.69	low	0.02	$3.69
sorghum	N.A.	-0.69	high	0.03	$1.24
soybeans, peanuts, wheat, & tobacco	inelastic (5)	-0.56	moderate	0.03	$13.08
cotton	-0.9, -1.23 (1)	N.A.	moderate	0.13	$0.72

(1) Burrows (1983), cotton only
(2) Pingali and Carlson (1985), apples only
(3) Miranowski (1980), corn only
(4) Huh (1978), corn insecticides and herbicides
(5) U.S. EPA (1974), corn or soybeans, only

c. Fungicides on oranges

The elasticity estimate of -1.0 is taken directly from U.S.D.A.'s (1985) estimate of the demand for oranges. No adjustments are made since the substitutability for fungicides on citrus is moderate, as is the marginal productivity of fungicides on oranges.

d. Fungicides on grapes

The elasticity estimate of -1.38 is again taken directly from U.S.D.A.'s (1985) estimate of the demand for retail foods. Since the feasibility of substitution for fungicides in this cluster is moderate and the marginal productivity is moderate, no adjustments are made.

e. Herbicides on sorghum, rice, and small grains

The best estimate of the elasticity of this food cluster is based on the demand elasticity of rice, as reported by U.S.D.A. (1985) and on the demand elasticity of sorghum. As discussed above, the elasticity of demand for sorghum, generally an animal feed crop, was calculated based on the elasticity of demand for animal meats. To estimate an elasticity for the crops in this cluster, the two crop elasticities were weighted by the amount of herbicides applied to each crop (as reported in Pimentel et al., 1991). The resulting elasticity estimate is -0.44.

However, it is likely that the elasticity of demand for this cluster of herbicides will exceed the elasticity of demand for the associated crops. Although the feasibility of substitution for herbicides in this cluster is moderate, herbicides contributed a relatively high percentage to total variable costs, and the marginal productivity of the herbicides is very low. There is no precise method by which to translate these factors into an estimate of the elasticity of demand for herbicides on sorghum, rice, and small grains. However, to account for the low marginal productivity and high contribution to costs of herbicides on sorghum, rice, and small grains, demand on herbicides on this cluster is assumed to be more elastic than demand for crops in this cluster. The elasticity estimate is adjusted from -0.44 to -1.0.

f. Herbicides on soybeans, cotton, peanuts, and alfalfa

As discussed earlier in this report, assuming that soybeans and alfalfa are fed to animals, the price elasticity of demand for the crops in this cluster, excluding cotton, is -0.67. Since the quantity of herbicides applied to cotton is small in comparison to the quantity of herbicides applied to soybeans, peanuts, and alfalfa, the exclusion of cotton should not substantially affect the elasticity estimate[2].

[2]According to Pimentel et al. (1991), 8.2 million kgs. per year of herbicides are applied to cotton and 60.6 million kgs. per year of herbicides are applied to soybeans, peanuts, and alfalfa combined.

Supporting the elasticity estimate of -0.67, U.S. EPA (1974) found the demand for herbicides on soybeans to be inelastic.

Three additional factors present information on the expected price elasticity of demand for this cluster of herbicides: the feasibility of substitution, the fraction of contribution to production costs, and the marginal productivity of the herbicides. The feasibility of substitution for this cluster of herbicides is low, influencing the demand for the herbicides to be inelastic. However, herbicides (including custom application) are estimated to contribute 33 percent of the total cost of production for this cluster. This high contribution to variable cost is likely to drive greater elasticity of demand. Also, the marginal productivity of herbicides in this cluster is estimated as $2.68. This return on herbicide use is fairly low, suggesting somewhat elastic demand.

Given the opposing factors that influence demand for herbicides in this cluster, it was judged that the estimated elasticity of demand for the crops, -0.67, serves well as an estimate of the elasticity of demand for the cluster of herbicides.

g. Herbicides on corn

The estimate of elasticity of demand for corn herbicides is -0.69. This value is based on the average elasticity of meats as listed in U.S.D.A. (1985), since the corn is assumed to be used as animal feed. Pesticides in this cluster contributed a relatively high percentage to total variable costs (19% including custom application) and the marginal productivity of these pesticides is low, at $1.11. Both of this factors indicate elastic demand. However, the feasibility of substitution for these pesticides is low, indicating inelastic demand. Therefore, it was judged that no additional adjustment to the elasticity estimate was warranted.

h. Herbicides on oranges

The estimate of the elasticity of demand for herbicides on oranges is -1.00, taken from U.S.D.A.'s estimate of the elasticity of demand for oranges. Although the feasibility of substitution for herbicides on oranges is high (indicating elastic demand), the marginal productivity of the herbicides is also fairly high (indicating inelastic demand). Therefore, no adjustment to the U.S.D.A. estimate of elasticity of demand for oranges is made.

i. Herbicides on tree fruits (except oranges), nuts, and sugarcane

The elasticity of demand for this cluster, based on the elasticity of demand for retail food, is estimated as -0.20. Pesticides in this cluster have a high feasibility of substitution with non-chemical pest

control methods, indicating elastic demand. However, the marginal productivity of these pesticides is also moderately high, at $19.19, indicating inelastic demand. Therefore, no adjustments are made to the elasticity estimate for retail food.

j. Herbicides on grapes

The price elasticity of demand for herbicides on grapes is estimated based on the elasticity of demand for grapes at the retail level. The estimated elasticity is -1.38. Since the marginal productivity on grapes is extremely high, the elasticity of demand may be less than -1.38. However, the marginal productivity is the only factor indicating inelastic demand; the feasibility of substitution for herbicides on grapes is moderate. Further, the degree of adjustment to the elasticity estimate warranted by the high marginal productivity is unclear. For these two reasons, this analysis relies on the elasticity estimate for retail grapes. However, it should be noted that this value may overstate elasticity, and therefore overstate the impact of the effluent guidelines on pesticide manufacturers.

k. Herbicides on vegetables

The weighted-average estimate of demand for vegetables at the retail level is -0.27. Since the feasibility of substitution is moderate and the marginal productivity is moderately high for this cluster, the elasticity estimate for food is used to represent the elasticity of demand for herbicides used on these foods.

l. Herbicides used on tobacco

U.S.D.A. did not estimate the elasticity of demand for tobacco at the retail level. However, the addictive nature of cigarette smoking probably results in inelastic demand for tobacco. It seems reasonable to assume demand for tobacco is as inelastic as the least elastic demand for retail food, since people seldom develop addictions to specific foods. Since U.S.D.A. found that the elasticity of demand for numerous food commodities was lower in absolute value than -0.20, the elasticity of demand for tobacco is estimated as -0.20.

Since the feasibility of substituting a non-chemical alternative for herbicides on tobacco is high, demand for the herbicides used on tobacco may be more elastic than demand for the tobacco itself. However, the costs of applying herbicides comprise only 3 percent of the total variable costs of production. Further, the estimate of the marginal productivity of herbicides used on tobacco is extremely high. These two factors indicate that demand for herbicides used on tobacco will be inelastic. Given these opposing factors, this analysis assumes that the elasticity of demand for herbicides used on tobacco will match the elasticity of demand for tobacco. The elasticity estimate for this cluster is therefore -0.20.

m. Herbicides on sugar beets, beans, and peas

The estimate of the elasticity of demand for this cluster is calculated from a weighted average of U.S.D.A.'s (1985) estimate of demand for food at the retail level. The value is -0.12. No adjustments are made since the indications regarding elasticity of demand for the herbicides conflict. The substitutability for herbicides on sugar beets, beans, and peas is low, indicating relatively inelastic demand, while the marginal productivity of the herbicides is low, indicating relatively elastic demand.

n. Insecticides on vegetables

The elasticity for this cluster is estimated as -0.33, based on a weighted-average of the values estimated by U.S.D.A. (1985) as the elasticities of demand for vegetables. No adjustments are made to the elasticity estimate for vegetables. The marginal productivity of insecticides in this cluster is moderate, at $7.92. Although the substitutability for insecticides on vegetables is low, there is no quantitative measure of the extent to which the estimate should be altered. Further, this is the only factor indicating that demand is relatively inelastic. Therefore, the elasticity estimate of -0.33 is used in this analysis.

o. Insecticides on fruits and nuts except oranges

The estimate of elasticity of demand for the food commodities in this cluster, based on U.S.D.A.'s (1985) estimates of elasticity of demand for food at the retail level, is -0.21. This value differs notably from the elasticity estimate of Pingali and Carlson (1985) for insecticides applied to apple orchards. Pingali and Carlson estimated the elasticity of demand as -1.39. Since the authors considered only apple orchards, the estimates are not perfectly comparable. However, since apples receive over 50 percent of insecticides applied to crops in this cluster, the differences between the two estimates is notable.

The marginal productivity of these insecticides is moderate and does not suggest that an adjustment to the elasticity estimate for retail food is required. However, the feasibility of non-chemical substitution for these insecticides is high, indicating elastic demand. To account for the high feasibility of substitution and the elasticity estimate of Pingali and Carlson, the elasticity estimate for this cluster is adjusted from -0.21 to -1.00.

p. Insecticides on oranges

The U.S.D.A. estimate of the elasticity of demand for oranges at the retail level was -1.00. This value is also used to represent the elasticity of demand for insecticides applied to oranges. Although the feasibility of substitution of insecticides used on oranges is high (indicating relatively elastic demand), the marginal productivity of the insecticides is also fairly high (indicating relatively inelastic demand). Therefore, no adjustments are made.

q. Insecticides on grapes

The U.S.D.A. estimate of the elasticity of demand for grapes at the retail level was -1.38. This value is also used to represent the elasticity of demand for insecticides applied to grapes. Although the feasibility of substitution of insecticides used on grapes is high (indicating relatively elastic demand), the marginal productivity of the insecticides is also high, at $37.80 (indicating relatively inelastic demand). Therefore, no adjustments are made to the U.S.D.A. elasticity estimate for grapes.

r. Insecticides on corn and alfalfa

Since a large proportion of production of each of these crops serves mainly as animal feed, an elasticity estimate for the crops was developed based on the retail demand for meat. As discussed above, the elasticity for corn and alfalfa is estimated to be -0.69. This elasticity estimate is also used to represent the elasticity of demand for insecticides applied to these crops.

Three literature values describe the elasticity of demand for crops in this cluster. U.S. EPA (1974) found the demand for corn insecticides to be inelastic. Miranowski's (1980) statistically significant estimate of the elasticity of demand for corn insecticides was -0.78. Finally, Huh (1978) estimated the elasticity of demand for corn insecticides and herbicides as -1.46. Since these literature estimates conflict, they do not indicate that an adjustment to the elasticity estimate is needed.

The feasibility of substitution on these crops is low, indicating that demand is relatively inelastic. The low contribution of insecticides to the costs of production of these crops also indicates that demand for the insecticides will be relatively inelastic. However, the marginal productivity of insecticides on corn and alfalfa is fairly low, at $3.69. Low productivity is associated with elastic demand. Given the opposing factors, no adjustment is made to the estimate of the elasticity of demand for corn and alfalfa.

s. Insecticides on sorghum

As was the case for corn and alfalfa, the elasticity of demand for sorghum is calculated based on the elasticity of demand for meat, since sorghum is used mainly as a feed crop. The elasticity estimate for sorghum is -0.69. Although the marginal productivity of insecticides on sorghum is low (indicating relatively elastic demand) and the feasibility of substitution is high (also indicating elastic demand), insecticides contribute only two percent of production costs (indicating inelastic demand). Given these opposing factors, no adjustment to the sorghum elasticity estimate is made. The elasticity of insecticides used on sorghum is estimated as -0.69.

t. Insecticides on soybeans, peanuts, wheat, and tobacco

The estimate of the elasticity of demand for soybeans, peanuts, and wheat is -0.56. Although an estimate of the elasticity of demand for tobacco is not available, this omission should not substantially affect the estimate since 80 percent of insecticides used in this cluster are applied to soybeans, peanuts, or wheat. The feasibility of substitution, fraction of contribution to production costs, and marginal productivity for this cluster of pesticides do not suggest that an adjustment to the elasticity of demand for the food crops is required. The elasticity estimate for this pesticide cluster is therefore -0.56. This estimate is consistent with the finding by U.S. EPA (1974) that demand for soybeans is inelastic.

u. Insecticides on cotton

No estimate of the elasticity of demand for cotton was given by U.S.D.A. However, Burrows (1983) empirically estimated this elasticity. Using a single equation model, Burrows estimated the elasticity of demand for cotton to be -0.9; with a simultaneous equation model, Burrows estimated the elasticity as -1.23. The average of these two estimates is -1.06.

Since the marginal productivity of insecticides on cotton is extremely low, at $0.72, the demand for the insecticides is expected to be elastic. Further, the insecticides contribute a fairly high fraction, 13 percent, of the variable cash costs of producing cotton. The feasibility of substitution for these insecticides is moderate. Since these factors are consistent with the elasticity estimate from Burrows, the elasticity of demand for cotton insecticides is estimated to be -1.06.

v. Fungicides on grain storage

In the absence of more specific information, the elasticity of demand for fungicides on grain storage is assumed to equal the elasticity of demand for grains. Elasticity estimates are available from Huang (1985) for wheat and rice. Other stored grains may be fed to animals. As discussed above, an estimate for the elasticity of grains fed to animals was developed as part of this analysis. However, since information was not located on the quantity of fungicides applied to each grain and each end-use, correct weighting factors for the different elasticity estimates could not be developed to estimate an average elasticity for all grains treated with fungicides in storage. The elasticity for this cluster is therefore estimated as a straight average of the elasticity of wheat flour (-0.11), rice (-0.15), and animal feed grains (-0.69). The resulting elasticity estimate for fungicides used on grain in storage is -0.31.

w. Fungicides used for seed treatment

Since no specific information on the elasticity of fungicides used for seed treatment was located, the elasticity of demand for fungicides in this cluster is calculated based on the demand elasticity for the crops

constituting the majority of seed plantings, and for which an elasticity estimate was available. These crops include corn (elasticity estimated as -0.69), wheat (-0.11), dried beans, peas, and nuts (-0.12), and rice (-0.15). Since no information was located on the quantity of fungicides applied to seeds of each crop, a straight average of the elasticities was used to estimate the demand elasticity for this cluster. The resulting estimate for this cluster is -0.27.

x. Fungicides - post-harvest

The elasticity of demand for fungicides applied post-harvest is based on a weighted average of the elasticities of demand for the crops to which fungicides are applied in the field. These crops are assumed to be vegetables, fruit and nut trees, and grapes, as these were the crops included in the four fungicide clusters for which the elasticity of fungicides used in field applications was calculated. Fungicides are assumed to be applied to the crops after harvest in the same ratios as they were applied to the crops in the field. These ratios are used to weight the demand elasticities for the individual crops. The resulting elasticity estimate is -0.65.

A complete list of Abt Associates' estimated price elasticities of demand for clusters defining agricultural end-uses is provided in Table 2.10.

Table 2.10
Estimates of Elasticity of Demand for Clusters in the Agricultural Sector

Cluster	Elasticity Estimate
Fungicides on:	
fruit and nut trees except oranges	-0.23
seed treatment	-0.27
grain storage	-0.31
vegetables	-0.38
post-harvest	-0.65
oranges	-1.00
grapes	-1.38
Herbicides on:	
sugar beets, beans, and peas	-0.12
tobacco	-0.20
tree fruits (except oranges, nuts, sugarcane)	-0.20
vegetables	-0.27
soybeans, cotton, peanuts, and alfalfa	-0.67
corn	-0.69
sorghum, rice, and small grains	-1.00
oranges	-1.00
grapes	-1.38
Insecticides on:	
vegetables	-0.33
soybeans, peanuts, wheat, and tobacco	-0.56
corn and alfalfa	-0.69
sorghum	-0.69
fruit and nut trees except oranges	-1.00
oranges	-1.00
cotton	-1.06
grapes	-1.38

Source: Abt Associates estimates based on Pimentel et al. (1991), USDA (1985), USDA (1989a), USDA (1989b), USDA (1989c), Burrows (1983), Pingali and Carlson (1985), Miranowski (1980), Huh(19878), U.S. EPA (1974)

3.0 PRICE ELASTICITY OF DEMAND FOR PESTICIDES USED NON-AGRICULTURALLY

Most of the pesticides included in this analysis are used in the agricultural sector; pesticides in non-agricultural clusters, as defined by OPP, constitute less than 30 percent of total pesticide use by weight (U.S. EPA, 1988). However, the non-agricultural pesticides are described by eighteen separate clusters. Unlike in the agricultural sector, these clusters represent eighteen distinct and generally unrelated end-uses, each with its own customers, competitors, and costs. The literature search described above yielded no studies of the price elasticity of demand for pesticides in the non-agricultural sector. Since the scope of this project does not allow for the gathering and examination of primary data on elasticities of demand for each of these eighteen markets and since non-agricultural pesticide use represents a relatively small percent of total pesticide use, the demand elasticities for the non-agricultural sector are developed based on a reasoned consideration of two factors. Consistent with the analysis of agricultural pesticide use, these factors are: (1) the availability of substitutes for a cluster of pesticides, and (2) the contribution of pesticides to the total production cost of the end-user.

Based on the above two factors, the eighteen non-agricultural clusters fit into two categories: (1) pesticides that contribute a small percentage to total cost but have substitutes, and (2) pesticides that contribute a small percentage of total production costs and for which there are limited substitutes. There were no cases in which it appeared that pesticides contributed a substantial percentage of total production costs. The two categories and the clusters described by them are listed below, along with a brief discussion of the reasoning behind the cluster categorization.

(1) Pesticides contribute a small percentage of total cost but substitutes are available

The two non-agricultural herbicide clusters are included in this category: (a) herbicides on ditches, rights of way, forestry, and ponds, and (b) herbicides on turf. The available substitute is labor, a viable alternative to chemical weed control. To determine the shift to manual/mechanical weed control given an increase in pesticides price, one would need to know: the cost of herbicide per unit of area, the effectiveness of herbicides, the labor cost of applying herbicides per unit of area, the labor cost of manual weed control per unit of area, and the effectiveness of manual weed control. Since these two clusters together constitute less than one percent of the pesticides of interest (by weight) it was decided not to invest resources in the gathering of these data.

Rather, Abt Associates considered the cost structure of the end-users of pesticides in these clusters. Herbicides used on ditches, rights of way, forestry, and ponds would generally be used by major industries such as railroads and utilities and by government agencies, such as state highway departments. The cost

of herbicides would be an insignificant percentage of their total production costs. Demand for this cluster of herbicides is therefore likely to be inelastic. While herbicides used on turf may contribute a greater percentage to the total production costs (assuming that these pesticides are used, for example, on golf courses and turf farms) the costs should still be relatively small. In addition, fungicides are applied in conjunction with herbicides to turf. It is therefore likely that an application system would be in place for fungicides, making the incremental costs of herbicide application small.

Based on the above discussion, this analysis assumes that demand for the two non-agricultural herbicides clusters is inelastic. Although the level of detail of the available information does not result in a quantitative measure of the elasticity, such a measure is required. Since only one of the two factors considered above indicates inelasticity (percent of production costs), while the other is inconclusive (substitute availability), this analysis assumes that demand for these two clusters is only moderately inelastic, and assigns a price elasticity of -0.66. The sensitivity analysis will consider the impacts on active ingredient manufacturers if demand for pesticides in these clusters is perfectly elastic.

(2) Pesticides contribute a small percentage of total production costs, and there are limited substitutes

The remaining sixteen non-agricultural clusters are grouped in this category. For each cluster, the cost of pesticides appeared incidental to the total cost of production and no readily available, cost-effective alternatives to the pesticides were known. These two factors suggest inelastic demand. Further, only three of the sixteen clusters in this category constitute more than one percent (by weight) of the pesticides of interest in this analysis. Therefore, little additional information on the ultimate costs to manufacturers would result from an investigation of the remaining thirteen clusters. The three clusters which included at least one percent by weight of the total pesticides of concern are listed below with a brief discussion of their categorization:

Insecticide fumigants and nematicides

According to Encyclopedia Britannica, "Fumigation, which requires some technical skills and certain precautions in application, is mostly feasible for non-selective quick killing of vermin in large commercial operations. For the control of household pests it has been, to a considerable extent, supplanted by more convenient methods of extermination such as the application of powders and residual sprays". Fumigants are largely used for killing insect pests of stored products, for fumigating nursery stock, or for fumigating sod, principally for the control of plant parasitic nematodes. Given the application in large commercial operations, the contribution of fumigants and nematicides to production cost is likely to be small. Further, since the use of these products has become somewhat specialized, it is probable that few substitutes exist.

Insecticides for termite control

Domestic and commercial use of chemical termite controls seems unlikely to contribute substantially to total consumer or commercial business expenses. Also, while in the long-run, wood could be replaced to some extent as a building material, in the short-run alternative protection from and eradication of termites is not readily available. Further, the cost of termite control can be viewed as insurance against the much larger cost of destruction of a building, making the cost of control appear small. For the reasonably foreseeable future, the demand for chemical termite control is likely to be inelastic.

Wood preservatives - industrial, commercial, marine use

The wood preservative industry developed because of the need for prolonging the life of wood structures, particularly where the structures come in contact with ground. Examples of treated wood include railroad ties, telephone poles, and marine pilings. Wood may be chemically treated to protect against fungicides, insects, and fire. According to U.S. EPA (1982), expenditures on wood preservative account for "only a small part" of the annual billion dollar preserved wood market. Cost-effective alternatives to chemical wood preservation are not known. Demand for pesticides in this cluster is therefore assumed to be inelastic.

The remaining clusters grouped in this category are:

- Insect repellents at non-agricultural sites
- Domestic bug control and food processing plants
- Mosquito larvacides
- Fungicides on turf
- Industrial preservatives - plastics, paints, adhesives, textiles, paper
- Synergist - used as insecticide synergists, surfactants, cheleating poultry and livestock
- Plant regulators, defoliants, desiccants - for all uses
- Sanitizers - dairies, food processing, restaurants, air treatment
- Insecticides on livestock and domestic animals
- Fungicides - ornamentals
- Industrial microbiocides, cutting oils, and oil well additives
- Preservatives, disinfectants, and slimicides
- Slimicides - pulp and paper, cooling towers, sugar mills
- Fungicides - ornamentals
- Industrial microbiocides, cutting oils, and oil well additives
- Preservatives, disinfectants, and slimicides

Ideally, a quantitative measure of the price elasticity of demand could be developed for each of the pesticides clusters listed above. However, the available data does not permit this precision. Since clusters in this category have no known cost-effective substitutes and since the pesticides are generally an insignificant portion of total production costs, demand is expected to be moderately to highly inelastic. The clusters in this category are assigned a price elasticity of demand of -0.33. The sensitivity analysis will examine the impact on manufacturers in the demand is perfectly elastic.

Finally, two clusters remain without demand elasticity estimates: herbicides for broad spectrum use and fungicides for broad spectrum use. The cluster "herbicides for broad spectrum use" contains only one active ingredient, 2,4-D. The price elasticity of demand for 2,4-D was estimated by Lacewell and Masch (1972) and by Carlson (1977a,b). Lacewell and Masch estimated the elasticity as approximately -0.38. Carlson estimated a short-run elasticity of -0.19 and a long-run elasticity of -0.59. Averaging Carlson's long-run estimate and the estimate of Lacewell and Masch results in an estimate of elasticity of demand for 2,4-D of -0.48. We use this value as the price elasticity of demand for broad spectrum herbicides.

The elasticity estimate for broad spectrum fungicides is calculated simply by a weighted average of the elasticity estimates for all of the other fungicide clusters. The weighting is based on the quantity (by weight) of active ingredient applied for the end-uses described by each cluster. The resulting elasticity estimate is -0.40. This value is in good agreement with the elasticity of demand for fungicides estimated by U.S. EPA (1985) as -0.35.

4.0 CONCLUSIONS

The estimated elasticities for all 44 clusters are listed in Table 4.0, in order of increasing elasticity of demand. As can be seen from the table, the elasticity estimates range from -0.12 (herbicides on sugar beets, beans, and peas) to -1.38 (fungicides on grapes, herbicides on grapes, and insecticides on grapes). The elasticity estimates vary substantially within the fungicide, herbicide, and insecticide clusters; the type of pesticide is not predicted to have a strong influence on the elasticity of demand.

The demand for pesticides in all of the clusters except four is expected to have unit elasticity or to be inelastic. Demand is expected to be inelastic for the three clusters of pesticides applied to grapes and for insecticides applied to cotton. The main factor driving the high elasticity for the grape clusters is the high elasticity of demand for grapes at the retail level. Demand for insecticides on cotton is expected to be somewhat elastic based on literature estimates of the elasticity and on the low marginal productivity of insecticides applied to cotton.

As should be clear from sections 2 and 3, the methodology employed to estimate the elasticity of demand for the clusters yields reasonable best estimates of elasticities rather than certain quantifications. The estimates are likely to accurately depict whether demand for a certain cluster of pesticides is extremely or only moderately elastic or inelastic; the specific numeric value should not be viewed as definitive. However, no estimates of elasticity of demand for clusters of pesticides that are more reliable than those developed through this analysis are known. To address the uncertainty implicit in the estimates, a scenario in which the manufacturers bear the total costs of regulatory compliance will also be examined.

Table 4.0

SUMMARY OF ESTIMATES OF ELASTICITY OF DEMAND

Cluster	Elasticity Estimate
Herbicides on sugar beets, beans, peas	-0.12
Herbicides on tree fruits (except oranges), sugar cane, nuts	-0.20
Herbicides on tobacco	-0.20
Fungicides on fruit and nuts trees (except oranges)	-0.23
Fungicides for seed treatment	-0.27
Herbicides on vegetables	-0.27
Fungicides on grain in storage	-0.31
Insecticides on vegetables	-0.33
Slimicides	-0.33
Fumigants and nematicides	-0.33
Insecticides on termites	-0.33
Wood preservatives	-0.33
Insect repellents at non-agricultural sites	-0.33
Domestic bug control and food processing plants	-0.33
Mosquito larvacides	-0.33
Fungicides on turf	-0.33
Industrial preservatives	-0.33
Insecticide synergists and surfactants	-0.33
Plant regulators, defoliants, desiccants	-0.33
Sanitizers - dairies, food processing, restaurants, air treatment	-0.33
Insecticides on livestock and domestic animals	-0.33
Industrial microbiocides, cutting oils, oil well addivites	-0.33
Preservatives, disinfectants, and slimicides	-0.33
Fungicides - ornamentals	-0.33
Fungicides on vegetables	-0.38
Fungicides - broad spectrum	-0.40
Herbicides - broad spectrum	-0.48
Insecticides on soybeans, peanuts, wheat, tobacco	-0.56
Fungicides - post harvest	-0.65
Herbicides on rights of way, drainage ditches	-0.66
Herbicides on turf	-0.66
Herbicides on soybeans, cotton, peanuts, alfalfa	-0.67
Herbicides on corn	-0.69
Insecticides on corn, alfalfa	-0.69
Insecticides on sorghum	-0.69
Herbicides on sorghum rice, small grains	-1.00
Herbicides on oranges	-1.00
Fungicides on oranges	-1.00
Insecticides on fruit and nut trees, except oranges and grapes	-1.00
Insecticides on oranges	-1.00
Insecticides on cotton	-1.06
Fungicides on grapes	-1.38
Insecticides on grapes	-1.38
Herbicides on grapes	-1.38

Source: Abt Associates estimates

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Appendix D
Compliance Costs as a Percentage of Revenue for Baseline Facility Closures

The facilities which were estimated to close in the baseline in the facility level analysis could not be analyzed for post-compliance impacts using the standard methodology, as these facilities had a negative baseline cash flow before the costs of complying with the proposed regulations were considered (see Chapter 4). EPA further analyzed the PSES facilities deemed to be baseline closures to estimate whether the facilities would be impacted by the initially selected regulation, Option 3/S, if the facilities were able to remain in business despite their financial weakness. The methodology used was an examination of the ratio of total annualized compliance costs under Option 3/S to the total annual average revenue of the facility. As discussed in Chapter 4, a cost to revenue ratio of greater than five percent may mean that the facility could face economic hardship as a result of compliance, although no operational changes are necessarily expected. Such an impact would be a moderate effect. The Agency found that relatively few facilities, if able to stay in business, would be moderately impacted by the costs of complying with the proposed effluent guidelines.

There are 372 PSES facilities that are estimated to close in the baseline. Of these, 124 would incur costs under Option 3/S. Among these 124 facilities, the mean and median ratio of costs of compliance to total revenue are 3.6 percent and 1.1 percent, respectively. Only 24 (19 percent), have a cost of compliance to revenue ratio of greater than five percent. These 24 facilities represent 6.5 percent of all of the PSES facilities projected to close in the baseline. The Agency does not expect compliance with the Option to represent a significant burden to the facilities which are predicted to close in the baseline.

Appendix E
Sensitivity Analysis of the Return on Asset Value Used in Line Conversion Analysis

This appendix provides a sensitivity analysis of the threshold value of return on assets (ROA) used in the line conversion analysis of facility impacts for PFPR facilities with less than 25 percent of their revenue from PFPR operations. The ROA threshold value is used as the criterion for projecting that PFPR facilities will convert their production lines from pesticide operations to other non-pesticide formulating and packaging activities. If a facility achieves at least the threshold ROA in the baseline analysis, but is projected to have post-compliance ROA less than the threshold value, the facility is said to incur the moderate impact of a line conversion.

The EIA set the ROA threshold value at 2.9 percent. This value is the lowest quartile value of firms operating in SIC code 2842 (specialty cleaning, polishing and sanitation preparations), averaged over the three-year period 1986-1988, as indicated by Robert Morris Associates. SIC 2842 is chosen as being representative of alternative FPR activities to which impacted facilities could turn. This SIC code was among the most frequently reported SIC codes for PFPR facilities obtaining less than 25 percent of the their revenue from PFPR operations.

As a sensitivity analysis to examine the stability of the number of moderate impacts within a range of plausible thresholds, EPA recalculated impacts using an ROA threshold of 7.2 percent. This value is the median value reported in SIC code 2842, averaged over the 1986-1988 period. Thus, the analysis assumes that a facility would convert its production lines from PFPR activities to other FPR activities if the facility could expect to obtain the return on assets of the median firm performing such activities. Using a higher threshold value will reduce the number of facilities considered for moderate impacts, because facilities achieving less than the threshold value in the baseline are not considered for line conversion impacts. The higher threshold, however, increases the number of impacts for those facilities that are considered for impacts. The net outcome in terms of the number of moderate impacts from these two effects is indeterminate; the number of facilities projected to convert PFPR lines may increase or decrease as a result of using a higher threshold value.

The results of this sensitivity analysis indicate that two fewer moderate impacts would be estimated to occur in the facility population under Option 3 if the line conversion decision were based on the higher ROA threshold value. Given this slight decrease in impacts, EPA concludes that the number of line conversion impacts is stable within a range of plausible ROA threshold values.

Appendix F
Facility Impact Analysis Assuming a Price-Adjustment Rule

F.0 Introduction

The facility impact analysis of the EIA was conducted assuming that facilities are unable to pass any cost increases through to consumers. As discussed in Chapter 4, this is an extremely conservative assumption that serves as a worst-case analysis. This appendix provides the results of the facility impact analysis using a price-adjustment rule in which facilities attempt to pass through half of their compliance costs (expressed as a percentage of revenue) to customers in the form of price increases. This assumption, while imprecise, reflects the reality that facilities are likely to attempt recovery of their cost increases by raising prices. Section 1 of this appendix describes the methodology EPA used to estimate pre-compliance and post-compliance prices and quantites under this price-adjustment rule, and the effects on cash flow. Section 2 provides the results of the analysis.

F.1 Price-Adjustment Methodology

Producers and consumers jointly determine the quantities and prices of pesticide products sold in the market place. Producers raise prices based on the change in their production costs and the expected reactions of competitors. In turn, consumers respond with reduced demand based on several factors, including the percent of consumers' production cost contributed by the pesticide product and the availability of substitute products. Producers then consider the impact of the price increase and demand decrease on profitability and may readjust their prices. The process repeats until an equilibrium is reached.

This analysis summarized in this Appendix approximates an end point of the supply and demand interaction. Producers are assumed to follow a pricing rule in which they increase product prices by an amount that would recover half of each facility's increase in costs *if their sales quantity remains constant.* However, as facilities raise prices under the pricing rule, consumers respond by changing the quantity of products purchased based on the price elasticity of demand for pesticides. Because the quantity demanded generally changes in response to the facility's increase in price based on the elasticity of demand, the result in terms of amount of cost increase recovered by the PFPR facility does not generally amount to 50 percent of the compliance costs.

The price elasticity of demand is defined as the percentage change in the quantity demanded, divided by the percentage change in price. If, in response to price increases, consumers reduce their purchases by more than the percentage increase in price, then revenues will decline and demand is said to be elastic: customers are sensitive to price changes. However, if, in response to price increases, consumers reduce their purchases by less than the percentage increase in price, then revenues will increase and demand is said to be inelastic: customers are not so sensitive to price changes. The value of the price elasticity of demand is unbounded and may be positive or negative. In general, though, price and demand are negatively correlated — an increase in price results in a decrease in the quantity demanded — and the price elasticity of demand is therefore usually negative.

Estimates of the price elasticity of demand for each pesticide cluster were generated as part of the EIA for Effluent Limitations Guidelines and Standards for the Pesticide Manufacturing Industry. The main source of data from which the pesticide elasticities were derived was the U.S. Department of Agriculture's (USDA) analysis of the price elasticity of demand for food commodities (USDA, 1985, 1989). The elasticity of demand for farm inputs can be derived from the elasticity of the demand for farm commodities since demand for production inputs must ultimately reflect demand for the end product. Though the two elasticities may not correspond exactly, the elasticity of demand for the food commodities can serve as a reasonable proxy for the elasticity of demand for pesticides in the absence of more relevant data. These elasticity estimates were therefore also used to estimate the demand elasticity faced by all PFPR facilities.

A list of the elasticity estimates by cluster is shown in Table F-1 in order of increasing elasticity of demand. As can be seen from the table, the elasticity estimates range from the relatively inelastic value of -0.12 (herbicides on sugar beets, beans, and peas) to the relatively elastic value of -1.38 (fungicides on grapes and herbicides on grapes). The elasticity estimates vary substantially within the fungicide, herbicide, and insecticide clusters: the elasticity of demand does not to appear to depend in any systematic way on whether a pesticide is a fungicide, herbicide, or insecticide.

The demand for pesticides in all but three of the clusters is expected to have unit elasticity (i.e., -1) or to be inelastic. Demand is expected to be elastic for fungicides and herbicides applied to grapes and for insecticides applied to cotton. The main factor driving the high elasticity for the grape clusters is the high elasticity of demand for grapes at the retail level. Demand for insecticides on cotton is

Table F.1
Summary of Estimates of Elasticity of Demand

Cluster	Elasticity Estimate
Herbicides on sugar beets, beans, peas	-0.12
Herbicides on tree fruits (except oranges), sugar cane, nuts	-0.20
Herbicides on tobacco	-0.20
Fungicides on fruit and nuts trees (except oranges)	-0.23
Fungicides for seed treatment	-0.27
Herbides on vegetables	-0.27
Fungicides on grain in storage	-0.31
Insecticides on vegetables	-0.33
Slimicides	-0.33
Fumigants and nematicides	-0.33
Insecticides on termites	-0.33
Wood preservatives	-0.33
Insect repellents at non-agricultural sites	-0.33
Domestic bug control and food processing plants	-0.33
Mosquito larvacides	-0.33
Fungicides on turf	-0.33
Industrial preservatives	-0.33
Insecticide synergists and surfactants	-0.33
Plant regulators, defoliants, desiccants	-0.33
Sanitizers - dairies, food processing, restaurants, air treatment	-0.33
Insecticides on livestock and domestic animals	-0.33
Industrial microbicides, cutting oils, oil well additives	-0.33
Preservatives, disinfectants, and slimicides	-0.33
Fungicides - ornamentals	-0.33
Insecticides on lawns, ornamentals and forest trees	-0.33
Unclassified uses	-0.33
Fungicides on vegetables	-0.38
Fungicides - broad spectrum	-0.40
Herbicides - broad spectrum	-0.48

Table F.1
Summary of Estimates of Elasticity of Demand

Cluster	Elasticity Estimate
Insecticides on soybeans, peanuts, wheat, tobacco	-0.56
Fungicides - post harvest	-0.65
Herbicides on rights of way, drainage ditches	-0.66
Herbicides on turf	-0.66
Herbicides on soybeans, cotton, peanuts, alfalfa	-0.67
Herbicides on corn	-0.69
Insecticides on corn and alfalfa	-0.69
Insecticides on sorghum	-0.69
Herbicides on sorghum, rice, small grains	-0.69
Herbicides on oranges	-1.00
Insecticides on fruit and nut trees, except oranges and grapes	-1.00
Insecticides on oranges	-1.00
Herbicides - other agricultural uses	-1.00
Insecticides on cotton	-1.06
Fungicides on grapes	-1.38
Herbicides on grapes	-1.38

Source: *Estimates of the Price Elasticity of Demand for Pesticide Clusters*, U.S. EPA and Abt Associates Inc., May 1991.

expected to be somewhat elastic, based on both the literature estimates of the elasticity and the low marginal productivity of insecticides applied to cotton.

The methodology used to estimate the elasticity of demand for the PAI clusters yields best estimates of elasticities. The estimates are good indicators of whether demand for a certain cluster of PAIs is extremely or only moderately elastic or inelastic; however, the specific numeric values should not be viewed as definitive. The estimated elasticities of demand for clusters of PAIs, developed through this analysis, are the most reliable estimates known at this time.

Baseline Quantities and Prices

The use of 272 PAIs in pounds by facilities is available from the Survey. EPA matched these PAIs to the clusters to which the PAIs belonged. The total weight of active ingredients is the facility's baseline quantity. A weighted average baseline price was approximated for each facility by dividing the

facility's revenue from PFPR activities involving the 272 PAIs (the sum of questions 3, 4 and 5 in Part B of the Survey) by the total weight of 272 PAIs used by the facility.

Post-Compliance Quantities and Prices

Because facility-level prices, costs, and compliance costs are not available for individual PAIs, clusters of PAIs, or pesticide products, an average pesticide demand elasticity was calculated for each facility based on the 272 PAIs used by the facility. The average elasticity of demand faced by a facility for pesticides was calculated by weighting the cluster elasticity estimates by the facility use of PAIs in each cluster:

$$E_k = \sum_{m=1}^{n} E_m \times \frac{PU_{m,k}}{PU_k}$$

where:

E_k = price elasticity of demand for 272 PAI pesticides faced by PFPR facility, k;

E_m = price elasticity of demand for cluster m;

$PU_{m,k}$ = use of PAIs in cluster m by facility k (lbs); and

PU_k = total use of 272 PAIs by facility k (lbs).

The change in the quantity of pesticide production resulting from price increases was calculated as:

$$\Delta Q_k = PER_k \times E_k \times Q_k$$

where:

ΔQ_k = change in production of 272 PAI pesticides at facility k (lbs.);

PER_k = percentage unit price increase for 272 PAI pesticide products at facility k (the percentage unit price increase is the amount necessary to recover one-half of the facility's total annualized cost of compliance assuming no change in production quantity);

E_k = price elasticity of demand faced by PFPR facility k; and

Q_k = pre-compliance production of 272 PAI pesticides at facility k (lbs.).

Post-Compliance Cash Flow

Under the assumption of a price-adjustment rule, three factors are accounted for in the estimate of post-compliance cash flow:

- the compliance costs, including capital and operating and maintenance;
- the change in revenue associated with the new price and quantity; and
- the decrease in variable costs of production resulting from reduced quantity of sales.

The post-compliance cash flow for a facility is calculated by adjusting baseline cash flow for each of these factors. The corresponding equation is:

$$PCCF = CF + (-CCadj + Radj + Cadj)$$

where:

PCCF = the post-compliance facility cash flow;
CF = facility baseline cash flow;
CCadj = compliance cost adjustment to cash flow;
Radj = the adjustment to cash flow from the change in revenue; and
Cadj = the adjustment to cash flow from the change in variable costs.

These three adjustments are discussed below.

Compliance Cost Adjustment

The compliance cost adjustment is identical to the adjustment under the zero cost pass-through assumption (see Chapter 4). Specifically, compliance costs have two components: capital costs and operating and maintenance costs. Full capital costs, funded both by debt and equity are included. An annualized capital cost was calculated by dividing the estimated capital and land investment by the present value factor, which is based on the weighted average cost of capital, as discussed in Chapter 4. In addition, the facility will pay reduced taxes as a result of depreciating the capital expenditures. Annual operating and maintenance costs are also offset somewhat by the reduction in taxes from reduced profits. The calculation is as follows:

$$CCadj = (OM \times (1-CT)) + (\frac{1}{PVF} \times CPT) - (\frac{CPT}{10} \times CT)$$

where:

CCadj = Compliance cost adjustment to cash flow;

OM	=	Operating and maintenance costs of compliance;
CT	=	Marginal corporate tax rate;
PVF	=	Present value factor; and
CPT	=	Capital costs of compliance.

Adjustment for Change in Revenue

The change in revenue contains two components: the increase in revenue resulting from the increase in price and the decrease in revenue resulting from the decrease in quantity. The change in revenue will be partially offset by the corresponding change in taxes. The calculation is as follows:

$$Radj = ((\Delta P \times PCQ) + (P \times \Delta Q)) \times (1-CT)$$

where:

Radj	=	Adjustment to cash flow due to the change in revenue;
ΔP	=	Change in price from baseline to post-compliance;
PCQ	=	Post-compliance quantity;
P	=	Baseline price;
ΔQ	=	Change in quantity from baseline to post-compliance; and
CT	=	Marginal corporate tax rate.

Adjustment for Change in Variable Cost of Production

The final adjustment to baseline cash flow reflects the decrease in variable costs resulting from decreased production. Variable costs were assumed to decrease in proportion to the decrease in quantity of pesticides produced. The decrease is again partially offset by an increase in taxes. The equation is:

$$Cadj = -\left(\frac{\Delta Q}{Q} \times VC\right) \times (1-CT)$$

where:

Cadj	=	Adjustment to the cash flow due to the change in variable costs;
ΔQ	=	Change in 272 PAI pesticide quantity from baseline to post-compliance;
Q	=	Baseline 272 PAI pesticide quantity;
VC	=	Eestimated variable cost associated with 272 PAI pesticide production; and
CT	=	Marginal corporate tax rate.

F.2 Results Using the Price-Adjustment Rule

Under the price-adjustment rule, the estimated impacts are unchanged from the analysis in the EIA using a zero cost pass-through methodology. These estimated impacts are presented in Table F-2 for the five PSES options initially considered for regulating Subcategory C facilities.

Table F.2
National Estimates of Economic Impacts upon Subcategory C Facilities
(Assuming A Price Adjustment Rule)

	Option 1	Option 2	Option 3	Option 4	Option 5
-Facilities Incurring Costs	578	558	558	558	578
-Compliance Capital Costs ($000,000)	$79.0	$66.1	$66.1	$18.4	$21.0
-Total Annualized Compliance Costs ($000,000)	$32.6	$27.9	$27.9	$286.5	$360.2
-Facility Closures	9	1	1	7	7
-Moderate Economic Impacts	171	170	170	193	217
-Worst Case Expected Job Losses (FTEs)	437	426	426	1,113	1,173

Cost-Effectiveness Analysis of Proposed Effluent Limitations Guidelines and Standards for the Pesticide Formulating, Packaging, and Repackaging Industry

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Section 1
Introduction

This analysis is submitted in support of the proposed effluent limitations guidelines and standards for the Pesticide Formulating, Packaging, and Repackaging (PFPR) Industry. The report analyzes the cost-effectiveness of six alternative Pretreatment Standards for Existing Sources (PSES) regulatory options for Subcategory C facilities based on the original 272 pesticide active ingredients (PAIs) studied for regulation. An additional Subcategory C PSES option covering all PAIs (except sodium hypochlorite) is analyzed. Also, two PSES regulatory options for Subcategory E facilities are evaluated.

Section 2 of the report defines cost-effectiveness, discusses the cost-effectiveness methodology, and describes the relevant regulatory options. Section 3 presents the findings of the analysis covering only the original 272 PAIs. Section 4 provides the results of the analysis of the option including non-272 PAIs. In Section 5, the cost-effectiveness values are compared to cost-effectiveness values for other promulgated rules. Four appendices are also included. Appendix A lists the original 272 pesticide active ingredients on which this analysis is based. Appendix B lists the toxic weighting factors for these 272 PAIs. Appendix C describes the cost-effectiveness results for direct discharging facilities to comply with the existing Best Practicable Control Technology Currently Available (BPT) regulation. Finally, Appendix D provides a sensitivity analysis of POTW removal efficiencies for PAIs.

Section 2
Methodology

This section defines cost-effectiveness, describes the steps taken in the cost-effectiveness analysis, and characterizes the regulatory options considered in the analysis.

Cost-effectiveness calculations are used in setting effluent limitations guidelines to compare the efficiency of one regulatory option in removing pollutants to another regulatory option. Cost-effectiveness is defined as the incremental annual cost of a pollution control option in an industry or industry subcategory per incremental pollutant removal. The increments considered are relative to another option or to a benchmark, such as existing treatment. Pollutant removals are measured in copper-based "pounds-equivalent." The cost-effectiveness value, therefore, represents the unit cost of removing the next pound-equivalent of pollutant. While not required by the Clean Water Act, cost-effectiveness analysis is a useful tool for evaluating regulatory options for the removal of toxic pollutants. Cost-effectiveness analysis is not intended to analyze the removal of conventional pollutants (oil and grease, biological oxygen demand, and total suspended solids). The removal of conventional pollutants is therefore not addressed in this report.

Three factors are of particular importance in cost-effectiveness calculations: (1) the normalization of pounds of pollutant removed to copper-based pounds-equivalent; (2) the incremental nature of cost-effectiveness, and (3) the fact that cost-effectiveness results are used for comparison purposes rather than on an absolute basis. First, the analysis is based on removals of pounds-equivalent - a term used to describe a pound of pollutant weighted by its toxicity relative to copper. These weights are known as toxic weighting factors. Copper is used as the standard pollutant for developing toxic weighting factors because it is a toxic metal commonly released in industrial effluent and removed from that effluent. The use of pounds-equivalent reflects the fact that some pollutants are more toxic than others. Also, by expressing removals in common terms, the removals can be summed across pollutants to give a meaningful basis for comparing cost-effectiveness results among alternative regulatory options or different regulations.

Second, cost-effectiveness analysis is done on an incremental basis to compare the incremental or marginal cost and removals of one control option to another control option or to existing treatment.

The third point is that no absolute scales exist for judging cost-effectiveness values. The values are considered high or low only within a given context, such as similar discharge status or compared to effluent limitations guidelines for other industries.

Cost-effectiveness analysis involves a number of steps, which may be summarized as follows:

- Determine the relevant wastewater pollutants;
- Estimate the relative toxic weights of priority and other pollutants;
- Define the pollution control approaches;
- Calculate pollutant removals for each control option;
- Determine the annualized cost of each control option;
- Rank the control options by increasing stringency and cost;
- Calculate incremental cost-effectiveness values; and
- Compare cost-effectiveness values.

These steps are discussed below.

Pollutant Discharges Considered in the Cost-Effectiveness Analysis

Some of the factors considered in selecting pollutants for regulation include toxicity, frequency of occurrence, and amount of pollutant in the wastestream. The cost-effectiveness of the Pesticide Formulator, Packager, and Repackager (PFPR) effluent limitations guidelines is based on 272 pesticide active ingredients (PAIs). A list of these pollutants is shown in Appendix A. Because priority pollutants generally do not appear in PFPR wastewater, no priority pollutants are included in the analysis.

Relative Toxic Weights of Pollutants

Cost-effectiveness analyses account for differences in toxicity among the regulated pollutants by using toxic weighting factors (TWFs). These factors are necessary because different pollutants have different potential effects on human and aquatic life. For example, a pound of nickel (TWF=0.036) in an effluent stream has significantly less potential effect than a pound of cadmium (TWF=5.12). The toxic weighting factors are used to calculate the pound-equivalent unit - a standardized measure of toxicity.

In the majority of cases, toxic weighting factors are derived from both chronic freshwater aquatic criteria (or toxic effect levels) and human health criteria (or toxic effect levels) established for the consumption of fish.[1] These factors are then standardized by relating them to copper.[2] The resulting toxic weighting factors for each PAI are provided in Appendix B. Some examples of the effects of different aquatic and human health criteria on weighting factors are shown in Table 1.

Table 1
Weighting Factors Based on Copper Freshwater Chronic Criteria

Pollutant	Human Health Criteria* (μg/l)	Aquatic Chronic Criteria (μg/l)	Weighting Calculation	Toxic Weighting Factor
Copper**	--	12.0	5.6/12.0	0.467
Hexavalent Chromium	3,400	11.0	5.6/3,400 + 5.6/11	0.511
Nickel	4,600	160.0	5.6/4,600 + 5.6/160	0.036
Cadmium	170	1.1	5.6/170 + 5.6/1.1	5.12
Benzene	12	265.0	5.6/12 + 5.6/265	0.488

Criteria are maximum contamination thresholds. Using the above calculation, the greater the values for the criteria used, the lower the toxic weighting factor. Units for criteria are micrograms of pollutant per liter of water.

* Based on ingestion of 6.5 grams of fish per day.

** While the water quality criterion for copper has been revised (to 12.0 μg/l), the cost-effectiveness analysis uses the old criterion (5.6 μg/l) to facilitate comparisons with cost-effectiveness values for other effluent limitations guidelines. The revised higher criteria for copper results in a toxic weighting factor for copper not equal to 1.0 but equal to 0.467.

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[1]A complete discussion of the development of the toxic weighting factors can be found in *Toxic Weighting Factors for Pesticide Active Ingredients and Priority Pollutants* Final Report, July 13, 1993, located in the Administrative Record.

[2]While the water quality criterion for copper has been revised (to 12.0 μg/l), the cost-effectiveness analysis uses the old criterion (5.6 μg/l) to facilitate comparisons with cost-effectiveness values for other effluent limitations guidelines. The revised higher criterion for copper results in a toxic weighting factor for copper equal to 0.467, not 1.0.

As indicated in Table 1, the toxic weighting factor is the sum of two criteria-weighted ratios: the "old" copper criterion divided by the human health criterion for the particular pollutant, and the "old" copper criterion divided by the aquatic chronic criterion. For example, using the values reported in Table 1, 10.96 pounds of copper pose the same relative hazard in surface waters as one pound of cadmium, since cadmium has a toxic weight 10.96 times (5.12/0.467 = 10.96) as large as the toxic weight of copper.

Pollution Control Options

This analysis considers the cost-effectiveness of a Pretreatment Standard for Existing Sources (PSES) regulation applicable to indirect discharging facilities. Two Subcategories of facilities are examined: Subcategory C (Pesticide Formulating, Packaging, and Repackaging Facilities), and Subcategory E (Refilling Establishments). Six PSES regulatory options are evaluated for Subcategory C facilities, and two PSES options are evaluated for Subcategory E facilities. The six options examined for Subcategory C facilities are as follows:

- **Option 1** consists of end-of-pipe treatment for the entire wastewater volume now generated by PFPR facilities through the Universal Treatment System[3] and discharge to POTWs.

- **Option 2** adds pollution prevention by recycling wastewaters generated from cleaning the interiors of formulating and packaging equipment and raw material and shipping containers into the product to recover product value in the wastewaters. Other wastewaters are still expected to be treated through the Universal Treatment System and discharged to POTWs.

- **Option 3** employs the same technology and pollution prevention practices as Option 2 but achieves zero discharge of all process wastewater by recycling the wastewater back to the facility after treatment through the Universal Treatment System.

[3]The Universal Treatment System consists of chemical emulsion breaking, hydrolysis, chemical oxidation, sulfide precipitation and activated carbon filtration treatment technologies.

- **Option 3/S** corresponds to Option 3 except that certain non-interior source wastewater streams are exempted from the regulatory requirements. Specifically, for facilities that process sanitizer chemicals, *the zero discharge requirement would not apply to physically separate, non-interior wastewater streams that contain only six sanitizer chemicals.* These non-interior wastewater streams include exterior equipment and floor wash, leak and spill cleanup, safety equipment rinsate, contaminated precipitation run-off, laboratory wastewater, air pollution control wastewater, and DOT test bath water. The *zero discharge requirement would apply to the interior wastewater streams of these facilities including discharge from cleaning the interiors of drum/shipping containers, bulk containers, and other equipment.*

- **Option 4** incorporates the pollution prevention aspects of Options 2 and 3, but instead of treatment, adds off-site disposal to an incinerator of the rest of the wastewater.

- **Option 5** disposes of all wastewater through off-site incineration.

The two options considered for Subcategory E facilities are:

- **Option 1** assumes that contaminated wastewater is used as make-up water in the application of pesticide chemicals to the field.

- **Option 2** disposes of wastewater through off-site incineration.

Calculation of Pollutant Removals

The reductions in pollutant loadings to the receiving water body were calculated for each control option. At-stream and end-of-pipe pollutant removals may differ because a portion of the end-of-pipe loadings for indirect dischargers may be removed by the POTW. As a result, the at-stream removal of pollutants due to PSES regulations are considered to be less than end-of-pipe removals. The cost-effectiveness analysis is based upon removals at-stream.

For example, if a facility is discharging 100 pounds of cadmium in its effluent stream to a POTW and the POTW has a removal efficiency for cadmium of 38 percent, then the cadmium discharged to

surface waters is only 62 pounds. If a regulation results in a reduction of cadmium in the effluent stream to 50 pounds, then the amount discharged to surface waters is calculated as 50 pounds multiplied by the POTW removal efficiency factor (1 - 0.38, or 0.62). Cost-effectiveness calculations reflect the fact that the actual reduction of pollutant discharge to surface waters is not 50 pounds (the change in the amount discharged to the POTW), but 31 pounds (= 62 - 31), the change in the amount ultimately discharged to surface waters.[4]

Annualized Costs for Each Control Option

Full details of the methods by which the costs of complying with the regulatory options were estimated can be found in the Technical Development Document. A brief summary of the compliance cost analysis is provided below.

Two categories of compliance costs were analyzed: (1) capital costs, and (2) operating and maintenance costs (including sludge disposal and self-monitoring costs). Although capital costs are one-time "lump sum" costs, operating and maintenance costs occur annually. The capital equipment is conservatively estimated to have a productive life of ten years. Using a real weighted average cost of capital, the capital costs are amortized to account for the cost of financing the investment (through equity and debt) over the ten-year period.[5] Total annualized costs are equal to annualized capital costs plus operating and maintenance costs. For ease of estimating costs, EPA assumed that non-manufacturing PFPR facilities have no treatment in place. For the PFPR/manufacturing facilities, it is assumed that, if possible, the facilities will build on existing treatment. The reported costs are the full costs of compliance to society, some of which will be borne by the government in the form of decreased tax receipts. The analysis therefore overstates the burden of the regulations on industry.

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[4]POTW removal efficiencies are not available for PAIs and are assumed to be zero. A laboratory study of the PAI removal performance that would be achieved by biotreatment at well-operated POTWs applying secondary treatment is reported in the Domestic Sewage Study (see the Technical Development Document). However, the data used for that analysis were derived under laboratory conditions, and therefore tend to overestimate POTW removal efficiencies and are considered to be inappropriate for the cost-effectiveness analysis. A sensitivity analysis based on 50 percent POTW removal efficiency for all PAIs is considered in Appendix D.

[5]For details on the real weighted average cost of capital, see the discussion of the facility impact analysis in *Economic Impact Analysis of Proposed Effluent Limitations Guidelines and Standards for the Pesticide Formulating, Packaging, and Repackaging Industry* (hereafter the Proposed EIA).

Compliance costs were estimated in terms of 1988 dollars. For the purpose of comparing cost-effectiveness values of the options under review to those of other promulgated rules, the compliance costs used in the cost-effectiveness analysis are deflated from to 1981 dollars using Engineering News Record's Construction Cost Index (CCI). This adjustment factor is:

$$\textit{Adjustment factor} = \frac{1981\ CCI}{1988\ CCI} = \frac{3535}{4519} = 0.7823$$

Stringency and Cost Ranking

The regulatory options are ranked to determine relative cost-effectiveness. Options are first ranked in increasing order of stringency, where stringency is aggregate pollutant removals, measured in pounds-equivalent. If two or more options remove equal amounts of pollutants, these options are then ranked in increasing order of cost. For example, if two or more options specify zero discharge, the removals under each option would be equal. The options would then be ranked from least expensive to most expensive.

Calculation of Incremental Cost-Effectiveness Values

After the options have been ranked by stringency and cost, the incremental cost-effectiveness values can be calculated. Cost-effectiveness values are calculated separately for Subcategories C and E. For a given subcategory, the cost-effectiveness value of a particular option is calculated as the incremental annual cost of that option divided by the incremental pounds-equivalent removed by that option. Algebraically, this equation is:

$$CE_k = \frac{ATC_k - ATC_{k-1}}{PE_k - PE_{k-1}}$$

where:

CE_k	=	Cost-effectiveness of Option k;
ATC_k	=	Total annualized compliance cost under Option k; and
PE_k	=	Removals in pounds-equivalent under Option k.

The numerator of the equation is the incremental cost in going from Option k-1 to Option k. Similarly, the denominator is the incremental removals associated with the move from Option k-1 to Option k. Thus, cost-effectiveness values are measured in dollars per pound-equivalent of pollutant removed. The incremental change can be from another regulatory option or from a baseline scenario.

Comparisons of Cost-Effectiveness Values

Two types of comparisons are typically done using cost-effectiveness values. First, compliance costs and pollutant removals may be plotted to derive a marginal cost curve to determine which options offer the most cost-effective regulatory control. The cost-effectiveness value calculated in the move from one option to another represents such a marginal cost curve. Second, the cost-effectiveness of regulatory options incremental to the baseline scenario can be used to assess the cost-effectiveness of controls relative to previously promulgated effluent limitations guidelines for other industries.

Section 3
Results Using Original 272 PAIs

The cost-effectiveness analysis is based on EPA's estimates of the full societal cost of compliance and wastewater pollutant removals associated with six Pretreatment Standards for Existing Sources (PSES) options for indirect discharging Subcategory C (Pesticide Formulating, Packaging, Repackaging Facilities) and two PSES options for Subcategory E (Refilling Establishments).

Subcategory C

Table 2 presents the estimated total annualized costs, total pounds and total pounds-equivalent of pollutants removed for the six options.

Table 2
National Estimate of Annualized Costs and Removals Under PSES
SUBCATEGORY C FACILITIES

Option	Annualized Cost, MM $ (1981 dollars)	Pound Removals	Pound-Equivalent Removals
Option 1	$25.4	111,653	12,127,075
Option 2	$21.8	111,683	12,127,666
Option 3/S	$20.4	111,793	12,134,031
Option 3	$21.8	111,996	12,134,051
Option 4*	$224.1	111,996	12,134,051
Option 5*	$281.8	111,996	12,134,051
*These options result in additional costs with no additional removals.			

Table 3 presents the incremental cost-effectiveness values for the six options considered for Subcategory C. As the table shows, the cost-effectiveness of Option 1 is $2.10 per pound-equivalent of pollutant removed. Option 1 is very cost-effective when compared to the cost-effectiveness values of other effluent limitations guidelines. Movement from Option 1 to Option 2 and from Option 2 to Option 3/S is cost-effective relative to Option 1 because costs are reduced while removals increase. Movement from Option 3/S to Option 3 is substantially less efficient than movement from Option 1 to Option 2 or

from Option 2 to Option 3/S. The average cost-effectiveness of Option 3 is $1.79 per pound-equivalent and for Option 3/S is $1.68. Options 4 and 5 are not cost-effective as they result in additional costs with no additional removals relative to Option 3. Option 3/S is the most cost-effective option. Successive improvements in weighted removals are achieved at progressively lower costs by moving from Option 1 through Option 2 to Option 3/S. Further movement from Option 3/S to Options 3, 4 or 5 provides minor additional removals at substantially higher marginal cost.

Table 3
Estimated Industry Incremental Cost-Effectiveness Under PSES
SUBCATEGORY C FACILITIES

Option	Cost-Effectiveness, $/lb.	Cost-Effectiveness, $/lb-eq.
Incremental from Baseline to Option 1	$227.87	$2.10
Incremental from Option 1 to Option 2	-$121,746*	-$6,232*
Incremental from Option 2 to Option 3/S	-$12,513*	-$215.86*
Incremental from Option 3/S to Option 3	$6,790	$71,252
Incremental from Option 3 to Option 4	undefined**	undefined**
Incremental from Option 4 to Option 5	undefined**	undefined**

Dollar values are in constant 1981 dollars.

* Options are ranked by increasing levels of pollutant removals. Negative cost-effectiveness numbers mean that costs have decreased from the previous option, while removals have increased, improving cost-effectiveness.

** These options result in additional costs with no additional removals. Therefore, the incremental cost-effectiveness ratio (incremental cost/incremental removals) is undefined.

EPA is not able to estimate cost-effectiveness values for the regulatory options by PAIs or groups of PAIs for several reasons. First, wastestreams containing multiple PAIs are often commingled at PFPR facilities. This commingling occurs because of the physical set-up of the PFPR lines and because products are often made with more than one PAI. EPA estimated compliance costs on a facility-specific basis, in part due to this commingling, therefore costs are not available at a PAI-specific level within a facility.

EPA is able, however, to estimate cost-effectiveness values classifying facilities by their primary markets. Question 19 of the Survey Introduction asked respondents to report the percentage of pesticide revenue obtained from nine specific markets: agricultural, institutional/commercial, industrial, wood preservatives, intermediate products, professional use, consumer home/lawn/garden, government use, and additives. The analysis assumed that the market from which a facility received at least 50 percent of its pesticide revenue is the primary market for that facility. The primary market a facility reports does not necessarily relate to the PAIs used by that facility. Many PAIs appear in products that have several uses, and those products may be used in more than one market. Table 4 provides the estimated industry incremental cost-effectiveness disaggregated by primary market. As the table illustrates, Option 3/S is cost-effective when considered relative to other effluent guidelines.

Table 4
Estimated Industry Incremental Cost-Effectiveness Under PSES,
Disaggregated by Primary Market
SUBCATEGORY C FACILITIES
($ / lb-eq)

Option	Agricultural Market	Institutional / Commercial Market	Industrial Market	Wood Preserv. Market	Intermed. Market	Profess. Use Market	Cons. Home / Lawn / Garden Market	Govt Use Market	Additives Market
Incremental from Baseline to Option 1	inefficient*	inefficient*	inefficient*	inefficient*	inefficient*	inefficient*	inefficient*	inefficient*	inefficient*
Incremental from Option 1 to Option 2	inefficient*	inefficient*	inefficient*	inefficient*	inefficient*	inefficient*	inefficient*	inefficient*	inefficient*
Incremental from Baseline to Option 3/S	$3.61	$1.64	$27.88	$0.62	$8.34	$113.76	$0.39	$28.32	$6.51
Incremental from Option 3/S to Option 3	**	$77,785	$2,279	$24,621	**	**	$59,990	**	$285 MM
Incremental from Option 3 to Option 4	**	**	**	**	**	**	**	**	**
Incremental from Option 4 to Option 5	**	**	**	**	**	**	**	**	**

Dollar values are in constant 1981 dollars.

* Options are ranked by increasing levels of pollutant removals. Options labelled as "inefficient" achieve lower removals, or have higher costs, or both, relative to Option 3/S.

** These options result in additional costs with no additional removals. Therefore, the incremental cost-effectiveness ratio (incremental cost/incremental removals) is undefined.

Subcategory E

Table 5 presents the estimated total annualized costs, total pounds, and total pounds-equivalent of pollutants removed for the two options considered for Subcategory E facilities. Option 1, the proposed option, is expected to be achieved with zero additional costs.

Table 5 National Estimate of Annualized Costs and Removals Under PSES SUBCATEGORY E FACILITIES			
Option	**Annualized Cost, (1981 dollars)**	**Pound Removals**	**Pound-Equivalent Removals**
Option 1	$0	1.0	1.3
Option 2*	$1,507	1.0	1.3
*This option results in additional costs with no additional removals.			

Because Option 1 is expected to be met with no additional compliance costs, its cost-effectiveness is zero. Option 2 requires additional costs but results in no additional removals, so its cost-effectiveness value is undefined. Therefore, Option 1 is the more cost-effective option.

Section 4
Results Using Additional Non-272 PAIs

EPA also estimated the cost-effectiveness of including under the proposed option all other PAIs not on the list of 272 PAIs studied in detail. This section presents the estimated cost-effectiveness of including these additional PAIs under the proposed PSES regulation for Subcategory C facilities. The regulatory option considered in this section is the same as Option 3/S discussed in the preceding section, with the exception that its regulatory coverage is broadened to include the additional non-272 PAIs. To distinguish the analysis of the proposed regulation including the non-272 PAIs from the preceding analysis based only on the 272 PAIs, the following discussion refers to the regulation *including coverage of the additional non-272 PAIs* as Option 3/S′.

Because toxic weighting factors are not available for the non-272 PAIs, two separate cost-effectiveness analyses of Option 3/S′ were performed. The first analysis assumes that no non-272 PAIs are removed from the wastestreams. This is a highly conservative approach, because costs to treat the non-272 PAIs are included, but credit is not taken for removal of those PAIs.[6] The second analysis estimates an average toxic weighting factor for the non-272 PAIs based on the toxic weighting factors of the original 272 PAIs. These analyses and results are discussed below.

Without Considering Non-272 PAI Removals

To conservatively estimate the cost-effectiveness of Option 3/S′, EPA calculated the cost-effectiveness of the option accounting for costs to remove non-272 PAIs but without considering the additional removals of non-272 PAIs. Table 6 presents the total annualized compliance costs and removals under this assumption.

Table 6
National Estimate of Annualized Costs and Removals Under PSES of Option 3/S′, Considering Non-272 PAI Costs but not Non-272 PAI Removals
SUBCATEGORY C FACILITIES

Option	Annualized Cost, MM $ (1981 dollars)	Pound Removals	Pound-Equivalent Removals
Option 3/S′	$43.9	111,793	12,134,031

[6]For a discussion of the compliance cost estimates under Option 3/S′, see Chapter 12 of the EIA.

Under this conservative assumption, the average cost-effectiveness of Option 3/S′ is $3.62 per pound-equivalent. Thus, Option 3/S′ is very cost-effective when compared to the cost-effectiveness values of other effluent limitations guidelines.

Considering Non-272 PAI Removals

A more realistic assessment of the cost-effectiveness of Option 3/S′ would recognize the additional pollutant removals achieved by the inclusion of the non-272 PAIs. Toxic weighting factors (TWFs) for these additional PAIs are not available, however. To provide a surrogate for the TWFs for these PAIs, EPA assumed that the weighted average toxicity of the pre-compliance loadings of non-272 PAIs is the same as that for pre-compliance loadings of the original 272 PAIs. Specifically, EPA estimated an weighted average TWF for the non-272 PAIs by dividing the pre-compliance pound-equivalent loadings of 272 PAIs by the pre-compliance loadings in pounds. This ratio yielded a weighted average TWF of 108.3436. The estimated pre-compliance loadings in pounds of non-272 PAIs was multiplied by this average TWF to provide pre-compliance pound-equivalent loadings.

For the post-compliance analysis, all loadings are among the designated sanitizer PAIs. To estimate the toxic-weighted loadings of the non-272 sanitizer PAIs in post-compliance discharge, EPA assumed that the weighted average toxicity of these loadings would be the same as the simple average of TWFs for the sanitizer PAIs among the original 272 PAIs. Specifically, EPA multiplied the average TWF for 272 sanitizer PAIs (0.1953) by the post-compliance loadings of non-272 sanitizer PAIs to estimate the pound-equivalent loadings of these PAIs. The quantity of pollutant removals due to Option 3/S′ was then calculated as the difference between the pre-compliance and post-compliance loadings. Table 7 presents the total and incremental estimates of compliance costs, pollutant removals, and cost-effectiveness, using these average TWFs for non-272 PAIs.

Table 7
National Estimate of Annualized Costs and Removals Under PSES of Option 3/S′, Considering Non-272 PAI Costs and Removals
SUBCATEGORY C FACILITIES

Option	Annualized Cost, MM $ (1981 dollars)	Pound Removals	Pound-Equivalent Removals	Cost-Effectiveness, $ / lb-eq.
Option 3/S	$20.4	111,793	12,134,031	$1.68
Incremental from Option 3/S to Option 3/S′	$23.5	198,662	21,613,832	$1.09
Option 3/S′	$43.9	310,455	33,747,863	$1.30

Note: Toxicity of the non-272 PAIs is estimated as the average pre-compliance loading-weighted average toxicity of the 272 PAIs.

As Table 6 indicates, Option 3/S′ is very cost-effective when compared to the cost-effectiveness values of other effluent limitations guidelines. Movement from Option 3/S to Option 3/S′ is cost-effective; the incremental cost-effectiveness value is $1.09 per pound-equivalent. The average cost-effectiveness of Option 3/S′ is $1.30 per pound-equivalent.

Section 5
Comparision of Cost-Effectiveness Values with Promulgated Rules

Table 8 illustrates the cost-effectiveness values for effluent limitations guidelines issued for indirect dischargers in other industries. The proposed PSES rule for pesticide formulating, packaging, repackaging facilities is cost-effective when compared to the cost-effectiveness values for other effluent limitations guidelines.

Table 8
Industry Comparison of Cost-Effectiveness for
Indirect Dischargers
(Toxic and Nonconventional Pollutants Only)
Copper Based Weights
(1981 Dollars)*

Industry	Pounds Equivalent Currently Discharged (To Surface Waters) (000's)	Pounds Equivalent Remaining at Selected Option (To Surface Waters) (000's)	Cost Effectiveness Selected Option Beyond BPT** ($/lb-eq. removed)
Aluminum Forming	1,602	18	155
Battery Manufacturing	1,152	5	15
Can Making	252	5	38
Coal Mining***	N/A	N/A	N/A**
Coil Coating	2,503	10	10
Copper Forming	34	4	10
Electronics I	75	35	14
Electronics II	260	24	14
Foundries	2,136	18	116
Inorganic Chemicals I	3,971	3,004	9
Inorganic Chemicals II	4,760	6	****
Iron & Steel	5,599	1,404	6
Leather Tanning	16,830	1,899	111
Metal Finishing	11,680	755	10
Nonferrous Metals Forming	89	5	90
Nonferrous Metals Mfg I	3,187	19	15
Nonferrous Metals Mfg II	38	0.41	12
OCPSF	5,210	72	34
Pesticide Manufacturing	257	19	18
Pharmaceuticals	340	63	1
Plast. Molding & Forming	N/A	N/A	N/A
Porcelain Enameling	1,565	96	14
Pulp & Paper *****	9,539	103	65

* Although toxic weighting factors for priority pollutants varied across these rules, this table reflects the cost-effectiveness at the time of regulation.
** N/A: Pretreatment Standards not promulgated, or no incremental costs will be incurred.
*** Reflects costs and removals of both air and water pollutants
**** Less than a dollar.
***** Results shown for proposed rules, December 1993.

Appendix A

Original 272 Pesticide Active Ingredients Considered for Regulation

This appendix provides the original 272 pesticide active ingredients considered for regulation.

Pesticide Number	Pesticide Name	CAS Number
1	Dicofol [1,1-Bis(chlorophenyl)-2,2,2-trichloroethanol]	00115-32-2
2	Maleic Hydrazide	00123-33-1
3	EDB [1,2-Ethylene dibromide]	00106-93-4
4	Vancide TH [1,3,5-Triethylhexahydro-s-triazine]	07779-27-3
5	Dichloropropene	00542-75-6
6	Oxybiphenoarsine	00058-36-6
7	Dowicil 75 [1-(3-Chloroallyl)-3,5,7-triaza-1-azoniaadamantanechloride]	04080-31-3
8	Triadimefon	43121-43-3
9	Hexachlorophene (nabac)	00070-30-4
10	Tetrachlorophene	01940-43-8
11	Dichlorophene	00097-23-4
12	Dichlorvos	00062-73-7
13	Landrin-2 [2,3,5-trimethylphenylmethylcarbamate]	02686-99-9
14	Fenac [2,3,6-Trichlorophenylacetic acid] or any salt or ester	00085-34-7
15	2,4,5-T [2,4,5-Trichlorophenoxyacetic acid] or any salt or ester	00093-76-5
16	2,4-D [2,4-Dichlorophenoxyacetic acid] or any salt or ester	00094-75-7
17	2,4-DB [2,4-Dichlorophenoxybutyric acid] or any salt or ester	00094-82-6
18	Anilazine [2,4-Dichloro-6-(o-chloroanilino)-s-triazine]	00101-05-3
19	Dinocap	39300-45-3
20	Dichloran (2,6-dichloro-4-nitroaniline)	00099-30-9
21	Busan 90 [2-Bromo-4-hydroxyacetophenone]	02491-38-5
22	Mevinphos	07786-34-7
23	Sulfallate [2-chloroallyldiethyldithiocarbamate]	00095-06-7
24	Chlorfenvinphos	00470-90-6
25	Cyanazine	21725-46-2
26	Propachlor	01918-16-7
27	MCPA [2-Methyl-4-chlorophenoxyacetic acid] or any salt or ester	00094-74-6
28	Octhilinone	26530-20-1
29	Pindone	00083-26-1
30	Dichlorprop [2-(2,4-Dichlorophenoxy) propionic acid] or any salt or ester	00120-36-5
31	MCPP [2-(2-Methyl-4-chlorophenoxy)propionic acid] or any salt or ester	00093-65-2
32	Thiabendazole	00148-79-8
33	Belclene 310 [2-(methylthio)-4-(ethylamino)-6-(1,2-dimethylamino)-s-triazine]	22936-75-0
34	Cloprop [2-(m-Chlorophenoxy)propionic acid] or any salt or ester	00101-10-0
35	TCMTB [2-(Thiocyanomethylthio)benzothiazole]	21564-17-0

Pesticide Number	Pesticide Name	CAS Number
36	HAE [2-((Hydroxymethyl)amino) ethanol	34375-28-5
37	Chlorophacinone	03691-35-8
38	Landrin-1 [3,4,5-trimethylphenylmethylcarbamate]	02686-99-9
39	Pronamide	23950-58-5
40	Methiocarb	02032-65-7
41	Propanil	00709-98-8
42	Polyphase antimildew [3-Iodo-2-propynyl butylcarbamate]	55406-53-6
43	3-(a-Acetonylfurfuryl)-4-hydroxycoumarin [Coumafuryl] or any salt or ester	00117-52-2
44	DNOC (4,6-dinitro-o-cresol)	00534-52-1
45	Metribuzin	21087-64-9
46	CPA (4-chlorophenoxyacetic acid) or any salt or ester	00122-88-3
47	MCPB [4-(2-Methyl-4-chlorophenoxy)butyric acid] or any salt or ester	00094-81-5
48	Aminocarb [4-(dimethylamino)-m-tolylmethylcarbamate]	02032-59-9
49	Etridiazole	02593-15-9
50	Ethoxyquin	00091-53-2
51	Quinoliol sulfate (8-Quinoliol sulfate)	00134-31-6
52	Acephate	30560-19-1
53	Acifluorfen or any salt or ester	50594-66-6
54	Alachlor	15972-60-8
55	Aldicarb	00116-06-3
56	Hyamine 3500 [Alkyl* dimethyl benzyl ammonium chloride * (50% C14, 40% C12, 10% C16)]	68424-85-1
57	Allethrin (all isomers and allethrin coil)	00584-79-2
58	Ametryn	00834-12-8
59	Amitraz	33089-61-1
60	Atrazine	01912-24-9
61	Bendiocarb	22781-23-3
62	Benomyl and Carbendazim	17804-35-2
63	Benzene Hexachloride	00608-73-1
64	Benzyl benzoate	00120-51-4
65	Lethane 384 [Beta-Thiocyanoethyl esters of mixed fatty acids containing from 10-18 carbons]	00301-11-1
66	Bifenox	42576-02-3
67	Biphenyl	00092-52-4
68	Bromacil or any salt or ester	00314-40-9
69	Bromoxynil or any salt or ester	01689-84-5
70	Butachlor	23184-66-9

Pesticide Number	Pesticide Name	CAS Number
71	Giv-gard [β-Bromo-β-nitrostyrene]	07166-19-0
72	Cacodylic acid or any salt or ester	00075-60-5
73	Captafol	02425-06-1
74	Captan	00133-06-2
75	Carbaryl [Sevin]	00063-25-2
76	Carbofuran	01563-66-2
77	Carbosulfan	55285-14-8
78	Chloramben or any salt or ester	00133-90-4
79	Chlordane	00057-74-9
80	Chloroneb	02675-77-6
81	Chloropicrin	00076-06-2
82	Chlorothalonil	01897-45-6
83	Chloroxuron	01982-47-4
84	Stirofos	00961-11-5
85	Chlorpyrifos methyl	05598-13-0
86	Chlorpyrifos	02921-88-2
87	Mancozeb	08018-01-7
88	Bioquin	10380-28-6
89	Copper EDTA	01495-19-18
90	Fenvalerate	51630-58-1
91	Cycloheximide	00066-81-9
92	Dalapon (2,2-dichloropropionic acid) or any salt or ester	00075-99-0
93	Dienochlor	02227-17-0
94	Demeton [O,O-Diethyl O-(and S-) (2-ethylthio)ethyl) phosphorothioate]	08065-48-3
95	Desmedipham	13684-56-5
96	Diammonium ethylenebisdithiocarbamate	03566-10-7
97	DBCP [Dibromo-3-chloropropane]	00096-12-8
98	Dicamba [3,6-Dichloro-o-anisic acid] or any salt or ester	01918-00-9
99	Dichlone (Phygon)	00117-80-6
100	Thiophanate ethyl	23564-06-9
101	Perthane [Diethyl diphenyl dichloroethane and related compounds]	00072-56-0
102	EXD [Diethyl dithiobis (thionoformate)]	00502-55-6
103	Diazinon	00333-41-5
104	Diflubenzuron	35367-38-5
105	Benzethonium chloride	00121-54-0
106	Dimethoate	00060-51-5

Pesticide Number	Pesticide Name	CAS Number
107	Parathion methyl	00298-00-0
108	Dicrotophos	00141-66-2
109	Crotoxyphos	07700-17-6
110	DCPA [Dimethyl 2,3,5,6-tetrachloroterephthalate]	01861-32-1
111	Trichlorofon	00052-68-6
112	Dinoseb	00088-85-7
113	Dioxathion	00078-34-2
114	Diphacinone	00082-66-6
115	Diphenamid	00957-51-7
116	Diphenylamine	00122-39-4
117	MGK 326 [Dipropyl isocinchomeronate]	00113-48-4
118	Nabonate [Disodium cyanodithioimidocarbonate]	00138-93-2
119	Diuron	00330-54-1
120	Metasol DGH [Dodecylguanidine hydrochloride]	13590-97-1
121	Dodine (dodecylquanidine acetate)	02439-10-3
122	Endosulfan [Hexachlorohexahydromethano-2,4,3-benzodioxathiepin-3-oxide]	00115-29-7
123	Endothall or any salt or ester	00145-73-3
124	Endrin	00072-20-8
125	Ethalfluralin	55283-68-6
126	Ethion	00563-12-2
127	Ethoprop	13194-48-4
128	Fenamiphos	22224-92-6
129	Chlorobenzilate	00510-15-6
130	Butylate	02008-41-5
131	Famphur	00052-85-7
132	Fenarimol	60168-88-9
133	Fenthion	00055-38-9
134	Ferbam	14484-64-1
135	Fluometuron	02164-17-2
136	Fluoroacetamide	00640-19-7
137	Folpet	00133-07-3
138	Glyphosate [N-(Phosphonomethyl) glycine] or any salt or ester	01071-83-6
139	Glyphosine	02439-99-8
140	Heptachlor	00076-44-8
141	Cycloprate	54460-46-7
142	Hexazinone	51235-04-2
143	Isofenphos	25311-71-1

Pesticide Number	Pesticide Name	CAS Number
144	Isopropalin	33820-53-0
145	Propham	00122-42-9
146	Karbutilate	04849-32-5
147	Lindane	00058-89-9
148	Linuron	00330-55-2
149	Malachite green [Ammonium(4-(p-(dimethylamino)-alpha-phenylbenzylidine)-2,5-cyclohexadien-1-ylidene)-dimethyl chloride]	00569-64-2
150	Malathion	00121-75-5
151	Maneb	12427-38-2
152	Manganous dimethyldithiocarbamate	15339-36-3
153	Mefluidide [N-(2,4-dimethyl-5-(((trifluoromethyl) sulfonyl)-amino) phenyl acetamide] or any salt or ester	53780-34-0
154	Methamidophos	10265-92-6
155	Methidathion	00950-37-8
156	Methomyl	16752-77-5
157	Methoprene	40596-69-8
158	Methoxychlor	00072-43-5
159	Methylbenzethonium chloride	15716-02-6
160	Methylbromide	00074-83-9
161	Methylarsonic acid or any salt or ester	00124-58-3
162	Hyamine 2389 [Methyldodecylbenzyl trimethyl ammonium chloride 80% and methyldodecylxylylene bis (trimethylammoniumchloride) 20%]	01399-80-0
163	Methylenebisthiocyanate	06317-18-6
164	Quinmethionate	02439-01-2
165	Metolachlor	51218-45-2
166	Mexacarbate	00315-18-4
167	Metiram	09006-42-2
168	Monuron TCA	00140-41-0
169	Monuron	00150-68-5
170	Napropamide	15299-99-7
171	Deet	00134-62-3
172	Nabam	00142-59-6
173	Naled	00300-76-5
174	Norea	18530-56-8
175	Norflurazon	27314-13-2
176	Naptalam [N-1-Naphthylphthalamic acid] or any salt or ester	00132-66-1
177	MGK 264 [N-2-Ethylhexyl bicycloheptene dicarboximide]	00136-45-8

Pesticide Number	Pesticide Name	CAS Number
178	Benfluralin	01861-40-1
179	Sulfotepp	03689-24-5
180	Aspon	03244-90-4
181	Coumaphos	00056-72-4
182	Fensulfothion	00115-90-2
183	Disulfoton	00298-04-4
184	Fenitrothion	00122-14-5
185	Phosmet	00732-11-6
186	Azinphos Methyl	00086-50-0
187	Oxydemeton methyl	00301-12-2
188	Organo-arsenic pesticides	-----
189	Organo-cadmium pesticides	-----
190	Organo-copper pesticides	-----
191	Organo-mercury pesticides	-----
192	Organo-tin pesticides	-----
193	Orthodichlorobenzene	00095-50-1
194	Oryzalin	19044-88-3
195	Oxamyl	23135-22-0
196	Oxyfluorfen	42874-03-3
197	Bolstar [Sulprofos]	35400-43-2
198	Sulprofos Oxon	38527-90-1
199	Santox (O-Ethyl O-(p-nitrophenyl) phenylphosphonothioate	02104-64-5
200	Fonofos	00944-22-9
201	Propoxur (o-Isopropylphenylmethylcarbamate)	00114-26-1
202	Paradichlorobenzene	00106-46-7
203	Parathion	00056-38-2
204	Pendimethalin	40487-42-1
205	Pentachloronitrobenzene	00082-68-8
206	Pentachlorophenol or any salt or ester	00087-86-5
207	Perfluidone	37924-13-3
208	Permethrin	52645-53-1
209	Phenmedipham	13684-63-4
210	Phenothiazine	00092-84-2
211	Phenylphenol	00090-43-7
212	Phorate	00298-02-2
213	Phosalone	02310-17-0
214	Phosphamidon	13171-21-6
215	Picloram or any salt or ester	01918-02-1

Pesticide Number	Pesticide Name	CAS Number
216	Piperonyl butoxide	00051-03-6
217	PBED (Busan 77) [Poly (oxyethylene (dimethylimino) ethylene (dimethylimino) ethylene dichloride]	31512-74-0
218	Busan 85 [Potassium dimethyldithiocarbamate]	00128-03-0
219	Busan 40 [Potassium N-hydroxymethyl-N-methyldithiocarbamate]	51026-28-9
220	KN Methyl [Potassium N-methyldithiocarbamate]	00137-41-7
221	Metasol J26 [Potassium N-(alpha-(nitroethyl) benzyl)-ethylenediamine]	53404-62-9
222	Profenofos	41198-08-7
223	Prometon	01610-18-0
224	Prometryn	07287-19-6
225	Propargite	02312-35-8
226	Propazine	00139-40-2
227	Propionic acid	00079-09-4
228	Propamocarb and Propamocarb HCL	24579-73-5
229	Pyrethrin coils	-----
230	Pyrethrin I	00121-21-1
231	Pyrethrin II	00121-29-9
232	Pyrethrum (other than pyrethrins)	08003-34-7
233	Resmethrin	10453-86-8
234	Ronnel	00299-84-3
235	Rotenone	00083-79-4
236	DEF [S,S,S-Tributyl phosphorotrithioate]	00078-48-8
237	Siduron	01982-49-6
238	Silvex [2-(2,4,5-Trichlorophenoxypropionic acid)] or any salt or ester	00093-72-1
239	Simazine	00122-34-9
240	Bentazon	25057-89-0
241	Carbam-S [Sodium dimethyldithiocarbanate]	00128-04-1
242	Sodium monofluoroacetate	00062-74-8
243	Vapam [Sodium methyldithiocarbamate]	00137-42-8
244	Sulfoxide	00120-62-7
245	Cycloate	01134-23-2
246	EPTC [S-Ethyl dipropylthiocarbamate]	00759-94-4
247	Molinate	02212-67-1
248	Pebulate	01114-71-2
249	Vernolate	01929-77-7
250	HPTMS [S-(2-Hydroxypropyl) thiomethanesulfonate]	29803-57-4

Pesticide Number	Pesticide Name	CAS Number
251	Bensulide	00741-58-2
252	Tebuthiuron	34014-18-1
253	Temephos	03383-96-8
254	Terbacil	05902-51-2
255	Terbufos	13071-79-9
256	Terbuthylazine	05915-41-3
257	Terbutryn	00886-50-0
258	Tetrachlorophenol or any salt or ester	25167-83-3
259	Dazomet	00533-74-4
260	Thiophanate methyl	23564-05-8
251	Thiram	00137-26-8
262	Toxaphene	08001-35-2
263	Merphos [Tributyl phosphorotrithioate]	00150-50-5
264	Trifluralin	01582-09-8
265	Warfarin [3-(a-Acetonylbenzyl)-4-hydroxycoumarin] or any salt or ester	00081-81-2
266	Zinc MBT [Zinc 2-mercaptobenzothiazolate]	00155-04-4
267	Zineb	12122-67-7
268	Ziram	00137-30-4
269	S-(2,3,3-trichloroallyl) diisopropylthiocarbamate	02303-17-5
270	Phenothrin	26002-80-2
271	Tetramethrin	07696-12-0
272	Chloropropham	00101-21-3

Appendix B
Toxic Weighting Factors for Pesticide Active Ingredients

This appendix provides the toxic weighting factors (TWFs) used in the analysis. Toxic weighting factors for pesticide active ingredients are listed in Table B-1.

Appendix C
Results of Compliance with the Existing 1978 BPT Regulation

This appendix describes the results of the cost-effectiveness analysis for direct discharging facilities to comply with the existing 1978 Best Practicable Control Technology Currently Available (BPT) regulation. The analysis is based on EPA's estimates of the full societal cost of compliance and wastewater pollutant removals associated with six BPT options for direct discharging Subcategory C facilities. These options are analogous to the PSES options described in Section 2.

Table C-1 presents the estimated total annualized costs, total pounds and total pounds-equivalent of pollutants removed for the six options.

Table C-1
National Estimate of Annualized Costs and Removals Under BPT
SUBCATEGORY C FACILITIES

Option	Annualized Cost, MM $ (1981)	Pound Removals	Pound-Equivalent Removals
Option 1	$5.9	49,411	72,258,866
Option 2	$5.5	49,415	72,259,368
Option 3/S	$5.5	49,435	72,259,886
Option 3	$5.5	49,435	72,259,886
Option 4*	$103.6	49,435	72,259,886
Option 5*	$107.6	49,435	72,259,886

*These options result in additional costs with no additional removals.

Table C-2 presents the incremental cost-effectiveness values for the six options considered. As the table shows, the cost-effectiveness of Option 1 is $0.08 per pound-equivalent of pollutant removed. That is very cost-effective when compared to the cost-effectiveness of other effluent limitations guidelines. Movement from Option 1 to Option 2 and from Option 2 to Option 3/S is cost-effective relative to Option 1 because costs are reduced while removals increase. Movement from Option 3/S to Option 3 results in

no additional costs or removals, so the incremental cost-effectiveness value is undefined. Options 4 and 5 are not cost-effective as they result in additional costs with no additional removals relative to Option 3/S. Option 3/S is the most cost-effective option. Successive improvements in weighted removals are achieved at progressively lower costs by moving from Option 1 through Option 2 to Option 3/S. Further movement from Option 3/S to Options 3, 4 or 5 provides minor additional removals at substantially higher marginal cost.

Table C-2
Estimated Industry Incremental Cost-Effectiveness Under BPT
SUBCATEGORY C FACILITIES

Option	Cost-Effectiveness, $/lb.	Cost-Effectiveness, $/lb-eq.
Incremental from Baseline to Option 1	$120.00	$0.08
Incremental from Option 1 to Option 2	-$90,723*	-$813.34*
Incremental from Option 2 to Option 3/S	$0	$0
Incremental from Option 3/S to Option 3	undefined**	undefined**
Incremental from Option 3 to Option 4	undefined**	undefined**
Incremental from Option 4 to Option 5	undefined**	undefined**

Dollar values are in constant 1981 dollars.

* Options are ranked by increasing levels of pollutant removals. Negative cost-effectiveness numbers mean that costs have decreased from the previous option, while removals have increased, improving cost-effectiveness.

** Option 3 results in the same costs and removals as Option 3/S. Options 4 and 5 result in additional costs with no additional removals. Therefore, the incremental cost-effectiveness ratio (incremental cost/incremental removals) is undefined.

Appendix D
Sensitivity Analysis of POTW Removal Efficiency

This appendix describes a sensitivity analysis applied to the assumption in the PSES cost-effectiveness analysis that pesticide active ingredients (PAIs) are not removed by POTWs. There is very little empirical data on the PAI removals actually achieved by POTWs. The only data available on POTW removal efficiencies for PAIs is from the Domestic Sewage Study (DSS) (Report to Congress on the Discharge of Hazardous Waste to Publicly Owned Treatment Works, February 1986, EPA/530-SW-86-004). The DSS provides laboratory data under ideal conditions to estimate biotreatment removal efficiencies at POTWs for different organic PAI structural groups. These data, however, are not full-scale/in-use POTW data and therefore, are not appropriate for use in the cost-effectiveness analysis.

For the sensitivity analysis it is assumed that POTWs remove 50 percent of the PAIs from the wastestream. The results are discussed below for Subcategory C and Subcategory E facilities.

Subcategory C

Table D-1 presents the estimated total annualized costs, total pounds and total pounds-equivalent of pollutants removed for the six options under the assumption of 50 percent POTW removal efficiency for PAIs.

Table D-1 National Estimate of Annualized Costs and Removals Under PSES SUBCATEGORY C FACILITIES Assuming 50 percent POTW Removal Efficiency for PAIs			
Option	**Annualized Cost, MM $ (1981 dollars)**	**Pound Removals**	**Pound-Equivalent Removals**
Option 1	$25.4	55,827	6,063,537
Option 2	$21.8	55,841	6,063,833
Option 3/S	$20.4	55,897	6,067,016
Option 3	$21.8	55,998	6,067,025
Option 4*	$224.1	55,998	6,067,025
Option 5*	$281.8	55,998	6,067,025
*These options result in additional costs with no additional removals.			

Table D-2 presents the incremental cost-effectiveness values for the six options considered for Subcategory C under the assumption of the sensitivity analysis. As the table shows, the cost-effectiveness of Option 1 is $4.20 per pound-equivalent of pollutant removed. Option 1 is very cost-effective when compared to the cost-effectiveness values of other effluent limitations guidelines. Movement from Option 1 to Option 2 and from Option 2 to Option 3/S is cost-effective relative to Option 1 because costs are reduced while removals increase. Movement from Option 3/S to Option 3 is substantially less efficient than movement from Option 1 to Option 2 or from Option 2 to Option 3/S. The average cost-effectiveness of Option 3 is $3.59 per pound-equivalent and for Option 3/S is $3.36. Options 4 and 5 are not cost-effective as they result in additional costs with no additional removals relative to Option 3. Option 3/S is the most cost-effective option. Successive improvements in weighted removals are achieved at progressively lower costs by moving from Option 1 through Option 2 to Option 3/S. Further movement from Option 3/S to Options 3, 4 or 5 provides minor additional removals at substantially higher marginal cost. Thus, the assumption of 50 percent PAI removal efficiency at POTWs does not alter the result that Option 3/S is the most cost effective option, and is cost-effective relative to promulgated effluent limitations guidelines.

Table D-2 Estimated Industry Incremental Cost-Effectiveness Under PSES SUBCATEGORY C FACILITIES Assuming 50 percent POTW Removal Efficiency for PAIs		
Option	**Cost-Effectiveness, $/lb.**	**Cost-Effectiveness, $/lb-eq.**
Incremental from Baseline to Option 1	$455.73	$4.20
Incremental from Option 1 to Option 2	-$243,491*	-$12,463*
Incremental from Option 2 to Option 3/S	-$25,025*	-$431.72*
Incremental from Option 3/S to Option 3	$13,580	$142,503
Incremental from Option 3 to Option 4	undefined**	undefined**
Incremental from Option 4 to Option 5	undefined**	undefined**

Dollar values are in constant 1981 dollars.

* Options are ranked by increasing levels of pollutant removals. Negative cost-effectiveness numbers mean that costs have decreased from the previous option, while removals have increased, improving cost-effectiveness.

** These options result in additional costs with no additional removals. Therefore, the incremental cost-effectiveness ratio (incremental cost/incremental removals) is undefined.

Subcategory E

Table D-3 presents the estimated total annualized costs, total pounds, and total pounds-equivalent of pollutants removed for the two options considered for Subcategory E facilities under the assumption of 50 percent PAI removal efficiency for POTWs. Option 1, the proposed option, is expected to be achieved with zero additional costs.

Table D-3 National Estimate of Annualized Costs and Removals Under PSES SUBCATEGORY E FACILITIES Assuming 50 percent POTW Removal Efficiency for PAIs			
Option	**Annualized Cost, (1981 dollars)**	**Pound Removals**	**Pound-Equivalent Removals**
Option 1	$0	0.5	0.6
Option 2*	$1,507	0.5	0.6
*This option results in additional costs with no additional removals.			

Because Option 1 is expected to be met with no additional compliance costs, its cost-effectiveness is zero. Option 2 requires additional costs but results in no additional removals, so its cost-effectiveness value is undefined. Therefore, Option 1 is still the more cost-effective option, even assuming POTWs can remove 50 percent of the PAIs in the wastestream.