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EPA Development Document For Effluent limitations Guidelines, Pretreatment Standards, And New Source Performance Standards For The

Pesticide Chemicals Manufacturing Point Source Category

(Final)

DEVELOPMENT DOCUMENT

FOR

EFFLUENT LIMITATIONS GUIDELINES,

PRETREATMENT STANDARDS, AND

NEW SOURCE PERFORMANCE STANDARDS

FOR THE

PESTICIDE CHEMICALS MANUFACTURING CATEGORY

Carol Browner
Administrator

Martha G. Prothro
Acting Assistant Administrator, Office of Water

Thomas P. O'Farrell
Director, Engineering and Analysis Division

Marvin B. Rubin
Chief, Energy Branch

Thomas E. Fielding
Project Officer

September 1993

Engineering and Analysis Division
Office of Science and Technology
U.S. Environmental Protection Agency
Washington, D.C. 20460

TABLE OF CONTENTS

Page

SECTION 1 - INTRODUCTION

SECTION 2 - SUMMARY

SECTION 3 - INDUSTRY DESCRIPTION

TABLE OF CONTENTS (Continued)

SECTION 4 - INDUSTRY SUBCATEGORIZATION

SECTION 5 - WATER USE AND WASTEWATER CHARACTERIZATION

TABLE OF CONTENTS (Continued)

SECTION 6 - POLLUTANT PARAMETERS SELECTED FOR REGULATION

SECTION 7 - TECHNOLOGY SELECTION AND LIMITS DEVELOPMENT

TABLE OF CONTENTS (Continued)

TABLE OF CONTENTS (Continued)

SECTION 8 - ENGINEERING COSTS

SECTION 9 - BEST PRACTICABLE CONTROL TECHNOLOGY (BPT)

TABLE OF CONTENTS (Continued)

TABLE OF CONTENTS (Continued)

SECTION 15 - NON-WATER QUALITY ENVIRONMENTAL IMPACTS

SECTION 16 - ANALYTICAL METHODS

SECTION 17 - GLOSSARY

SECTION 18 - REFERENCES

LIST OF TABLES

LIST OF TABLES (Continued)

LIST OF TABLES (Continued)

LIST OF TABLES (Continued)

LIST OF FIGURES

SECTION 1

INTRODUCTION

1.0 LEGAL AUTHORITY

This regulation is being promulgated under the authorities of Sections 301, 304, 306, 307, and 501 of the Clean Water Act (the Federal Water Pollution Control Act Amendments of 1972, 33 U.S.C. 1251 et seq., as amended by the Clean Water Act of 1977, Pub. L. 95-217, and the Water Quality Act of 1987, Pub. L. 100-4), also referred to as "the Act."

1.1. BACKGROUND

1.1.1 Clean Water Act

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 the Act, EPA is to issue effluent limitations guidelines, pretreatment standards and new source performance standards for industrial dischargers.

These guidelines and standards are summarized briefly below:

1. Best Practicable Control Technology Currently Available (BPT) (Section 304(b)(1) of the Act).

BPT effluent limitations guidelines are generally based on the average of the best existing performance by plants of various sizes, ages, and unit processes within the category or subcategory for control of pollutants.

In establishing BPT effluent limitations guidelines, EPA considers the total cost of achieving effluent reductions in relation to the effluent reduction benefits, the age of equipment and facilities involved, the processes employed, process changes required, engineering aspects of the control technologies, non-water quality environmental impacts (including energy requirements) and other factors as the EPA Administrator deems appropriate (Section 304(b)(1)(B) of the Act). The Agency considers the category or subcategory-wide cost of applying the technology in relation to the effluent reduction benefits. Where existing performance is uniformly inadequate, BPT may be transferred from a different subcategory or category.

2. Best Available Technology Economically Achievable (BAT) (Sections 304(b)(2)(B) and 307(a)(2) of the Act).

In general, BAT effluent limitations represent the best existing economically achievable performance of plants in the industrial subcategory or category. The Act establishes BAT as the principal national means of controlling the direct discharge of priority pollutants and nonconventional pollutants to navigable waters. The factors considered in assessing BAT include the age of equipment and facilities involved, the process employed, potential process changes, and non-water quality environmental impacts (including energy requirements, (Section 304(b)(2)(B)). The Agency retains considerable discretion in assigning the weight to be accorded these factors. As with BPT, where existing performance is uniformly inadequate, BAT may be transferred from a different subcategory or category. BAT may include process changes or internal controls, even when these technologies are not common industry practice.

3. Best Conventional Pollutant Control Technology (BCT) (Section 304(a)(4) of the Act).

The 1977 Amendments added Section 301(b)(2)(E) to the Act establishing BCT for discharges of conventional pollutants from existing industrial point sources. Section 304(a)(4) designated the following as conventional pollutants: Biochemical oxygen demanding pollutants (BOD_5), total suspended solids (TSS), fecal coliform, pH, and any additional pollutants defined by the Administrator as conventional. The Administrator designated oil and grease as an additional conventional pollutant on July 30, 1979 (44 FR 44501).

BCT is not an additional limitation, but replaces BAT for the control of conventional pollutants. In addition to other factors specified in Section 304(b)(4)(B), the Act requires that BCT limitations be established in light of a two part "cost-reasonableness" test. [American Paper Institute v. EPA, 660 F.2d 954 (4th Cir. 1981)]. EPA's current methodology for the general development of BCT limitations was issued in 1986 (51 FR 24974; July 9, 1986).

4. New Source Performance Standards (NSPS) (Section 306 of the Act).

NSPS are based on the best available demonstrated treatment technology. New plants have the opportunity to install the best and most efficient production processes and wastewater treatment technologies. As a result, NSPS should represent the most stringent numerical values attainable through the application of the best available control technology for all pollutants (i.e., conventional, nonconventional, and priority pollutants). In establishing NSPS, EPA is directed to take into consideration the cost of achieving the effluent reduction and any non-water quality environmental impacts and energy requirements.

5. Pretreatment Standards for Existing Sources (PSES) (Section 307(b) of the Act).

PSES are designed to prevent the discharge of pollutants that pass through, interfere with, or are otherwise incompatible with the operation of publicly owned treatment works (POTWs). The Act requires pretreatment standards for pollutants that pass through POTWs or interfere with POTWs' treatment processes or sludge disposal methods. The legislative history of the 1977 Act indicates that pretreatment standards are to be technology-based and analogous to the BAT effluent limitations guidelines for removal of toxic pollutants. For the purpose of determining whether to promulgate national category-wide pretreatment standards, EPA generally determines that there is pass-through of a pollutant and thus a need for categorical standards if the nation-wide average percent of a pollutant removed by well-operated POTWs achieving secondary treatment is less than the percent removed by the BAT model treatment system.

The General Pretreatment Regulations, which set forth the framework for the implementation of categorical pretreatment standards, are found at 40 CFR Part 403. (Those regulations contain a definition of pass-through that addresses localized rather than national instances of pass-through and does not use the percent removal comparison test described above. See 52 FR 1586, January 14, 1987.)

6. Pretreatment Standards for New Sources (PSNS) (Section 307(b) of the Act).

Like PSES, PSNS are designed to prevent the discharges of pollutants that pass through, interfere with, or are otherwise incompatible with the operation of POTWs. PSNS are to be issued at the same time as NSPS. New indirect dischargers, like the new direct dischargers, have the opportunity to incorporate into their plants the best available demonstrated technologies. The Agency considers the same factors in promulgating PSNS as it considers in promulgating NSPS.

1.1.2 Section 304(m) Requirements and Litigation

Section 304(m) of the Clean Water Act (33 U.S.C. 1314(m)), added by the Water Quality Act of 1987, requires EPA to establish schedules for (i) reviewing and revising existing effluent limitations guidelines and standards ("effluent guidelines"), and (ii) promulgating new effluent guidelines. On January 2, 1990, EPA published an Effluent Guidelines Plan (55 FR 80), in which schedules were established for developing new and revised effluent guidelines for several industry categories. One of the industries for which the Agency established a schedule was the Pesticide Chemicals category.

Natural Resources Defense Council, Inc. (NRDC) and Public Citizen, Inc., challenged the Effluent Guidelines Plan in a suit filed in U.S. District Court for the District of Columbia (NRDC et al. v. Reilly, Civ. No. 89-2980). The plaintiffs charged that EPA's plan did not meet the requirements of Section 304(m). A Consent Decree in this litigation was entered by the Court on January 31, 1992. The Decree requires, among other things, that EPA propose effluent guidelines for the manufacturing subcategories of the Pesticide Chemicals category by March, 1992, and take final action by July, 1993. Shortly before the end of July 1993, EPA asked the Court for a limited extension of this deadline.

1.1.3 Pollution Prevention Act

In the Pollution Prevention Act of 1990 (42 U.S.C. 13101 et seq., Pub.L. 101-508, November 5, 1990), Congress declared pollution prevention to be the national policy of the United States. The Act declares that pollution should be prevented or reduced at the source whenever feasible; pollution that cannot be prevented should be recycled or reused in an environmentally safe manner whenever feasible; pollution that cannot be recycled should be treated in an environmentally safe manner whenever feasible; and disposal or release into the environment should be chosen only as a last resort and should be conducted in an environmentally safe manner.

1.1.4 Prior Regulation and Litigation for the Pesticide Chemicals Category

EPA promulgated BPT for the Pesticides Chemicals Manufacturing Category on April 25, 1978 (43 FR 17776; 40 CFR Part 455), and September 29,1978 (43 FR 44846; 40 CFR Part 455, Subpart A). The BPT effluent limitations guidelines established limitations for chemical oxygen-demand (COD), BOD_5, TSS, and pH for wastewaters discharged by the organic pesticide active ingredient (PAI) manufacturing subcategory (Subcategory A), except that discharges of these pollutants resulting from the manufacture of 25 organic PAIs and classes of PAIs were specifically excluded from the limitations. In addition, BPT set a limitation for this subcategory on total pesticide discharge which was applicable to the manufacture of 49 specifically listed organic PAIs. BPT limitations requiring zero discharge of process wastewater pollutants were set for metallo-organic PAIs containing arsenic, mercury, cadmium, or copper.

Several industry members challenged the BPT regulation in 1978 and the U.S. Court of Appeals remanded them on two minor issues [BASF Wyandotte Corp. v. Costle, 596 F.2d 637 (1st Cir. 1979), cert. denied, Eli Lilly v. Costle, 444 U.S. 1096 (1980)]. The Agency subsequently addressed the two issues on remand and the Court upheld the regulations in their entirety [BASF Wyandotte Corp. v. Costle, 614 F.2d 21 (1st Cir. 1980)].

On November 30, 1982, EPA proposed additional regulations to control the discharge of wastewater pollutants from pesticide chemical operations to navigable waters and to POTWs (47 FR 53994). The proposed regulations included effluent limitations guidelines based upon BPT, BAT, BCT, NSPS, PSES, and PSNS. The proposed effluent limitations guidelines and standards covered the organic pesticide chemicals manufacturing segment, the metallo-organic chemicals manufacturing segment and the formulating/packaging segment of the pesticide chemical industry. In addition, the Agency proposed guidelines for test procedures to analyze the nonconventional pesticide pollutants covered by these regulations on February 10, 1983 (48 FR 8250).

Based on the new information collected by EPA in response to the comments on the November 30, 1982 proposal, on June 13, 1984, EPA published a Notice of Availability (NOA) of new information (49 FR 24492). In this NOA, the Agency indicated it was considering changing its approach to developing regulations for this industry. EPA requested comments on the data. EPA published a second NOA of new information on January 24, 1985, which primarily made available for public review technical and economic data which had previously been claimed confidential by industry.

EPA issued a final rule on October 4, 1985, that limited the discharge of pollutants into navigable waters and into POTWs (50 FR 40672). The regulation included effluent limitations guidelines and standards for the BAT, NSPS, PSES, and PSNS levels of control for new and existing facilities that were engaged in the manufacture and/or formulation and packaging of pesticides. The regulation also established analytical methods for 61 PAIs for which the Agency had not previously promulgated approved test procedures.

Several parties filed petitions in the Court of Appeals challenging various aspects of the pesticide regulation [Chemical Specialties Manufacturers Association, et al., v. EPA (86-8024)]. After a review of the database supporting the regulation the Agency found flaws in the basis for these effluent limitations guidelines and standards. Subsequently, the Agency and the parties filed a joint motion for a voluntary remand of the regulation in the Eleventh Circuit Court of Appeals. The Court dismissed the case on July 25, 1986, in response to the Joint Motion. Upon consideration of the parties' motion to modify the dismissal, on August 29, 1986, the Court modified its order to clarify the terms of the dismissal. The Eleventh Circuit Court of Appeals ordered that: (1) the effluent limitation guidelines and standards for the pesticide chemicals industry be remanded to EPA for reconsideration and further rulemaking; and (2) EPA publish a Federal Register notice removing the remanded pesticide regulation from the Code of Federal Regulations.

EPA formally withdrew the regulations from the Code of Federal Regulations on December 15, 1986 (51 FR 44911). Although no errors were found in the analytical methods promulgated October 4, 1985, these methods were also withdrawn to allow for further testing and possible revision. The BPT limitations that were published on April 25, 1978 and September 29, 1978 were not affected by the withdrawal notice and remain in effect.

Scope of the 1992 Proposed Rule

The April 10, 1992 proposed regulations covered the two manufacturing subcategories of the pesticide chemicals industry:

- Subcategory A: Manufacturers of organic pesticide chemicals; and

- Subcategory B: Manufacturers of metallo-organic pesticide chemicals.

EPA will address the Pesticide Chemicals Formulating and Packaging subcategory (Subcategory C) at a later date. Under the Consent Decree in NRDC et al v. Reilly referred to above, the Administrator is to sign final effluent guidelines covering this industry by the end of August 1995.

In the 1992 proposal, EPA proposed expanded water pollution control requirements for the organic pesticide chemicals manufacturing subcategory by establishing effluent limitations guidelines and standards for BAT, NSPS, PSES, and PSNS for new and existing facilities that are engaged in the manufacture of organic pesticide chemicals. In addition, BCT for conventional pollutants was proposed equal to BPT for the organic pesticide chemicals manufacturing subcategory.

For the metallo-organic pesticide chemicals manufacturing subcategory, current BPT limitations require no discharge of process wastewater pollutants. EPA proposed reserving the BCT, BAT, NSPS, PSES, and PSNS effluent limitations for this subcategory.

EPA proposed that the effluent limitations guidelines and standards would be applicable to discharges generated during the manufacture of PAIs from chemical reactions. (For one PAI, the effluent guidelines applied only to discharges of wastewater generated during the purification of that PAI to a higher quality PAI product.) The proposed regulations did not apply to the production of pesticide products through the physical mixing, blending, or dilution of PAIs without an intended chemical reaction (except where dilution is a necessary step following chemical reaction to stabilize the product), nor did the proposed regulations apply to packaging or repackaging of pesticide products. These two types of operations are part of the Pesticide Chemicals Formulating and Packaging Subcategory which will be covered under the separate rulemaking referred to previously. The proposed regulations also did not apply to the manufacture of "intermediate" chemicals, which are not pesticides but which subsequently are converted by further chemical reactions to pesticide active ingredients. The "intermediates" may be covered by other regulations, such as the Organic Chemicals, Plastics, and Synthetic Fibers (OCPSF) effluent guidelines and standards (40 CFR Part 414) when the intermediate is an organic chemical, or the Inorganic Chemicals effluent guidelines and standards (40 CFR Part 415) when the intermediate is an inorganic chemical.

The BPT regulations promulgated in 1978, which limit discharges from the manufacture of certain specified PAIs, are not being changed. However, EPA proposed extending the applicability of the existing Subcategory A limitations to discharges from the manufacture of fifteen organic PAIs and organo-tin PAIs, which were previously excluded or omitted from coverage by the organic pesticides chemicals manufacturing subcategories. Information collected and developed on direct dischargers indicated that all manufacturers of these 15 organic PAIs and organo-tin PAIs were already subject to permit limitations equal to or more stringent than the BPT Subcategory A limitations; the limitations in these permits were developed on a "best professional judgment" basis, using the existing BPT limitations as guidance.

EPA proposed BCT limits for conventional pollutants (pH, BOD_5 and TSS) equal to BPT limits for subcategory A.

EPA proposed BAT limitations for subcategory A PAIs based on the use of the following treatment technologies: hydrolysis, activated carbon, chemical oxidation, resin adsorption, solvent extraction, distillation, biological treatment and/or incineration to control the discharge of PAIs in wastewater. EPA has also based the proposed BAT limitations on pollution prevention, including in-process recycling (recirculation), and (out-of-process) recycle/reuse where possible. For some PAIs, compliance with the proposed BAT limitations would require implementation of pollution prevention practices and/or improvements to treatment technologies currently in place at facilities by enhancing the operations, such as increasing retention time for hydrolysis or carbon adsorption treatment. BAT effluent limitations for all but one of the priority pollutants were proposed based on the use of model control technologies identified in the OCPSF effluent guidelines. For total cyanide, long-term data from three pesticide chemical industry facilities and five OCPSF facilities were used.

EPA proposed NSPS limitations for subcategory A PAIs based on the mass-based BAT limitations for the PAIs, but modified NSPS limitations for certain PAIs to reflect a wastewater flow reduction of 28% to account for the ability of new sources to utilize less water or to reuse water generated in the chemical reactions. The NSPS proposed for priority pollutants were concentration based, and so were set equal to the BAT limitations for subcategory A priority pollutants. For these pollutants, the flow reduction of with 28% would be applied by permit writers in setting the mass limits for each site.

EPA proposed PSES for subcategory A equal to BAT limitations for PAIs. As with BAT, proposed PSES for the priority pollutants were primarily based on a direct transfer of the OCPSF pretreatment standards. In addition, two priority pollutants for which pretreatment standards were proposed were deemed not to pass through or interfere with POTWs and therefore were not proposed to be regulated by PSES.

For PSNS for subcategory A, the following were proposed: (1) the same PAIs were proposed to be subject to regulation under PSNS for this subcategory as were proposed for BAT and NSPS; and (2) the same priority pollutants proposed for PSES regulations were proposed for regulation by PSNS. PSNS limitations were proposed for PAIs in subcategory A as equal to NSPS limitations. For the priority pollutants, PSNS limitations for priority pollutants were proposed as equal to the PSES limitations. For PSES and PSNS, the 28% flow reduction would be applied when calculating the site specific mass limits.

Post-Proposal Notice of Data Availability

On April 14, 1993, EPA published a Notice of Data Availability (NOA) (58 FR 19392), making available for public comment additional information received since the time of the proposal and placing in the public record information previously, but no longer, claimed as confidential business information (CBI).

The new information consisted largely of additional long-term treatment system performance data for control of discharges of certain PAIs. This new data provided information on treatment system performance over a wider variety of conditions than was previously available. In addition, performance data were also submitted to EPA for new full-scale treatment systems to be used as a basis for limitations instead of transferring technology information from pilot studies or full-scale treatment of similar PAIs. Data were also submitted on analytical methods where the commenter believed the methods in use differed from the proposed method.

The NOA also solicited comment on certain information excluded from public review at the time of proposal based on claims of CBI by the submitter of this information. Based upon subsequent review of these claims, some submitters withdrew their CBI claims, allowing for public review of the information. The information that was previously, but no longer, claimed as CBI included questionnaire responses from eleven facilities; reports (visits, sampling, health and safety plans, analytical results and correspondence) for six of the eleven facilities visited and/or sampled; long-term treatment system performance data for five of the eleven facilities; and information on EPA's development of limitations based on this data, along with the analysis of the cost impacts on these eleven facilities.

1.2 SCOPE OF TODAY'S RULE

The regulation promulgated today covers two manufacturing subcategories of the pesticide chemicals industry:

- Subcategory A: Manufacturers of organic pesticide chemicals; and

- Subcategory B: Manufacturers of metallo-organic pesticide chemicals.

EPA will address the Pesticide Chemicals Formulating and Packaging subcategory at a later date.

In today's notice, EPA is promulgating expanded water pollution control requirements for the organic pesticide chemicals manufacturing subcategory by establishing effluent limitations guidelines and standards for BAT, NSPS, PSES, and PSNS for new and existing facilities that are engaged in the manufacture of organic pesticide chemicals. In addition, BCT for conventional pollutants is promulgated equal to BPT for the organic pesticide chemicals manufacturing subcategory. Also, the coverage of the existing BPT regulations has been expanded.

For the metallo-organic pesticide chemicals manufacturing subcategory, current BPT limitations require no discharge of process wastewater pollutants. EPA is reserving BCT, BAT, NSPS, PSES, and PSNS effluent limitations for this subcategory.

The final effluent limitations guidelines and standards are intended to cover discharges generated during the manufacture of PAIs from chemical reactions. (For one PAI, the effluent guidelines apply only to discharges of wastewater generated during the purification of that PAI to a higher quality PAI product.) These guidelines do not apply to the production of pesticide products through the physical mixing, blending, or dilution of PAIs without an intended chemical reaction (except where dilution is a necessary step following chemical reaction to stabilize the product), nor do these regulations apply to packaging or repackaging of pesticide products. These two types of operations are part of the Pesticide Chemicals Formulating and Packaging Subcategory which will be covered under a separate rulemaking at a later date. These regulations also do not apply to the manufacturer of chemicals ("intermediates") which are not pesticides but which subsequently are converted by further chemical reactions to pesticide active ingredients. The "intermediates" may be covered by other guidelines, such as the Organic Chemicals, Plastics, and Synthetic Fibers (OCPSF) effluent guidelines (40 CFR Parts 414 and 416) or the Inorganic Chemicals effluent guidelines (40 CFR Part 415).

SECTION 2

SUMMARY

2.0 OVERVIEW OF THE INDUSTRY

According to data collected by EPA during the development of this rule, in 1986 the pesticide chemicals manufacturing industry included 90 facilities whose production activities would be covered under the proposed pesticide chemicals manufacturing regulation. Over half of the pesticide manufacturing facilities also conduct pesticide formulating and/or packaging (PFP) activities. In addition, more than half of the pesticide manufacturing facilities generate wastewater discharges which are currently regulated under the Organic Chemicals, Plastics, and Synthetic Fibers (OCPSF) Point Source Category (see 40 CFR Part 414).

There are approximately 128 pesticide active ingredients (PAIs) and classes of PAIs representing 186 individual active ingredients (Pyrethrin I and Pyrethrin II are counted as one PAI because they are not separated in the commercial product) manufactured by 225 separate pesticide production processes. Of the reported 225 manufacturing processes used to produce pesticides in 1986, 178 were batch processes. A "typical" facility manufactures one active ingredient and is the only facility in the country producing that PAI. "Typical" production is between 1,000,000 and 10,000,000 pounds of total PAI for the year.

The technical study included all 90 facilities. Of the 90 facilities, 67 are dischargers: 32 facilities are direct dischargers, and 36 are indirect dischargers (one facility is both a direct and indirect discharger). The remaining 23 facilities do not discharge pesticide manufacturing process wastewater: 15 facilities dispose of their wastewater by either on-site or off-site deepwell injection or incineration, and 8 facilities generate no process wastewater because of recycle/reuse operations or because they do not use water.

Since proposal, there have been two major changes in the industry that are relevant to this rulemaking. First, EPA's latest information is that there has been a decrease in the number of plants that manufacture pesticides from 90 to 75 due to plant closures. Second, a number of plants have installed additional or improved wastewater treatment facilities since the time of EPA's data collection for this rulemaking. (See Section 5 of this document, describing the data EPA has received concerning these new treatment facilities.) Also as explained in that section, EPA has incorporated these new data into the development of the limitations in today's final rule where possible.

As a result of the wide variety of raw materials and processes used and of products manufactured in the pesticide chemicals manufacturing industry, a wide variety of pollutants are found in the wastewaters of this industry. This includes conventional pollutants (pH, BOD_5, and TSS), a variety of toxic priority pollutants, and a large number of nonconventional pollutants (i.e., COD and the PAIs). The PAIs are organic and metallo-organic compounds produced by the industry for sale.

Pesticide manufacturing plants use a broad range of in-plant and end-of-pipe controls and treatment techniques to control and treat the wide variety of pollutants. The treatment technologies used include physical-chemical treatment technologies to remove PAIs, followed by steam stripping to remove volatile priority pollutants, followed by biological treatment to remove non-volatile priority pollutants and other organic and conventional pollutants. The major physical-chemical treatment technologies in use for PAI removal are activated carbon, chemical oxidation, and hydrolysis. More detail is provided in Section 7.

2.1 SUMMARY OF THE FINAL REGULATIONS

2.1.1 Applicability of the Final Regulations

The final pesticide chemicals manufacturing regulations would apply to process wastewater discharges from existing and new pesticide chemicals manufacturing facilities. These regulations do not apply to wastewaters from pesticide formulators and packagers, which will be addressed in a separate rulemaking.

2.1.2 BPT

EPA promulgated BPT effluent limitations guidelines in 1978 (40 FR 17776; 43 FR 44846; 40 CFR Part 455) applicable to pesticide chemicals manufacturing processes resulting from the manufacturing of: (1) All organic PAIs (with some exceptions; see below), and (2) all metallo-organic PAIs containing arsenic, mercury, cadmium, or copper. For plants manufacturing organic PAIs, the regulations limited COD, BOD_5, TSS, and pH. The organic PAI regulation also limited total pesticides in wastewaters resulting from the manufacturing of 49 specific organic PAIs. For metallo-organic PAIs, the BPT limitations require that there be no discharge of process wastewater pollutants.

The BPT limitations for organic pesticide chemical manufacturing excluded from regulation 25 specific PAIs and classes of PAIs. In addition, organo-tin pesticides were not covered by BPT. In this final rule, EPA is expanding the coverage of BPT limitations (for BOD_5, COD, TSS, and pH) to include manufacture of three of the previously excluded organic PAIs and organo-tin PAIs. Information demonstrates that all manufacturers of these PAIs are already subject to permit limitations that are at least as stringent as the BPT limitations. Table 2-1 presents these three organic PAIs and organo-tin PAIs.

In addition, EPA is amending the BPT regulation to include 11 PAIs which will now be subject to the existing BPT limitations for BOD_5, TSS and pH, but will not be subject to the existing BPT limitations for COD. All

Table 2-1

PAIs ADDED TO BPT

PAI CODE	PAI
025	Cyanazine
058	Ametryn
060	Atrazine
138	Glyphosate
142	Hexazinone
157	Methoprene*
192	Organo-tin Pesticides*
211	Phenylphenol*
211.05	Sodium Phenylphenate*
223	Prometon
224	Prometryn
226	Propazine
239	Simazine
256	Terbuthylazine
257	Terbutryn

*Limitations for BOD_5, TSS, COD and pH apply to these PAIs only. For the other 11 PAIs, limitations for BOD_5, TSS and pH apply, but the COD limitations do not apply.

manufacturers of these 11 PAIs are already subject to permit limitations for BOD_5, TSS and pH that are at least as stringent as the BPT limitations but the facilities cannot achieve the BPT limitations for COD.

In this final rule, the existing BPT limitations (i.e., those promulgated in 1978) are not being changed. Additionally, there is no change to the existing BPT effluent limitations guidelines for metallo-organic PAIs.

2.1.3 BCT

In this final regulation, the Agency is setting BCT equal to BPT for conventional pollutants under the organic pesticide chemicals manufacturing subcategory. The Agency is reserving BCT for the metallo-organic pesticide chemicals manufacturing subcategory.

The technology basis for BPT under the organic pesticide chemicals manufacturing subcategory includes flow equalization and biological treatment followed by clarification to remove BOD_5, COD, and TSS. Options for further removal of TSS and/or BOD_5, initially considered for evaluation as BCT candidate technologies, included multimedia filtration, carbon adsorption, membrane filtration, incineration, evaporation, additional biological oxidation (above the level required to meet BPT), and clarification through the use of settling ponds. Of these options, multimedia filtration appeared to be the most promising option for BCT. However, EPA determined that multi-media filtration has not been demonstrated to consistently achieve additional removals of BOD_5 and TSS in this industry. Multimedia filtration was then evaluated by the BCT cost test. This technology also failed the BCT cost test. Since no other technologies were identified that would be expected to enhance conventional pollutant removal above that provided by BPT technologies, the Agency is setting BCT equal to BPT limitations for conventional pollutants. Table 2-2 presents the BCT organic pesticide chemicals manufacturing subcategory effluent limitations.

2.1.4 BAT

The final BAT limitations for PAIs under the organic pesticide chemicals manufacturing subcategory are based on the use of the following treatment technologies: hydrolysis, activated carbon, chemical oxidation, resin adsorption, biological treatment, solvent extraction, distillation, and/or incineration.

Limitations for PAIs were derived on a mass basis, using long-term data where available. Where long-term effluent and flow data were not available, limitations were developed based on performance data from either industry or EPA treatability studies. In these cases, in lieu of BAT performance data from full scale operating systems, treatability studies were used to determine the PAI concentration achievable through a specific treatment technology. These concentration data were then applied to the total flow of PAI contaminated streams and the reported PAI production data to calculate a mass based limitation. In cases where treatability studies did

Table 2-2

BCT EFFLUENT LIMITATIONS FOR THE ORGANIC PESTICIDE CHEMICALS MANUFACTURING SUBCATEGORY

Effluent Characteristic	Maximum for Any One Day*	Average of Daily Values for 30 Consecutive Days Shall Not Exceed*
BOD_5	7.4	1.6
TSS	6.1	1.8
pH	**	**

*Metric units: kilogram/1,000 kg of PAI produced; English units: pound/ 1,000 lbs of PAI produced; Established on the basis of pesticide production.

**Within the range of 6.0 to 9.0.

not contain sufficient information to determine process variability, daily and monthly variability were based on the performance of operating BAT treatment systems. For some PAIs for which there were no treatability data, limitations were developed based on the treatment performance achieved for chemically and structurally similar PAIs. This "technology transfer" was supplemented by treatability studies.

BAT effluent limitations are established for 28 priority pollutants. For 27 of the 28 priority pollutants limitations are based on the use of model control technologies identified in the OCPSF rulemaking. Both the OCPSF end-of-pipe biological treatment subcategory and the non-end-of-pipe biological treatment subcategory limitations are being transferred for the priority pollutants regulated under BAT in the organic pesticide chemicals manufacturing subcategory.

Derivation of the final BAT limitations is detailed in Section 7 of this document. "Daily Maximum" and "Monthly Average" production-based limitations have been calculated for each regulated PAI pollutant. "Maximum for any one day" and "Maximum for Monthly Average" concentration limitations have been transferred from the OCPSF rulemaking for 23 of the 28 regulated priority pollutant. The final BAT effluent limitations for organic PAIs and classes of PAIs and priority pollutants under the organic pesticide chemicals manufacturing subcategory are listed in Tables 2-3, 2-4, and 2-5.

The Agency is reserving BAT for the metallo-organic pesticide chemicals manufacturing subcategory.

The BAT regulations in this rulemaking will be the basis for limitations in the National Pollutant Discharge Elimination System (NPDES) permit issued to direct dischargers. The limitations for pesticide chemicals manufacturing plants include all priority pollutants regulated and those PAIs manufactured at each plant.

2.1.5 NSPS

EPA is promulgating mass-based new source performance standards (NSPS) for the organic pesticide chemicals manufacturing subcategory on the basis of the BAT limitations plus a 28% achievable flow reduction for certain PAIs. NSPS are promulgated for conventional pollutants (BOD_5, TSS, and pH) and COD on the basis of BPT limitations and a 28% achievable flow reduction. NSPS regulation of priority pollutants are based on BAT limitations from the OCPSF rulemaking; because the limitations for priority pollutants are concentration-based, the permit writer would apply the 28% flow reduction when calculating NPDES permit effluent limitations. The final NSPS limitations for conventional pollutants and COD are given in Table 2-6; for PAIs in Table 2-7; and for priority pollutants in Tables 2-4 and 2-5.

The Agency is reserving NSPS for the metallo-organic pesticide chemicals manufacturing subcategory.

Table 2-3

ORGANIC PESTICIDE ACTIVE INGREDIENT EFFLUENT LIMITATIONS BEST AVAILABLE TECHNOLOGY ECONOMICALLY ACHIEVABLE (BAT) AND PRETREATMENT STANDARDS FOR EXISTING SOURCES (PSES)

BAT/PSES Limitations*

	BAT/PSES effluent limitations		
Organic Pesticide Active Ingredient (PAI)	**Daily Maximum Shall Not Exceed**	**Monthly Average Shall Not Exceed**	**Notes**
2, 4-D	1.97 x 10^{-3}	6.40 x 10^{-4}	
2, 4-D salts and esters	No discharge of process wastewater pollutants		
2,4-DB salts and esters	No discharge of process wastewater pollutants		
Acephate	6.39 x 10^{-4}	1.97 x 10^{-4}	
Acifluorfen	2.45	9.3 x 10^{-1}	
Alachlor	5.19 x 10^{-3}	1.54 x 10^{-3}	
Aldicarb	7.23 x 10^{-4}	3.12 x 10^{-4}	
Ametryn	7.72 x 10^{-3}	2.53 x 10^{-3}	
Atrazine	5.12 x 10^{-3}	1.72 x 10^{-3}	
Azinphos Methyl	2.74 x 10^{-2}	1.41 x 10^{-2}	
Benfluralin	3.22 x 10^{-4}	1.09 x 10^{-4}	1
Benomyl and Carbendazim	3.50 x 10^{-2}	8.94 x 10^{-3}	2
Bolstar	1.69 x 10^{-2}	8.72 x 10^{-3}	
Bromacil, lithium	No discharge of process wastewater pollutants		
Bromacil	3.83 x 10^{-1}	1.16 x 10^{-1}	
Bromoxynil	3.95 x 10^{-3}	1.27 x 10^{-3}	
Bromoxynil octanoate	3.95 x 10^{-3}	1.27 x 10^{-3}	
Busan 40 [Potassium N-hydroxymethyl-N-methyldithiocarbamate]	5.74 x 10^{-3}	1.87 x 10^{-3}	

Table 2-3

(Continued)

Organic Pesticide Active Ingredient (PAI)	BAT/PSES effluent limitations		Notes
	Daily Maximum Shall Not Exceed	Monthly Average Shall Not Exceed	
Busan 85 [Potassium dimethyldithiocarbamate]	5.74×10^{-3}	1.87×10^{-3}	
Butachlor	5.19×10^{-3}	1.54×10^{-3}	
Captafol	4.24×10^{-6}	1.31×10^{-6}	
Carbam S [Sodium dimethyldithiocarbamate]	5.74×10^{-3}	1.87×10^{-3}	
Carbaryl	1.60×10^{-3}	7.30×10^{-4}	
Carbofuran	1.18×10^{-4}	2.80×10^{-5}	
Chloroneb	8.16×10^{-2}	3.31×10^{-2}	
Chlorothalonil	1.51×10^{-3}	4.57×10^{-4}	
Chlorpyrifos	8.25×10^{-4}	2.43×10^{-4}	
Cyanazine	1.03×10^{-2}	3.33×10^{-3}	
Dazomet	5.74×10^{-3}	1.87×10^{-3}	
DCPA	7.79×10^{-2}	2.64×10^{-2}	
DEF	1.15×10^{-2}	5.58×10^{-3}	
Diazinon	2.82×10^{-3}	1.12×10^{-3}	
Dichlorprop, salts and esters	No discharge of process wastewater pollutants		
Dichlorvos	9.60×10^{-5}	2.95×10^{-5}	
Dinoseb	4.73	1.43	
Dioxathion	3.40×10^{-2}	1.29×10^{-2}	
Disulfoton	7.33×10^{-3}	3.79×10^{-3}	
Diuron	3.15×10^{-2}	1.40×10^{-2}	

Table 2-3

(Continued)

Organic Pesticide Active Ingredient (PAI)	BAT/PSES effluent limitations		Notes
	Daily Maximum Shall Not Exceed	Monthly Average Shall Not Exceed	
Endothall, salts and esters	No discharge of process wastewater pollutants		
Endrin	2.20×10^{-2}	5.10×10^{-3}	
Ethalfluralin	3.22×10^{-4}	1.09×10^{-4}	1
Ethion	5.51×10^{-3}	1.57×10^{-3}	
Fenarimol	1.02×10^{-1}	3.61×10^{-2}	
Fensulfothion	1.48×10^{-2}	7.64×10^{-3}	
Fenthion	1.83×10^{-2}	9.45×10^{-3}	
Fenvalerate	5.40×10^{-3}	2.08×10^{-3}	
Heptachlor	8.80×10^{-3}	2.90×10^{-3}	
Isopropalin	7.06×10^{-3}	2.49×10^{-3}	
KN Methyl	5.74×10^{-3}	1.87×10^{-3}	
Linuron	2.69×10^{-3}	1.94×10^{-3}	
Malathion	2.35×10^{-4}	9.55×10^{-5}	
MCPA salts and esters	No discharge of process wastewater pollutants		
MCPP salts and esters	No discharge of process wastewater pollutants		
Merphos	1.15×10^{-2}	5.58×10^{-3}	
Methamidophos	1.46×10^{-2}	7.53×10^{-3}	
Methomyl	3.82×10^{-3}	1.76×10^{-3}	
Methoxychlor	3.23×10^{-3}	1.31×10^{-3}	
Metribuzin	1.36×10^{-2}	7.04×10^{-3}	
Mevinphos	1.44×10^{-4}	5.10×10^{-5}	
Nabam	5.74×10^{-3}	1.87×10^{-3}	

Table 2-3

(Continued)

	BAT/PSES effluent limitations		
Organic Pesticide Active Ingredient (PAI)	Daily Maximum Shall Not Exceed	Monthly Average Shall Not Exceed	Notes
Nabonate	5.74×10^{-3}	1.87×10^{-3}	
Naled	No discharge of process wastewater pollutants		
Norflurazon	7.20×10^{-4}	3.10×10^{-4}	
Organotins	1.72×10^{-2}	7.42×10^{-3}	3
Parathion Ethyl	7.72×10^{-4}	3.43×10^{-4}	
Parathion Methyl	7.72×10^{-4}	3.43×10^{-4}	
PCNB	5.75×10^{-4}	1.90×10^{-4}	
Pendimethalin	1.17×10^{-2}	3.62×10^{-3}	
Permethrin	2.32×10^{-4}	6.06×10^{-5}	
Phorate	3.12×10^{-4}	9.37×10^{-5}	
Phosmet	No discharge of process wastewater pollutants		4
Prometon	7.72×10^{-3}	2.53×10^{-3}	
Prometryn	7.72×10^{-3}	2.53×10^{-3}	
Pronamide	6.64×10^{-4}	2.01×10^{-4}	
Propachlor	5.19×10^{-3}	1.54×10^{-3}	
Propanil	1.06×10^{-3}	4.84×10^{-4}	
Propazine	7.72×10^{-3}	2.53×10^{-3}	
Pyrethrin I and Pyrethrin II	1.24×10^{-2}	3.33×10^{-3}	
Simazine	7.72×10^{-3}	2.53×10^{-3}	
Stirofos	4.10×10^{-3}	1.35×10^{-3}	
TCMTB	3.89×10^{-3}	1.05×10^{-3}	

Table 2-3

(Continued)

Organic Pesticide Active Ingredient (PAI)	BAT/PSES effluent limitations Daily Maximum Shall Not Exceed	BAT/PSES effluent limitations Monthly Average Shall Not Exceed	Notes
Tebuthiuron	9.78×10^{-2}	3.40×10^{-2}	
Terbacil	3.83×10^{-1}	1.16×10^{-1}	
Terbufos	4.92×10^{-4}	1.26×10^{-4}	
Terbuthylazine	7.72×10^{-3}	2.53×10^{-3}	
Terbutryn	7.72×10^{-3}	2.53×10^{-3}	
Toxaphene	1.02×10^{-2}	3.71×10^{-3}	
Triadimefon	6.52×10^{-2}	3.41×10^{-2}	
Trifluralin	3.22×10^{-4}	1.09×10^{-4}	1
Vapam [Sodium methyldithiocarbamate]	5.74×10^{-3}	1.87×10^{-3}	
Ziram [Zinc dimethyldithiocarbamate]	5.74×10^{-3}	1.87×10^{-3}	

*Limitations are in Kg/kkg (lb/1,000 lb) i. e., kilograms of pollutant per 1,000 kilograms product (pounds of pollutant per 1,000 lbs product).

[1] Monitor and report as total toluidine PAIs, as Trifluralin.

[2] Pounds of product include Benomyl and any Carbendazim production not converted to Benomyl.

[3] Monitor and report as total tin.

[4] Applies to purification by recrystallization portion of the process.

Table 2-4

BAT EFFLUENT LIMITATIONS AND NSPS FOR PRIORITY POLLUTANTS FOR DIRECT DISCHARGE POINT SOURCES THAT USE END-OF-PIPE BIOLOGICAL TREATMENT

	BAT/NSPS effluent limitations		
Priority Pollutant	Maximum for Any One Day (μg/L)	Maximum for Monthly Average (μg/L)	Notes
Benzene	136	37	
Tetrachloromethane	38	18	
Chlorobenzene	28	15	
1,2-Dichloroethane	211	68	
1,1,1-Trichloroethane	54	21	
Trichloromethane	46	21	
2-Chlorophenol	98	31	
1,2-Dichlorobenzene	163	77	
1,4-Dichlorobenzene	28	15	
1,1-Dichloroethylene	25	16	
1,2-trans-Dichloroethylene	54	21	
2,4-Dichlorophenol	112	39	
1,2-Dichloropropane	230	153	
1,3-Dichloropropene	44	29	
2,4-Dimethylphenol	36	18	
Ethylbenzene	108	32	
Dichloromethane	89	40	
Chloromethane	190	86	
Bromomethane	380	142	
Tribromomethane	794	196	
Bromodichloromethane	380	142	
Dibromochloromethane	794	196	
Naphthalene	59	22	
Phenol	26	15	

Table 2-4

(Continued)

Priority Pollutant	BAT/NSPS effluent limitations		Notes
	Maximum for Any One Day (μg/L)	Maximum for Monthly Average (μg/L)	
Tetrachloroethylene	56	22	
Total Cyanide	640	220	1
Total Lead	690	320	1

[1] Lead and total cyanide limitations apply only to noncomplexed lead-bearing or cyanide-bearing waste streams. Discharges of lead from complexed lead-bearing process wastewater or discharges of cyanide from complexed cyanide-bearing process wastewater are not subject to these limitations.

Table 2-5

BAT EFFLUENT LIMITATIONS AND NSPS FOR PRIORITY POLLUTANTS FOR DIRECT DISCHARGE POINT SOURCES THAT DO NOT USE END-OF-PIPE BIOLOGICAL TREATMENT

	BAT/NSPS effluent limitations		
Priority Pollutant	**Maximum for Any One Day (µg/L)**	**Maximum for Monthly Average (µg/L)**	**Notes**
Benzene	134	57	
Tetrachloromethane	380	142	
Chlorobenzene	380	142	
1,2-Dichloroethane	574	180	
1,1,1-Trichloroethane	59	22	
Trichloromethane	325	111	
1,2-Dichlorobenzene	794	196	
1,4-Dichlorobenzene	380	142	
1,1-Dichloroethylene	60	22	
1,2-trans-Dichloroethylene	66	25	
1,2-Dichloropropane	794	196	
1,3-Dichloropropene	794	196	
2,4-Dimethylphenol	47	19	
Ethylbenzene	380	142	
Dichloromethane	170	36	
Chloromethane	295	110	
Bromomethane	380	142	
Tribromomethane	794	196	
Bromodichloromethane	380	142	
Dibromochloromethane	794	196	
Naphthalene	47	19	
Phenol	47	19	
Tetrachloroethylene	164	52	
Toluene	74	28	

Table 2-5

(Continued)

Priority Pollutant	BAT/NSPS effluent limitations		Notes
	Maximum for Any One Day (μg/L)	Maximum for Monthly Average (μg/L)	
Total Cyanide	640	220	1
Total Lead	690	320	1

[1] Lead and total cyanide limitations apply only to noncomplexed lead-bearing or cyanide-bearing waste streams. Discharges of lead from complexed lead-bearing process wastewater or discharges of cyanide from complexed cyanide-bearing process wastewater are not subject to these limitations.

Table 2-6

NSPS EFFLUENT LIMITATIONS FOR CONVENTIONAL POLLUTANTS AND COD

Effluent Characteristic	Maximum for Any 1 Day	Average of Daily Values for 30 Consecutive Days Shall Not Exceed**
COD	9.36	6.48
BOD_5	5.33	1.15
TSS	4.39	1.30
pH	*	*

[1] These standards incorporate a 28% flow reduction achievable by new sources.

*Within the range 6.0 to 9.0.

**Metric units: Kilogram/1,000 kg of PAI produced; English units: Pound/1,000 lb of PAI produced; established on the basis of pesticide production.

Table 2-7

NSPS AND PSNS EFFLUENT LIMITATIONS FOR ORGANIC PESTICIDES ACTIVE INGREDIENTS (PAIs)

NSPS/PSNS Effluent Limitations*

Organic Pesticide Active Ingredient	NSPS/PSNS Effluent Limitations		Notes
	Daily Maximum Shall Not Exceed	Monthly Average Shall Not Exceed	
2, 4-D	1.42×10^{-3}	4.61×10^{-4}	
2, 4-D salts and esters	No discharge of process wastewater pollutants		
2,4-DB salts and esters	No discharge of process wastewater pollutants		
Acephate	6.39×10^{-4}	1.97×10^{-4}	
Acifluorfen	1.77	6.69×10^{-1}	
Alachlor	3.74×10^{-3}	1.11×10^{-3}	
Aldicarb	5.21×10^{-4}	2.25×10^{-4}	
Ametryn	5.56×10^{-3}	1.82×10^{-3}	
Atrazine	3.69×10^{-3}	1.24×10^{-3}	
Benfluralin	3.22×10^{-4}	1.09×10^{-4}	1
Benomyl and Carbendazim	2.52×10^{-2}	6.44×10^{-3}	2
Bolstar	1.22×10^{-2}	6.28×10^{-3}	
Bromacil, lithium	No discharge of process wastewater pollutants		
Bromacil	2.76×10^{-1}	8.36×10^{-2}	
Bromoxynil	2.84×10^{-3}	9.14×10^{-4}	
Bromoxynil octanoate	2.84×10^{-3}	9.14×10^{-4}	
Busan 40	4.14×10^{-3}	1.35×10^{-3}	
Busan 85	4.14×10^{-3}	1.35×10^{-3}	
Butachlor	3.74×10^{-3}	1.11×10^{-3}	
Captafol	4.24×10^{-6}	1.31×10^{-6}	
Carbam S	4.14×10^{-3}	1.35×10^{-3}	
Carbaryl	1.18×10^{-3}	5.24×10^{-4}	

Table 2-7

(Continued)

Organic Pesticide Active Ingredient	NSPS/PSNS Effluent Limitations		Notes
	Daily Maximum Shall Not Exceed	Monthly Average Shall Not Exceed	
Carbofuran	1.18×10^{-4}	2.80×10^{-5}	
Chloroneb	5.87×10^{-2}	2.39×10^{-2}	
Chlorothalonil	1.09×10^{-3}	3.29×10^{-4}	
Chlorpyrifos	5.94×10^{-4}	1.75×10^{-4}	
Cyanazine	7.42×10^{-3}	2.40×10^{-3}	
Dazomet	4.14×10^{-3}	1.35×10^{-3}	
DCPA	5.61×10^{-2}	1.90×10^{-2}	
DEF [S,S,S-Tributyl phosphorotrithioate]	1.15×10^{-2}	5.58×10^{-3}	
Diazinon	2.05×10^{-3}	8.13×10^{-4}	
Dichlorprop, salts and esters	No discharge of process wastewater pollutants		
Dichlorvos	6.88×10^{-5}	2.13×10^{-5}	
Dinoseb	3.41	1.03	
Dioxathion	2.54×10^{-2}	9.31×10^{-3}	
Disulfoton	5.28×10^{-3}	2.72×10^{-3}	
Diuron	2.27×10^{-2}	1.01×10^{-2}	
Endothall, salts and esters	No discharge of process wastewater pollutants		
Endrin	1.57×10^{-2}	3.69×10^{-3}	
Ethalfluralin	3.22×10^{-4}	1.09×10^{-4}	
Ethion	3.97×10^{-3}	1.33×10^{-3}	
Fenarimol	1.02×10^{-1}	3.61×10^{-2}	
Fensulfothion	1.06×10^{-2}	5.50×10^{-3}	

Table 2-7

(Continued)

Organic Pesticide Active Ingredient	NSPS/PSNS Effluent Limitations: Daily Maximum Shall Not Exceed	NSPS/PSNS Effluent Limitations: Monthly Average Shall Not Exceed	Notes
Fenthion	1.32×10^{-2}	6.79×10^{-3}	
Fenvalerate	3.91×10^{-3}	1.50×10^{-3}	
Guthion	1.97×10^{-2}	1.02×10^{-2}	
Heptachlor	6.31×10^{-3}	2.06×10^{-3}	
Isopropalin	5.07×10^{-3}	1.82×10^{-3}	
KN Methyl	4.14×10^{-3}	1.35×10^{-3}	
Linuron	1.94×10^{-3}	1.40×10^{-3}	
Malathion	1.69×10^{-4}	6.88×10^{-5}	
MCPA salts and esters	No discharge of process wastewater pollutants		
MCPP salts and esters	No discharge of process wastewater pollutants		
Merphos	1.15×10^{-2}	5.58×10^{-3}	
Methamidophos	1.05×10^{-2}	5.42×10^{-3}	
Methomyl	2.75×10^{-3}	1.27×10^{-3}	
Methoxychlor	2.34×10^{-3}	9.25×10^{-4}	
Metribuzin	9.80×10^{-3}	5.06×10^{-3}	
Mevinphos	1.03×10^{-4}	3.69×10^{-5}	
Nabam	4.14×10^{-3}	1.35×10^{-3}	
Nabonate	4.14×10^{-3}	1.35×10^{-3}	
Naled	No discharge of process wastewater pollutants		
Norflurazon	7.20×10^{-4}	3.10×10^{-4}	
Organotins	1.25×10^{-2}	5.36×10^{-3}	3
Parathion Ethyl	5.56×10^{-4}	2.45×10^{-4}	
Parathion Methyl	5.56×10^{-4}	2.45×10^{-4}	

Table 2-7

(Continued)

Organic Pesticide Active Ingredient	NSPS/PSNS Effluent Limitations		Notes
	Daily Maximum Shall Not Exceed	**Monthly Average Shall Not Exceed**	
PCNB	4.16×10^{-4}	1.38×10^{-4}	
Pendimethalin	1.17×10^{-2}	3.62×10^{-3}	
Permethrin	1.68×10^{-4}	4.39×10^{-5}	
Phorate	3.12×10^{-4}	9.37×10^{-5}	
Phosmet	No discharge of process wastewater pollutants		4
Prometon	5.56×10^{-3}	1.82×10^{-3}	
Prometryn	5.56×10^{-3}	1.82×10^{-3}	
Pronamide	4.78×10^{-4}	1.45×10^{-4}	
Propachlor	3.74×10^{-3}	1.11×10^{-3}	
Propanil	7.63×10^{-4}	3.48×10^{-4}	
Propazine	5.56×10^{-3}	1.82×10^{-3}	
Pyrethrin I and Pyrethrin II	8.91×10^{-3}	2.40×10^{-3}	
Simazine	5.56×10^{-3}	1.82×10^{-3}	
Stirofos	2.95×10^{-3}	9.72×10^{-4}	
TCMTB	2.80×10^{-3}	7.54×10^{-4}	
Tebuthiuron	9.78×10^{-2}	3.41×10^{-2}	
Terbacil	2.76×10^{-1}	8.36×10^{-2}	
Terbufos	4.92×10^{-4}	1.26×10^{-4}	
Terbuthylazine	5.56×10^{-3}	1.82×10^{-3}	
Terbutryn	5.56×10^{-3}	1.82×10^{-3}	
Toxaphene	7.35×10^{-3}	2.67×10^{-3}	
Triadimefon	4.69×10^{-2}	2.46×10^{-2}	

Table 2-7

(Continued)

Organic Pesticide Active Ingredient	NSPS/PSNS Effluent Limitations		Notes
	Daily Maximum Shall Not Exceed	Monthly Average Shall Not Exceed	
Trifluralin	3.22×10^{-4}	1.09×10^{-4}	1
Vapam [Sodium methyldithiocarbamate]	4.14×10^{-3}	1.35×10^{-3}	
Ziram [Zinc dimethyldithiocarbamate]	4.14×10^{-3}	1.35×10^{-3}	

*Limitations are in Kg/kkg (lb/1,000 lb) i.e., kilograms of pollutant per 1,000 kilograms product (pounds of pollutant per 1,000 lbs product).

Notes

[1] Monitor and report as total Trifluralin.
[2] Pounds of product shall include Benomyl and any Carbendazim production not converted to Benomyl.
[3] Monitor and report as total tin.
[4] Applies to purification by recrystallization portion of the process.

2.1.6 PSES

Pretreatment standards for existing sources which apply to indirect dischargers are generally analogous to BAT limitations which apply to direct dischargers. The Agency is promulgating PSES for the same PAIs regulated under BAT and for 24 priority pollutants of the 28 regulated under BAT (which the Agency has determined pass through POTWs). The final standards would apply to all existing indirect discharging organic pesticide chemicals manufacturing plants.

EPA determines which pollutants to regulate in PSES on the basis of whether or not they pass through, cause an upset, or otherwise interfere with operation of a POTW (including interference with sludge practices). A detailed discussion of the pass-through analysis conducted for priority pollutants is presented in Section VI of the OCPSF Development Document. PAI pass-through analysis is presented in Section 7.

Indirect dischargers generate wastewater with the same pollutant characteristics as the direct dischargers; therefore, the same technologies that were discussed for BAT are appropriate for application of PSES. For priority pollutants, the Agency established PSES for all indirect dischargers on the same technology basis as PSES in the OCPSF Development Document. PSES for PAIs and priority pollutants in the organic pesticide chemicals manufacturing subcategory are shown in Tables 2-3 and 2-8, respectively.

The Agency is reserving PSES for the metallo-organic pesticide chemical manufacturing subcategory.

2.1.7 PSNS

PSNS which apply to new facilities are generally analogous to PSES which apply to existing facilities. The Agency is promulgating PSNS for PAIs under the organic pesticide chemicals manufacturing subcategory on the same technology basis as PSES with a 28% achievable flow reduction for certain PAIs. For priority pollutants, the Agency established PSNS for all indirect dischargers on the same technology basis as PSES. PSNS for PAIs and priority pollutants in the organic pesticide chemicals manufacturing subcategory are shown in Tables 2-7 and 2-8, respectively.

The Agency is reserving PSNS for the metallo-organic pesticide chemicals manufacturing subcategory

Table 2-8

EFFLUENT LIMITATIONS FOR PRIORITY POLLUTANTS PRETREATMENT STANDARDS FOR EXISTING AND NEW SOURCES (PSES/PSNS)

Priority Pollutant	PSES/PSNS Effluent Limitations		Notes
	Maximum for Any One Day (μg/L)	Maximum for Monthly Average (μg/L)	
Benzene	134	57	
Tetrachloromethane	380	142	
Chlorobenzene	380	142	
1,2-Dichloroethane	574	180	
1,1,1-Trichloroethane	59	22	
Trichloromethane	325	111	
1,2-Dichlorobenzene	794	196	
1,4-Dichlorobenzene	380	142	
1,1-Dichloroethylene	60	22	
1,2-Trans-Dichloroethylene	66	25	
1,2-Dichloropropane	794	196	
1,3-Dichloropropene	794	196	
Ethylbenzene	380	142	
Dichloromethane	170	36	
Chloromethane	295	110	
Bromomethane	380	142	
Tribromomethane	794	196	
Bromodichloromethane	380	142	
Dibromochloromethane	794	196	
Naphthalene	47	19	
Tetrachloroethylene	164	52	
Toluene	74	28	
Total Cyanide	640	220	1
Total Lead	690	320	1

[1] Lead and total cyanide limitations apply only to noncomplexed lead-bearing or cyanide-bearing waste streams. Discharges of lead from complexed lead-bearing process wastewater or discharges of cyanide from complexed cyanide-bearing process wastewater are not subject to these limitations.

SECTION 3

INDUSTRY DESCRIPTION

3.0 INTRODUCTION

This section discusses characteristics of the Pesticide Chemicals Manufacturing Industry and presents the following topics:

- Methods of data collection used by EPA;
- Overview of the industry;
- Pesticide production;
- Pesticide manufacturing processes; and
- Changes in the industry.

3.1 DATA COLLECTION METHODS

EPA has gathered and evaluated technical data from various sources in the course of developing the effluent limitations guidelines and standards for the Pesticide Chemicals Manufacturing Industry. These data sources include:

- Responses to EPA's Questionnaire entitled "Pesticide Manufacturing Facility Census for 1986" (the "Facility Census");
- EPA's 1988-1990 sampling of selected pesticide manufacturers;
- Industry self-monitoring data;
- Industry treatability studies;
- EPA treatability studies;
- Previous EPA Office of Water studies of Pesticides Industry;
- Literature data;
- Toxic Release Inventory (TRI) database;
- Data transferred from the OCPSF Rulemaking;
- Office of Pesticide Programs (OPP) database;
- Other EPA studies of Pesticides Industry; and
- Data submitted during and after the comment period for the proposed rule.

EPA used data from these sources to profile the industry with respect to: production; manufacturing processes; geographical distribution; and wastewater generation, treatment, and disposal. EPA then characterized the wastewater generated by pesticide manufacturing operations through an evaluation of water use, type of discharge or disposal, and the occurrence of conventional, non-conventional, and priority pollutants.

3.1.1 Pesticide Product Registration Process

A pesticide, as defined by the Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA), includes "any substance or mixture of substances intended for preventing, destroying, repelling, or mitigating any pest, and any substance or mixture of substances intended for use as a plant regulator, defoliant, or desiccant." Under FIFRA all pesticides must be registered with EPA prior to shipment, delivery, or sale in the United States. A pesticide product is a formulated product; that is, it is a mixture of an "active ingredient" (the PAI) and "inert" diluents. Each formulation has a distinct registration.

As part of its activities in regulating pesticides, EPA requires all producers of pesticides (technical grade and formulated product) to report annually the amount of pesticides produced by that facility each year. The database containing these reports provides comprehensive data concerning the PAIs produced in the United States and, therefore, is an excellent single source of information on which PAIs are potentially manufactured in the United States. This source is treated by EPA as Confidential Business Information because it contains production information. Other sources, such as the "Directory of Chemical Producers" published by SRI International, list chemicals and the producer of each chemical, including chemicals typically used as pesticides. This source does not include any production information and is publicly available.

Although the data sources discussed above were very useful, the most focused, comprehensive source of information on which facilities manufactured PAIs was the administrative record for the remanded 1985 pesticide chemicals effluent limitations guidelines and standards.

3.1.2 Selection of PAIs for Consideration

At proposal, there were 270 PAIs or classes of PAIs that EPA considered for regulation. Since proposal, EPA has revoked the registration of biphenyl for use as a pesticide. Because biphenyl can no longer be used as a pesticide, it is no longer considered for coverage under these regulations, and, therefore, 269 PAIs or classes of PAIs are considered for regulation in the final rule. The initial basis for the list of covered PAIs was the 284 PAIs and classes of PAIs presented in Appendix 2 of the October 4, 1985 regulation (50 FR 40672). These 284 PAIs were originally selected in 1977 on the basis of significant production and/or commercial use. EPA then expanded this list to 835 PAIs by adding the following group of PAIs:

- All salts and esters of listed organic acids (such as 2,4-D);
- All metallo-organic PAIs (consisting of an organic portion bonded to arsenic, cadmium, copper, or mercury);
- All organo-tin PAIs;
- All PAIs that appeared to be structurally similar to other listed PAIs (such as organo-phosphorus pesticides); and
- Any other PAIs with an analytical method previously demonstrated to be applicable to wastewater.

EPA excluded from this list of 835 PAIs those PAIs already subject to regulation under other effluent guidelines - specifically, those regulated by OCPSF (40 CFR Part 414), Inorganic Chemicals Manufacturing (40 CFR part 415), and Pharmaceuticals (40 CFR Part 439). Information provided to EPA under FIFRA indicated that 335 of those 835 PAIs were produced in 1984-1985, and the other 500 were not produced for domestic use in either 1984 or 1985. An additional 15 (of the 835) were added to the 335 PAIs because those 15 PAIs had been manufactured prior to 1984 and might still be manufactured for export. The list of 350 PAIs and derivatives, such as salts and esters, was then consolidated by putting salts and esters of a PAI into a PAI class, to arrive at a total of 272 PAIs and classes of PAIs. Because the consolidated classes include all elements of the class, such as all salts and esters of 2,4-D (i.e., not just those in use in 1986), the 272 PAIs and classes of PAIs actually include 606 of the 835 specific PAIs. Figure 3-1 presents a flow chart of the methodology for determining the 272 PAIs that were included in the Pesticide Manufacturing Facility Census of 1986 (hereinafter referred to as the "Facility Census"). Table 3-1 lists these 272 PAIs and classes of PAIs, including the three PAIs -- biphenyl, ortho-dichlorobenzene, and para-dichlorobenzene -- that were included in the Facility Census but are not being considered for regulation in the final rule.

3.1.3 The "Pesticide Manufacturing Facility Census of 1986"

A major source of information and data used in developing effluent limitations guidelines and standards is industry responses to questionnaires distributed by EPA under the authority of Section 308 of the Clean Water Act. These questionnaires typically request information concerning production processes and pollutant generation, treatment, and disposal, as well as wastewater treatment system performance data. Questionnaires also request financial and economic data for use in assessing economic impacts and the economic achievability of technology options.

Figure 3-1

FLOW CHART FOR DETERMINING INCLUSION OF PAI
IN PESTICIDE MANUFACTURING FACILITY CENSUS FOR 1986

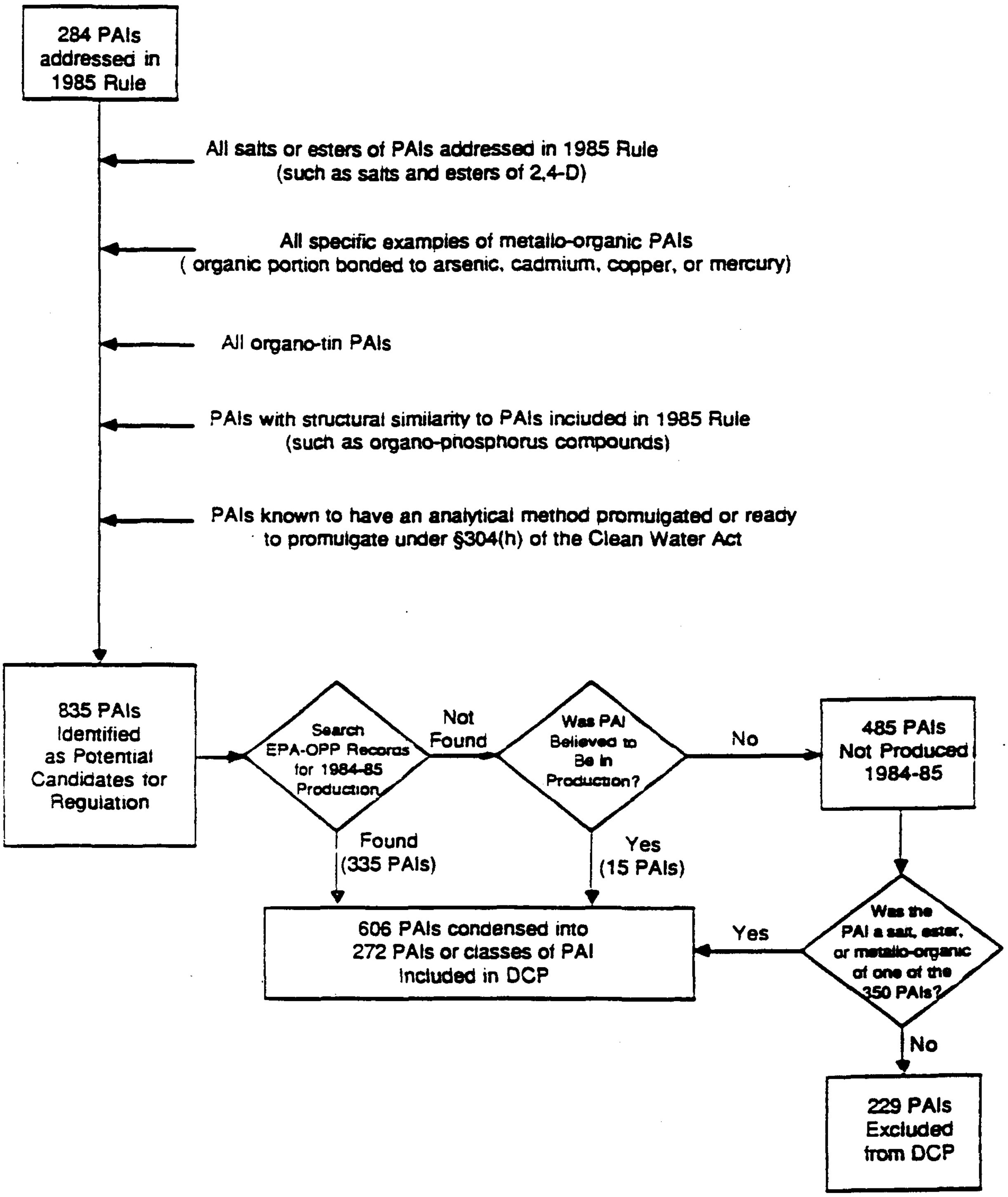


Table 3-1

LIST OF PESTICIDE ACTIVE INGREDIENTS (PAIs)

	PAI Code	Chemical Name	CAS #	Structural Group	Pesticide Type
10501	1	1,1-Bis(chlorophenyl)-2,2,2- trichloro ethanol [Dicofol]	00115-32-2	DDT	Insecticide
51501	2	1,2-Dihydro-3,6-pyridazinedione[Maleic Hydrazide]	00123-33-1	Hydrazide	Herbicide, growth regulator
42002	3	1,2-Ethylene dibromide [EDB]	00106-93-4	EDB	Fumigant
82901	4	1,3,5-Triethylhexahydro-s-Triazine [Vancide TH]	07779-27-3	s-Triazine	Fungicide
29001	5	1,3-Dichloropropene	00542-75-6	EDB	Nematocide
12601	6	Phenarsazine Oxide	00058-36-6	Organoarsenic	Fungicide
12602	6	10,10'-Oxybisphenoxarsine	04095-45-8	Organoarsenic	Fungicide
17901	7	[1-(3-Chloroallyl)-3,5,7-triaza-1-azoniaadamantane chloride] [Dowicil 75]	04080-31-3	Ammonium	Disinfectant
109901	8	1-(4-Chlorophenoxy)-3,3-dimethyl-1-(1H-1,2,4-triazol-1-yl)-2-butanone [Triadimefon]	43121-43-3	Triazine	Fungicide
44901	9	2,2'-Methylenebis(3,4,6- trichlorophenol) [Hexachlorophene]	00070-30-4	Chlorophene	Disinfectant
55004	10	2,2'-Methylenebis(4,6-dichloro phenol) [Tetrachlorophene]	01940-43-8	Chlorophene	Disinfectant
55001	11	2,2'-Methylenebis(4-chloro phenol) [Dichlorophene]	00097-23-4	Chlorophene	Disinfectant
84001	12	2,2-Dichlorovinyl dimethyl phosphate [Dichlorvos]	00062-73-7	Phosphate	Insecticide
102401	13	2,3,5-Trimethylphenylmethylcarbamate [Landrin-2]	02686-99-9	Carbamate	Insecticide
82601	14	2,3,6-Trichlorophenylacetic acid [Fenac]	00085-34-7	Phenoxy acid	Herbicide
**	14	2,3,6-Trichlorophenylacetic acid, salts and esters	**	Phenoxy acid	Herbicide
82001	15	2,4,5-Trichlorophenoxyacetic acid [2,4,5-T]	00093-76-5	Phenoxy acid	Herbicide
**	15	2,4,5-Trichlorophenoxyacetic acid, salts and esters	**	Phenoxy acid	Herbicide
30001	16	2,4-Dichlorophenoxyacetic acid [2,4-D]	00094-75-7	Phenoxy acid	Herbicide
**	16	2,4-Dichlorophenoxyacetic acid, salts and esters	**	Phenoxy acid	Herbicide
30801	17	2,4-Dichlorophenoxybutyric acid [2,4-DB]	00094-82-6	Phenoxy acid	Herbicide
**	17	2,4-Dichlorophenoxybutyric acid, salts and esters	**	Phenoxy acid	Herbicide
80811	18	2,4-Dichloro-6- (o-chloroanilino)-s-Triazine [Anilazine]	00101-05-3	s-Triazine	Herbicide

Table 3-1 (Continued)

LIST OF PESTICIDE ACTIVE INGREDIENTS (PAIs)

	PAI Code	Chemical Name	CAS #	Structural Group	Pesticide Type
36001	19	2,4-Dinitro-6-octylphenyl crotonate, 2,6-Dinitro-4-octylphenylcrotonate, and Nitrooctylphenols [Dinocap] (The octyl's are a mixture of 1-Methylheptyl, 1-Ethylhexyl, and 1-Propylpentyl)	39300-45-3	Phenylcrotonate	Insecticide
31301	20	2,6-Dichloro-4-nitroaniline [Dichloran]	00099-30-9	Arylhalide	Fungicide
8707	21	2-Bromo-4-hydroxy acetophenone [Busan 90]	02491-38-5	Miscellaneous	Slimicide
15801	22	2-Carbomethoxy-1-methylvinyl dimethyl phosphate, and related compounds [Mevinphos]	07786-34-7	Phosphate	Insecticide
39001	23	2-Chloroallyl diethyldithiocarbamate [Sulfallate]	00095-06-7	Dithiocarbamate	Herbicide
84101	24	2-Chloro-1-(2,4-dichlorophenyl)vinyl diethyl phosphate [Chlorfenvinphos]	00470-90-6	Phosphate	Insecticide
100101	25	2-Chloro-4-(1-cyano-1-methylethyl)amino)-6-ethylamino)-s-Triazine [Cyanazine]	21725-46-2	s-Triazine	Herbicide
19101	26	2-Chloro-N-isopropylacetanilide [Propachlor]	01918-16-7	Acetanilide	Herbicide
30501	27	2-Methyl-4-chlorophenoxyacetic acid [MCPA]	00094-74-6	Phenoxy acid	Herbicide
**	27	2-Methyl-4-chlorophenoxyacetic acid, salts and esters	**	Phenoxy acid	Herbicide
99901	28	2-n-Octyl-4-isothiazolin-3-one [Octhilinone]	26530-20-1	Heterocyclic	Fungicide
67703	29	2-Pivalyl-1,3-indandione [Pindone]	00083-26-1	Indandione	Rodenticide
31401	30	2-(2,4-Dichlorophenoxy) propionic acid [Dichlorprop]	00120-36-5	Phenoxy acid	Herbicide
**	30	2-(2,4-Dichlorophenoxy) propionic acid, salts and esters	**	Phenoxy acid	Herbicide
31501	31	2-(2-Methyl-4-chlorophenoxy) propionic acid [MCPP]	00093-65-2	Phenoxy acid	Herbicide
**	31	2-(2-Methyl-4-chlorophenoxy) propionic acid, salts and esters	**	Phenoxy acid	Herbicide
60101	32	2-(4-Thiazolyl)benzimidazole [Thiabendazole]	00148-79-8	Heterocyclic	Fungicide
80815	33	2-(methylthio)-4-(ethylamino)-6-(1,2-dimethylamino)-s-Triazine	22936-75-0	Triazine	Herbicide
21201	34	2-(m-Chlorophenoxy)propionic acid [Cloprop]	00101-10-0	Phenoxyacetic acid	Herbicide
**	34	2-(m-Chlorophenoxy)propionic acid, salts and esters	**	Phenoxyacetic acid	Herbicide
35603	35	2-(Thiocyanomethylthio)benzo thiazole [TCMTB]	21564-17-0	Heterocyclic	Fungicide
99001	36	2-((Hydroxymethyl)amino) ethanol [HAE]	34375-28-5	Alcohol	Bacteriostat

Table 3-1 (Continued)

LIST OF PESTICIDE ACTIVE INGREDIENTS (PAIs)

	PAI Code	Chemical Name	CAS #	Structural Group	Pesticide Type
67707	37	2-((p-Chlorophenyl)phenyl acetyl)-1,3-indandione [Chlorophacinone]	03691-35-8	Indandione	Rodenticide
102401	38	3,4,5-trimethylphenyl methylcarbamate [Landrin-1]	02655-15-4	Carbamate	Insecticide
101701	39	3,5-Dichloro-N-(1,1-dimethyl-2-propynyl)benzamide [Pronamide]	23950-58-5	Chlorobenzamide	Herbicide
100501	40	3,5-Dimethyl-4-(methylthio) phenyl dimethylcarbamate [Methiocarb]	02032-65-7	Carbamate	Insecticide, Molluscide
28201	41	3',4'-Dichloropropionanilide [Propanil]	00709-98-8	Chloropropionanilide	Herbicide
107801	42	3-Iodo-2-propynyl butylcarbamate	55406-53-6	Carbamate	Fungicide
86001	43	3-(a-Acetonylfurfuryl)-4-hydroxycoumarin [Coumafuryl]	00117-52-2	Hydroxycoumarin	Rodenticide
**		3-(a-Acetonylfurfuryl)-4-hydroxycoumarin, salts and esters	**	Hydroxycoumarin	Rodenticide
37507	44	4,6-Dinitro-o-cresol [DNOC]	00534-52-1	Phenol	Herbicide
101101	45	4-Amino-6-(1,1-dimethylethyl)-3-(methylthio)-1,2,4-triazin-5(4H)-one [Metribuzin]	21087-64-9	Triazine	Herbicide
19401	46	4-chlorophenoxyacetic acid [CPA]	00122-88-3	Phenoxy acid	Herbicide
**	46	4-chlorophenoxyacetic acid, salts and esters	**	Phenoxy acid	Herbicide
19201	47	4-(2-Methyl-4-chlorophenoxy)butyric acid [MCPB]	00094-81-5	Phenoxy acid	Herbicide
**	47	4-(2-Methyl-4-chlorophenoxy)butyric acid, salts and esters	**	Phenoxy acid	Herbicide
44401	48	4-(Dimethylamino)-m-tolyl methylcarbamate [Aminocarb]	02032-59-9	Carbamate	Insecticide, Miticide, Molluscide
84701	49	5-Ethoxy-3-(trichloromethyl)-1,2,4-thiadiazole [Etridiazole]	02593-15-9	Heterocyclic	Fungicide - soil
55501	50	6-Ethoxy-1,2-dihydro-2,2,4-trimethyl quinoline [Ethoxyquin]	00091-53-2	Quinoline	Fungicide, growth regulator, antioxidant
59804	51	8-Quinoliol sulfate [Quinoliol sulfate]	00134-31-6	Quinoline	Fungicide, bacteriostat
103301	52	Acephate (O,S-Dimethyl acetylphosphoramidothioate)	30560-19-1	Phosphor amidothioate	Insecticide
114401	53	Acifluorfen (5-(2-Chloro-4-(trifluoromethyl) phenoxy)-2-nitrobenzoic acid)	50594-66-6	Benzoic acid	Herbicide
**	53	Acifluorfen, salts and esters	**	Benzoic acid	Herbicide
90501	54	Alachlor (2-Chloro-2'6'-diethyl-N-(methoxymethyl)acetanilide	15972-60-8	Acetanilide	Herbicide

Table 3-1 (Continued)

LIST OF PESTICIDE ACTIVE INGREDIENTS (PAIs)

	PAI Code	Chemical Name	CAS #	Structural Group	Pesticide Type
98301	55	Aldicarb (2-Methyl-2-(methylthio)propionaldehyde O-(methylcarbamoyl)oxime)	00116-06-3	Carbamate	Insecticide
69105	56	[Alkyl* dimethyl benzyl Ammonium chloride * (50% C14, 40% C12, 10% C16)]	68424-85-1	Ammonium	Antimicrobial
**	57	Allethrin (all isomers and allethrin coil)	**	Cyclopropane carboxylic acid	Insecticide
80801	58	Ametryn (2-(Ethylamino)-4-(isopropylamino)-6-(methylthio)-s-Triazine)	00834-12-8	s-Triazine	Herbicide
106201	59	Amitraz (N'-2,4-Dimethylphenyl)-N-(((2,4-dimethylphenyl)imino)methyl)-N-methylmethanimidamide)	33089-61-1	Imidamide	Insecticide
80803	60	Atrazine (2-Chloro-4-(ethylamino)-6-(isopropylamino)-s-Triazine)	01912-24-9	s-Triazine	Herbicide
105201	61	Bendiocarb (2,2-Dimethyl-1,3-benzodioxol-4-yl methylcarbamate	22781-23-3	Carbamate	Insecticide
99101	62	Benomyl (Methyl 1-(butylcarbamoyl)-2-benzimidazolecarbamate)	17804-35-2	Carbamate	Fungicide - vegetables
8901	63	Benzene Hexachloride	00608-73-1	Arylhalide	Disinfectant
9501	64	Benzyl benzoate	00120-51-4	Ester	Repellant
10101	65	Beta-Thiocyanoethyl esters of mixed fatty acids containing from 10-18 carbons [Lethane 384]	00112-56-1	Thiocyanate	Insecticide
104301	66	Bifenox [Methyl-5-(2,4-dichloro phenoxy)-2-nitrobenzoate]	42576-02-3	Nitrobenzoate	Herbicide
17002	67	Biphenyl[1]	00092-52-4	Aryl	Fungicide
12301	68	Bromacil [5-Bromo-3-sec-Butyl-6-methyluracil]	00314-40-9	Uracil	Herbicide
12302	68	Bromacil, lithium salt	53404-19-6	Uracil	Herbicide
35301	69	Bromoxynil [3,5-Dibromo-4-hydroxy benzonitrile]	01689-84-5	Benzonitrile	Herbicide
35302	69	Bromoxynil octanoate	01689-99-2	Benzonitrile	Herbicide
112301	70	Butachlor [N-(Butoxymethyl)-2-chloro-2',6'-diethylacetanilide]	23184-66-9	Acetanilide	Herbicide
101401	71	^{a}-Bromo-^{a}-nitrostyrene [Giv-gard]	07166-19-0	Miscellaneous	Slimicide
12501	72	Cacodylic acid [Dimethylarsenic acid]	00075-60-5	Organoarsenic	Herbicide
**	72	Cacodylic acid, salts and esters	**	Organoarsenic	Herbicide

Table 3-1 (Continued)

LIST OF PESTICIDE ACTIVE INGREDIENTS (PAIs)

	PAI Code	Chemical Name	CAS #	Structural Group	Pesticide Type
81701	73	Captafol [cis-N-((1,1,2,2-Tetrachloroethyl)thio)-4-cyclohexene-1,2-dicarboximide]	02425-06-1	Phthalimide	Fungicide
81301	74	Captan [N-Trichloromethylthio-4-cyclohexene-1,2-carboximide]	00133-06-2	Phthalimide	Fungicide
56801	75	Carbaryl [1-Naphthylmethylcarbamate]	00063-25-2	Carbamate	Insecticide
90601	76	Carbofuran [2,3-Dihydro-2,2-dimethyl-7-benzofuranyl methylcarbamate]	01563-66-2	Carbamate	Insecticide
90602	77	Carbosulfan [2,2-Dihydro-2,2-dimethyl-7-benzofuranyl (dibutylamino)thio)methylcarbamate]	55285-14-8	Carbamate	Insecticide
29901	78	Chloramben [3-Amino-2,5-dichlorobenzoic acid]	00133-90-4	Benzoic acid	Herbicide
**	78	Chloramben, salts and esters	**	Benzoic acid	Herbicide
58201	79	Chlordane [Octachloro-4,7-methanotetrahydroindane]	00057-74-9	Multiring halide	Insecticide
27301	80	Chloroneb [1,4-Dichloro-2,5-dimethoxy benzene]	02675-77-6	Arylhalide	Fungicide
81501	81	Chloropicrin [Trichloronitromethane]	00076-06-2	Alkylhalide	Fumigant
81901	82	Chlorothalonil [2,4,5,6-Tetrachloro-1,3-dicyanobenzene]	01897-45-6	Phthalonitrile	Fungicide
25501	83	Chloroxuron [3-(4-(4-Chlorophenoxy)phenyl)-1,1-dimethylurea]	01982-47-4	Urea	Herbicide
83701	84	Chloro-1-(2,4,5-trichloro phenyl)vinyl dimethylphosphate [Stirofos]	00961-11-5	Phosphate	Insecticide
59102	85	Chlorpyrifos methyl [O,O-Dimethyl O-(3,5,6-trichloro-2-pyridyl)phosphorothioate]	05598-13-0	Phosphorothioate	Insecticide
59101	86	Chlorpyrifos [O,O-Diethyl O-(3,5,6-trichloro-2-pyridyl) [phosphorothioate]	02921-88-2	Phosphorothioate	Insecticide
14504	87	Coordination product of Manganses 16%, Zinc 2%, and Ethylenebisdithiocarbamate 62% [Mancozeb]	08018-01-7	Dithiocarbamate	Fungicide
24002	88	Copper 8-hydroxyquinoline	10380-28-6	Organocopper	Fungicide
39105	89	Copper ethylenediaminetetraacetate	14951-91-8	Organo-copper	Slimicide
109301	90	Cyano(3-phenoxyphenyl)methyl 4-chloro-a-(1-methylethyl) benzeneacetate (9CA) [Fenvalerate]	51630-58-1	Benzeneacetic acid ester	Insecticide
43401	91	Cycloheximide [3-(2-(3,5-Dimethyl-2-oxocyclohexyl)-2-hydroxyethyl)glutarimide]	00066-81-9	Cyclic ketone	Growth regulator

Table 3-1 (Continued)

LIST OF PESTICIDE ACTIVE INGREDIENTS (PAIs)

	PAI Code	Chemical Name	CAS #	Structural Group	Pesticide Type
28901	92	Dalapon (2,2-dichloropropionic acid)	00075-99-0	Alkylhalide	Herbicide
**	92	Dalapon, salts and esters	**	Alkylhalide	Herbicide
27501	93	Decachloro-bis(2,4-cyclopenta diene-1-yl) [Dienochlor]	02227-17-0	Arylhalide	Miticide
57601	94	Demeton [O,O-Diethyl O-(and S-)(2-ethylthio)ethyl)phosphorothioate]	08065-48-3	Phosphoro dithioate	Insecticide
104801	95	Desmedipham [Ethyl *m*-hydroxycarbanilate carbanilate]	13684-56-5	Carbamate	Herbicide
14502	96	DiAmmonium salt of ethylenebisdithiocarbamate	03566-10-7	Dithiocarbamate	Fungicide
11301	97	Dibromo-3-chloropropane [DBCP]	00096-12-8	EDB	Nematocide
29801	98	Dicamba [3,6-Dichloro-o-anisic acid]	01918-00-9	Arylhalide	Herbicide
**	98	Dicamba, salts and esters	**	Arylhalide	Herbicide
29601	99	Dichlone [2,3-Dichloro-1,4- naphthoquinone]	00117-80-6	Quinone	Fungicide
103401	100	Diethyl 4,4'-o-phenylenebis(3-thioallophanate) [Thiophanate ethyl]	23564-06-9	Carbamate	Fungicide
32101	101	Diethyl diphenyl dichloroethane and related compounds [Perthane]	00072-56-0	DDT	Insecticide
86501	102	Diethyl dithiobis(thionoformate) [EXD]	00502-55-6	Dithiocarbamate	Herbicide
57801	103	Diethyl O-(2-isoprppryl-6- methyl-4-pyrimidinyl) phosphorothioate [Diazinon]	00333-41-5	Phosphorothioate	Insecticide
108201	104	Diflubenzuron [N-(((4-Chlorophenyl)amino) carbonyl)-2,6-difluorobenzamide]	35367-38-5	Urea	Insecticide
69122	105	Diisobutylphenoxyethoxyethyl dimethl benzyl Ammonium chloride [Benzethonium chloride]	00121-54-0	Ammonium	Disinfectant
35001	106	Dimethoate [O,O-Dimethyl[S-((methylcarbamoyl)methyl) phosphorothioate]	00060-51-5	Phosphoro dithioate	Insecticide
53501	107	Dimethyl O-p-nitrophenyl phosphorothioate [Parathion methyl]	00298-00-0	Phosphorothioate	Insecticide
35201	108	Dimethyl phosphate ester of 3-hydroxy-N,N-dimethyl-cis-crotonate [Dicrotophos]	00141-66-2	Phosphate	Insecticide, Miticide
58801	109	Dimethyl phosphate ester of a-methylbenzyl 3-hydroxy-cis-crotonate [Crotoxyphos]	07700-17-6	Phosphate	Insecticide

Table 3-1 (Continued)

LIST OF PESTICIDE ACTIVE INGREDIENTS (PAIs)

	PAI Code	Chemical Name	CAS #	Structural Group	Pesticide Type
78701	110	Dimethyl 2,3,5,6-tetrachloroterephthalate [DCPA]	01861-32-1	Terephthalic acid ester	Herbicide
57901	111	Dimethyul (2,2,2-trichloro-1-hydroxyethyl) phosphonate [Trichlorofon]	00052-68-6	Phosphonate	Insecticide
37505	112	Dinoseb [2-sec-Butyl-4,6-dinitrophenol]	00088-85-7	Phenol	Herbicide
37801	113	Dioxathion [2,3-p-Dioxanedithiol S,S-bis(O,O-diethyl [phosphorodithioate)]	00078-34-2	Phosphoro dithioate	Insecticide
67701	114	Diphacinone [2-(Diphenylacetyl)-1,3-indandione]	00082-66-6	Indandione	Rodenticide
36601	115	Diphenamid [N,N-Dimethyl-2,2-diphenyl acetamide]	00957-51-7	Acetamide	Herbicide
38501	116	Diphenylamine	00122-39-4	Arylamine	Insecticide
47201	117	Dipropyl isocinchomeronate [MGK 326]	00113-48-4	Ester	Repellant
63301	118	Disodium cyanodithioimidocarbonate [Nabonate]	00138-93-2	Isocyanate	Slimicide
35505	119	Diuron [3-(3,4-Dichlorophenyl)-1,1-dimethylurea]	00330-54-1	Urea	Herbicide
44303	120	Dodecylguanidine hydrochloride [Metasol DGH]	13590-97-1	Ammonium	Fungicide
44301	121	Dodine [Dodecylquanidine acetate]	02439-10-3	Ammonium	Fungicide
79401	122	Endosulfan [Hexachlorohexahydromethano-2,4,3-benzodioxathiepin-3-oxide]	00115-29-7	Multiring halide	Insecticde
38901	123	Endothall [7-Oxabicyclo(2,2,1)heptane-2,3-dicarboxylic acid]	00145-73-3	Bicyclic	Herbicide
**	123	Endothall, salts and esters	**	Bicyclic	Herbicide
41601	124	Endrin [Hexachloroepoxy octahydro-endo,endo-dimethanonaphthalene]	00072-20-8	Multiring halide	Insecticide
113101	125	Ethalfluralin [N-Ethyl-N-(2-methyl-2- propenyl)-2,6-dinitro-4-(trifluoromethyl)benzeneamine]	55283-68-6	Toluidine	Herbicide
58401	126	Ethion [O,O,O',O'-Tetraethyl S,S'-methylene bisphosphorodithioate]	00563-12-2	Phosphoro dithioate	Insecticide
41101	127	Ethoprop [O-Ethyl S,S-dipropyl phosphorodithioate]	13194-48-4	Phosphoro dithioate	Insecticide
100601	128	Ethyl 3-methyl-4-(methylthio)phenyl 1-(methylethyl) phosphoramidate [Fenamiphos]	22224-92-6	Phosphoroamidate	Nematocide
28801	129	Ethyl 4,4'-dichlorobenzilate [Chlorobenzilate]	00510-15-6	Arylhalide	Miticide

Table 3-1 (Continued)

LIST OF PESTICIDE ACTIVE INGREDIENTS (PAIs)

	PAI Code	Chemical Name	CAS #	Structural Group	Pesticide Type
41405	130	Ethyl diisobutylthiocarbamate [Butylate]	02008-41-5	Thiocarbamate	Herbicide
59901	131	Famphur [O,O-Dimethyl O-(p-(dimethylsulfamoyl)phenyl) phosphorothioate]	00052-85-7	Phosphorothioate	Insecticide
206600	132	Fenarimol [a-(2-Chlorophenyl)-a-(4-chlorophenyl)-5-pyrimidinemethanol]	60168-88-9	Pyrimidine	Fungicide
53301	133	Fenthion [O,O-Dimethyl O-(4-methylthio)-m-toluyl) phosphorothioate]	00055-38-9	Phosphorothioate	Insecticide
34801	134	Ferbam [Ferric dimethyldithiocarbamate]	14484-64-1	Dithiocarbamate	Fungicide
35503	135	Fluometuron [1,1-Dimethyl-3-(a,a,a-trifluoro-m-tolyl)urea]	02164-17-2	Urea	Herbicide
75002	136	Fluoroacetamide	00640-19-7	Acetamide	Rodenticide
81601	137	Folpet [N-((Trichloromethyl) thio)phthalimide]	00133-07-3	Phthalimide	Fungicide
103601	138	Glyphosate [N-(Phosphonomethyl)glycine]	01071-83-6	Phosphoramidate	Herbicide
**	138	Glyphosate, salts and esters	**	Phosphoramidate	Herbicide
103602	139	Glyphosine [N,N-bis(Phosphonomethyl) glycine]	02439-99-8	Phosphoramidate	Herbicide
44801	140	Heptachlor [Heptachlorotetrahydro-4,7-methanoindene]	00076-44-8	Multiring halide	Insecticide
115601	141	Hexadecyl cyclopropanecarboxylate [Cycloprate]	54460-46-7	Cyclopropane carboxylic acid	Insecticide
107201	142	Hexazinone [3-Cyclohexyl-6-(dimethy lamino)-1-methyl-1,3,5-triazine-2,4-(1H,3H)-dione]	51235-04-2	s-Triazine	Herbicide
109401	143	Isofenphos [1-Methylethyl 2-((ethoxy((1-methylethyl) amino)phosphinothioyl)oxy) benzoate]	25311-71-1	Phosphoro amidothioate	Insecticide
100201	144	Isopropalin [2,6-Dinitro-N,N-dipropyl cumidine]	33820-53-0	Toluidine	Herbicide
47601	145	Isopropyl N-phenyl carbamate [Propham]	00122-42-9	Carbamate	Insecticide
97401	146	Karbutilate [tert-Butylcarbamic acid esterof3-(m-hydroxy phenyl)-1,1-dimethylurea]	04849-32-5	Carbamate/Urea	Herbicide
9001	147	Lindane [gamma isomer of Benzene hexachloride, 99% pure]	00058-89-9	Arylhalide	Insecticide
35506	148	Linuron [3-(3,4-Dichlorophenyl)-1-methoxy-1-methylurea]	00330-55-2	Urea	Herbicide

Table 3-1 (Continued)

LIST OF PESTICIDE ACTIVE INGREDIENTS (PAIs)

	PAI Code	Chemical Name	CAS #	Structural Group	Pesticide Type
39504	149	Malachite green [Ammonium(4-(p-(dimethy lamino)-alpha-phenylbenzylidine)-2,5-cyclo hexadien-1-ylidene)-dimethylchloride]	00569-64-2	Ammonium	Fungicide, Bacteriostat
57701	150	Malathion [O,O-Dimethyl dithiophosphate of diethyl [mercaptosuccinate]	00121-75-5	Phosphoro dithioate	Insecticide
14505	151	Maneb [Manganese salt of ethylenebisdithiocarbamate]	12427-38-2	Dithiocarbamate	Fungicide
34802	152	Manganous dimethyldithiocarbamate	15339-36-3	Dithiocarbamate	Fungicide
114001	153	Mefluidide [N-(2,4-dimethyl-5-(((trifluoro methyl)sulfonyl)amino)phenyl acetamide]	53780-34-0	Acetamide	Defoliant
**	153	Mefluidide, salts and esters	**	Acetamide	Defoliant
101201	154	Methamidophos [O,S-Dimethyl phosphoramidothioate]	10265-92-6	Phosphoro amidothioate	Insecticide
100301	155	Methidathion [O,O-Dimethyl phosphorodithioate, S-ester of 4-(mercaptomethyl)-2-methoxy-delta 2-1,3,4-thiadiazolin-5-one]	00950-37-8	Phosphoro dithioate	Insecticide, Miticide
90301	156	Methomyl [S-Methyl N-((methylcarbamoyl)oxy)thio acetimidate]	16752-77-5	Carbamate	Insecticide
105401	157	Methoprene [Isopropyl(E,E)-11-methoxy-3,7,11-trimethyl-2,4-dodecadienoate]	40596-69-8	Ester	Regulator
34001	158	Methoxychlor [2,2-bis(p-methoxyphenyl)-1,1,1-trichloroethane]	00072-43-5	DDT	Insecticide
69134	159	Methylbenzethonium chloride	15716-02-6	R4N	Disinfectant
53201	160	Methylbromide	00074-83-9	Alkylhalide	Fumigant
**	161	Methylarsonic acid, salts and esters	**	Organoarsenic	Herbicide
69129	162	Methyldodecylbenzyl trimethyl Ammonium chloride 80% and methyldodecylxylylene bis(trimethylammoniumchloride) 20%[HYAMINE 2389]	01399-80-0	Ammonium	Disinfectant
68102	163	Methylene bisthiocyanate	06317-18-6	Thiocyanate	Slimicide
54101	164	Methyl-2,3-quinoxalinedithiol cyclic S,S-dithiocarbamate [Quinmethionate]	02439-01-2	Heterocyclic	Fungicide, Miticide
108801	165	Metolachlor [2-Chloro-N-(2-ethyl-6-methyl phenyl)-N-(2-methoxy-1-methylethyl)acetamide]	51218-45-2	Acetanilide	Herbicide
44201	166	Mexacarbate [4-(Dimethylamino)-3,5-xylyl methylcarbamate]	00315-18-4	Carbamate	Insecticide

Table 3-1 (Continued)

LIST OF PESTICIDE ACTIVE INGREDIENTS (PAIs)

	PAI Code	Chemical Name	CAS #	Structural Group	Pesticide Type
14601	167	Mixture of 83.9% Ethylenebis(dithiocarbamato) zinc and 16.1% Ethylenebisdithiocarbamate, bimolecular and trimolecular cyclic anhydrosulfides and disulfides [Metiram]	09006-42-2	Dithiocarbamate	Fungicide
35502	168	Monuron TCA = Monuron trichloroacetate	00140-41-0	Urea	Herbicide
35501	169	Monuron [3-(4-Chlorophenyl)-1,1- dimethylurea]	00150-68-5	Urea	Herbicide
103001	170	N,N-Diethyl-2-(1-naphathalenyloxy)propionamide [Napropamide]	15299-99-7	Amide	Herbicide
80301	171	N,N-Diethyl-meta-toluamide and other isomers [Deet]	00134-62-3	Toluamide	Repellant
14503	172	Nabam [Disodium salt of ethylenebisdithiocarbamate]	00142-59-6	Dithiocarbamate	Fungicide
34401	173	Naled [1,2-Dibromo-2,2-dichloroethyl dimethyl phosphate]	00300-76-5	Phosphate	Insecticide
35801	174	Norea [3-Hexahydro-4,7-methano indan-5-yl-1,1-dimethylurea]	18530-56-8	Urea	Herbicide
105801	175	Norflurazon [4-Chloro-5-(methylamino)-2-(a,a,a-trifluoro-m-tolyl)-3(2H)-pyridazinone]	27314-13-2	Heterocyclic	Herbicide
30701	176	N-1-Naphthylphthalimide	05333-99-3	Phthalamide	Herbicide
30702	176	Naptalam (N-1-Naphthylphthalamic acid)	00132-66-1	Phthalamide	Herbicide
**	176	Naptalam, salts and esters	**	Phthalamide	Herbicide
57001	177	N-2-Ethylhexyl bicycloheptene dicarboximide [MGK 264]	00136-45-8	Bicyclic	Repellant
84301	178	N-Butyl-N-ethyl-a,a,a-trifluoro- 2,6-dinitro-p-toluidine [Benfluralin]	01861-40-1	Toluidine	Herbicide
79501	179	O,O,O,O-Tetraethyl dithiopyrophosphate [Sulfotepp]	03689-24-5	Dithiopyro phosphate	Insecticide
79101	180	O,O,O,O-Tetrapropyl dithiopyrophosphate [Aspon]	03244-90-4	Dithiopyro phosphate	Insecticide, Miticide
36501	181	O,O-Diethyl O-(3-chloro-4-methyl-2-oxo-2H-1-benzopyran-7-yl [Coumaphos]	00056-72-4	Phosphorothioate	Insecticide
32701	182	O,O-Diethyl O-(p-(methylsulfinyl)phenyl) phosphorothioate [Fensulfothion]	00115-90-2	Phosphorothioate	Insecticide
32501	183	O,O-Diethyl S-(2-(ethylthio)ethyl)phosphorodithioate [Disulfoton]	00298-04-4	Phosphoro dithioate	Insecticide
105901	184	O,O-Dimethyl O-(4-nitro-m-tolyl)phosphoro thioate [Fenitrothion]	00122-14-5	Phosphorothioate	Insecticide

Table 3-1 (Continued)

LIST OF PESTICIDE ACTIVE INGREDIENTS (PAIs)

	PAI Code	Chemical Name	CAS #	Structural Group	Pesticide Type
59201	185	O,O-Dimethyl S-(phthalimidomethyl) phosphorodithioate [Phosmet]	00732-11-6	Phosphoro dithioate	Insecticide
58001	186	O,O-Dimethyl S-((4-oxo-1,2,3-benzotriazin- 3(4H)-yl)methyl) phosphorodithioate [Azinphos Methyl]	00086-50-0	Phosphoro dithioate	Insecticide
58702	187	O,O-Dimethyl S-((ethylsulfinyl)ethyl) phosphorothioate [Oxydemeton methyl]	00301-12-2	Phosphoro dithioate	Insecticide
**	188	Organo-arsenic pesticides (not otherwise listed)	**	Organoarsenic	Coccidiostat
**	189	Organo-cadmium pesticides	**	Organocadmium	
**	190	Organo-copper pesticides	**	Organocopper	Fungicide
**	191	Organo-mercury pesticides	**	Organomercury	Disinfectant
**	192	Organo-tin pesticides	**	Tin alkyl	Fungicide
59401	193	ortho Dichlorobenzene[1]	00095-50-1	Aryl halide	Insecticide
104201	194	Oryzalin [3,5-Dinitro-N^4,N^4-dipropylsulfanilamide]	19044-88-3	Sulfanylimide	Herbicide
103801	195	Oxamyl [Methyl N',N'-dimethyl-N-((methyl carbamoyl)oxy)-1-thiooxamidate]	23135-22-0	Carbamate	Insecticide
111601	196	Oxyfluorfen [2-Chloro-1-(3-ethoxy-4-nitro phenoxy)-4-(trifluoromethyl)benzene]	42874-03-3	Miscellaneous	Herbicide
111501	197	O-Ethyl O-(4-(methylthio)phenyl) S-propyl phosphorodithioate [Sulprofos; Bolstar]	35400-43-2	Phosphoro dithioate	Insecticide
219900	198	O-Ethyl O-(4-(methylthio)phenyl) S-propyl phosphorothioate {9CA} [Sulprofos Oxon]	38527-90-1	Phosphorothioate	Insecticide
41801	199	O-Ethyl O-(p-nitrophenyl)phenylphosphonothioate [Santox]	02104-64-5	Phosphonothioate	Insecticide, Miticide
41701	200	O-Ethyl S-phenyl ethylphosphonodithioate [Fonofos]	00944-22-9	Phosphono dithioate	Insecticide
47802	201	o-Isoproxyphenyl methylcarbamate [Propoxur]	00114-26-1	Carbamate	Insecticide
61501	202	para Dichlorobenzene[1]	00106-46-7	Aryl halide	Mothballs
57501	203	Parathion [O,O-Diethyl O-(p-nitrophenyl)phosphorothioate]	00056-38-2	Phosphorothioate	Insecticide
108501	204	Pendimethalin [N-(1-ethylpropyl)-3,4-dimethyl-2,6-dinitrobenzenamine]	40487-42-1	Benzeneamine	Herbicide
56502	205	Pentachloronitrobenzene	00082-68-8	Aryl chloride	Herbicide

Table 3-1 (Continued)

LIST OF PESTICIDE ACTIVE INGREDIENTS (PAIs)

	PAI Code	Chemical Name	CAS #	Structural Group	Pesticide Type
63001	206	Pentachlorophenol	00087-86-5	Phenol	Preservative
**	206	Pentachlorophenol, salts and esters	**	Phenol	Preservative
108001	207	Perfluidone [1,1,1-Trifluoro-N-(2-methyl-4-(phenylsulfonyl)phenyl) methanesulfonamide]	37924-13-3	Sulfonamide	Herbicide
109701	208	Permethrin [(3-Phenoxyphenyl)methyl 3-(2,2-dichlorethenyl)-2,2-dimethylcyclopropane carboxylate]	52645-53-1	Cyclopropane carboxilic acid	Insecticide
98701	209	Phenmedipham [Methyl m-hydroxycarbanilate m-methyl carbanilate]	13684-63-4	Carbamate	Herbicide
64501	210	Phenothiazine	00092-84-2	Heterocyclic	Insecticide
64103	211	Phenylphenol	00090-43-7	Phenol	Bacteriostat
57201	212	Phorate [O,O-Diethyl S-((ethylthio)methyl)phosphorodithioate]	00298-02-2	Phosphoro dithioate	Insecticide
97701	213	Phosalone [O,O-Diethyl S-((6-chloro-2-oxobenzoxazolin-3-yl) methyl) phosphorothioate]	02310-17-0	Phosphoro dithioate	Insecticide, Miticide
18201	214	Phosphamidon [2-Chloro-N,N-diethyl-3- hydroxycrotonamide ester of dimethylphosphate]	13171-21-6	Phosphate	Insecticide
5101	215	Picloram [4-Amino-3,5,6-trichloropicolinic acid]	01918-02-1	Pyridine	Herbicide
**	215	Picloram, salts and esters	**	Pyridine	Herbicide
67501	216	Piperonyl butoxide [(Butylcarbityl)(6-propylpiperonyl)ether]	00051-03-6	Ester	Synergist
69183	217	Poly(oxyethylene(dimethylimino)ethylene(dimethylimino)ethylene dichloride [PBED (Busan 77)]	31512-74-0	Ammonium	Fungicide
34803	218	Potassium dimethyldithiocarbamate [Busan 85]	00128-03-0	Dithiocarbamate	Fungicide
102901	219	Potassium N-hydroxymethyl-N-methyldithiocarbamate [Busan 40]	51026-28-9	Dithiocarbamate	Fungicide
39002	220	KN Methyl [Potassium N-methyldithiocarbamate]	00137-41-7	Dithiocarbamate	Fungicide
101301	221	Potassium N-(alpha-(nitroethyl)benzyl)ethylenediamine [Metasol J26]	53404-62-9	Miscellaneous	Fungicide, Slimicide
111401	222	Profenofos [O-(4-Bromo-2-chlorophenyl) O-ethyl S-propyl [phosphosothioate]	41198-08-7	Phosphorothioate	
80804	223	Prometon [2,4-bis(Isopropylamino)-6-methoxy-s-Triazine]	01610-18-0	s-Triazine	Herbicide
80805	224	Prometryn [2,4-bis(Isopropylamino)-6-(methylthio)-s-Triazine]	07287-19-6	s-Triazine	Herbicide

Table 3-1 (Continued)

LIST OF PESTICIDE ACTIVE INGREDIENTS (PAIs)

	PAI Code	Chemical Name	CAS #	Structural Group	Pesticide Type
97601	225	Propargite [2-(p-tert-Butylphenoxy) cyclohexyl-2-propynyl sulfite]	02312-35-8	Miscellaneous	Insecticide, Miticide
80808	226	Propazine [2-Chloro-4,6-(isopropylamino)-s-Triazine]	00139-40-2	s-Triazine	Herbicide
77702	227	Propionic acid	00079-09-4	Alkyl acid	Fungicide
119301	228	Propyl (3-dimethylamino)propyl carbamate hydrochloride [Propamocarb and Propamocarb HCl]	25606-41-1	Carbamate	Fungicide
69004	229	Pyrethrin coils		Cyclopropane carboxylic acid	Insecticide
69001	230	Pyrethrin I	00121-21-1	Cyclopropane carboxylic acid	Insecticide
69002	231	Pyrethrin II	00121-29-9	Cyclopropane carboxylic acid	Insecticide
69006	232	Pyrethrum (synthetic pyrethrin)	08003-34-7	Cyclopropane carboxylic acid	Insecticide
97801	233	Resmethrin [(5-Phenylmethyl)-3-furanyl)methyl 2,2-dimethyl-3-(2-methyl-1-propenyl) cyclopropanecarboxylate]	10453-86-8	Cyclopropane carboxylic acid	Insecticide
58301	234	Ronnel [O,O-Dimethyl O-(2,4,5-trichlorophenyl) phosphorothioate]	00299-84-3	Phosphorothioate	Insecticide
71003	235	Rotenone	00083-79-4	Miscellaneous	Insecticide
74801	236	S,S,S-Tributyl phosphorotrithioate [DEF]	00078-48-8	Phosphoro trithioate	Defoliant
35509	237	Siduron [1-(2-Methylcyclohexyl)-3-phenylurea]	01982-49-6	Urea	Herbicide
82501	238	Silvex [2-(2,4,5-Trichlorophenoxy propionic acid)]	00093-72-1	Phenoxy acid	Herbicide
**	238	Silvex, salts and esters	**	Phenoxy acid	Herbicide
80807	239	Simazine [2-Chloro-4,6-bis(ethylamino) -s-Triazine]	00122-34-9	s-Triazine	Herbicide
103901	240	Sodium bentazon [3-Isopropyl-1H-2,1,3-benzothiadiazin-4(3H)-one-2,2-dioxide]	25057-89-0	Heterocylic N,S	Herbicide
34804	241	Sodium dimethyldithiocarbanate [Carbam-S]	00128-04-1	Dithiocarbamate	Fungicide
75003	242	Sodium monofluoroacetate	00062-74-8	Acetate salt	Rodenticide
39003	243	Sodium methyldithiocarbamate [Vapam]	00137-42-8	Dithiocarbamate	Fungicide

Table 3-1 (Continued)

LIST OF PESTICIDE ACTIVE INGREDIENTS (PAIs)

	PAI Code	Chemical Name	CAS #	Structural Group	Pesticide Type
57101	244	Sulfoxide [1,2-Methylenedioxy-4-(2-(octylsulfidynyl) propyl) benzene]	00120-62-7	Heterocyclic	Insecticide
41301	245	S-Ethyl cyclohexylethylthiocarbamate [Cycloate]	01134-23-2	Thiocarbamate	Herbicide
41401	246	S-Ethyl dipropylthiocarbamate [EPTC]	00759-94-4	Thiocarbamate	Herbicide
41402	247	S-Ethyl hexahydro-1H-azepine-1-carbothioate [Molinate]	02212-67-1	Thiocarbamate	Herbicide
41403	248	S-Propyl butylethylthiocarbamate [Pebulate]	01114-71-2	Thiocarbamate	Herbicide
41404	249	S-Propyl dipropylthiocarbamate [Vernolate]	01929-77-7	Thiocarbamate	Herbicide
35604	250	S-(2-Hydroxypropyl)thio methanesulfonate [HPTMS]	29803-57-4	Thiosulphonate	Fungicide
9801	251	S-(O,O-Diisopropyl) phosphorodithioate ester of N-(2-mercaptoethyl)benzenesulfonamide [Bensulide]	00741-58-2	Phosphoro dithioate	Herbicide
105501	252	Tebuthiuron [N-(5-(1,1-Dimethylethyl)-1,3,4-thiadiazol-2-yl)-N,N'-dimethylurea]	34014-18-1	Urea	Herbicide
59001	253	Temephos [O,O,O',O'-Tetramethyl-O,O'-thiodi-p-phenylenephosphorothioate]	03383-96-8	Phosphorothioate	Insecticide
12701	254	Terbacil [3-tert-Butyl-5-chloro-6-methyl uracil]	05902-51-2	Uracil	Herbicide
105001	255	Terbufos [S-(((1,1-Dimethylethyl)thio) methyl) O,O-diethyl phosphorodithioate]	13071-79-9	Phosphoro dithioate	Insecticide
80814	256	Terbuthylazine [2-(tert-Butylamino)-4-chloro-6-(ethylamino)-s-Triazine]	05915-41-3	s-Triazine	Herbicide
80813	257	Terbutryn [2-(tert-Butylamino)-4-(ethyl amino)-6-(methylthio)-s-Triazine]	00886-50-0	s-Triazine	Herbicide
63004	258	Tetrachlorophenol	25167-83-3	Phenol	Preservative
**	258	Tetrachlorophenol salts and esters	**	Phenol	Preservative
35602	259	Tetrahydro-3,5-dimethyl-2H-1,3,5-thiadiazine-2-thione [Dazomet]	00533-74-4	Heterocyclic	Fungicide
102001	260	Thiophanate methyl [Dimethyl 4,4'-o-phenylenebis (3-thioallophanate)]	23564-05-8	Carbamate	Insecticide
79801	261	Thiram [Tetramethylthiuram disulfide]	00137-26-8	Dithiocarbamate	Fungicide
80501	262	Toxaphene [technical chlorinated camphene (67-69% chlorine)]	08001-35-2	Multiring halide	Insecticide

Table 3-1 (Continued)

LIST OF PESTICIDE ACTIVE INGREDIENTS (PAIs)

	PAI Code	Chemical Name	CAS #	Structural Group	Pesticide Type
74901	263	Tributyl phosphorotrithioate [Merphos]	00150-50-5	Phosphoro trithioate	Defoliant
36101	264	Trifluralin [a,a,a-Trifluoro-2,6-dinitro-N,N-dipropyl-p-toluidine]	01582-09-8	Toluidine	Herbicide
86002	265	Warfarin [3-(a-Acetonylbenzyl)-4-hydroxycoumarin]	00081-81-2	Hydroxycoumarin	Rodenticide
**	265	Warfarin salts and esters	**	Hydroxycoumarin	Rodenticide
51705	266	Zinc 2-mercaptobenzothiazolate [Zinc MBT]	00155-04-4	Organozinc	Fungicide
14506	267	Zineb [Zinc ethylenebisdithiocarbamate]	12122-67-7	Dithiocarbamate	Fungicide
34805	268	Ziram [Zinc dimethyldithiocarbamate]	00137-30-4	Dithiocarbamate	Fungicide
78802	269	S-(2,3,3-Trichloroallyl)diisopropylthiocarbamate	02303-17-5	Thiocarbamate	Herbicide
69005	270	(3-Phenoxyphenyl)methyl d-cis and trans* 2,2-dimethyl-3-(2-methylpropenyl) cyclopropanecarboxylate *(Max. d-cis 25%; Min. trans 75%) [Phenothrin]	26002-80-2	Cyclopropane carboxylic acid	Insecticide
69003	271	(4-Cyclohexene-1,2-dicarbox imido)methyl 2,2-dimethyl-3-(2-methylpropenyl)cyclopropanecarboxylate [Tetramethrin]	07696-12-0	Cyclopropane carboxylic acid	Insecticide
18301	272	Isopropyl N-(3-chlorophenyl) carbamate [Chloropropham]	00101-21-3	Carbamate	Herbicide plant growth regulator

[1] Deleted because the chemical is covered by OCPSF Effluent Limitations Guidelines and Standards

[2] No longer registered for use as a pesticide.

EPA used its experience with previous questionnaires, including the questionnaires distributed to the pesticides industry for the remanded regulation, to develop a draft questionnaire for this study. EPA sent the draft questionnaire to pesticide industry trade associations, pesticide manufacturers and pesticide formulator/packagers who had expressed interest, and to environmental groups for review and comment. Based on the comments from those reviewers, EPA determined that the draft questionnaire needed extensive revision to better define and focus the questions and that the pesticide formulator/packager segment of the industry was significantly different from the manufacturing segment and should be covered by a separate study.

As required by the Paperwork Reduction Act, 44 U.S.C. 3501 *et seq.*, EPA submitted the revised questionnaire to the Office of Management and Budget for review, and published a notice in the Federal Register that the questionnaire was available for review and comment. EPA also distributed the revised questionnaire to the same industry trade associations, pesticide industry facilities, and environmental groups that had provided comments on the previous draft and to any others who requested a copy of the draft questionnaire.

Based on additional comments received, EPA made changes to the questionnaire to reduce the extent of production process information requested and clarify certain other questions. EPA had included the request for detailed production process information in part to have sufficient data to adequately and rapidly respond to potential requests for variances from effluent limitations and standards based on "fundamentally different factors." However, the Water Quality Act of 1987 amended Section 301(n) of the Act, superseding NPDES regulations at 40 CFR 122.21 regarding application for a "fundamentally different factors" variance. Based on that amendment, EPA determined that detailed production process information should not be requested of all questionnaire recipients. OMB cleared the technical portion of the questionnaire (the Introduction and Part A) for distribution on April 8, 1988, but denied clearance to the economic portion (Part B). The economic portion was subsequently revised, resubmitted and cleared. (See "Economic Impact Analysis of Final Effluent Limitations Guidelines and Standards for the Pesticide Manufacturing Industry" for information concerning the development of the economic portion of the questionnaire.)

Distribution of the Facility Census for 1986

EPA's database for the remanded regulation identified 247 facilities that at one time had produced or manufactured pesticides. Other sources cited above (see Section 3.1.1) identified only facilities that were already part of the list of 247 facilities. Therefore, EPA believes that the list covered all manufacturing facilities that were operating in 1986.

Under the authority of Section 308 of the Act, EPA distributed the questionnaire entitled the "Pesticide Manufacturing Facility Census for 1986" to all 247 facilities in EPA's database. EPA received responses from all 247 facilities (a 100% response rate). The responses in many cases indicated that the facility did not manufacture PAIs anymore and in some cases indicated that the facility was closed. The responses indicated that 90 facilities manufactured pesticides in 1986 compared to 120 facilities in 1985, and since proposal EPA has determined that 75 of the 90 facilities are still in operation (see Section 3.5 for a discussion on changes in the industry).

The questionnaire specifically requested information on: (1) the PAI manufacturing processes used; (2) the quantity, treatment, and disposal of wastewater generated during PAI manufacturing; (3) the analytical monitoring data available for PAI manufacturing wastewaters; (4) the information on treatability studies performed by or for facilities; (5) the degree of co-treatment (treatment of PAI manufacturing wastewater mixed with wastewater from other industrial manufacturing operations at the facility); and (6) the extent of wastewater recycling and/or reuse at the facility. Information was also obtained through follow-up telephone calls and written requests for clarification of questionnaire responses. A summary of the information obtained from the Facility Census, and from the follow-up telephone calls and written requests for clarification of the information provided in the industry responses, is presented in this technical development document.

3.1.4 Industry Self-Monitoring Data

All facilities which discharge wastewater directly to receiving streams must have NPDES permits which establish effluent limitations and monitoring requirements. Some POTWs also require indirect dischargers to monitor their effluent. To make use of these self-monitoring data, the Facility Census requested that each respondent provide all monitoring data available for 1986 on raw waste loads, individual process stream measurements, pollutant concentration profiles, or any other data on pollutants associated with the manufacture of pesticide active ingredients. EPA later requested selected plants to provide additional monitoring data for 1987-1989. Plants selected to provide additional data were those with extensive self-monitoring programs and wastewater treatment technologies that appeared to be exemplary. EPA requested that all monitoring data be provided in the form of individual data points rather than as monthly aggregates.

Under authority of Section 308 of the Act, EPA also requested two facilities to conduct more extensive sampling of their wastewater treatment systems. These two plants appeared to have exemplary PAI wastewater treatment systems but the facilities had previously conducted no or only very limited monitoring of their PAI wastewater. The sampling programs conducted by these two facilities at EPA's request provided needed long-term treatment system performance data.

Fifty-five (55) facilities submitted some form of self-monitoring data. One facility submitted data only for conventional pollutants, while 37 of the 55 facilities submitted conventional pollutant data along with priority pollutant and/or nonconventional pollutant data (including the PAIs). Thirty-four (34) of the 55 facilities submitted priority pollutant data, and

49 facilities submitted data for PAIs. However, much of these data were not useful in characterizing pesticide manufacturing wastewaters. In many cases, only one detection was reported for a specific pollutant, or the sampling locations represented commingled wastewaters containing pollutant discharges from other industrial processes, such as OCPSF production. Often the data represented sampling results only at the end-of-pipe plant discharge. As will be discussed in Section 5, self-monitoring data from only six facilities were useful in characterizing priority pollutant discharges in raw pesticide process wastewaters. However, industry-supplied data from 27 facilities covering 55 PAIs were evaluated for use in determining treatment system performance for PAI removal.

3.1.5 EPA's 1988-1991 Sampling of Selected Pesticide Manufacturers

Between 1988 and 1991, EPA visited 32 of the 90 manufacturing facilities. During each visit, EPA gathered production process information and information on waste and wastewater generation, treatment and disposal. Based on these data and the responses to the Facility Census, EPA conducted wastewater sampling at 20 of the 32 facilities in order to characterize process discharges and treatment system performance. In addition, EPA collected wastewaters for treatability studies at seven of the 32 facilities. Four of these seven were among the 20 facilities sampled in order to characterize process discharges and treatment system performance. That is, EPA collected wastewater samples at 23 of the 32 facilities visited. The other nine facilities visited were not sampled: two plants do not discharge wastewater (they recycle/reuse their wastewater); two plants had no wastewater treatment; three plants had pesticide manufacturing process wastewater so intimately commingled with wastewaters from other manufacturing processes that sampling for characterization was not possible; one plant disposed of wastewater by deep-well injection; and the ninth plant was not in production during possible sampling times (however, the ninth plant did provide long-term self-monitoring data).

During sampling activities, raw wastewaters from the manufacture of 38 different PAIs were characterized. Samples were also collected to assist in the evaluation of the performance of 62 specific treatment unit operations. Table 3-2 presents a breakdown of the types of treatment units sampled. Through the treatability studies, EPA analyzed the efficacy of activated carbon adsorption, membrane filtration, hydrolysis and alkaline chlorination for control of 76 PAIs. More detailed studies using actual manufacturing process wastewater to develop additional treatment performance data for activated carbon adsorption, hydrolysis, and alkaline chlorination technologies were subsequently conducted. These more detailed studies involved 13 specific PAIs included in the final rule and are described in more detail in Section 3.1.6.

Table 3-2

TREATMENT UNIT OPERATIONS SAMPLED

Treatment Unit Operation	Total Number of Units	Total Number of Units Sampled
Biological Oxidation	29	7
Flocculation	8	1
Activated Carbon	19	11
Aeration	1	0
Multimedia Filtration	5	1
Chemical Oxidation	14	7
Pressure Filtration	8	3
Hydrolysis	11	7
Evaporation Pond	2	0
Steam Stripping	11	4
Dechlorination	4	1
Resin Adsorption	2	1
Metal Separation	1	1
Solvent Extraction	13	3
Air Stripping	5	1
UV Decomposition	2	1
Land Application	1	0
Coagulation	2	2
Mechanical Evaporation	1	0
Cyanide Destruction	1	1

Note: Plants may operate more than one treatment unit.

Facilities were selected for sampling after an evaluation of existing data and responses to the Facility Census. The facilities were selected for sampling if the data indicated that: (1) the wastewater treatment system was effective in removing PAIs, and (2) the PAIs manufactured appeared to be representative of one or more PAI structural categories, such as organo-phosphate PAIs. Wastewaters containing PAIs in 21 structural groups were analyzed during EPA sampling.

Prior to a sampling episode at a manufacturing facility, representatives from the Agency conducted an engineering site visit. During this visit, EPA gathered information about the manufacturing process(es), treatment operation(s), and potential sample locations. Following the visit, a draft sampling plan was prepared which provided the rationale for the selection of sampling locations as well as the procedures to be followed during sampling. A copy of this draft plan was provided to the plant for comments prior to any wastewater sampling to ensure that the sample sites selected would properly characterize the process wastewater and evaluate the wastewater treatment system.

During the sampling episode, teams of EPA contractor engineers and technicians collected and preserved samples and shipped them to EPA contract laboratories for analysis. Levels of conventional pollutants, non-conventional pollutants (including the pesticide active ingredients), and priority pollutants were measured in raw wastewater and treated effluent. EPA always offered to split the samples with the facility. In some cases, the facility accepted the split samples provided by the EPA, while in some other cases, plant personnel independently collected wastewater from the EPA sampling sites. Following the sampling episode, a draft trip report was prepared that included descriptions of the manufacturing and treatment processes, sampling procedures, analytical results, QA/QC evaluation, and discussion of the raw wastewater composition and treatment system performance. The report was provided to the sampled facility for review and comment, and any corrections were incorporated into the report. The facilities also identified any information in the draft report that the facility considered confidential business information.

Because treatability data were lacking for some PAIs, individual PAIs, which were expected to be treatable with a specific technology, were targeted for treatability studies. EPA collected samples of actual pesticide manufacturing process wastewater at plants manufacturing those PAIs. Following sample collection, the samples were transferred to an EPA contractor for bench-scale testing. The data were then evaluated for use in developing limitations for these PAIs when it was demonstrated that the technology was effective at PAI removal (these treatability studies are discussed in the next section).

3.1.6 EPA Bench-Scale Treatability Studies

EPA conducted a number of bench-scale studies to evaluate the treatability of PAIs by various wastewater treatment technologies, including:

hydrolysis, membrane filtration, chemical oxidation, and activated carbon adsorption. Treatability studies were conducted on both clean water to which PAIs were added ("synthetic wastewaters") and on actual pesticide process wastewater.

The hydrolysis, membrane filtration, and carbon isotherm treatability studies used synthetic wastewaters. General factors in EPA's selection of specific PAIs for use in the synthetic wastewaters were the availability of an analytical method for the specific PAI and the ready availability of the PAI in a pure form from either government or commercial sources.

The hydrolysis studies were conducted in some cases to confirm the results of literature hydrolysis data for certain PAIs in order to assess the appropriateness of the bench scale testing. In other cases studies were conducted to obtain hydrolysis data not available in the literature. All of the PAIs selected were expected to hydrolyze under some conditions.

In the hydrolysis treatability study, EPA conducted a series of bench-scale tests to determine the hydrolysis rates of selected PAIs. Thirty-eight (38) PAIs were selected for testing and separated into four synthetic test solutions. The hydrolysis treatability study was conducted under six conditions using a matrix of three pH levels (2, 7, and 12) and two different temperatures (20°C and 60°C).

The carbon isotherm studies used PAIs selected from various structural groups to determine which groups would be most amenable to activated carbon technology. Manufacturers of PAIs in a few of those groups were known to use activated carbon technology to treat the wastewater, and treatability data from those manufacturers were available; in this case, the purpose of the carbon isotherm studies was to establish benchmarks for determining the potential efficacy of activated carbon technology to other structural groups. Another factor in selecting the PAIs for these studies was the ability to measure the PAI following the testing. For example, too rapid a hydrolysis rate could destroy the PAI before chemical analyses of the samples are complete following activated carbon testing, thus giving an erroneously high removal value. The results of the isotherm tests were evaluated using the Freundlich isotherm equation.

The membrane filtration studies used PAIs selected to span the molecular weight range of the 269 PAIs and classes of PAIs under consideration for regulation, because the effectiveness of membrane filtration tends to vary with molecular weight. In the membrane filtration treatability studies, EPA conducted a series of bench-scale tests to identify specific PAIs which could be separated from water by various membrane materials. Synthetic test solutions containing 19 PAIs were tested on 7 different types of membranes. The membranes were manufactured from three types of materials (cellulose acetate, thin-film composite, and Aramid) and were of various pore sizes, with nominal molecular weight cut-offs ranging from 150 to 500.

The treatability studies using actual pesticide manufacturing process wastewater were conducted to supplement full-scale treatment system performance data, to fill in gaps in performance data where no treatability data were available for the PAI, and to help assess performance of existing full scale treatment systems where the performance of those systems appeared to be inadequate compared to performance of other facilities treating the same or similar PAIs. The PAIs selected for study were the PAIs in production at the plants during the treatability study.

In one series of tests EPA also conducted activated carbon treatability studies to determine adsorption properties of selected PAIs. These studies included carbon adsorption isotherm tests and accelerated column tests which are used in estimating full scale carbon system designs and cost.

One series of chemical oxidation treatability studies was conducted to determine the applicability of alkaline chlorination as a method of treating pesticide manufacturing process wastewaters. In these bench-scale tests, manufacturing wastewaters from six PAI manufacturing processes were tested at chlorine dosages equal to 50, 100, and 125% of the chlorine demand for the specific wastewater at pH 12, and ambient temperatures. Contact times of 0.5, 1.5, and 4.0 hours were examined.

Because alkaline chlorination of wastewater containing organic matter may generate volatile organic toxic pollutants, which must subsequently be controlled, EPA also conducted chemical oxidation treatability studies for five of those same six PAIs using ozone rather than chlorine. The preliminary results of those studies indicate that ozone can achieve about the same degree of PAI reduction as chlorine. Chemical oxidation with ozone is usually more expensive than chemical oxidation with chlorine. However, ozone oxidation does not produce volatile toxic pollutants. When the cost of controlling those volatile toxic pollutants is added to the cost of alkaline chlorination, the total cost for chlorination may exceed the cost of ozone oxidation.

3.1.7 Data Submitted After Proposal

EPA received comments on the April, 1992 proposed regulations from 34 interested parties. A number of the commenters submitted new information to EPA, including the following:

1. Additional long-term treatment system performance data for control of discharges of PAIs. These new data provide information on treatment system performance over a wider variety of conditions than was previously available.

2. Long-term treatment system performance data for new treatment systems to control discharges of PAIs. These new treatment systems were installed after the period for which EPA collected information for the proposed rulemaking; they replaced inadequate treatment or supplemented existing treatment. The new data allow more of the limitations to be

based on demonstrated performance of full-scale treatment systems instead of treatment system performance data transferred from other PAIs or estimates from treatability studies of the performance expected of full-scale treatment.

3. Analytical methods used by dischargers to monitor PAIs in discharges, where the commenter believed the proposed EPA methods were different from those currently in use.

4. Additional information identifying specific pollution prevention practices and "out-of-process" recycle/reuse.

3.1.8 Data Transferred from the OCPSF Rulemaking

The Clean Water Act of 1977 stressed the control of toxic pollutants, including 65 toxic pollutants and classes of pollutants. From this list of 65, EPA has derived a subset of 126 individual "priority" pollutants on which the Agency has focused (see, e.g., list of 126 priority pollutants at 40 CFR Part 423, Appendix A). EPA has determined that 28 of the 126 priority pollutants may be present in pesticides manufacturers' wastewaters. In this final rule, EPA is promulgating direct discharge limitations for these 28 priority pollutants and pretreatment standards for all but 4 of these 28 pollutants, as described below. For 23 of these 28 priority pollutants, EPA is relying on the OCPSF technical database to promulgate limitations. Limitations for one priority pollutant, cyanide, are based on long-term data collected from the pesticide industry. The other four priority pollutants are volatile organic compounds, but they were not regulated under the OCPSF guidelines and there are no treatment performance data for these four specific pollutants. EPA developed limitations for these four priority pollutants by transferring limitations from other structurally similar priority pollutants based on OCPSF technology (steam stripping). This is the same procedure that was used in developing OCPSF limitations (40 CFR Part 414) when performance data were lacking for certain volatile priority pollutants.

Limitations were developed under the OCPSF rulemaking for 23 priority pollutants that were also detected in pesticide manufacturers' wastewaters during the EPA sampling and industry self-monitoring. Forty-six (46) of the 75 pesticide chemicals manufacturing facilities (55 of 90 at proposal) also manufacture compounds regulated under the OCPSF category. Based on these factors, EPA is transferring technical data from the OCPSF category and effluent limitations for priority pollutants based on that data to the pesticide chemicals manufacturing category as supporting data for the limitations for the priority pollutants in this regulation.

The 23 priority pollutants for which EPA is relying on the OCPSF database to set BAT and NSPS limitations for the pesticide chemicals manufacturing category are presented in Section 2 of this technical development document. The OCPSF limitations for volatile priority pollutants were based on data from plants that exhibited efficient volatile pollutant reduction using either in-plant steam stripping technologies alone or in-plant steam stripping followed by biological treatment. OCPSF limitations were also based on activated carbon or in-plant biological treatment for some semi-volatile organic priority pollutants. The OCPSF guideline established limitations for lead based on performance data obtained from EPA's study of the metal finishing industry.

EPA is also transferring PSES and PSNS standards and data supporting those standards from the OCPSF category for the same 23 priority pollutants. EPA is relying on analyses conducted in support of the OCPSF regulations to determine pass-through for these pollutants. See Section 7.6 for a discussion of priority pollutant limitations development.

3.2 OVERVIEW OF THE INDUSTRY

This subsection provides an overview of the Pesticide Chemicals Manufacturing Industry by presenting general information on the geographical locations, SIC code distribution, age, typical markets, and types of facilities.

3.2.1 Geographical Location of Manufacturing Facilities

In 1986, 90 manufacturing facilities, located in 29 states, reported producing 1 or more of 178 PAIs from the list of 270 PAIs and classes of PAIs; 8 other PAIs were produced before and after 1986, but not in 1986. Since 1986, 15 of the 90 manufacturing facilities have closed, and these 15 facilities produced 22 of the 178 PAIs in 1986. Currently, as in 1986, the majority of the pesticide manufacturing facilities are located in the eastern half of the United States and along the Gulf Coast. Approximately 50% of all pesticide production occurs in these areas. The geographic distribution of pesticide manufacturing facilities by EPA region is presented in Figure 3-2; EPA Regions I, II, and III are included in the "Northeast" region on the figure, EPA Region IV is included in the "Southeast" region, EPA Regions V, VI, and VII are included in the "Midwest" region, and EPA Regions VIII, IX, and X are included in the "West" region.

Table 3-3 presents the geographic distribution of OCPSF manufacturing facilities by EPA Region as surveyed in 1983, in relation to the pesticide manufacturing facilities. The distribution of the OCPSF manufacturing facilities is similar to the distribution of the pesticide chemicals manufacturing industry. Of the 90 pesticide chemicals manufacturers operating in 1986, 55 also manufactured products covered under the OCPSF guidelines. Forty-six (46) of the current 75 pesticide chemicals manufacturers also manufacture OCPSF products.

Figure 3-2

Distribution of Pesticide Manufacturing Facilities by EPA Region

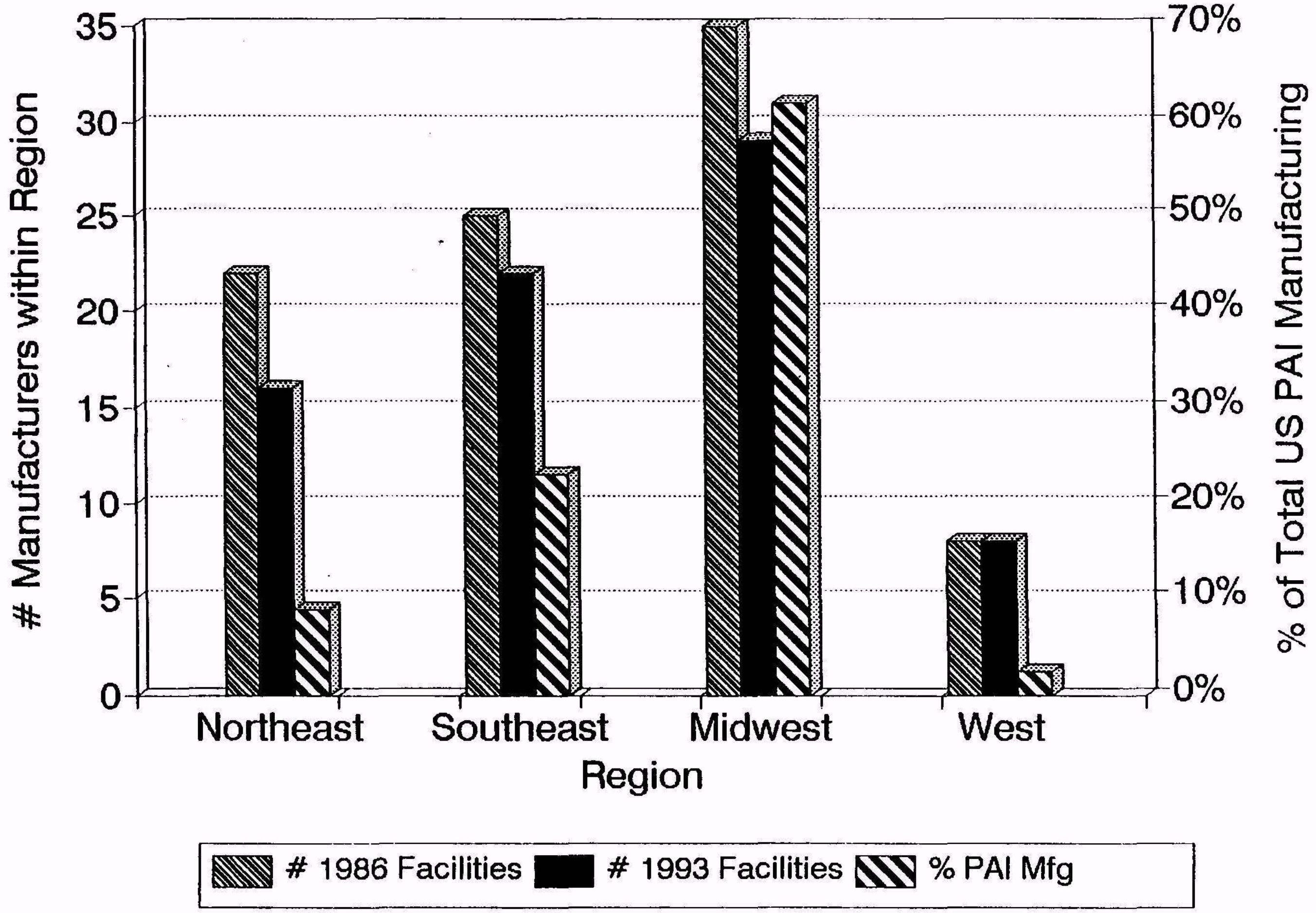


Table 3-3

COMPARISON OF THE GEOGRAPHIC DISTRIBUTION OF THE OCPSF vs. PESTICIDE INDUSTRY BY REGION

Region[1]	No. of OCPSF Manufacturing Facilities	No. of Pesticide Manufacturing Facilities		% of OCPSF Manufacturing Facilities	% of Pesticides Manufacturing Facilities	
		1986	Current[2]		1986	Current[2]
Northeast	311	22	16	33.1	24.4	21.3
Southeast	181	25	22	19.3	27.8	29.3
Midwest	361	35	29	38.4	38.9	38.7
West	87	8	8	9.2	8.9	10.7
TOTAL	**940**	**90**	**75**	**100**	**100**	**100**

[1] The "Northeast" region includes EPA Regions I, II, and III; the "Southeast" region includes EPA Region IV; the "Midwest" region includes EPA Regions V, VI, and VII; and the "West" region includes EPA Regions VIII, IX, and X.

[2] Accounts for facility closures since 1986.

3.2.2 SIC Code Distribution

Standard Industrial Classification (SIC) codes, established by the U.S. Department of Commerce, are classifications of commercial and industrial establishments by type of activity in which they are engaged. The primary purpose of the SIC code is to classify the manufacturing industries for the collection of economic data. An operating establishment is assigned an industry code on the basis of its primary activity, which is determined by its principal product or group of products. The primary product of a manufacturing establishment is determined by the value of production.

This industry is included within, but not limited to, SIC Major Group 28, Chemical and Allied products. More specifically, facilities manufacturing PAIs may be engaged in one or more of the following SIC groups: 2831; 2833; 2834; 2842; 2843; 2861; 2865; 2869; 2879; and 2899.

3.2.3 Age of Facilities

Most of the facilities which currently manufacture PAIs began manufacturing operations in the 1950s and 1960s. Most of the pesticide manufacturing operations also began about this time and pesticide operations start-ups continued at about the same rate into the 1970s. The oldest reported pesticide operation began in 1909, while the most recent operation began in 1987. Thirty-four (34) of the current 75 pesticide manufacturers reported that pesticide operations began at the same time that the facility operations began. Table 3-4 presents the distribution of pesticide manufacturing facilities by decade of when operations began at the facility, when pesticide operations began at the facility, and when the most recent major expansion of pesticide operations occurred.

3.2.4 Market Types

Figure 3-3 presents the percent of PAI production by market type from information reported on the 1986 questionnaire for pesticide chemicals manufacturing facilities. Approximately 18% of 1986 pesticide active ingredient production was delivered to industry, commerce, or U.S. government markets. Fifty-two percent of production was reported to be used in the agricultural end use market and 14% was exported. The remaining PAI production (~16%) was reported by other market types including OCPSF, pharmaceuticals, formulating/packaging operations and home and garden use.

3.2.5 Type of Facilities

Fifty-five (55) of the 90 pesticide manufacturing facilities that were operating in 1986 generated wastewater discharges from OCPSF operations, and 46 of the 75 current pesticide manufacturers generate OCPSF wastewaters. Thirty-two (32) of the 75 current facilities co-treat OCPSF wastewater with pesticide manufacturing wastewater.

Figure 3-3

1986 PESTICIDE MARKET COMPOSITION

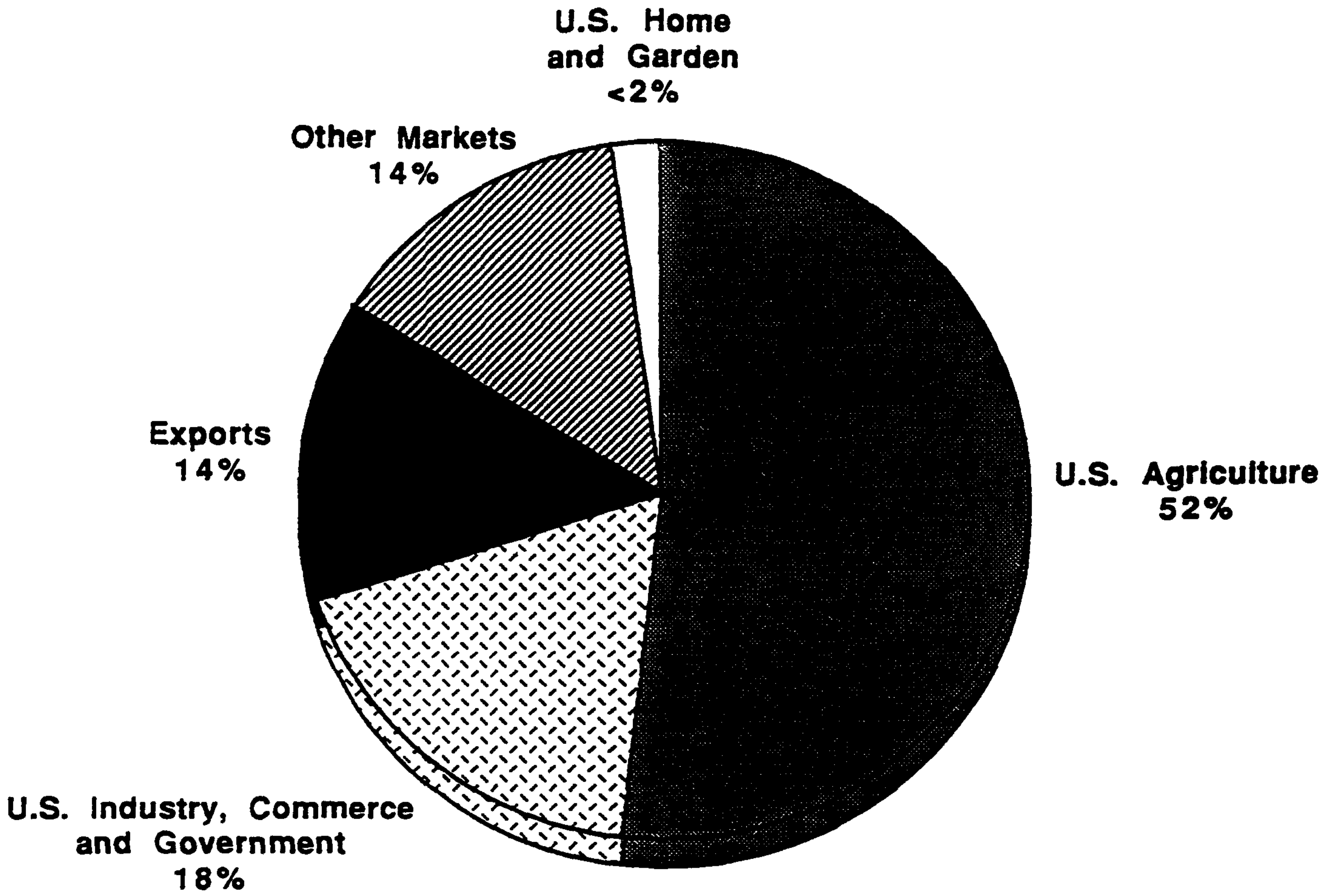


Table 3-4

DISTRIBUTION OF PESTICIDE MANUFACTURING FACILITIES BY DECADE OF OPERATION

	No. of Facilities Reporting					
	Facility Operations Began		Pesticides Operations Began		Last Major Expansion of Pesticides Operations	
Decade	1986	Current[1]	1986	Current[1]	1986	Current[1]
Prior to 1930s	15	12	1	1	0	0
1930s	6	3	7	5	1	0
1940s	9	8	6	4	0	0
1950s	16	16	16	15	0	0
1960s	20	20	22	20	5	5
1970s	12	8	22	19	18	15
1980s	8	8	12	11	53	50
No Response	4	0	4	0	13	5
TOTAL	90	75	90	75	90	75

[1] Accounts for facility closures since 1986.

Over half of the 75 pesticide manufacturing facilities also conduct pesticide formulating and/or packaging (PFP) activities. Nineteen (19) of these facilities co-treat PFP wastewater with pesticide manufacturing wastewater.

The census data suggest that a "typical" facility reported manufacturing one active ingredient in 1986, was the only facility in the country producing that PAI, produced between 1,000,000 and 10,000,000 pounds total pesticide active ingredient for the year, also manufactured OCPSF chemicals, and conducted PFP operations.

3.3 PESTICIDE PRODUCTION

A wide variety of PAIs or classes of PAIs are produced by the pesticide chemicals manufacturing industry. A summary of the 270 pesticide active ingredients considered for regulation, their production levels, and production distribution is presented below.

3.3.1 Types of Pesticides

Pesticide active ingredients (PAIs) and classes of PAIs can be categorized into the following nine types of pesticides:

- Herbicides: used for weed control;
- Insecticides: used for control of insects;
- Rodenticides: used for control of rodents;
- Fungicides: used for control of fungi;
- Nematocides: used for control of a particular class of worms, which are often parasites of animals and plants;
- Miticides: used for control of mites, which are tiny arachnids that often infest prepared food or act as parasites on animals, plants, or insects;
- Disinfectants: used for control of bacteria and viruses;
- Defoliants: used to remove leaves from growing plants; and
- Synergists: used in conjunction with other substances to enhance the effects of each.

Table 3-1 presents the 269 PAIs or classes of PAIs considered for regulation by pesticide type. One type of pesticide, the rodenticides, were not manufactured in 1986. Table 3-1 also includes three PAIs that have been dropped from consideration: ortho- and para-dichlorobenzene and biphenyl. Ortho- and para-dichlorobenzene were deleted prior to proposal because those two chemicals are covered by the Organic Chemicals, Plastics and Synthetic Fibers (OCPSF) guidelines (40 CFR 414), and biphenyl has been dropped because it is no longer a registered pesticide.

The 269 PAIs or classes of PAIs may also be grouped into 70 groups, based on their chemical structure (or arrangement of atoms in each molecule) as shown in Table 3-1. Pesticide active ingredients or classes of PAIs which have the same structure have similarities in physical properties, such as molecular weight and solubility. These similarities may result in similar amounts and types of pollutants in the wastewater generated during the manufacture of the pesticide. Pesticide chemicals with similar structures may also be controlled or removed from wastewater by similar wastewater treatment technologies. These topics will be discussed further in Section 7 (Treatment Technologies and Performance Data).

3.3.2 1986 Pesticide Active Ingredient Production

Based on responses to the Facility Census, the pesticide chemicals manufacturing industry, in 1986 (90 facilities), manufactured 129 of the 269 PAIs and classes of PAIs and 48 salts and esters of these PAIs (for a total of 177 PAIs). These PAIs were manufactured by 223 separate pesticide production processes. In addition, there were eight other PAIs which were manufactured either before or after 1986, but not during 1986. The 15 pesticide manufacturers that have closed since 1986 manufactured 22 of the 177 PAIs that were manufactured during 1986.

A pesticide production process involves the manufacture of one PAI or salt or ester at a facility. One or more individual manufacturing processes may exist at an individual facility. In addition, a facility may use one set of unit operations or one reactor to manufacture different PAI products at different times. For example, a facility may manufacture two PAIs using the same equipment with one PAI manufactured during the spring and the other manufactured during the fall.

Total 1986 industry production reported for the 177 PAIs was approximately 1.2 billion pounds with 55% of this total accounted for by herbicides. About 1.1 billion of the 1.2 billion pounds of total industry production in 1986 was reported by the 75 pesticide manufacturing facilities that are currently still in operation. Table 3-5 presents the list of individual PAIs manufactured in 1986 and the 8 PAIs manufactured before or after 1986.

Table 3-5

PESTICIDE ACTIVE INGREDIENTS AND SALTS AND ESTERS REPORTED TO BE MANUFACTURED IN 1986[1]

	AI Code	Common Name
1	3.00	EDB
2	4.00	Vancide TH
3	5.00	Dichloropropene
4	7.00	Dowicil 75
5	8.00	Triadimefon
6	11.00	Dichlorophene
7	12.00	Dichlorvos
8	16.00	2,4-D
9	16.09	2,4-D; 2-Butoxyethyl ester
10	16.12	2,4-D; Butyl ester
11	16.13	2,4-D; Diethanolamine salt
12	16.17	2,4-D; Dimethylamine salt
13	16.27	2,4-D; 2-ethylhexyl ester
14	16.29	2,4-D; 2-octyl ester
15	16.31	2,4-D; Isopropylamine salt
16	16.32	2,4-D; Isopropyl ester
17	16.50	2,4-D; Triethanolamine salt
18	16.52	2,4-D; Triisopropanolamine salt
19	17.17	2,4-DB; Dimethylamine salt
20	17.27	2,4-DB; 2-Ethylhexyl ester
21	17.32	2,4-DB; Isopropyl ester
22	20.00	Dichloran or DCNA
23	21.00	Busan 90
24	22.00	Mevinphos
25	25.00	Cyanazine or Bladex
26	26.00	Propachlor
27	27.01	MCPA; Sodium salt
28	27.16	MCPA; 2-Ethylhexyl ester
29	27.17	MCPA; Dimethylamine salt
30	27.29	MCPA; Isooctyl ester
31	28.00	Octhilinone

Table 3-5 (Continued)

PESTICIDE ACTIVE INGREDIENTS AND SALTS AND ESTERS
REPORTED TO BE MANUFACTURED IN 1986[1]

	AI Code	Common Name
32	30.17	2,4-DP; Dimethylamine salt
33	30.27	2,4-DP; 2-Ethylhexyl ester
34	30.29	2,4-DP; Isooctyl ester
35	31.13	MCPP; Diethanolamine salt
36	31.17	MCPP; Dimethylamine salt
37	31.27	MCPP; 2-Ethylhexyl ester
38	31.29	MCPP; Isooctyl ester
39	32.00	Thiabendazole
40	35.00	TCMTB
41	36.00	HAE
42	39.00	Pronamide
43	41.00	Propanil
44	42.00	3-Iodo-2-propynyl butylcarbamate
45	45.00	Metribuzin
46	49.00	Etridiazole
47	52.00	Acephate or Orthene
48	53.00	Acifluorfen
49	54.00	Alachlor
50	55.00	Aldicarb
51	56.00	Hyamine 3500
52	58.00	Ametryn
53	60.00	Atrazine
54	62.00	Benomyl (and Carbendazim)
55	66.00	Bifenox
56	68.00	Bromacil
57	68.02	Bromacil; Lithium salt
58	69.00	Bromoxynil
59	69.03	Bromoxynil; Octanoic acid ester
60	70.00	Butachlor
61	71.00	Giv-gard
62	73.00	Captafol

Table 3-5 (Continued)

PESTICIDE ACTIVE INGREDIENTS AND SALTS AND ESTERS REPORTED TO BE MANUFACTURED IN 1986[1]

	AI Code	Common Name
63	74.00	Captan
64	75.00	Sevin (Carbaryl)
65	76.00	Carbofuran
66	80.00	Chloroneb
67	81.00	Chloropicrin
68	82.00	Chlorothalonil
69	*84.00	Stirofos
70	86.00	Chlorpyrifos
71	88.00[2]	Bioquin
72	*90.00	Fenvalerate
73	91.00	Cycloheximide
74	98.00	Dicamba
75	103.00	Diazinon
76	*107.00	Methyl Parathion
77	110.00	DCPA
78	112.00	Dinoseb
79	113.00	Dioxathion
80	115.00	Diphenamid
81	117.00	MGK 326
82	118.00	Nabonate
83	*119.00	Diuron
84	120.00	Metasol DGH
85	123.00	Endothall
86	123.02	Endothall; N,N-Dimethylcocoamine salt
87	123.03	Endothall; Potassium salt
88	123.04	Endothall; Sodium salt
89	*124.00	Endrin
90	125.00	Ethalfluralin
91	126.00	Ethion
92	127.00	Ethoprop
93	129.00	Chlorobenzilate or Acaraben

Table 3-5 (Continued)

PESTICIDE ACTIVE INGREDIENTS AND SALTS AND ESTERS REPORTED TO BE MANUFACTURED IN 1986[1]

	AI Code	Common Name
94	130.00	Butylate
95	132.00	Fenarimol
96	133.00	Fenthion or Baytex
97	135.00	Fluometuron
98	138.00	Glyphosate
99	138.01	Glyphosate; Isopropylamine salt
100	140.00	Heptachlor
101	142.00	Hexazinone
102	144.00	Isopropalin
103	*148.00	Linuron
104	150.00	Malathion
105	154.00	Methamidophos
106	156.00	Methomyl
107	157.00	Methoprene
108	158.00	Methoxychlor
109	160.00	Methylbromide or Bromomethane
110	161.01[2]	Monosodium methyl arsenate
111	163.00	Methylene Bisthiocyanate
112	170.00	Napropamide
113	171.00	Deet
114	172.00	Nabam
115	173.00	Naled
116	175.00	Norflurazon
117	176.00	N-1-Naphthylphthalimide
118	177.00	MGK 264
119	178.00	Benfluralin
120	182.00	Fensulfothion
121	183.00	Disulfoton
122	185.00	Phosmet
123	186.00	Azinphos Methyl
124	190.01[2]	Copper naphthenate

Table 3-5 (Continued)

PESTICIDE ACTIVE INGREDIENTS AND SALTS AND ESTERS
REPORTED TO BE MANUFACTURED IN 1986[1]

	AI Code	Common Name
125	190.02[2]	Copper octoate
126	190.03[2]	Copper salt of fatty & resin acids
127	191.01[2]	Phenyl mercuric dodecyl succinate
128	191.02[2]	Phenyl mercuric acetate
129	191.03[2]	Phenyl mercuric oxide
130	191.05[2]	Chloromethoxy propyl mercuric acetate
131	192.01	Tributyltin neodecanoate
132	192.02	Tributyltin monopropylene glycol maleate
133	192.03	2-(Methyl-2-phenyolpropyl) distannoxane
134	192.04	Tricyclohexyl tin hydroxide
135	192.05	Tributyltin oxide
136	192.06	Triphenyl tin hydroxide
137	192.07	Tributyl tin fluoride
138	192.08	Tributyl tin benzoate
139	196.00	Oxyfluorfen
140	197.00	Bolstar (Sulprofos)
141	200.00	Fonofos
142	203.00	Parathion
143	204.00	Pendimethalin
144	*205.00	PCNB
145	206.00	Pentachlorophenol (PCP)
146	206.01	Pentachlorophenol; Sodium salt
147	208.00	Permethrin
148	210.00	Phenothiazine
149	211.00	Phenylphenol
150	211.05	Phenylphenol; Sodium salt
151	212.00	Phorate
152	215.00	Picloram
153	215.01	Picloram; Potassium salt
154	215.03	Picloram; Triisopropanolamine salt
155	216.00	Piperonyl butoxide

Table 3-5 (Continued)

PESTICIDE ACTIVE INGREDIENTS AND SALTS AND ESTERS REPORTED TO BE MANUFACTURED IN 1986[1]

	AI Code	Common Name
156	218.00	Busan 85 Or Arylane
157	219.00	Busan 40
158	220.00	KN Methyl
159	221.00	Metasol J26
160	223.00	Prometon or Caparol
161	224.00	Prometryn
162	226.00	Propazine or Milogard
163	227.00	Propanoic acid
164	230.00	Pyrethrin I
165	232.00	Pyrethrin II
166	236.00	DEF
167	239.00	Simazine
168	241.00	Carbam-S or Sodam
169	243.00	Vapam
170	245.00	Cycloate or Ro-Neet
171	246.00	EPTC or Eptam
172	247.00	Molinate
173	249.00	Vernolate or Vernam
174	250.00	HPTMS
175	251.00	Bensulide or Betesan
176	252.00	Tebuthiuron
177	253.00	Temephos
178	254.00	Terbacil
179	255.00	Terbufos or Counter
180	256.00	Terbuthylazine
181	257.00	Terbutryn
182	259.00	Dazomet
183	*262.00	Toxaphene
184	264.00	Trifluralin or Treflan

Table 3-5 (Continued)

PESTICIDE ACTIVE INGREDIENTS AND SALTS AND ESTERS
REPORTED TO BE MANUFACTURED IN 1986[1]

	AI Code	Common Name
185	268.00	Ziram
186	272.00	Chloropropham

---

[1] This list also includes eight additional PAIs manufactured between 1985 and 1990 (these PAIs are marked with an asterisk).

[2] These PAIs are metallo-organic PAIs.

3.3.3 Distribution of PAI Production by Facility

Tables 3-6, 3-7, and 3-8 present different views of the distribution of PAI production by facility, for both the 90 manufacturers in operation in 1986 and for the 75 current manufacturers. Table 3-6 presents the distribution of PAIs produced by number of manufacturing facilities. Table 3-7 presents the distribution of manufacturing facilities by number of PAIs produced. Table 3-8 presents the distribution of facilities by quantity of production. As shown in Table 3-6, 143 of the 177 PAIs produced in 1986 were reported to be manufactured by only one facility in the United States; the 75 current pesticide manufacturers produced 130 of the 177 PAIs. As shown in Table 3-7, about one-half of the pesticide manufacturing facilities reported producing only one active ingredient in 1986; 47 of the 90 facilities in operation in 1986 (52%) and 37 of the 75 facilities that are still in operation (49%). The remaining facilities produced between 2 and 16 PAIs each. In 1986, each of the seven largest pesticide manufacturing facilities, which are all still currently in operation, produced more than 45 million pounds of active ingredient. These 7 facilities together represented almost half (47%) of all 1986 pesticide production for the 177 PAIs. Approximately 42% of the facilities produced between 1 million and 10 million pounds of active ingredient in 1986.

3.3.4 Distribution of PAI Production During the Year

The bulk of PAIs identified in the Facility Census are either herbicides or insecticides. These PAIs are used during the growing season, or in the case of preemergent PAIs, just before the growing season. Therefore, PAI production is expected to be seasonal. PAIs must also be formulated into final end use products prior to sale or use. Therefore, the manufacture of the PAIs would be expected to precede the time of use. Herbicide production in 1986 increased rapidly through the fall and early winter and peaked in March of that year, just prior to the growing season. However, the 1986 production data for other pesticide types (e.g., disinfectants) indicated that production often reflects individual facility manufacturing schedules rather than any seasonal trends.

Most of the facilities indicated that pesticide production operations were managed on a campaign basis and that production of a specific PAI occurred as a short-term production run from a few days to a few months. For some other PAIs, however, production often continued nearly year round.

3.4 PESTICIDE MANUFACTURING PROCESSES

There are two stages in the production of pesticides: the manufacture of a PAI, followed by the formulation and packaging of the PAI. A PAI is manufactured by the chemical reaction of two or more raw materials often in the presence of solvents, catalysts, and acidic or basic reagents. The raw materials may include any of a large number of organic and inorganic

Table 3-6

NUMBER OF PESTICIDE ACTIVE INGREDIENTS PRODUCED BY NUMBER OF MANUFACTURING FACILITIES

AI Production At:	No. of PAIs	
1986	**Current**[a]	
143	130	One Facility
25	24	Two Facilities
7	7	Three Facilities
1	1	Four Facilities
1	1	**Five Facilities**
177	**163bb**	**Total**

Table 3-7

NUMBER OF MANUFACTURING FACILITIES BY NUMBER OF PESTICIDE ACTIVE INGREDIENTS PRODUCED

No. of PAIs Produced	No. of Facilities	
1986	**Current**[a]	
47	37	One
16	13	Two
10	8	Three
7	7	Four
10	10	Five or More
90	**75**	**Total**

Table 3-8

DISTRIBUTION OF FACILITIES BY QUANTITY OF PAI PRODUCTION

Number of Facilities		Range of PAI Production (1986 lb/yr)
1986	Current[a]	
7	7	>45,000,000
19	17	10,000,000-45,000,000
38	32	1,000,000-9,999,999
18	14	100,000-999,999
8	5	0-99,999
90	75	~1,150,108,000 (90 Facilities)
		~1,086,645,000 (75 Facilities)

compounds. Pesticide active ingredients may also be used as raw materials in manufacturing derivative PAIs typically through the formation of various salts and esters. This final rule is intended to control the discharge of pollutants in wastewater generated during the manufacture of PAIs from raw materials. (For one PAI, the effluent limitations apply only to the discharge of wastewater generated during the purification of that PAI to a higher quality PAI product.) The final regulations do not apply to the manufacturer of chemicals ("intermediates") which are not pesticides but which subsequently are converted by further chemical reactions to PAIs. The "intermediates" may be other effluent guidelines, such as covered by the OCPSF effluent guidelines (40 CFR Parts 414 and 416) for organic intermediates or the inorganic chemicals effluent guidelines (40 CFR Part 415) for inorganic intermediates.

The formulation of pesticides through the mixing, blending, or dilution of one or more PAIs, without an intended chemical reaction is distinct from pesticide manufacturing and will be covered under separate guidelines. Therefore, formulation will not be discussed further in this section.

The PAI manufacturing processes used by facilities are highly dependent upon the type of PAIs being manufactured at that facility. The types of processes used (batch or continuous), the process chemistry, and the intermediate/byproduct manufacture are described in the next section.

3.4.1 Batch vs. Continuous Processes

Batch processes are those in which raw materials and reagents are added to a reactor, a reaction occurs, and then product is removed from the reactor. The composition of the reactor changes over time, but flow neither enters nor leaves the reactor until the chemical reaction process is complete. Of the 223 manufacturing processes used to produce pesticides in 1986, 178 were batch processes. All salts and esters produced in 1986 were manufactured using batch processes.

During continuous processes, raw materials and reagents flow continuously into the reactor and are converted into product while they reside in the reactor. Product also flows continuously out of the reactor. Continuous processes may operate for days, weeks, or months at a time. Forty-five (45) of the reported 223 manufacturing processes used to produce pesticides in 1986 were continuous processes.

The survey data showed no relationship between the magnitude of daily or annual production and the use of batch or continuous processes. This result was as expected because a number of variations exist, such as multistage batch operations, and combinations of batch and continuous stages in a single process.

3.4.2 General Process Reactions

The following paragraphs describe the generic reaction mechanisms for several of the structural categories of pesticide active ingredients. The mechanisms described are not directly applicable to every pesticide active ingredient manufactured in each structural category. They do attempt to present a general mechanism for the majority of pesticide active ingredients produced within each category.

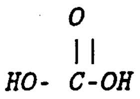
NITROGEN-CONTAINING PESTICIDES

a. s-Triazines

s-Triazines are produced by reacting hydrogen cyanide and chlorine to form cyanuric chloride followed by substitution of one or more of the chlorines with amines, mercaptans or alcohols to form the desired product. Atrazine is produced by the reaction of ethylamine and cyanuric chloride followed by the addition of isopropylamine. Atrazine can then be reacted with methyl mercaptan to form ametryn. The general structure and reaction for the s-triazines as well as the specific reactions for atrazine and ametryn are shown in Figure 3-4.

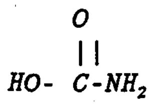
b. Carbamates

The fundamental building block of carbamate pesticides is carbamic acid, the monoamide of carbonic acid:



$$HO-\overset{O}{\overset{||}{C}}-OH$$

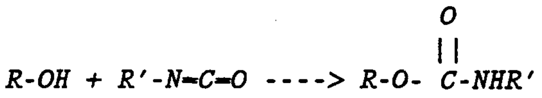
Carbonic acid



$$HO-\overset{O}{\overset{||}{C}}-NH_2$$

Carbamic acid

Carbamates are made by the reaction of alkyl or aryl alcohols with isocyanate as shown:

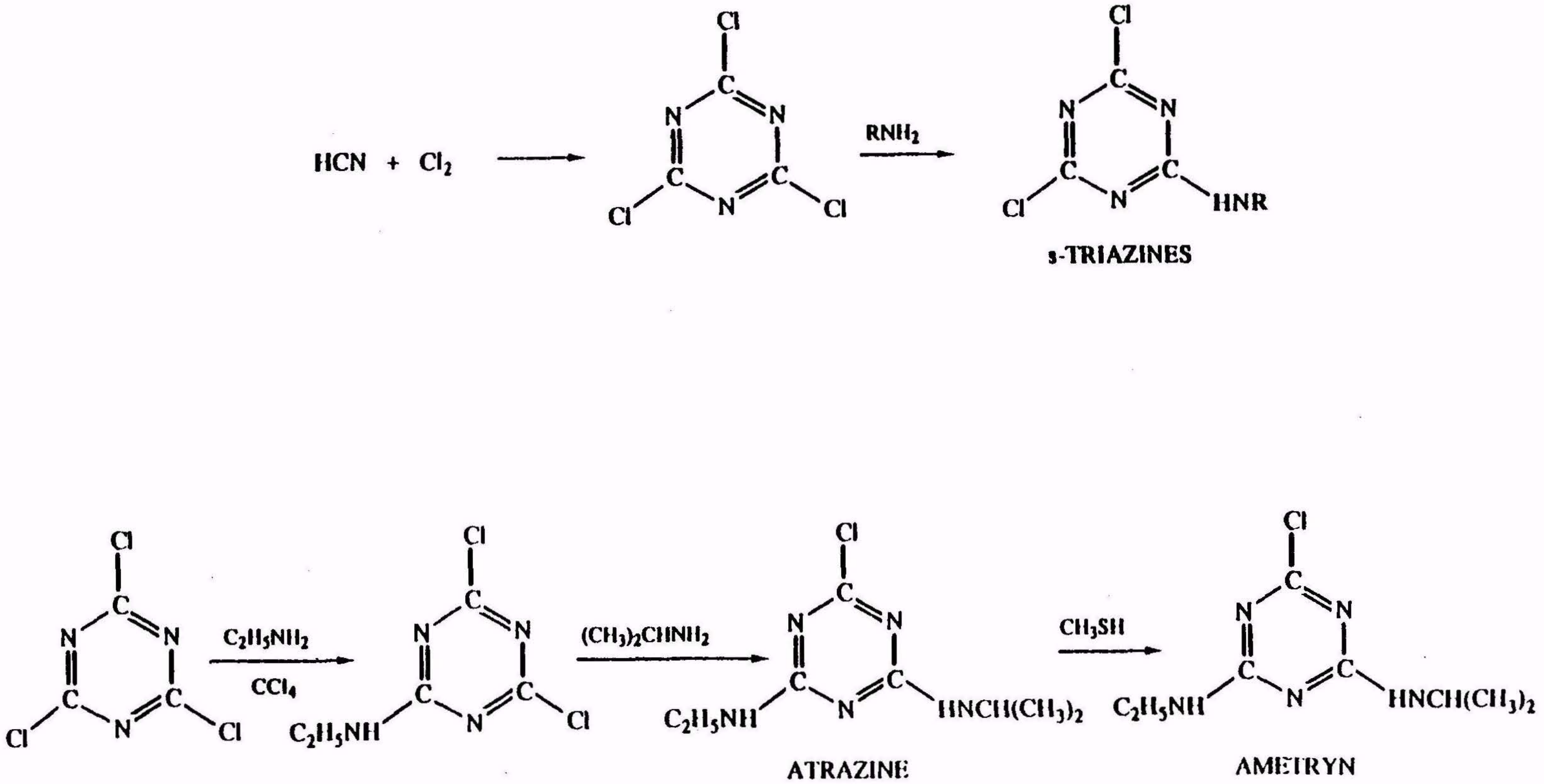


$$R-OH + R'-N{=}C{=}O \text{ ----> } R-O-\overset{O}{\overset{||}{C}}-NHR'$$

N-Methyl carbamates are produced when methyl isocyanate is used. The aryl N-methylcarbamates are easily formed when phenol and methyl isocyanate are

Figure 3-4

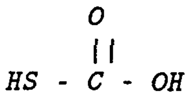
REACTION MECHANISMS FOR s-TRIAZINES AND ATRAZINE AND AMETRYN



Marshall Sittig, editor, Pesticide Manufacturing and Toxic Materials Control Encyclopedia, Noyes Data Corporation, Park Ridge, NJ, 1980; p. 51, 63.

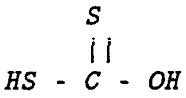
reacted. The pesticide carbofuran can be synthesized by reacting 2,2-dimethyl-2,3-dihydrobenzofuran with methyl isocyanate in the presence of triethylamine and ether as shown in Figure 3-5. (Nabam, also shown in Figure 3-5, is discussed later in this section). Other commercially feasible processes for carbamates involve the reaction of the alcohol with phosgene followed by the appropriate amine.

Thiolcarbonic acid and dithiocarbonic acid are the sulfur analogs of carbonic acid which can form thiolcarbamic acid and dithiocarbamic acid upon the addition of an amide:



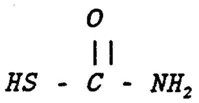
$HS - \overset{O}{\overset{\|}{C}} - OH$

Thiolcarbonic acid



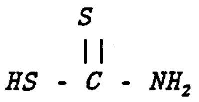
$HS - \overset{S}{\overset{\|}{C}} - OH$

Dithiocarbonic acid



$HS - \overset{O}{\overset{\|}{C}} - NH_2$

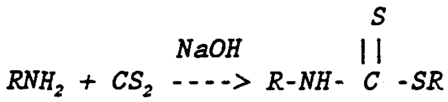
Thiolcarbamic acid



$HS - \overset{S}{\overset{\|}{C}} - NH_2$

Dithiocarbamic acid

Dithiocarbamates are produced by the reaction of an alkyl amine and carbon disulfide with sodium hydroxide, as shown:

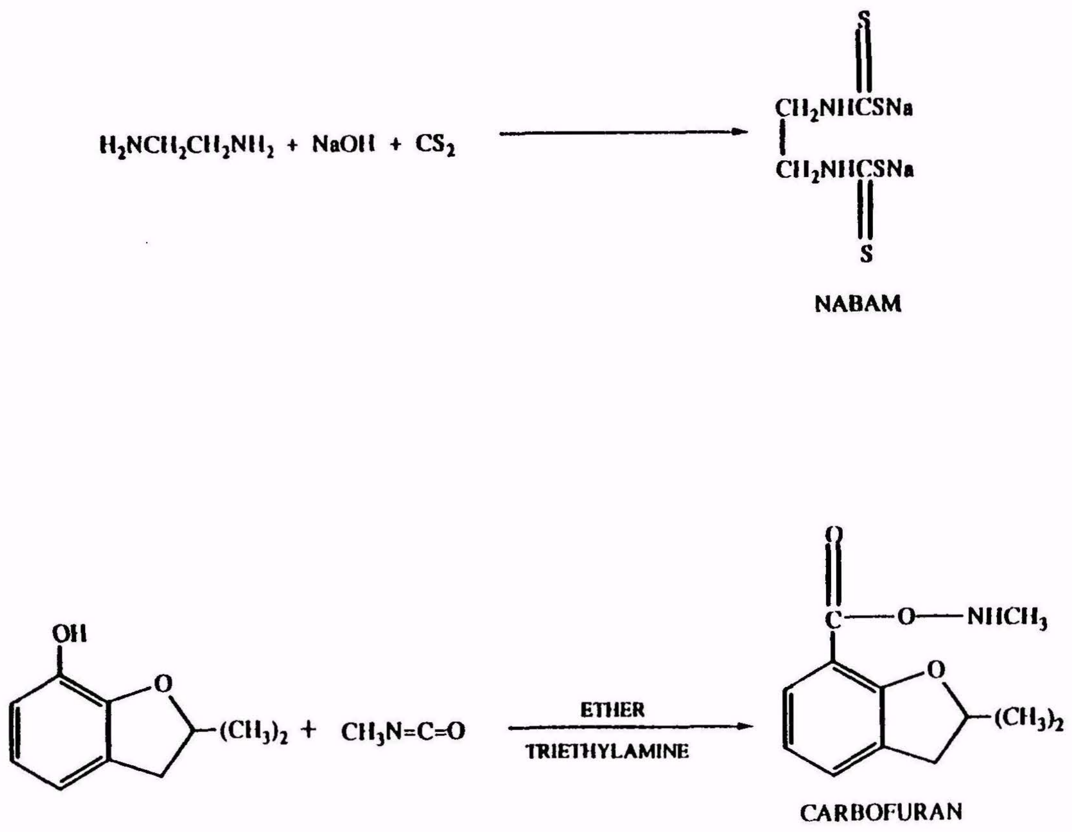


$$RNH_2 + CS_2 \xrightarrow{NaOH} R\text{-}NH\text{-}\overset{S}{\overset{\|}{C}}\text{-}SR$$

In like manner, the ethylene-bisdithiocarbamates are produced by the reaction of a diamine with carbon disulfide. The reaction for Nabam using ethylenediamine is shown in Figure 3-5.

Figure 3-5

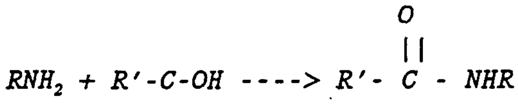
REACTION MECHANISMS FOR CARBOFURAN AND NABAM



Marshall Sittig, editor, <u>Pesticide Manufacturing and Toxic Materials Control Encyclopedia</u>, Noyes Data Corporation, Park Ridge, NJ, 1980; p. 145, 545.

c. Amides and Anilides

Nitrogen containing pesticides that are not carbamic acid derivatives can be made by reacting an amine with a carbonyl acid or carbonyl acid chloride. At this stage the intermediate can then be further reacted with alcohols, sulfonyl halides, or other reagents to synthesize the desired product. The general reaction mechanism is shown below. The specific reactions for propanil and alachlor are shown in Figure 3-6.



$$RNH_2 + R'\text{-}C\text{-}OH \text{ ----> } R'\text{-}\overset{\overset{O}{\|}}{C}\text{-}NHR$$

Other mechanisms for nitrogen-containing pesticides include the reaction of an amine with chloro-alkyls or chloro-aryls, where, by simple substitution, the desired pesticide can be formed. The reaction for isopropalin are shown in Figure 3-7.

PHENOXYACETIC ACID HERBICIDES

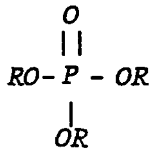
d. 2,4-D

An alkyl substituted phenol or phenoxide is reacted with chlorine or the alkyl substituted benzene or 2,4-dichlorophenol is reacted with carboxylic acid and/or sodium hydroxide to produce 2,4-dichlorophenoxyacetate. The product can then be reacted with an alcohol to produce 2,4-D esters, an amine to produce 2,4-D amine salts, or with sodium hydroxide to produce 2,4-D sodium salts. The general reaction is shown in Figure 3-8.

ORGANOPHOSPHORUS PESTICIDES

e. Phosphorothioates and Phosphorodithioates

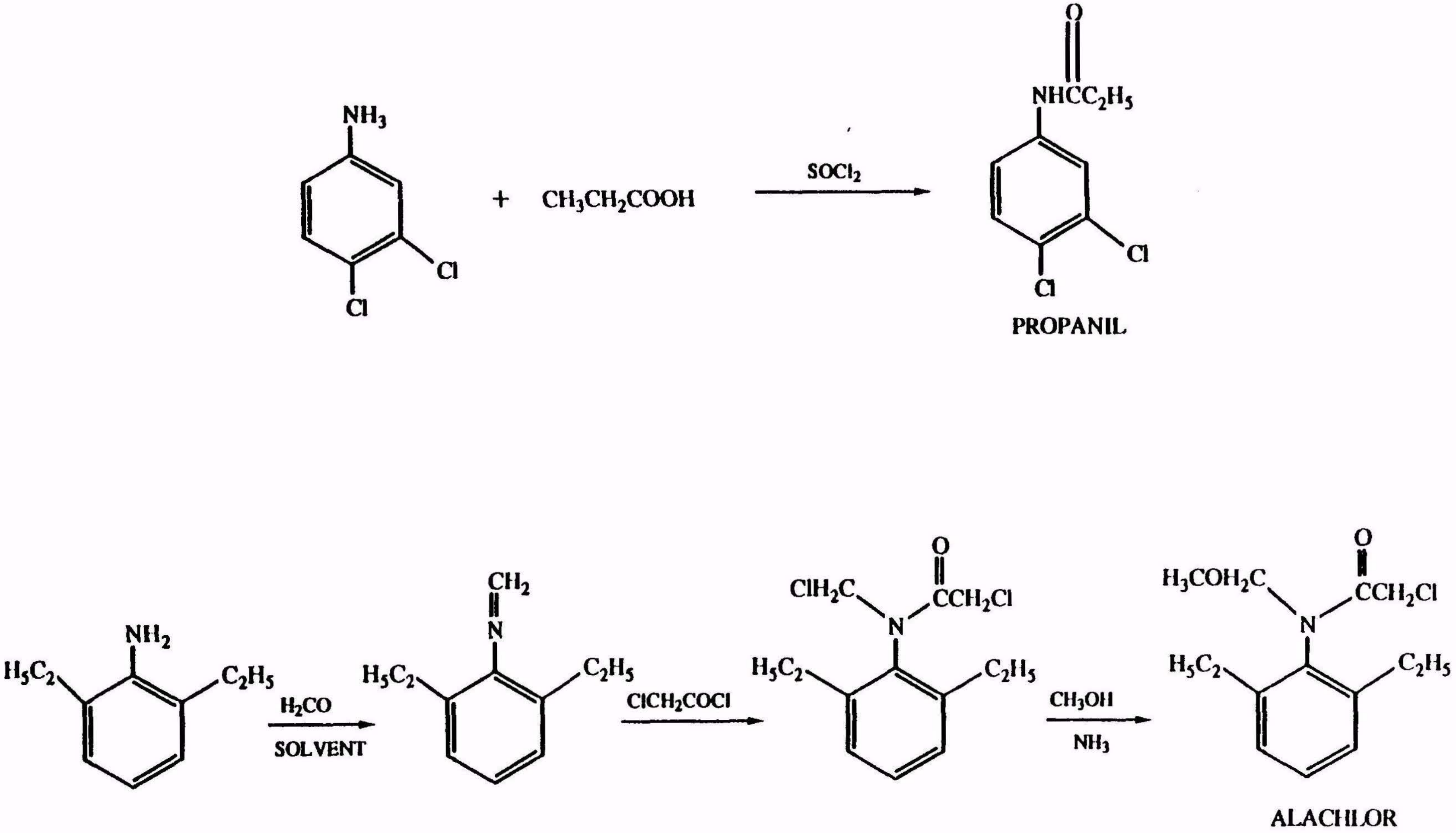
The fundamental building block of organophosphorus pesticides is phosphoric acid having the chemical structure:



$$RO\text{-}\underset{\underset{OR}{|}}{\overset{\overset{O}{\|}}{P}}\text{-}OR$$

Figure 3-6

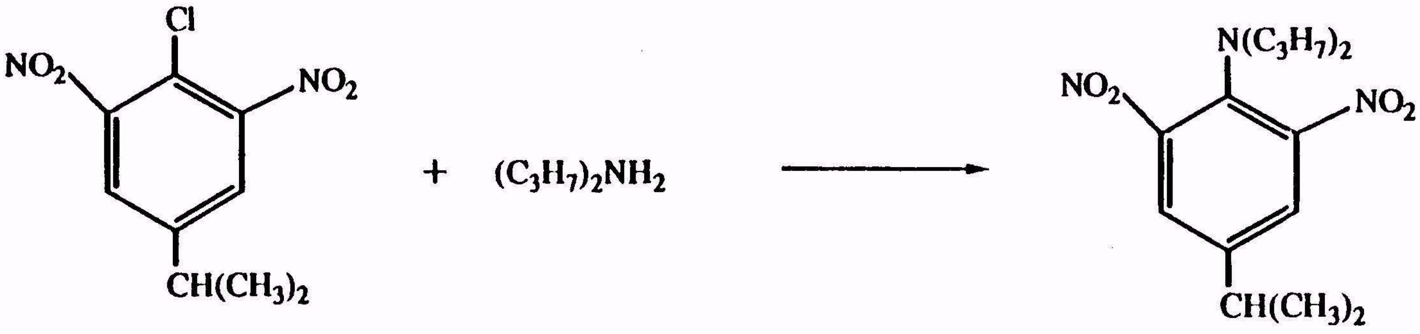
REACTION MECHANISMS FOR PROPANIL AND ALACHLOR



Marshall Sittig, editor, Pesticide Manufacturing and Toxic Materials Control Encyclopedia, Noyes Data Corporation, Park Ridge, NJ, 1980; p. 32, 639.

Figure 3-7

REACTION MECHANISMS FOR ISOPROPALIN

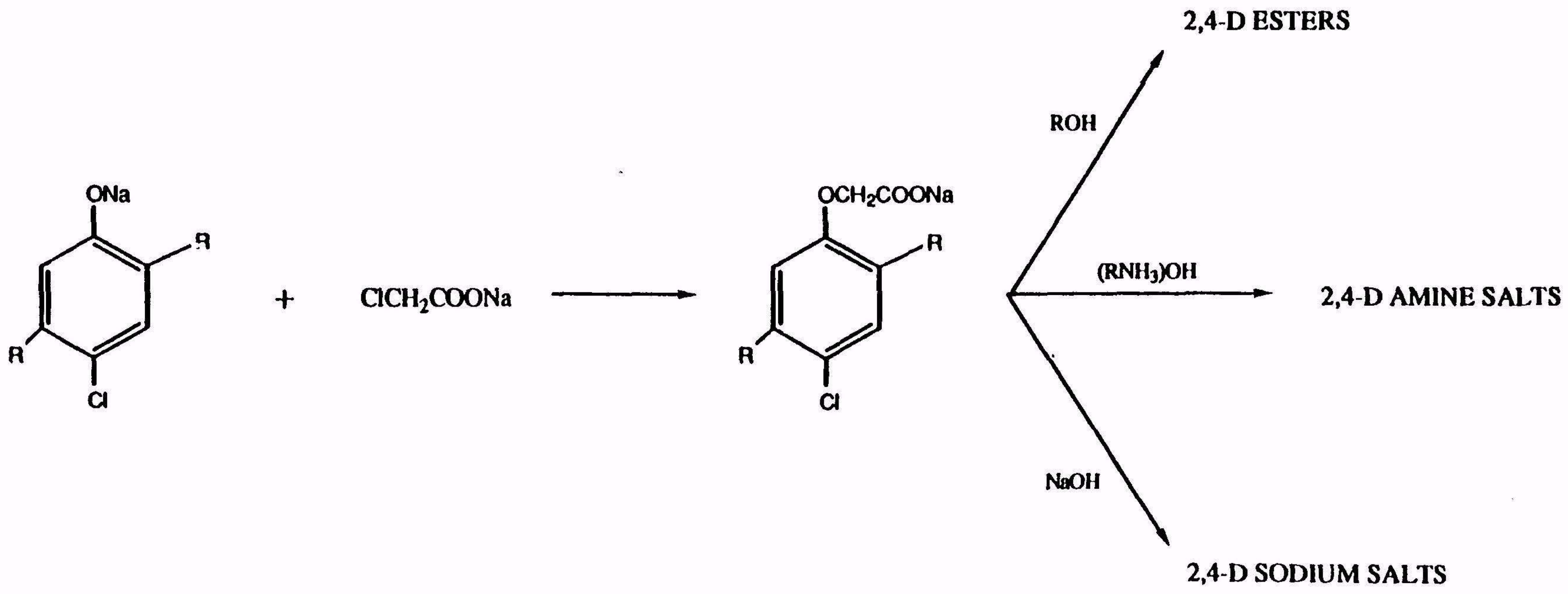


ISOPROPALIN

Marshall Sittig, editor, Pesticide Manufacturing and Toxic Materials Control Encyclopedia, Noyes Data Corporation, Park Ridge, NJ, 1980; p. 460.

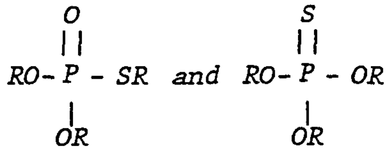
Figure 3-8

REACTION MECHANISMS FOR 2,4-D



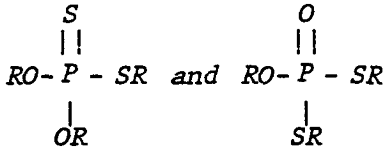
Marshall Sittig, editor, Pesticide Manufacturing and Toxic Materials Control Encyclopedia, Noyes Data Corporation, Park Ridge, NJ, 1980; p. 229.

The phosphorothioates are derivatives of phosphorothioic acid, the sulfur analog of phosphoric acid with the following structures:



$$RO-\underset{OR}{\overset{O}{\overset{\|}{P}}}-SR \quad \text{and} \quad RO-\underset{OR}{\overset{S}{\overset{\|}{P}}}-OR$$

The phosphorodithioates are further sulfur-substituted as follows:

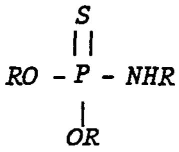


$$RO-\underset{OR}{\overset{S}{\overset{\|}{P}}}-SR \quad \text{and} \quad RO-\underset{SR}{\overset{O}{\overset{\|}{P}}}-SR$$

To synthesize these organophosphorus pesticides, phosphorus pentasulfide is reacted with an alcohol to form the phosphorothioic acid. The acid can then be chlorinated and further substituted with an alkyl or aryl group to produce the desired product. To form the phosphorodithioates, the phosphorothioic acid is reacted with formaldehyde or other appropriate reagents, and then further reacted with mercaptan to form the desired phosphorordithioate. Example chemical reactions for parathion, a phosphorothioate, and phorate, a phosphorodithioate are shown in Figure 3-9.

f. Phosphoroamidates

Like the phosphorothioates, the phosphoroamidates are the nitrogen analog of phosphoric acid having the chemical structure:



$$RO-\underset{OR}{\overset{S}{\overset{\|}{P}}}-NHR$$

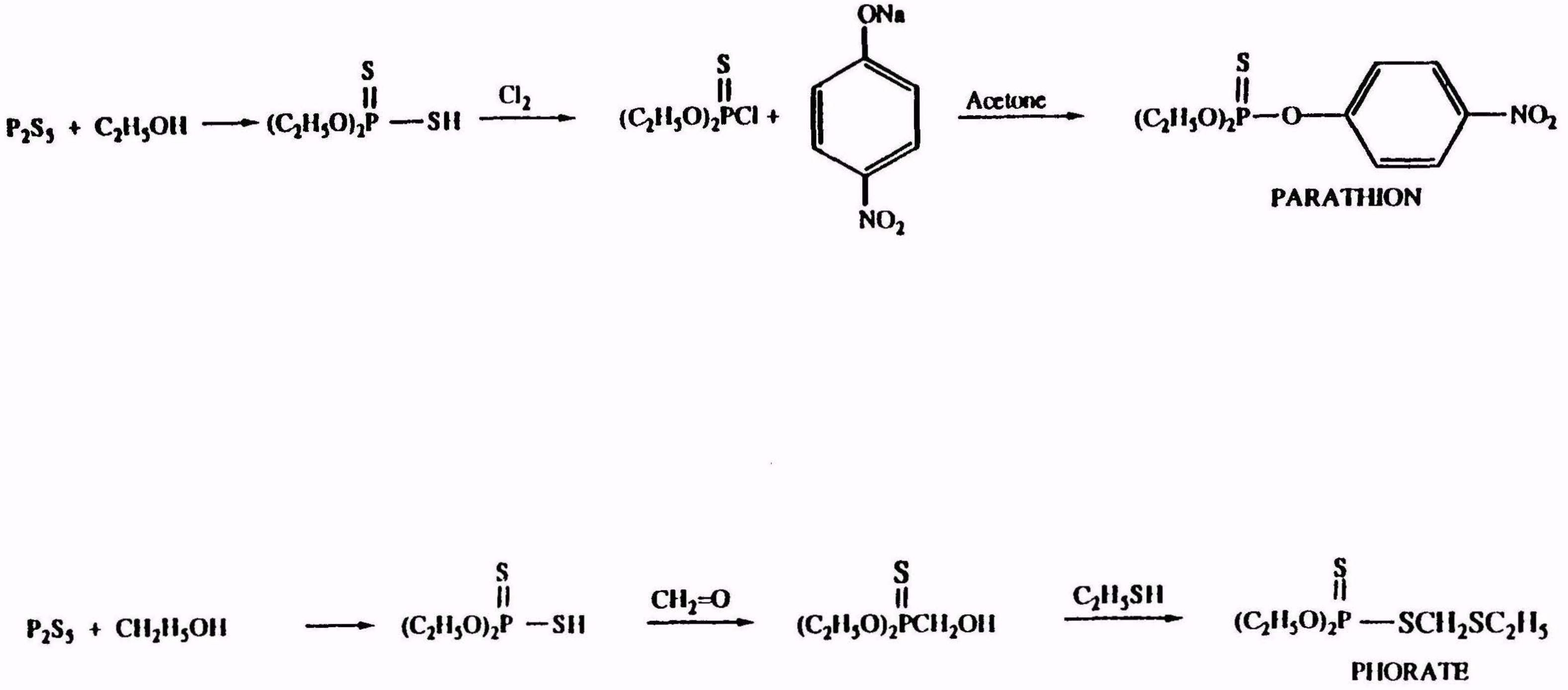
Again, the reaction involves substitution of the acid with the appropriate akyl groups to form the desired product. The reaction for glyphosate is shown in Figure 3-10.

3.4.3 Intermediate/By-product Manufacture

In the 1986 Pesticide Manufacturing Facility Census, the EPA specifically asked for the identification of pesticide intermediates and the amount of intermediate sold. A PAI intermediate, as defined in the Facility Census, is any "specific precursor compound formed in the process of

Figure 3-9

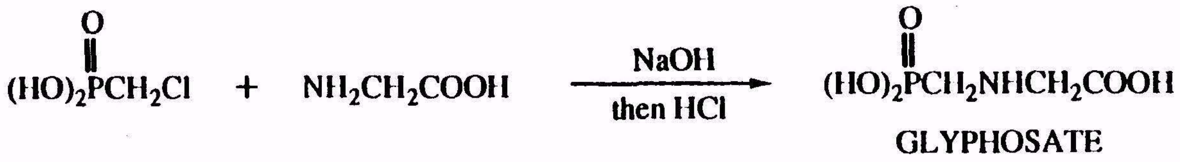
REACTION MECHANISMS FOR PARATHION AND PHORATE



Marshall Sittig, editor, <u>Pesticide Manufacturing and Toxic Materials Control Encyclopedia</u>, Noyes Data Corporation, Park Ridge, NJ, 1980; p. 584, 611.

Figure 3-10

REACTION MECHANISM FOR GLYPHOSATE



$$(HO)_2\overset{O}{\overset{\|}{P}}CH_2Cl + NH_2CH_2COOH \xrightarrow[\text{then HCl}]{\text{NaOH}} (HO)_2\overset{O}{\overset{\|}{P}}CH_2NHCH_2COOH$$

GLYPHOSATE

Marshall Sittig, editor, Pesticide Manufacturing and Toxic Materials Control Encyclopedia, Noyes Data Corporation, Park Ridge, NJ, 1980; p. 441.

manufacturing an active ingredient." For example, if chemical A and chemical B are reacted to form chemical C, and then chemical C is reacted further to produce a PAI, then chemical C is an intermediate. The Facility Census did not require facilities to provide detailed process chemistry because industry objected to providing sensitive CBI, and because the Agency determined that its primary reason for requesting this information in preliminary versions of the Census questionnaire (for use in fundamentally different factors variance determinations) was no longer necessary. Fifteen intermediates at 11 facilities were reported to be produced and sold in 1986, and two of these 11 facilities are now closed. As discussed in Section 3.4, the manufacturers of PAI intermediates are not subject to this regulation.

A by-product is identified as a stream from the reaction process, other than intermediates or active ingredients, which is sold. For example, if chemical A and chemical B are reacted to form chemical C and chemical D, of which chemical D is the desired PAI, then chemical C is a by-product if sold. Fifteen (15) by-products at 17 facilities were reported to be produced and sold in 1986, and 14 of these 17 facilities are still currently in operation.

3.5 CHANGES IN THE INDUSTRY

Data compiled from the Facility Census provides a snapshot of the pesticide chemicals manufacturing industry as it was in 1986. However, the industry had and has undergone changes prior to and since 1986. The nature and extent of those changes are discussed below.

The 1986 Facility Census identified 90 pesticide manufacturing facilities -- 8 metallo-organic pesticide manufacturers and 86 organic pesticide manufacturers (four facilities manufacture both metallo-organic and organic pesticides). Since 1986, the Agency is aware of 15 facility closings; three metallo-organic and 13 organic pesticide manufacturers (one of the facility closures manufactured both organic and metallo-organic PAIs).

One hundred seventy-seven (177) PAIs and salts and esters of PAIs were identified in the Facility Census as being manufactured that year from 223 production processes, and eight PAIs were produced before or after 1986, but not in 1986. The Agency believes that 42 PAI production processes have closed since 1986 -- 38 organic PAIs and 4 metallo-organic PAIs -- and 20 of these PAI processes were in operation at the 15 facilities that have closed since 1986. However, these 42 PAIs are included in this regulation if data were available to develop limitations. In addition, several facilities have decreased production of PAIs due to economic factors or to restricted use of their pesticide products.

SECTION 4

INDUSTRY SUBCATEGORIZATION

4.0 INTRODUCTION

Division of a point source category into groupings entitled "subcategories" provides a mechanism for addressing variations between products, raw materials, processes, and other parameters which result in distinctly different effluent characteristics. Regulation of a category by subcategory provides that each subcategory has a uniform set of effluent limitations which take into account technological achievability and economic impacts unique to that subcategory.

The factors considered in the subcategorization of the pesticide point source category include:

- Product type;
- Raw materials;
- Manufacturing process and process changes;
- Nature of waste generated;
- Dominant product;
- Plant size;
- Plant age;
- Plant location;
- Non-water quality characteristics;
- Treatment costs and energy requirements.

EPA evaluated these factors and determined that subcategorization is necessary. These evaluations are discussed in detail in the following sections. The pesticide chemicals point source category was divided into three subcategories:

A. Organic pesticide chemicals manufacturing;

B. Metallo-organic pesticide chemicals manufacturing; and

C. Pesticide Chemicals Formulating and Packaging.

Subcategory C, the pesticide chemicals formulating and packaging industry, will be addressed separately at a later date.

4.1 BACKGROUND

In the November 1, 1976, Federal Register, EPA promulgated interim final BPT guidelines for the pesticide point source category establishing a subcategorization approach which included five subcategories. Comments received on this notice were incorporated into the April 25, 1978 and September 29, 1978 final rule which presented a revised subcategorization approach including three subcategories.

In the November 30, 1982, Federal Register, EPA proposed additional guidelines (including BAT, BCT, NSPS, PSNS, and PSES) for the pesticide point source category which established 13 subcategories. A Notice of Availability (NOA) appeared in the June 13, 1984, Federal Register, which presented on alternative subcategorization approach of three subcategories. The October 4, 1985, Federal Register, which promulgated BAT, NSPS, PSNS, and PSES guidelines for the pesticide point source category incorporated the alternative subcategorization approach of the June 13, 1984, Federal Register. Subsequent to the October 4, 1985 promulgated rule, EPA voluntarily withdrew the BAT, NSPS, PSNS, and PSES guidelines pursuant to litigation brought by the industry.

This section discusses the subcategorization methodologies for the interim final and final BPT guidelines and the proposed and final BAT, NSPS, PSNS, and PSES guidelines which were later remanded and presents the concerns and issues raised during the public comment periods for each.

4.1.1 November 1, 1976, Interim Final BPT Guidelines

The interim final BPT effluent limitations guidelines promulgated November 1, 1976 for the pesticide chemicals point source category established five subcategories:

- The halogenated organic pesticides subcategory (Subpart A);
- The organo-phosphorous pesticides subcategory (Subpart B);
- The organo-nitrogen pesticides subcategory (Subpart C);
- The metallo-organic pesticides subcategory (Subpart D); and
- The pesticide formulating and packaging subcategory (Subpart E).

The subcategories chosen reflected differences in the character, volume, and treatability of wastewater streams due to manufacturing process variables related to each grouping of chemicals. EPA believed that the differences in process wastewater characteristics were significant and warranted the establishment of five separate subcategories.

4.1.2 April 25, 1978, Promulgated BPT Guidelines

On promulgating the interim final regulations, the Agency recognized that certain ambiguities were present in its subcategorization based on chemical structure. Many pesticides contain more than one functional group, such as halogens, phosphorous, sulfur, nitrogen, etc. and do not fit the former subcategorization scheme. Such compounds could not be readily assigned to particular subcategories. In order to resolve these ambiguities and also in response to industry comments, the Agency re-examined its data to determine if there were reasons to provide different effluent limitations on the basis of chemical structure and other potential differences among plants. Review of raw waste load characteristics revealed no consistent pattern between or within chemical family groupings that would provide a basis for subcategorization. The Agency found that the quantities of pollutants in the effluents of those plants with properly operated treatment technologies installed were similar, regardless of the organic pesticide chemicals manufactured. The Agency, therefore, concluded that the wastewaters of all organic pesticide chemicals can be treated or controlled to similarly documented levels in the Agency's treatability database. For the final BPT regulation, the Agency consolidated the halogenated organic, organo-phosphorous, and organo-nitrogen pesticide subcategories into a single subcategory, designated as the organic pesticide chemicals manufacturing subcategory.

EPA retained distinct subcategories for the manufacture of metallo-organic pesticide chemicals and formulating and packaging of pesticide chemicals for the promulgated BPT effluent limitations guidelines.

4.1.3 November 30, 1982, Proposed BAT, BCT, NSPS, PSES, PSNS Guidelines

On November 30, 1982, EPA proposed additional regulations to control the discharge of wastewater pollutants from pesticide chemicals manufacturing and formulating/packaging operations to navigable waters and to publicly owned treatment works (POTWs) (47 FR 53994).

EPA proposed to subdivide the Organic Pesticide Chemicals Manufacturing Subcategory (Subpart A) into 11 subcategories. EPA proposed to retain the Metallo-organic Pesticide Chemicals Manufacturing Subcategory and the Pesticide Chemicals Formulating and Packaging Subcategory as the 12th and 13th subcategories. EPA based this proposed new subcategorization scheme on the nature of the priority pollutants and groups of priority pollutants which had been detected or were likely to be present in pesticide wastewaters, and the treatment technologies to remove those priority pollutants from industry wastewater prior to discharge.

4.1.4 June 13, 1984, Notice of Availability (NOA)

Commenters criticized the proposed subcategorization scheme on the grounds that (1) the priority pollutant - PAI combination were often inaccurate, (2) subcategorization by treatment technology assumed a technology would be used when an alternative technology could be used, and (3) the subcategorization scheme projected was overly complex and possibly unworkable. Commenters recommended that EPA not change the subcategorization used for BPT. The Agency in general agreed with these comments, and in the June 13, 1984 Notice of Availability (NOA) stated that it was considering reducing the number of subcategories back to three:

- Organic pesticide chemicals manufacturing;
- Metallo-organic pesticide chemicals manufacturing; and
- Pesticide chemicals formulating and packaging.

The NOA announced the availability of new information collected in response to comments received on the November 30, 1982 proposal. EPA then requested comments on the new data and the new subcategorization.

4.1.5 October 4, 1985, Promulgated BAT, NSPS, PSES, and PSNS Guidelines

Commenters supported the revised subcategorization scheme presented in the June 1984 NOA. Therefore, on October 4, 1985, the Agency promulgated effluent limitations guidelines for BAT, NSPS, PSES, and PSNS based on the three subcategories identified in the June 1984 Notice of New Information. The primary factors for subcategorizing plants in the industry were dominant product type, manufacturing processes, and raw materials used. As discussed in Section 1.1.4, the October 1985 guidelines were voluntarily withdrawn by EPA in 1986.

4.2 CURRENT SUBCATEGORIZATION BASIS

In the current study, the Agency has developed new data and has evaluated these data to determine the appropriate subcategorization. Based on this evaluation, the Agency believes the pesticides chemicals industry should be subdivided into the same three subcategories established by BPT. These are:

Subcategory A - Organic Pesticide Chemicals Manufacturing

Subcategory B - Metallo-organic Pesticide Chemicals Manufacturing

Subcategory C - Pesticide Chemicals Formulating and Packaging

The following paragraphs discuss EPA's consideration of the factors listed previously (see Section 4.0) in determining appropriate subcategories for the Pesticides Chemicals Category. The primary bases for subcategorizing plants in this industry were found to be product type and raw materials used.

4.2.1 Product Type and Raw Materials

Metals or metallic compounds are generally not used as raw materials in the manufacture of organic pesticide chemicals, but such substances are used as raw materials for metallo-organic pesticide chemicals manufacturing. For this reason, wastewaters from metallo-organic pesticide chemicals manufacturing have a much higher concentration of metals and metallo-organic compounds than wastewater from organic pesticide chemicals manufacturing. The types of treatment technologies effective for treating wastewater from metallo-organic wastewaters are different from those technologies used to treat organic pesticide chemicals, due to the higher concentrations of metals and metallo-organic compounds in wastewaters from metallo-organic pesticide chemicals. Therefore, product type and raw materials are appropriate bases for subcategorization of this industry.

4.2.2 Manufacturing Process and Process Changes

Facilities that manufacture pesticide active ingredients use a variety of unit operations, including chemical synthesis, separation, recovery, purification, and product finishing. The specific active ingredient product dictates not only the raw materials that will be used but also the sequence of unit operations and the quantity and quality of wastewater that is generated. Some pesticide chemicals manufacturing facilities have introduced process changes which affect wastewater characteristics and quality. In the period from 1977 to 1986, a number of facilities eliminated the use of priority pollutants as solvents. Other facilities implemented solvent extraction to recover raw materials, intermediates, or products from wastewater streams for reuse within the process, and recycle of process waters, in order to minimize the discharge of pollutants from the manufacturing process. Given the wide range of process chemistry and unit operations used in the manufacture of different pesticide active ingredients, subcategorization based on the manufacturing process and process changes would result in too many subcategories, thus are not appropriate for the purpose of delineating subcategories.

4.2.3 Nature of Waste Generated

Based on an analysis of the data available to EPA, there are no consistent differences in the amount and identity of pollutants (except for the active ingredient itself) in waste loads from different organic pesticide chemicals manufacturing facilities. However, manufacturers of metallo-organic pesticide chemicals tend to generate smaller volumes of wastewater with higher metal concentrations compared to manufacturers of organic pesticide chemicals (see Section 5). Therefore, the nature of the waste generated from pesticide manufacturing operations is also a good basis for subcategorization that differentiates between organic PAIs and metallo-organic PAIs. This factor is directly related to the product type and raw materials used, and therefore is consistent with subcategorization based on product type and raw materials.

4.2.4 Dominant Product

In the pesticide chemicals manufacturing category, there are a large number of products produced. The category also includes a large variety of manufacturing processes and wastewater characteristics. Subcategorization based on dominant product manufactured would result in a large number of subcategories and is therefore not appropriate for subcategorization for the pesticide chemicals manufacturing industry.

4.2.5 Plant Size

Plant size and production capacity do not impact characteristics of wastewater produced during the manufacture of pesticide chemicals based on data available to EPA. The size of the plant will not affect the effectiveness of treatment technologies (i.e., the pollutant concentration levels in the effluent that can be achieved with treatment technologies), although it can affect the cost of treatment facilities and the cost of treatment per unit of production. Overall, EPA does not believe that plant size is an appropriate method of subcategorization for the pesticide chemicals manufacturing industry.

4.2.6 Plant Age

The age of a plant or a production process can sometimes have a direct bearing on the volume of wastewater generated, how the wastewater is segregated, and the ability of the plant to implement new treatment technologies. Compared to new plants, older facilities tend to have a greater volume of wastewater and higher pollutant loadings, even though pollutant concentrations may be lower due to water contributions from noncontact sources. However, plants that began manufacturing one set of products may be manufacturing entirely different products now. Also, older facilities that have continued to manufacture the same product have often improved or modified the process and treatment technologies over time. Therefore, subcategorization on the basis of plant age is not appropriate.

4.2.7 Plant Location

As discussed in Section 3, the majority of pesticide chemicals manufacturing facilities are located in the eastern half of the United States, with a concentration in the southeast corridor and Gulf Coast states. Based on analyses of existing data, plant location has little effect on wastewater quality, although it may affect the cost of treatment and disposal of process wastes.

Facilities located in urban areas have higher land costs for treatment facilities. Distance from the plant to an off-site disposal location may also increase costs of off-site disposal of solid or liquid waste. Climatic conditions may affect the performance of some treatment technologies and necessitate special provisions (e.g., heating of biological oxidation units in colder climates or cooling requirements in warmer climates). However, for pesticide chemicals manufacturing there are no consistent differences in wastewater treatment performance or cost due to location. Therefore, geographical location is not an appropriate basis for subcategorization.

4.2.8 Non-Water Quality Characteristics

Non-water quality characteristics from the pesticide chemicals manufacturing industry could include environmental impacts due to solid waste disposal, transportation of wastes to an off-site location for treatment or disposal, and emissions to the air. The impact from solid waste disposal is dependent upon the treatment technology employed by a facility and the quantity and quality of solid waste generated by that facility. Contract hauling wastewater from pesticide chemicals manufacturing creates a hazard through the transportation of potentially hazardous materials. However, both of these impacts are a result of individual facility practices, rather than a trend of different segments of the industry.

Air emissions from the pesticide chemicals manufacturing industry are somewhat related to the active ingredient product(s) manufactured and/or the raw materials used. However, most PAIs are very low in volatility compared to the various solvents used in the manufacturing processes. The same solvents are used in manufacturing many different PAIs, therefore, air pollution control problems and equipment utilized are not generally unique to different segments of this industry. For example, baghouses or wet scrubbing devices remove particulates and vapors and toxic gases are frequently incinerated.

Based on these discussions, the Agency believes that subcategorization on the basis of non-water quality characteristics is not needed.

4.2.9 Treatment Costs and Energy Requirements

The same treatment unit operation could be utilized for different wastewater sources, such as steam stripping to remove volatile priority pollutants and hydrolysis to remove organo-phosphorus pesticides. However, the cost of treatment and the energy required will vary depending on flow rates, wastewater quality, and the amount and identity of pollutants in the wastewater. Moreover, alternative technologies could be selected by dischargers. Therefore, subcategorization based on treatment costs and energy requirements is not appropriate.

4.3 FINAL SUBCATEGORIES

Based on product type, raw materials, and the nature of waste generated, EPA has defined two subcategories for the pesticide chemicals manufacturing industry. The two subcategories are the same as the manufacturing subcategories contained in the existing 40 CFR Part 455 regulations.

4.3.1 Organic Pesticide Chemicals Manufacturing

This subcategory applies to discharges resulting from the production of carbon-containing PAIs, excluding metallo-organic active ingredients containing arsenic, cadmium, copper, or mercury. Although organo-tin pesticides otherwise fit the definition of a metallo-organic active ingredient given in the BPT regulation (see Section 455.31(a)), organo-tin pesticides were not included in the metallo-organic pesticide chemicals subcategory (see Section 455.30) during the 1978 rulemaking because wastewaters from their manufacture have significantly different wastewater characteristics from wastewaters from the manufacture of metallo-organic pesticides containing arsenic, cadmium, copper, and mercury. EPA does not believe it is appropriate to include the organo-tin pesticides in the metallo-organic subcategory because their pollutants are different, and the organo-tin production has larger volumes of wastewater. The amounts and types of pollutants from organo-tin pesticide manufacture are closer to the amounts and types of pollutants from the manufacture of the organic pesticide chemicals. Therefore, EPA has determined that organo-tin pesticides should be included in the organic pesticide chemicals manufacturing subcategory. EPA is regulating a broad range of pollutants in this subcategory: conventional pollutants, nonconventional pollutants (including COD and the PAIs), and priority pollutants.

4.3.2 Metallo-Organic Pesticide Chemicals Manufacturing

This subcategory applies to discharges resulting from the manufacture of metallo-organic pesticide active ingredients that contain mercury, cadmium, arsenic, or copper (see Section 455.30 and Section 455.31 (a)). The three existing direct dischargers in this subcategory are currently subject to BPT effluent limitations requiring zero discharge of process wastewater pollutants. Currently there are only two existing indirect dischargers in this subcategory.

SECTION 5

WATER USE AND WASTEWATER CHARACTERIZATION

5.0 INTRODUCTION

In 1988, under the authority of Section 308 of the Clean Water Act, EPA distributed the Facility Census to 247 facilities that EPA had previously identified as possible pesticide chemicals manufacturers. Responses to the Facility Census by these 247 facilities indicated that 90 facilities manufactured pesticides in 1986. This section presents information on water use at these 90 facilities, and at the 75 of the 90 manufacturing facilities that are still currently in operation. This section also presents information on process wastewater characteristics for those PAI manufacturing processes that were sampled by EPA and for those PAI manufacturing processes that provided self-monitoring data.

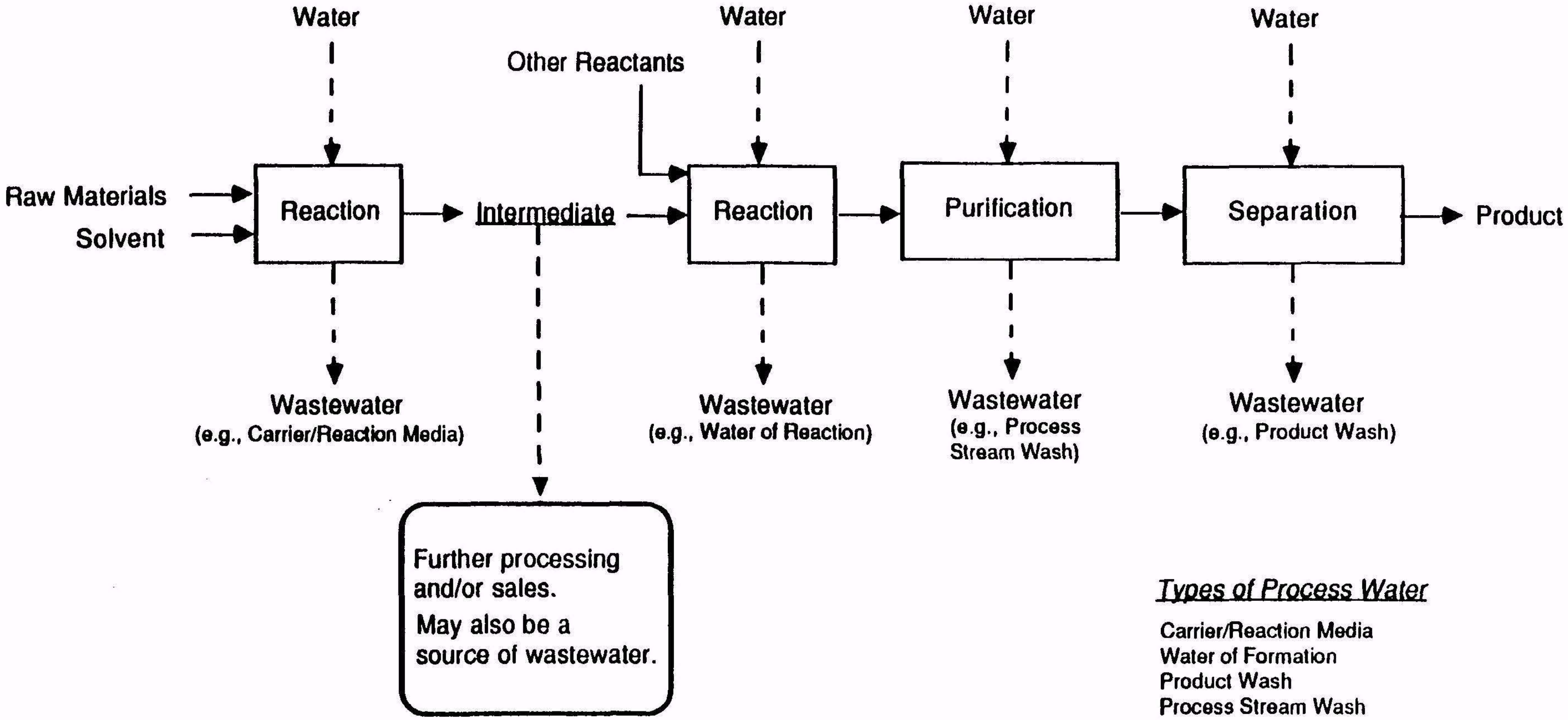
5.1 WATER USE AND SOURCES OF WASTEWATER

As described in Section 3, pesticide active ingredient manufacturing processes vary from facility to facility and from active ingredient to active ingredient. A simplified flow diagram for pesticide active ingredient manufacture is presented in Figure 5-1, showing typical streams which enter and leave the manufacturing process. The manufacture of a pesticide active ingredient requires several types of input streams. These include raw materials, solvents, other reactants, and water. Raw materials are those organic and inorganic compounds that chemically react with one another to form the pesticide active ingredient. Solvents are organic or inorganic compounds used as reaction or transport media, but which do not participate in the chemical reaction. Other reactants include acidic or basic compounds used to facilitate, catalyze, or participate in the chemical reaction (for example, an acidic reaction medium may be required to ensure the desired pesticide product). Water or steam may be added to the reaction medium to act as a solvent or carrier, or water may be added during subsequent separation or purification steps.

Streams leaving the process include the active ingredient products, by-products, intermediates which are sold or used in other manufacturing processes, and liquid and solid wastes. A by-product is a compound formed during the reaction process other than the active ingredient product which can be sold. A common by-product in the pesticide manufacturing industry is hydrochloric acid. An intermediate is defined in the Facility Census as "any specific precursor compound formed in the process of manufacturing an active ingredient." An intermediate is not a PAI itself but instead is usually an organic chemical compound. In some cases, part of the intermediate is removed from the pesticide process for use in other manufacturing processes or for sale. Liquid and solid wastes include hazardous and nonhazardous organic and inorganic wastes as well as wastewater. In addition, some chemical compounds may leave the manufacturing process in the form of air emissions.

Figure 5-1

EXAMPLE OF PESTICIDE ACTIVE INGREDIENT MANUFACTURING PROCESS



Types of Process Water

Carrier/Reaction Media
Water of Formation
Product Wash
Process Stream Wash
Equipment Wash
Pump Seal Wash
Pump Seal Water
Steam Jets/Vacuum Pumps
Scrubber Water

Three sources of wastewater were reported at pesticide manufacturing facilities in 1986. These include:

- PAI process wastewater - water leaving the manufacturing process;
- Other pesticide wastewater - pesticide-containing wastewater generated from sources not directly associated with the manufacturing process, such as employee shower water or contaminated storm water; and
- Other facility wastewater - wastewater from other manufacturing operations, such as organic chemicals production, or other facility sources, such as sanitary wastewater, which is typically commingled and treated with pesticide-containing wastewater. Other types of liquid wastes leaving the pesticide manufacturing process include spent solvents, spent acids, and spent caustics. These wastes are often combined with other sources of process wastewaters that are being treated and/or discharged.

These sources are described in more detail below.

5.1.1 PAI Process Wastewater

Process wastewater is defined by EPA regulations at 40 CFR 122.2 as "any water which, during manufacturing or processing, comes into direct contact with or results from the production or use of any raw material, intermediate product, finished product, by-product or waste product." For this final rule, process wastewater flow is defined to mean the sum of the average daily flows from the following wastewater streams: process stream and product washes, equipment and floor washes, water used as solvent for raw materials, water used as reaction medium, spent acids, spent bases, contact cooling water, water of reaction, air pollution control blowdown, steam jet blowdown, vacuum pump water, pump seal water, safety equipment cleaning water, shipping container cleanout, safety shower water, contaminated storm water, and product/process laboratory quality control wastewater. See section 455.21(d).

Specifically, PAI process wastewaters associated directly with the production process are:

- Water of reaction: water which is formed during the chemical reaction, such as from the reaction of an acid with an alcohol;
- Process solvent: water used to transport or support the chemicals involved in the reaction process; this water is usually removed from the process through a separation stage, such as centrifugation, decantation, drying, or stripping;

- Process stream washes: water added to the carrier, spent acid, or spent base which has been separated from the reaction mixture, in order to purify the stream by washing away the impurities;

- Product washes: water added to the reaction medium in order to purify an intermediate product or active ingredient by washing away the impurities; this water is subsequently removed through a separations stage; or water which is used to wash the crude product after it has been removed from the reaction medium;

- Spent Acid/Caustic: acid and basic reagents are used to facilitate, catalyze, or participate in the reaction process. Spent acid and caustic streams, which may be primarily water, are discharged from the process during the separation steps which follow the reaction step;

- Product/process Laboratory Quality Control Wastewater: water from laboratories used to determine product and/or process quality; and

- Safety Shower Water: Safety showers, which are used to deluge an employee, clothing and all, in the event of an accident, are always located near production equipment. Accidents are very infrequent and these showers are therefore seldom used. When used, any water generated is process wastewater. Because of the infrequent use, the amount of water is minuscule compared to other sources of process wastewater.

Most of the above sources are present in manufacturing almost all PAIs. Other sources of process wastewater associated with pesticide operations include:

- Steam jets or vacuum pumps: water which contacts the reaction mixture, or solvents or water stripped from the reaction mixture, through the operation of a venturi or vacuum pump;

- Air pollution control scrubber blowdown: water or acidic or basic compounds used in air emission control scrubbers to control fumes from reaction vessels, storage tanks, and other process equipment;

- Equipment and floor washes: water used to clean process equipment and floors during unit shutdowns;

- Pump seal water: water used to cool packing and lubricate pumps which may contact pesticide-containing water through leakage and may therefore become pesticide-containing wastewater;

- Shipping Container Cleanout: water used to clean out shipping containers for reuse;

- Contact Cooling Water: water used to cool steam and other emissions from evaporating water from products; and

- General/Uncategorized process wastewater: a combination of sources or cases where total flow is greater than the sum of individual identified parts.

These water uses could result in the water becoming contaminated with pesticide active ingredient or other compounds used in the manufacturing process. These sources may be intermittent or absent entirely. The water use reported for each source is presented in Table 5-1. As shown in the table, about 34% of the water use in 1986 was for product wash.

5.1.2 Other Pesticide Wastewater Sources

In addition to process wastewater, other types of wastewater may be generated during pesticide production from non-process sources which can also contain pesticide pollutants and other pollutants. These include:

- Showers used by pesticide production employees. Many facilities provide shower facilities for employees coming off shift so that any PAIs that the employee may inadvertently have contacted can be washed away before the employee leaves the facility. [Note: Safety showers, which are used to deluge an employee, clothing and all, in the event of an accident, are always located near production equipment. Accidents are very infrequent and these showers are therefore seldom used. When used, any water generated is process wastewater and is included as a source of process wastewater in Section 5.1.1. Because of the infrequent use, the amount of water is minuscule compared to other sources of process wastewater.];

- Laundries used to wash clothing from pesticide production employees. Many facilities provide on-site laundry facilities to wash employee uniforms to remove any PAIs that may inadvertently be on the uniform after the work shift;

Table 5-1

PESTICIDE ACTIVE INGREDIENT PROCESS WASTEWATERS GENERATED IN 1986 BY EFFLUENT TYPE

Effluent Type	Waste Volume (gal/yr)	Percent	# Facilities
Product Wash	487,669,000	33.7	40
Scrubber Blowdown	207,232,000	14.3	33
Process Stream Wash	201,058,000	13.9	35
Process Solvent	196,042,000	13.6	29
Spent Acid	178,212,000	12.3	7
General Process/Unidentified Wastewater[1]	58,894,000	4.1	17
Contaminated Stormwater[2]	43,810,000	3.0	4
Steam Jet/Vacuum Pump	28,255,000	2.0	7
Equipment Wash	22,492,000	1.6	18
Spent Solvent	15,001,000	1.0	15
Spent Caustic	6,890,000	0.5	4
TOTAL	1,445,554,000	100.0	

[1] General process wastewater also includes water of reaction and pump seal water.

[2] Total contaminated stormwater is presented here. See Table 5-2 for the average daily contaminated stormwater flow per plant.

- Cleaning safety equipment used in pesticide production. Equipment includes goggles, respirators, and boots. These must be cleaned after every use so they will be free of contaminants when next needed. Cleaning is usually done with solvents followed by a soap and water wash; and

- Contaminated stormwater. Accidents, leaks, spills, shipping losses, and fugitive emissions can all lead to PAIs and other pollutants coming into contact with stormwater. This contaminated stormwater is process wastewater and should be treated before discharge.

Not all plants have all of these "other" sources, and no facility reported monitoring flows for these sources (except for stormwater). The number of plants that reported these sources is presented in Table 5-2, both for the 90 facilities that were operating in 1986 and for the 75 of the 90 facilities that are still currently in operation. For example, 56 of the 67 facilities that reported shower water in 1986 are still currently in operation. Table 5-2 also presents the average estimated flows reported for employee showers, laundries, safety equipment cleaning, and contaminated stormwater. The flows for employee showers, laundries, and safety equipment cleaning are all very small compared to stormwater, which itself is a relatively small portion of total industry wastewater generation (see Table 5-1). The flows for employee showers and laundries were excluded from the definition of process wastewater flow (section 455.21(d)) and were excluded from consideration in developing the regulatory limitations.

5.1.3 Other Facility Wastewater Co-Treated with Pesticide Wastewate

Often, a facility which manufactures pesticides also manufactures other products. Wastewaters generated from other operations may be co-treated with wastewaters from pesticide chemicals manufacturing. Facilities reported co-treating wastewater from the following production operations:

- Pesticide Formulating/Packaging (PFP) of "in-scope" and "out-of-scope" PAIs ("out of scope" PAIs are those PAIs not included in the list of 269 PAIs and classes of PAIs considered for regulation);

- Organic Chemicals, Plastics, Synthetic Fibers (OCPSF);

- Inorganic Chemicals;

- Pharmaceuticals;

Table 5-2

WASTEWATER GENERATED IN 1986 FROM OTHER PESTICIDES WASTEWATER SOURCES

# Facilities		Average Wastewater Generated (gal/day)		Source
1986	Current[2]	1986	Current[2]	
67	56	3,070	2,300	Showers
21	19	1,210	1,330	Laundry
47	39	1,352	1,414	Safety Equipment
47	39	177,000	210,211	Contaminated Stormwater[1]

[1] The average daily contaminated stormwater flow per plant is presented here. See Table 5-1 for total contaminated stormwater flow.

[2] Seventy-five (75) of the 90 facilities in operation in 1986 are still currently in operation, and 15 of the 90 facilities have closed. The numbers in this column are based on the Facility Census responses from the 75 facilities still currently in operation.

- Other Manufacturing: including production of out-of-scope PAIs or wastewater from manufacturing operations not listed above; and

- Other Wastewater: including sources such as sanitary wastewater.

Table 5-3 presents the number of facilities co-treating wastewater from these operations along with the average percentage of the total flow co-treated for each wastewater source in 1986. This information is presented separately for all 90 pesticide manufacturers operating that were operating in 1986 and for the 75 of the 90 manufacturers that are still currently in operation. For example, 19 of the current 75 PAI manufacturers reported that, in 1986, they co-treated PFP wastewaters with pesticide manufacturing wastewaters.

OCPSF operations contributed the largest percentage of the co-treated wastewater, and the largest number of facilities. On average, 50% of the total wastewater volume from treatment systems that co-treat pesticide and OCPSF manufacturing wastewaters is due to OCPSF processes, and 32 of the current 75 PAI manufacturers reported co-treating pesticide and OCPSF manufacturing wastewaters in 1986. In contrast, only 4% of the total wastewater volume from treatment systems that co-treat pesticide manufacturing and PFP wastewaters is due to PFP processes. Other facility wastewater, such as sanitary wastewater, was commingled with pesticide wastewater at 27 of the 90 facilities operating in 1986; 23 of these 27 facilities are still currently in operation.

5.2 WASTEWATER VOLUME BY DISCHARGE MODE

5.2.1 Definitions

Direct discharge refers to the discharge of a pollutant or pollutants directly to waters of the United States (not to a publicly owned treatment works). Facilities that directly discharge wastewaters do so under the National Pollutant Discharge Elimination System (NPDES) permit program.

Indirect discharge refers to the discharge of pollutants indirectly to waters of the United States, through publicly owned treatment works (POTWs).

No discharge refers to facilities that do not discharge their wastewaters to waters of the United States, as a result of either reuse of process water back into the product, no water use, recycle off-site or within the plant in other manufacturing processes, or disposal off-site or on-site that does not result in a discharge to waters of the United States.

Table 5-3

OTHER FACILITY WASTEWATER GENERATED IN 1986 FROM SOURCES OTHER THAN PESTICIDE PRODUCTION AND CO-TREATED WITH PESTICIDE WASTEWATER

Source	# Facilities[1]		Average % of Total Flow Co-Treated	
	1986	Current[2]	1986	Current[2]
Pesticide Formulating/ Packaging	19	19	4	4
Organic Chemicals, Plastics, and Synthetic Fibers	39	32	50	48
Inorganic Chemicals	14	12	23	18
Pharmaceuticals	9	8	28	21
Other Manufacturing Wastewater	17	13	28	32
Other Wastewater[3]	27	23	34	39

[1] A facility is double counted if it co-treated more than one source of water with pesticide manufacturing wastewater.

[2] Seventy-five (75) of the 90 facilities in operation in 1986 are still currently in operation, and 15 of the 90 facilities have closed. The numbers in this column are based on the Facility Census responses from the 75 facilities still currently in operation.

[3] Other wastewater includes, for example, sanitary water.

5.2.2 Discharge Status of Pesticide Manufacturing Facilities

Twenty-eight (28) of the 75 current manufacturing facilities are direct dischargers and 28 are indirect dischargers. One facility discharges wastewater both directly and indirectly; therefore, there are 55 current dischargers. Of the remaining 20 facilities, 13 facilities dispose of their wastewater by on- or off-site deep well injection, incineration, or evaporation and 7 facilities generated no process wastewater by recycle/reuse or no water use.

5.2.3 Flow Rates by Discharge Status

The total amount of process wastewater generated in 1986 by pesticide manufacturing facilities was 1.45 billion gallons, and approximately 1.30 billion gallons were discharged either directly or indirectly to surface waters of the United States. The 75 current pesticide manufacturers generated approximately 1.36 billion of the 1.45 billon gallons of total wastewater generated in 1986. These 75 facilities discharged, either directly or indirectly, 1.22 billion of the 1.30 billion gallons of wastewater that was discharged by all pesticide manufacturers in 1986.

In 1986, about 83% of all process wastewater generated by the 75 current pesticide manufacturers was discharged directly (1.134 billion gallons), while 6% was discharged indirectly (0.087 billion gallons). Similarly, about 82% of the total wastewater volume generated by all 90 facilities operating in 1986 was discharged directly and 8% was discharged indirectly. Most of the wastewater not discharged in 1986 was disposed of by deep well injection (DWI). Table 5-4 presents the volumes of pesticide process wastewater discharged or disposed in 1986, for both the 90 manufacturers operating in 1986 and the 75 manufacturers still currently in operation.

Table 5-5 summarizes process wastewater flows by discharge status for organic pesticide chemicals manufacturing (Subcategory A) and metallo-organic pesticide chemicals manufacturing (Subcategory B) facilities. Over 99% of the wastewater generated and discharged in the pesticide manufacturing industry is due to the manufacturing of Subcategory A PAIs. In 1986, the 75 current pesticide manufacturers generated 1.36 billion of the 1.44 billion gallons of Subcategory A wastewater, or about 94 percent. The 15 pesticide manufacturers that have closed since 1986 generated only 6% of the total Subcategory A wastewater. However, the 15 now-closed manufacturers were responsible for a significant portion of the Subcategory B wastewater that was discharged indirectly in 1986. These 15 facilities discharged 525,000 gallons of the 621,000 gallons of Subcategory B wastewater that was discharged indirectly in 1986.

Table 5-4

TOTAL PROCESS WASTEWATER FLOW IN 1986 BY TYPE OF DISCHARGE (Gallons per Year)

All Facilities Operating in 1986

Discharge Status	Number of Facilities	Percent of Facilities	Total Flow (gal)
Direct	32	36	1,179,246,000
Indirect	36	40	117,938,000
No Discharge[1]	23	26	148,370,000
TOTAL	**91[2]**	**102**	**1,445,554,000**

Facilities Still Currently in Operation[3]

Discharge Status	Number of Facilities	Percent of Facilities	Total Flow (gal)
Direct	28	37	1,133,784,000
Indirect	28	37	87,365,000
No Discharge[1]	20	26	142,197,000
TOTAL	**76[2]**	**100**	**1,363,346,000**

[1] "No discharge" facilities dispose of their wastewater through deep well injection (DWI), incineration (on or off-site), or evaporation. Although incineration was reported as a "no discharge" technology, there is a potential for a residual discharge of scrubber blowdown water. Incineration was not considered to be a fully zero-discharge technology for purposes of setting the final limitations.

[2] The number of facilities is greater than 90 and greater than 75 and the percent is greater than 100 due to one facility that discharges both directly and indirectly.

[3] Seventy-five (75) of the 90 facilities in operation in 1986 are still currently in operation. The numbers in this column are based on the Facility Census responses from the 75 facilities still currently in operation.

Table 5-5

PESTICIDE PROCESS WASTEWATER FLOW IN 1986 FOR THE ORGANIC PESTICIDE SUBCATEGORY (SUBCATEGORY A) AND THE METALLO-ORGANIC PESTICIDE SUBCATEGORY (SUBCATEGORY B)

All Facilities Operating in 1986

Discharge Status	Total Subcategory A Flow (gal)	Total Subcategory B Flow (gal)
Direct	1,179,246,000	0
Indirect	117,317,000	621,000
No Discharge[1]	146,318,000	2,052,000
TOTAL	**1,442,881,000**	**2,673,000**

Facilities Still Currently in Operation[2]

Discharge Status	Total Subcategory A Flow (gal)	Total Subcategory B Flow (gal)
Direct	1,133,784,000	0
Indirect	87,269,000	96,000
No Discharge[1]	140,145,000	2,052,000
TOTAL	**1,361,198,000**	**2,148,000**

[1] "No discharge" facilities dispose of their wastewater through deep well injection (DWI), incineration (on or off-site), or evaporation. Although incineration was reported as a "no discharge" technology, there is a potential for a residual discharge of scrubber blowdown water. Incineration was not considered to be a fully zero-discharge technology for purposes of setting the final limitations.

[2] Seventy-five (75) of the 90 facilities in operation in 1986 are still currently in operation. The numbers in this column are based on the Facility Census responses from the 75 facilities still currently in operation.

5.3 RAW WASTEWATER DATA COLLECTION

Section 3.1 of this document introduced the many wastewater data collection efforts undertaken for development of these regulations. Studies that produced data on raw wastewater characteristics include industry-supplied self-monitoring data submitted as a follow-up to the Facility Census, data obtained from EPA sampling at pesticide manufacturing facilities, and self-monitoring data submitted after the proposal for new or improved treatment systems. Results of these data gathering efforts are described in more detail below.

5.3.1 Industry-Supplied Self-Monitoring Data

As part of the Facility Census, EPA requested that pesticide manufacturing facilities submit any available wastewater monitoring data and requested that these data be submitted as individual data points (as opposed to monthly averages, for example). In response, facilities submitted monitoring data for conventional and priority pollutants, as well as for PAIs and other non-conventional pollutants, such as COD. However, these monitoring data usually represented pollutant concentrations in end-of-pipe wastewater streams. Therefore, EPA made additional requests for data from sampling locations that would characterize pesticide process wastewater discharges prior to commingling with wastewaters from other industrial sources. Many facilities were able to provide these types of monitoring data for raw pesticide process wastewaters and also for sampling locations that allowed EPA to evaluate certain treatment technologies.

In comments to the proposed regulations, some facilities submitted new or additional self-monitoring data. These data are generally PAI concentrations in effluents from new or improved treatment systems, and do not provide additional information on raw wastewater characterization. However, the PAI self-monitoring data submitted before and after proposal are often quite detailed and were useful in developing the final PAI limitations and standards. Self-monitoring data submitted by 27 facilities for 55 PAIs were of sufficient quality to develop effluent limitations and standards as part of the final rule. Development of the final limitations are discussed in more detail in Section 7.

Priority pollutant data submitted by facilities were not quite as useful as the PAI data. In most cases, these priority pollutant data were collected at sampling locations representing commingled wastewaters. For this reason, it was difficult to attribute many of these pollutants to the pesticide processes. In some cases, however, facilities had analyzed raw pesticide process wastewaters for priority pollutants. These data usually matched well with the facility's indication in the Facility Census that the pollutant was known or believed present in their pesticide process wastewaters. Although quantitative priority pollutant data were supplied by 43 facilities for a total of 49 priority pollutants, only 11 facilities reported these concentration data for raw pesticide process wastewaters.

The conventional and non-conventional (other than the PAIs) pollutant data were submitted for both in-plant and end-of-pipe sampling locations. At sampling points following commingling of other industry-related wastewaters, it was not possible to attribute these pollutants solely to the pesticide processes. These data were useful, however, in evaluating the overall performance of the end-of-pipe BPT treatment systems.

5.3.2 EPA Pesticide Manufacturers Sampling Program

As described above in Section 5.3.1, the wastewater self-monitoring data submitted as a follow-up to the Facility Census were the result of sampling and analyses conducted by individual plants and their laboratories. To expand and augment these wastewater characterization data, EPA conducted sampling episodes at 23 pesticide manufacturing facilities between 1988 and 1990. Through this sampling effort, EPA verified the presence of many of the priority pollutants that were indicated as known or believed present according to responses to the Facility Census. In addition, EPA verified the presence of certain priority pollutants that may not have been reported by the facilities, but were expected to be present based on EPA's process analysis.

The sampling episodes also allowed EPA to test analytical methods for the PAIs. Results of the PAI analyses obtained by EPA contract laboratories were compared with results obtained by the facilities' laboratories when the facilities chose to split samples with EPA. EPA also requested and reviewed information on the analytical methods typically used by the facilities to quantify the concentration of PAIs in their wastewaters.

Facilities were selected for sampling based on self-monitoring data which indicated that the wastewater treatment system was effective in removing PAIs, and the PAIs manufactured at the facility appeared to be representative of one or more PAI structural groups. During the sampling episodes, raw wastewaters from the manufacture of 38 different PAIs were characterized. In addition, EPA sampled at various locations throughout the treatment systems at these facilities to evaluate pollutant removal performance.

The EPA sampling episodes were usually three days in duration. Samples were collected to represent a "snapshot characterization" of the wastewater stream at each sampling point. Automatic sampling devices were used where possible to collect the daily composite samples. If an automatic sampler could not be used, discrete equal volume grab samples, or aliquots, were manually collected at equal time intervals and added to the compositing container (a specially clean 10-liter glass jar). At the end of each daily sampling period, each composite sample was poured into specially cleaned individual fraction containers for shipment to the EPA contract laboratories. These fractions included analyses for: Group I (BOD_5, TSS, total fluoride, and pH); Group II (TOC, COD, ammonia nitrogen, and nitrate and nitrite nitrogen); extractable (semi-volatile) organics; metals; and the pesticide active ingredient(s). The fractions for volatile organics, cyanide, and oil and grease analyses were not poured from the composite containers, but manually collected as individual grab samples during each daily sampling period.

After the individual sample fraction containers were filled each day, they were preserved according to EPA protocol. In addition, the samples were maintained at 4°C (using ice) during storage and shipment, with the exception of the metals fraction which does not need to be kept iced. The purpose of this procedure was to minimize any potential degradation reactions, including biological activity, that could occur in the samples prior to analysis. It was not necessary to follow this procedure for the metals fraction since these analyses are not specific to the compounds containing the metal analyte but rather are reported as total metals contained in the sample (such as total copper, total mercury, etc.).

5.4 WASTEWATER CHARACTERIZATION

The pesticide chemicals manufacturing industry generates process wastewaters containing a variety of pollutants. Most of this process wastewater receives some treatment, either in-plant at the process unit prior to commingling with other facility wastewaters or in the end-of-pipe wastewater treatment system. This section presents the Agency's database on the pollutant characterization of raw pesticide process wastewaters. This database was compiled from the data gathering efforts previously described in Section 5.3. Wastewater characterization data were used by EPA to evaluate which pollutants are present in industry wastewaters at significant levels that merit regulation and to determine which technologies are applicable for treatment of wastewaters containing these pollutants. Wastewater characterization is discussed separately below for conventional pollutants, priority pollutants, PAIs, and other non-conventional pollutants. Treatment technologies are discussed later in Section 7.

5.4.1 Conventional Pollutants

Conventional pollutants include:

- Biochemical Oxygen Demand (BOD_5);
- Total Suspended Solids (TSS);
- pH;
- Oil and Grease (O&G); and
- Fecal Coliform.

The most widely used measure of general organic pollution in wastewater is five-day biochemical oxygen demand (BOD_5). BOD_5 is the quantity of oxygen used in the aerobic stabilization of wastewater streams. This analytical determination involves the measurement of dissolved oxygen used by microorganisms to biodegrade organic matter and varies with the amount of biodegradable matter that can be assimilated by biological organisms under aerobic conditions. The nature of specific chemicals discharged into wastewater affects the BOD_5 due to the differences in susceptibility of different molecular structures to microbiological degradation. Compounds with lower susceptibility to decomposition by microorganisms or that are more toxic to microorganisms tend to exhibit lower BOD_5 values, even though the total amount of organic pollutant may be much higher than compounds exhibiting substantially higher BOD_5 values. Therefore, while BOD_5 is a useful gross measure of organic pollutant, it does not give a useful measure of specific pollutants, particularly priority pollutants and PAIs.

Total solids in wastewater is defined as the residue remaining upon evaporation at just above the boiling point. Total suspended solids (TSS) is the portion of the total solids that can be filtered out of solution using a 1 micron filter. Raw wastewater TSS content is a function of the active ingredients manufactured and their processes, as well as the manner in which fine solids may be removed during a processing step. It can also be a function of a number of other external factors, including storm water runoff, runoff from material storage areas, and landfill leachates that may be diverted to the wastewater treatment system. Solids are frequently washed into the plant sewer and removed at the wastewater treatment plant. The total solids are composed of matter which is settleable, in suspension, or in solution and can be organic, inorganic, or a mixture of both. Settleable portions of the suspended solids are usually removed in a primary clarifier. Finer materials are carried through the system, and in the case of an activated sludge system, become enmeshed with the biomass where they are then removed with the sludge during secondary clarification. Some manufacturing plants may show an increase in TSS in the effluent from the treatment plant. This characteristic is usually associated with biological systems and indicates an inefficiency of secondary clarification in removal of secondary solids. Treatment systems that include polishing ponds or lagoons may also exhibit this characteristic due to algae growth.

pH is a unitless measurement which represents the acidity or alkalinity of a wastewater stream (or any aqueous solution), based on the dissociation of the acid or base in the solution into hydrogen (H^+) or hydroxide (OH^-) ions, respectively.

Raw wastewater pH can be a function of the nature of the processes contributing to the waste stream. This parameter can vary widely from plant to plant and can also show extreme variations in a single plant's raw wastewater, depending on such factors as waste concentration and the portion of the process cycle discharging at the time of measurement. Fluctuations in pH are readily reduced by equalization followed by a neutralization system, if necessary. Control of pH is important regardless of the final disposition of the wastewater stream (e.g., indirect discharge to a POTW or direct discharge) to maintain favorable conditions for various treatment system unit operations, as well as receiving streams.

Raw wastewater oil and grease (O&G) is an important parameter in some wastewaters as it can interfere with the smooth operation of wastewater treatment plants and, if not removed prior to discharge, it can interfere with the biological life in receiving streams and/or create films along surface waters. However, oil and grease monitoring involves use of a solvent to extract oil and grease from the sample. This solvent usually also extracts organic materials other than petroleum oil, such as priority pollutants and the PAIs. None of the pesticide plants sampled or visited have any petroleum oil problems in wastewater; the oil and grease measurements reflect only gross levels of organics and are poor measures of priority pollutants and PAIs (because there are much more accurate pollutant-specific methods for these parameters). Therefore, oil and grease is not an important parameter in pesticide wastewaters.

The drinking water standard for microbial contamination is based on coliform bacteria. The presence of coliform bacteria in wastewater, a microorganism that resides in the human intestinal tract, indicates that the wastewater has been contaminated with feces from humans or other warm-blooded animals. The promulgated BPT limitations do not include a limit for coliform bacteria, because very few pesticide manufacturing plants directly discharge sanitary wastewater, and because coliform bacteria is not expected to be present in the PAI contaminated wastewater streams generated by pesticide manufacturing facilities. EPA did not pursue any further data collection efforts characterizing fecal coliform in pesticide manufacturing plants for this regulation.

Self-monitoring data submitted by pesticide manufacturers included substantial amounts of conventional pollutant analytical results. The data indicate that conventional pollutant levels are widely scattered for in-plant process streams. Analytical data developed through EPA's sampling program show the same results. However, industry data for end-of-pipe sampling locations show that wastewater treatment systems are reducing conventional pollutant concentrations to levels consistent with the long term average BPT concentrations.

The industry-submitted BOD_5 data characterizing end-of-pipe discharges are summarized in Figure 5-2. The figure displays the number of BOD_5 results reported in ranges of 100 mg/L (i.e., 0-100 mg/L, 100-200 mg/L, etc.) and compares these self-monitoring data to the BPT long term average concentration of 24 mg/L. Figure 5-2 shows that BOD_5 concentrations in end-of-pipe discharges are typically in the 0-100 mg/L range, which is consistent with the BPT long term average concentration. The industry-submitted TSS data characterizing end-of-pipe discharge are summarized in Figure 5-3, along with the BPT long term average concentration of 28 mg/L. Similar to BOD_5, the table shows that TSS concentrations in end-of-pipe discharges are typically in the 0-100 mg/L concentration range, which is consistent with the BPT long term average concentration for TSS (28 mg/L). The industry-submitted pH data characterizing end-of-pipe discharges are summarized in Figure 5-4. BPT limitations require pesticide manufacturers to maintain the pH of their effluent discharges between 6 and 9. Figure 5-4 shows that the majority of the reported results are within this pH range.

Figure 5-2

INDUSTRY SELF-MONITORING BOD LEVELS IN FINAL EFFLUENT DISCHARGE

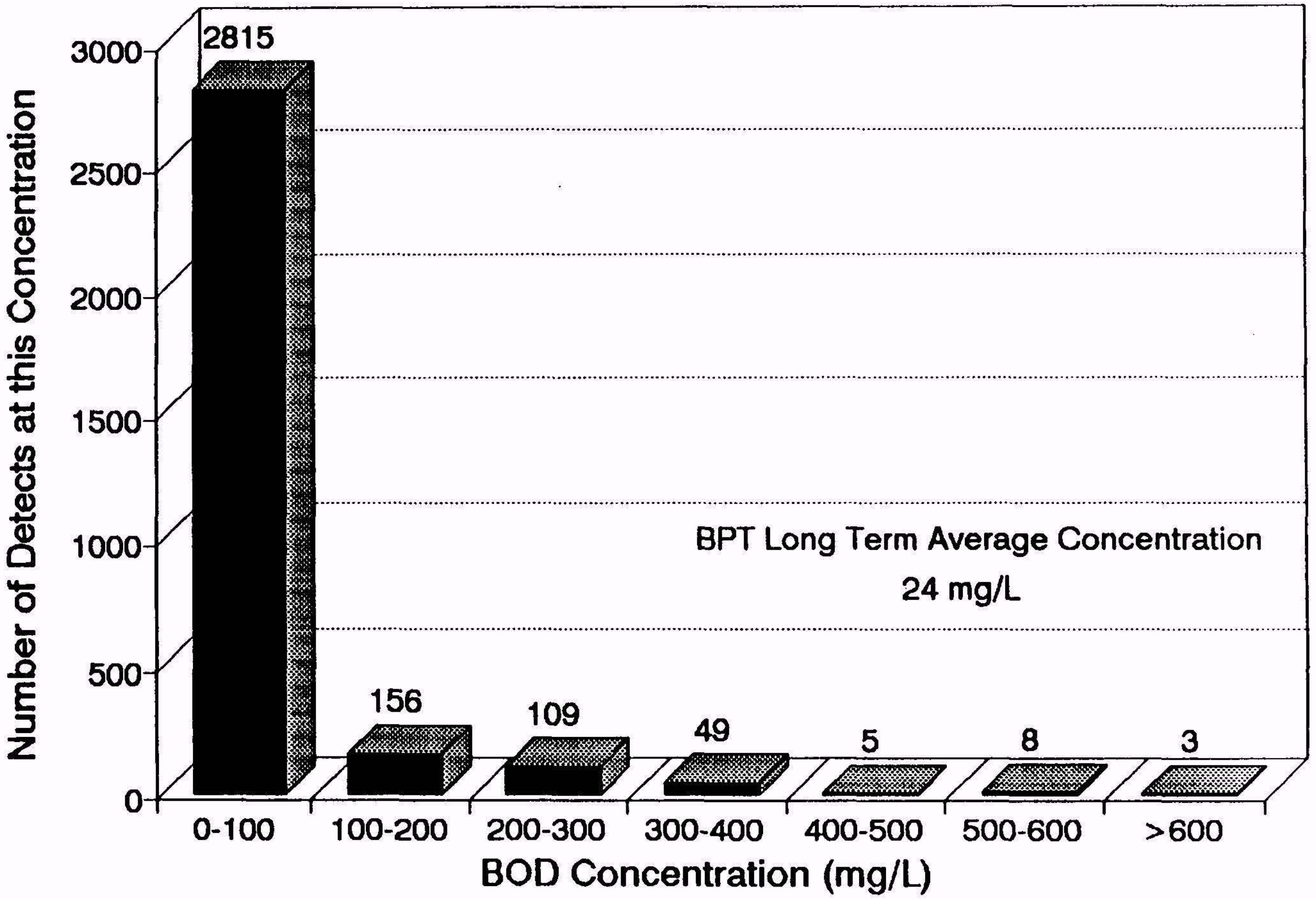


Figure 5-3

INDUSTRY SELF-MONITORING TSS LEVELS IN FINAL DISCHARGE

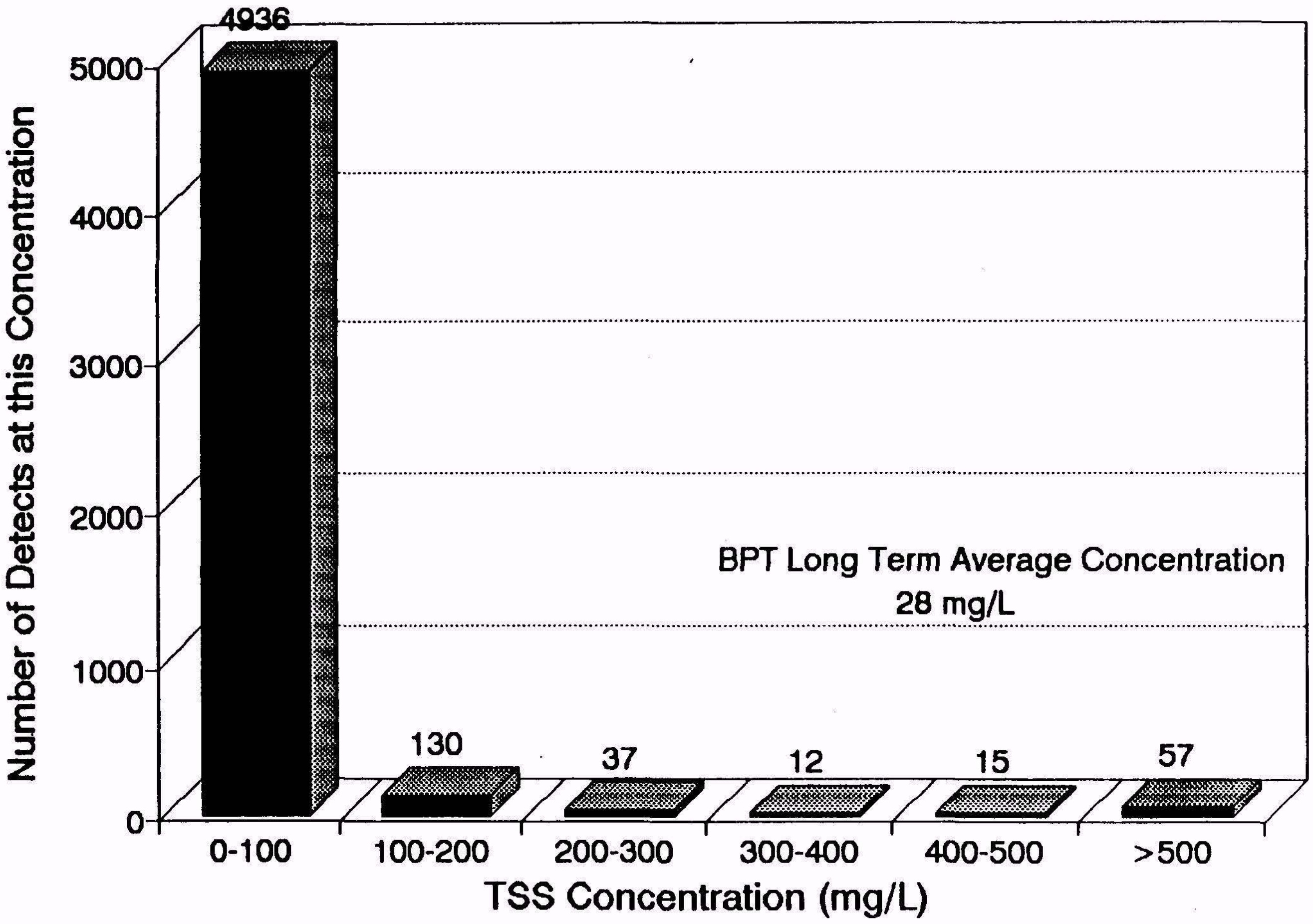
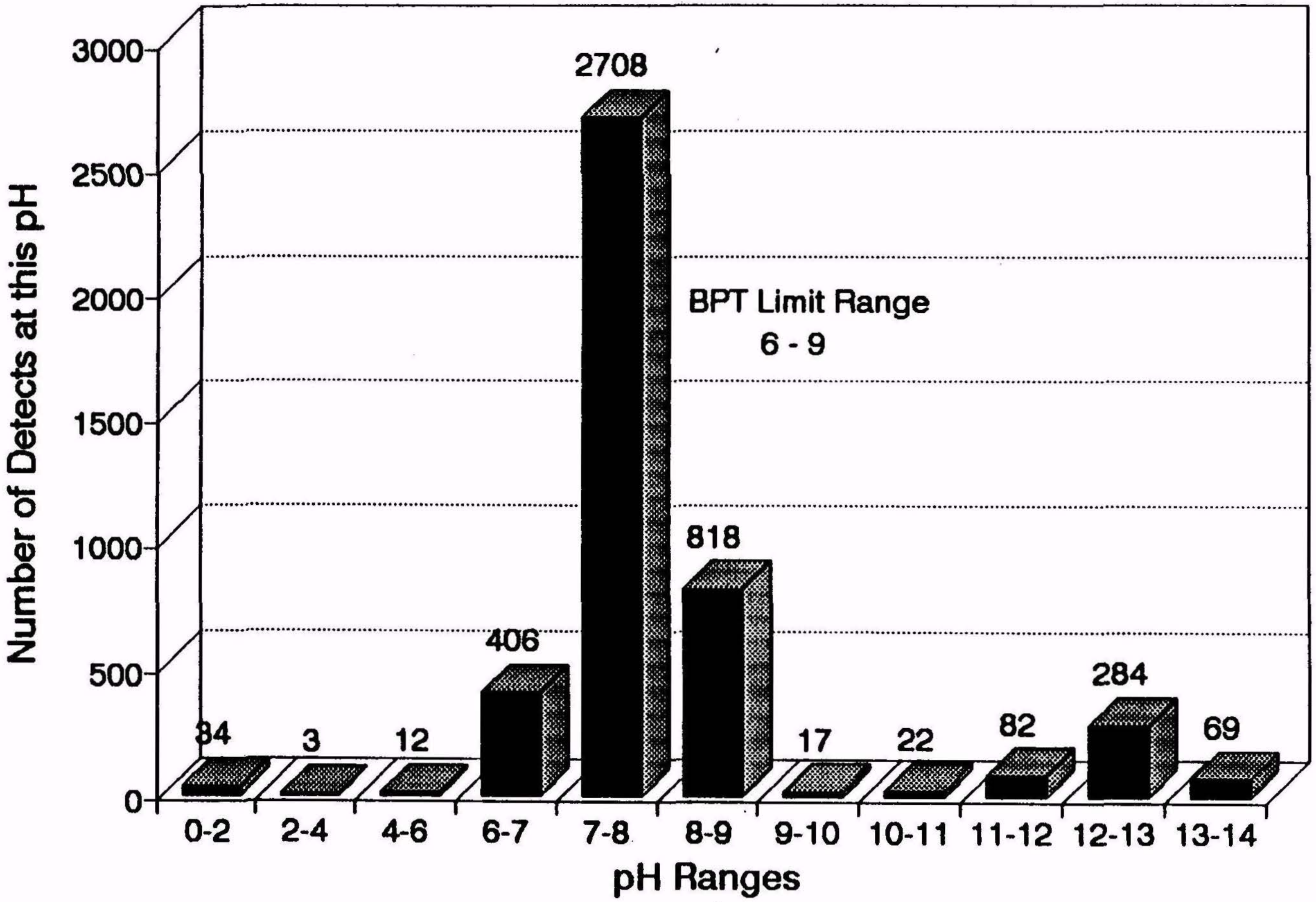


Figure 5-4

INDUSTRY SELF-MONITORING pH LEVELS IN FINAL DISCHARGE



5.4.2 Priority Pollutants

Data characterizing pesticide process wastewaters with respect to priority pollutants have been gathered by EPA qualitatively from industry responses to the Facility Census and quantitatively from industry supplied self-monitoring data and EPA sampling episodes. In addition, the EPA Toxic Release Inventory System (TRIS) was used to confirm the presence of priority pollutants in pesticide process wastewaters at some facilities. Due to the aggregated nature of the reporting in TRIS, however, it was not useful for quantifying priority pollutant discharges in pesticide process wastewaters. Many of the plants with priority pollutant emissions exceeding the TRIS reporting thresholds manufacture pesticide and non-pesticide chemicals. For this reason, these priority pollutant emissions could not be attributed solely to the pesticide processes.

In the Facility Census, respondents were asked to identify all priority pollutants that were known or believed to be present in wastewaters from each pesticide manufacturing process or indicate if those priority pollutants were known to be absent. They were also asked to indicate the source of the priority pollutant (i.e., raw material, reaction by-product, solvent, catalyst, or contaminant). Priority pollutants were reported by 47 pesticide manufacturing facilities in their responses to the Facility Census. A total of 60 unique priority pollutants were known or believed present in wastewaters associated with the production of 83 PAIs at these 47 facilities. Twenty-two facilities reported that no priority pollutants would be expected in their pesticide manufacturing process wastewaters, and the other 21 facilities did not know whether priority pollutants would be present.

In addition to reporting priority pollutants in the Facility Census, some facilities also submitted priority pollutant data obtained during self-monitoring sampling. As discussed earlier in this section, most of these data were not generally useful since they represented end-of-pipe sampling locations at facilities that also manufacture non-pesticide chemicals. However, six facilities submitted priority pollutant concentrations for raw process wastewaters where multiple detections were reported. Table 5-6 summarizes the priority pollutant data submitted by these organic pesticide chemical (Subcategory A) manufacturing facilities (no Subcategory B facilities submitted priority pollutant data for raw process wastewaters). Table 5-6 shows the minimum and maximum concentrations reported for each priority pollutant as well as the total number of samples analyzed for each pollutant and the number of these samples with detectable concentrations. These data are aggregated for all facilities, so the maximum and minimum concentrations may represent samples collected at different facilities. Table 5-6 also shows whether or not at least one of the facilities submitting data for each priority pollutant had indicated in the Facility Census that the pollutant was known or believed present in their process wastewaters. Nine of the 12 priority pollutants shown in the table were reported as known or believed present in pesticide process wastewaters.

Table 5-6

PRIORITY POLLUTANT DATA-FACILITY SELF MONITORING

Pollutant	Number of Samples Analyzed	Number of Reported Detections	Reported Concentrations (μg/L)		Known or Believed Present
			Minimum	Maximum	
Tetrachloromethane	21	11	0.5	3,100	Known
Hexachloroethane	2	2	260	1,300	-
2,4,6-Trichlorophenol	10	10	590	15,700	Known
Chloroform	32	28	0.5	110,000	Known
2-Chlorophenol	12	12	7	24,320	Believed
2,4-Dichlorophenol	6	6	13,350	108,000	Known
2,4-Dimethylphenol	5	2	2,300	2,600	-
Methylene Chloride	30	24	0.5	7,400,000	Known
Chloromethane	8	4	3	50	Known
Phenol	5	4	100	690	_
Toluene	6	6	2,200	400,000	Known
Cyanide	235	235	180	7,625,000	Known

To verify the presence of priority pollutants reported as known or believed present by facilities and to augment the limited priority pollutant data submitted by facilities, EPA conducted sampling episodes at 23 pesticide manufacturing facilities. At three of the 23 facilities, sampling was conducted to collect wastewater for bench-scale studies. For the other 20 episodes, samples were collected for three days at locations throughout the wastewater generation, treatment, and discharge path. A report that there was a detection of a priority pollutant in at least two daily samples at the same location indicates high probability that the priority pollutant was in fact present. A reported detection of a priority pollutant in only one sample cast doubt on the presence of that pollutant. Where priority pollutants were reported detected in only one sample at any sample site, EPA used the following procedure to evaluate the report. First, EPA examined samples collected at other sites during the episode for reported detections for that same pollutant in pesticide manufacturing process wastewaters. Second, EPA examined the details of the production process to determine if the pollutant was a raw material, by-product, or a likely contaminant of any raw materials or solvents used in the process. Finally, EPA contacted knowledgeable plant personnel to determine if the pollutant was a known or likely contaminant, and to determine if the plant had also detected the pollutant during sampling; particularly if the pollutant was detected during sampling conducted the same day EPA sampled and if the sample was analyzed by the plant using the same or a similar analytical method as EPA.

Seventy (70) priority pollutants were detected in pesticide manufacturing wastewaters during EPA sampling at the 20 facilities. However, in many cases, the priority pollutants were detected in only one sample at one sample site, and the presence of the pollutants could not be confirmed after checking all the sources described above. EPA's conclusion in these cases, where detections could not be confirmed, is that the reported results are incorrect and the pollutant is not in fact present. In addition, some of the pollutants that were detected at the same sample point on multiple days were present in only trace amounts and often very close to the analytical detection limit.

Table 5-7 presents priority pollutant characterization data for raw process wastewaters based on EPA sampling at organic pesticide chemicals (Subcategory A) manufacturing facilities. The table shows the minimum and maximum concentrations detected for each priority pollutant that was confirmed present during the sampling episodes. These data are aggregated to include all sampling episodes, and, therefore, the minimum and maximum concentrations may have been reported for wastewater samples collected at different facilities. Table 5-7 also shows whether or not at least one of the facilities where each priority pollutant was confirmed present either knew or believed that the priority pollutant was present in their wastewaters. Of the 27 priority pollutants shown in the table, 15 (~55%) were reported as either known or believed present according to Facility Census responses from the sampled facilities.

Table 5-7

PRIORITY POLLUTANT DATA - EPA SAMPLING ORGANIC PESTICIDE CHEMICALS MANUFACTURING

Pollutant	Concentration (μg/L) Minimum	Concentration (μg/L) Maximum	Known or Believed Present
Benzene	16	31,000	Believed
Tetrachloromethane	892	44,260	Known
Chlorobenzene	38	113	---
1,2-Dichloroethane	1,007	3,255,900	Known
1,1,1-Trichloroethane	30	60	---
Hexachloroethane	34	5,346	---
Chloroform	12	20,110	Known
2-Chlorophenol	40	8,264	Believed
1,2-Dichlorobenzene	70	14,202	---
1,4-Dichlorobenzene	84	554	---
1,1-Dichloroethene	133	261	---
Trans-1,2-Dichloroethene	16	18	---
2,4-Dichlorophenol	11,890	360,940	Believed
Ethylbenzene	71	9,550	Known
Methylene Chloride	14	11,261,100	Known
Chloromethane	55	111	---
Tribromomethane	93	42,679	Known
Bromodichloromethane	22	29,370	Known
Dibromochloromethane	21	39,434	Known
Naphthalene	27	1,197	---
Nitrobenzene	32	44	---
Phenol	25	97,794	Believed
Tetrachloroethene	51	402,655	Believed
Toluene	27	331,649	Known

Table 5-7

(Continued)

Pollutant	Concentration (μg/L)		Known or Believed Present
	Minimum	Maximum	
Trichloroethene	19	38	---
Cyanide	50	2,740,000	Known
Lead	930	1,600	---

As discussed in Section 6, not all of the priority pollutants in Table 5-7 are regulated in the final rule. Three pollutants shown in the table -- hexachloroethane, nitrobenzene, and trichloroethene -- are excluded from regulation because they are either cotreated with regulated pollutants or unique to a small number of sources. Also, four regulated pollutants -- 1,2-dichloropropane, 1,3-dichloropropene, bromomethane, and 2,4-dimethylphenol -- are not shown in Table 5-7. One of the pollutants, 2,4-dimethylphenol, was reported in industry self-monitoring samples (see Table 5-6), and the other three pollutants are manufactured for use as PAIs and were all reported as known to be present in pesticide process wastewaters.

EPA also collected samples at three metallo-organic pesticide manufacturing (Subcategory B) facilities. Two of the plants were indirect dischargers and one plant was a "direct" discharger subject to the zero discharge BPT regulation. The direct discharger achieves compliance by off-site disposal. Two plants (one the direct discharger) also manufacture organic PAIs. During two of the sampling episodes (one the direct discharger), however, only one sample of raw process wastewater could be collected at each facility. In all three episodes, the specific metal used in the production of the metallo-organic pesticide (e.g., copper in organo-copper pesticides) was detected in the raw wastewaters. The detected concentrations were also much greater than the concentrations expected in wastewaters due to equipment corrosion. Some organic priority pollutants were also reported, and some of these were expected to be present due to solvent or raw material use in the pesticide process. However, as mentioned above, in two sampling episodes only one sample each was collected, and, therefore, there is some doubt as to whether other priority pollutants that were reported are actually present. Both of the indirect dischargers sampled have ceased manufacturing pesticides.

The priority pollutant characterization data presented in this section for organic and metallo-organic pesticide process wastewaters were used by EPA to evaluate which priority pollutants to regulate. The decision to regulate was not based solely on whether a priority pollutant was verified present during sampling; EPA evaluated a number of other factors as well, such as whether the pollutant was present in more than trace amounts. However, most of the priority pollutants shown in Table 5-7 are being regulated as discussed in Section 6.

5.4.3 Pesticide Active Ingredients

Raw wastewater data for PAIs are available from both industry self-monitoring and EPA sampling. The industry self-monitoring data as EPA sampling data submitted both before and after proposal were not quite as useful for quantifying PAI concentrations in raw wastewaters because the sampling locations often represented commingled or partially treated wastewaters. Unlike priority pollutants, however, PAIs detected in commingled wastewaters can be attributed to the pesticide processes since PAIs should not be present in wastewaters generated by non-pesticide processes. The facility self-monitoring data did confirm that when wastewaters are generated during the production of a specific PAI, that PAI is usually present in those wastewaters. Fifteen (15) facilities submitted PAI data for raw and partially treated wastewaters associated with 29 unique PAIs manufactured in 1986. A total of 5,153 samples were analyzed by the 15 facilities, and PAIs were reported in concentrations above the detection limits for 4,756 of these samples, or about 92% of the samples. In many cases, the PAI was reported above the detection limit in every sample that was analyzed.

EPA sampling also confirmed the presence of PAIs in raw process wastewaters. EPA conducted three-day sampling episodes at 20 pesticide manufacturing facilities, and these sampling episodes were used to characterize pesticide process wastewaters from 38 different PAI processes, as well as to evaluate analytical methods for the PAIs. Detections were reported for 34 of the 38 PAIs in samples of the raw process wastewaters; that is, about 90% of the PAI processes sampled generated wastewaters containing the PAI at concentrations above the analytical detection limit. Specific results obtained during EPA sampling of raw process wastewaters are not presented in this document due to confidentiality concerns - in many cases, presenting results for specific PAIs would identify where EPA conducted the sampling episodes.

5.4.4 Non-conventional Pollutants (other than Pesticide Active Ingredients)

Non-conventional pollutants (other than PAIs) and pollutant parameters include chemical oxygen demand (COD), total organic carbon (TOC), and non-priority organic pollutants (and any other non-priority, non-conventional pollutants). COD is a measure of the pollutants in a wastewater stream that can be oxidized by subjecting the waste to a powerful chemical oxidizing agent (such as potassium dichromate) in an acidic medium. Therefore, the COD test can show the presence of organic materials that are not readily susceptible to attack by biological microorganisms. As a result of this difference, COD values are almost invariably higher than BOD_5 values for the same sample. The COD test cannot be substituted directly for the BOD_5 test because the COD/BOD_5 ratio is a factor that is extremely variable and is dependent on the specific chemical constituents in the wastewater. However, a COD/BOD_5 ratio for the wastewater from a single manufacturing facility with a constant product mix or from a single manufacturing process may be established. This ratio is applicable only to the wastewater from which it was derived and cannot be utilized to estimate the BOD_5 of another facility's wastewater. It is often established by facility personnel to monitor process and treatment plant performance with a minimum of analytical delay. As production rate and product mix changes, however, the COD/BOD_5 ratio must be reevaluated for the new conditions. Even if there are no changes in production, the ratio should be reconfirmed periodically.

TOC measurement is another means of determining the pollution potential of wastewater. This measurement shows the presence of organic matter in wastewater and is especially applicable to small concentrations. Certain organic compounds may be resistent to oxidation and the measured TOC value will be less than the actual amount. The promulgated BPT limitations do not include a limit for TOC. TOC is a parameter which is controlled under the BOD_5 and COD regulations. In addition, the most highly toxic TOC constituents will be organic PAIs and priority pollutants, which will be individually regulated.

EPA's sampling data collection efforts included analyses for non-priority organic and metal pollutants. The metals found most frequently in pesticide manufacturing plant wastewater include sodium, iron, barium, calcium, manganese, potassium, iodine, and strontium. Other inorganic, non-priority pollutants frequently detected include phosphorus, silicon, and sulfur. Non-priority organic pollutants detected in more than 10% of the samples collected include 2-propanone, 2-butanone, 1,4-dioxane, and xylenes. However, many of the compounds discussed above were detected in commingled wastewaters and cannot be attributed to the PAI processes. Also, in many cases, these compounds were detected in trace amounts or are currently being controlled by treatment technologies in place at the facilities where they were detected.

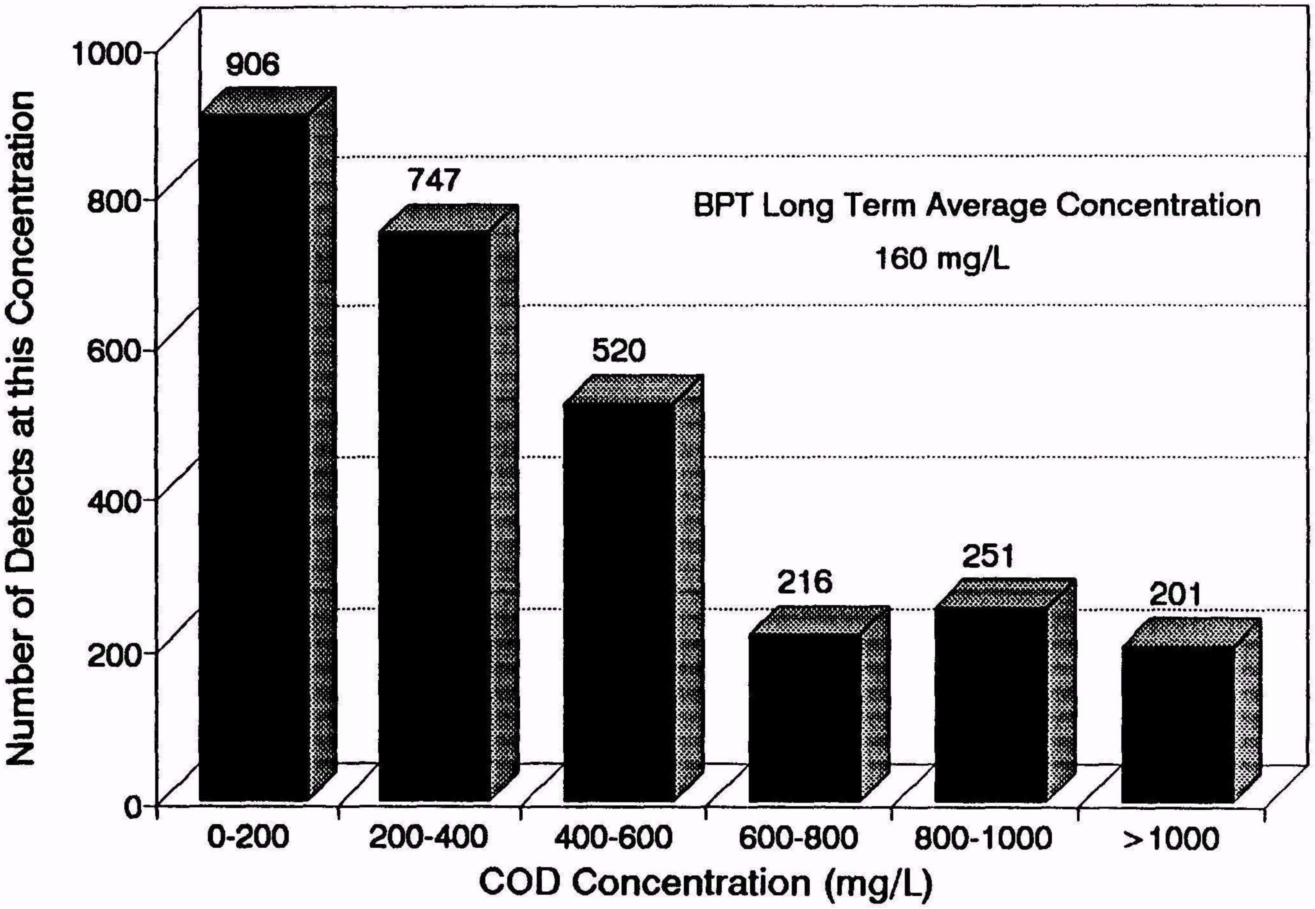
The only non-conventional pollutant regulated under BPT (aside from the PAIs) is COD. Self-monitoring data submitted by pesticide manufacturers included substantial amounts of COD analytical results, and these COD results are summarized in Figure 5-5. The figure shows the number of reported COD detections in concentration ranges of 200 mg/L (i.e., 0-200 mg/L, 200-400 mg/L, etc.) and compares the reported detections with the long term average BPT concentration (160 mg/L) for pesticide manufacturing facilities.

5.5 WASTEWATER POLLUTANT DISCHARGES

The concentration data discussed above were used by the Agency to estimate pollutant loadings discharged by pesticide chemicals manufacturing facilities. In estimating these wastewater pollutant discharges, EPA accounted for in-plant and end-of-pipe treatment currently in-place at each facility. The Agency's estimates for annual discharges of conventional pollutants, priority pollutants, and non-conventional pollutants (including the PAIs) are discussed below. The performance of the treatment technologies in-place at pesticide manufacturing facilities is discussed later in Section 7. The costs to upgrade current facility treatment systems to comply with the proposed regulations are discussed in Section 8. EPA estimates that approximately 2.7 million pounds per year of the conventional pollutants BOD_5 and TSS and 7.2 million pounds per year of the non-conventional pollutant COD are discharged directly by organic pesticide chemical manufacturing facilities. Because the BOD_5 and TSS discharged by this industry are compatible with POTWs, these parameters are not currently monitored by any of the indirect dischargers that manufacture metallo-organic pesticides. Therefore, EPA cannot estimate the quantity of BOD_5 or TSS discharged to POTWs by these facilities; these facilities also do not monitor for COD. There are no facilities that discharge process wastewater resulting from the manufacture of organo-arsenic, organo-copper, or organo-mercury PAIs directly to receiving streams.

Figure 5-5

INDUSTRY SELF-MONITORING COD LEVELS IN FINAL DISCHARGE



The pesticide chemicals industry manufactures large volumes of PAIs, and the use of contact process water, as well as the collection of spills, leaks, and rainwater results in significant discharges of organic PAIs and priority pollutants from this industry. At proposal, EPA estimated that approximately 310,00 pounds per year (lb/yr) of PAIs and 46,000 lb/yr of priority pollutants were being discharged (direct plus indirect discharges) by Subcategory A plants after in-place treatment. Since proposal, EPA has learned of 15 plant closures, and some facilities reported that they have upgraded existing treatment systems or installed new treatment systems. Taking these changes into account, EPA estimates that current PAI discharges total 204,000 lb/yr and priority pollutant discharges total 38,000 lb/yr. In addition, it is estimated that about 6 million pounds per year of volatile organic priority pollutants are present in PAI wastewaters with considerable potential for volatilization to the atmosphere. The incremental PAI and priority pollutant removals achieved by the final rule are discussed in Sections 10 and 12 of this technical development document.

SECTION 6

POLLUTANT PARAMETERS SELECTED FOR REGULATION

6.0 INTRODUCTION

As discussed in Section 5, EPA evaluated all available wastewater characterization data to determine the presence or absence of conventional, non-conventional (including the PAIs), and priority pollutants in pesticide process wastewaters. Using this information, EPA selected specific pollutants for regulation. This section presents the criteria used in the selection process and identifies those pollutants regulated under BPT, BAT, PSES, NSPS, and PSNS for the organic pesticides chemicals manufacturing subcategory (Subcategory A). No new limitations and standards are being promulgated for the metallo-organic pesticide chemicals manufacturing subcategory (Subcategory B), and, therefore, Subcategory B is not discussed in this section. Section 14 presents the Agency's decisions for Subcategory B.

6.1 CONVENTIONAL POLLUTANT PARAMETERS

Conventional pollutants include BOD_5, TSS, fecal coliform, pH, and oil and grease. These pollutants are general indicators of water quality rather than specific compounds. Current BPT for the organic pesticide chemicals manufacturing subcategory regulates the pH and the quantity of BOD_5 and TSS discharged in process wastewaters; except for the wastewater discharges from 25 specifically excluded organic PAIs and classes of PAIs. These 25 specific PAIs and classes of PAIs were specifically excluded due to a lack of treatment data available in 1978. Since then, the Agency has collected data on 14 organic PAIs within the group of 25 PAIs and classes of PAIs, and BPT is amended to include these PAIs. These 14 PAIs are presented below.

Ametryn
Prometon
Prometryn
Terbutryn
Cyanazine
Atrazine
Propazine
Simazine
Terbuthylazine
Glyphosate
Phenylphenol
Hexazinone
Sodium Phenylphenate
Methoprene

EPA has also developed analytical methods and collected effluent data to support BPT coverage of organo-tin pesticides. Therefore, EPA is extending the applicability of BPT to cover BOD_5, TSS and pH discharges from the manufacture of these 14 previously excluded organic PAIs and classes of PAIs and the organo-tin pesticides. For the reasons explained in Section 7, the COD limitations apply to discharges from the manufacture of Phenylphenol, Sodium Phenylphenate, Methoprene and the organo-tin pesticides, but not to discharges from manufacture of the other 11 PAIs in the above list.

Although EPA is amending the applicability of BPT to cover previously excluded PAIs and classes of PAIs, no additional conventional pollutants are being selected for regulation. Limitations are not being established for oil and grease and fecal coliform. Oil and grease measurements in this industry are not related to petroleum oil. The analytical method includes in the oil and grease measurement organic compounds such as the priority pollutants and the PAIs, which are being regulated separately under this proposed rulemaking. Also, fecal coliform is not expected to be present at significant concentrations in pesticide process wastewaters. For these reasons, oil and grease and fecal coliform are not being selected for regulation.

6.2 PRIORITY POLLUTANTS

Prior to this rulemaking, there were no effluent guideline regulations covering the discharge of individual priority pollutants in wastewaters generated during organic pesticide chemicals manufacturing, with the exception of those priority pollutants regulated as PAIs under 40 CFR 455.20(b). Priority pollutants are indirectly covered under 40 CFR 455.32 for the metallo-organic pesticides subcategory since BPT requires no discharge of process wastewater pollutants from facilities in this subcategory.

As discussed in Section 5, EPA sampling verified the known or believed presence of priority pollutants in many pesticide process wastewaters, and also verified the presence of certain priority pollutants that could be present due to the process chemistry. However, some priority pollutants reported as known or believed present by facilities were not confirmed during EPA sampling. In some cases, this was because EPA did not sample at the facility reporting the priority pollutant, and in other cases, the PAI process associated with the reported priority pollutant was not in operation during EPA sampling at that facility.

Three priority pollutants which were not confirmed during EPA or industry sampling, and therefore not shown on Table 5-6 or 5-7, are bromomethane, 1,2-dichloropropane, and 1,3-dichloropropene. However, the Agency believes these priority pollutants are present in pesticide process wastewaters. Bromomethane was reported as known to be present in wastewater at two facilities due to use as a raw material in these PAI processes and believed to be present at one other facility as a contaminant. One facility reported that 1,2-dichloropropane was known present in wastewaters as a waste product of the PAI process, and a separate facility believed this pollutant to be present as a contaminant. The third priority pollutant, 1,3-dichloropropene, is manufactured as a PAI and was also reported by one facility as believed to be present as a contaminant. Because these three priority pollutants are known or believed present in wastewaters at multiple facilities, the Agency is selecting them for regulation. Limits have also been developed for these pollutants under the OCPSF rulemaking, and, as will be discussed in Section 7, limits are being transferred to cover these three pollutants as well as the other priority pollutants discussed earlier in Section 5.

Not all of the priority pollutants shown in Tables 5-6 and 5-7 are being selected for regulation by the Agency. Some of those priority pollutants were detected in only trace amounts, will indirectly be controlled by the proposed PAI limitations, or were detected in only one or a very small number of wastewaters. After evaluating all of these factors, the Agency selected for regulation 26 organic priority pollutants, lead (non-complexed), and cyanide (non-complexed). The 28 priority pollutants selected for regulation are presented in Table 6-1. The development of limitations for these priority pollutants is discussed in Section 7.

Table 6-1

PRIORITY POLLUTANTS SELECTED FOR REGULATION

Pollutant Number	Pollutant
004	Benzene
006	Tetrachloromethane
007	Chlorobenzene
010	1,2-Dichloroethane
011	1,1,1-Trichloroethane
023	Chloroform
024	2-Chlorophenol
025	1,2-Dichlorobenzene
027	1,4-Dichlorobenzene
029	1,1-Dichloroethene
030	Trans-1,2-Dichloroethene
031	2,4-Dichlorophenol
032	1,2-Dichloropropane
033	1,2-Dichloropropene
034	2,4-Dimethylphenol
038	Ethylbenzene
044	Methylene Chloride
045	Chloromethane
046	Bromomethane
047	Tribromomethane
048	Bromodichloromethane
051	Dibromochloromethane
055	Naphthalene
065	Phenol
085	Tetrachloroethene
086	Toluene

Table 6-1

(Continued)

Pollutant Number	Pollutant
121	Cyanide
122	Lead

EPA is not selecting 95 priority pollutants for regulation, and the reason for excluding or not regulating each of these pollutants is discussed below.

- The pollutant has not been detected in the effluent with the use of analytical methods promulgated pursuant to Section 304(h) of the Act or other state-of-the-art methods.

Acrylonitrile	Chlordane
1,1,2-Trichloroethane	4,4'-DDT
2-Chloroethyl vinyl ether	4,4'-DDE
3,3'-Dichlorobenzidine	4,4'-DDD
2,6-Dinitrotoluene	alpha-Endosulfan
4,6-Dinitro-o-cresol	beta-Endosulfan
Bis (2-Chloroisopropyl) ether	Endosulfan sulfate
Bis (2-Chloroethoxy) methane	alpha-BHC
N-Nitrosodimethylamine	beta-BHC
N-Nitrosodiphenylamine	gamma-BHC
Pentachlorophenol	delta-BHC
Butyl benzyl phthalate	PCB-1242
Acenaphthalene	PCB-1254
Benzo (A) pyrene	PCB-1221
Benzo (GHI) perylene	PCB-1232
Dimethyl phthalate	PCB-1248
Dibenzo (A,H) anthracene	PCB-1260
Ideno (1,2,3-CD) pyrene	PCB-1016
Aldrin	2,3,7,8-Tetrachlorodibenzo-p-dioxin
Dieldrin	

- The pollutant is present only in trace amounts and is neither causing nor likely to cause toxic effects. In addition, the pollutant is present in amounts too small to be effectively reduced by technologies known to the Administrator.

2-Chloronaphthalene	Cadmium
1,3-Dichlorobenzene	Chromium
2,4-Dinitrotoluene	Copper
1,2-Diphenylhydrazine	Mercury
Bis (2-ethylhexyl) phthalate	Nickel
Di-n-butyl phthalate	Selenium
Diethyl phthalate	Silver
Antimony	Thallium
Arsenic	Zinc
Beryllium	1,1-Dichloroethane

- The pollutant is detectable in the effluent from only a small number of sources and the pollutant is uniquely related to only those sources.

Acenapthene	Nitrobenzene
Acrolein	2-Nitrophenol
Benzidene	2,4-Dinitrophenol
1,2,4-Trichlorobenzene	Di-n-octyl Phthalate
Hexachlorobenzene	Benzo (A) anthracene
1,1,2,2-Tetrachloroethane	Benzo fluoranthene
Chloroethane	Benzo (B) fluoranthene
Bis (2-Chloroethyl) ether	Chrysene
Parachlorometacresol	Anthracene
Fluoranthene	Fluorene
4-Chlorophenyl phenyl ether	Phenanthrene
4-Bromophenyl phenyl ether	Pyrene
Isophorone	Vinyl chloride

- The pollutant will be effectively controlled by the technologies which are the basis for controlling certain pesticide active ingredients in the effluent limitations guidelines and standards.

Hexachloroethane	
N-Nitrosodi-n-propylamine	
Endrin aldehyde	
Heptachlor epoxide	
1,1,2-Trichloroethylene	
2,4,6-Trichlorophenol	

- EPA is not regulating the following priority pollutants due to lack of treatability data. These priority pollutants were not detected during sampling but would be expected in wastewaters from the manufacture of certain pesticides. However, those pesticides were not in production when sampling activities were scheduled by EPA and may not be manufactured in the future.

Hexachlorobutadiene	
Hexachlorocyclopentadiene	
4-Nitrophenol	

- EPA is also not regulating <u>Asbestos</u> because there is no promulgated Section 304(h) analytical method for that pollutant in water.

6.3 NONCONVENTIONAL POLLUTANTS

Nonconventional pollutants selected for regulation by the Agency include certain PAIs and one other non-conventional pollutant, COD. Current BPT regulations limit the discharge of COD from both organic and metallo-organic pesticide manufacturing subcategories. The BPT numerical limitations for COD discharged by the organic pesticides manufacturers are not being amended although EPA is extending the applicability of BPT to cover COD resulting from the manufacture of 3 previously excluded organic PAIs (phenylphenol, sodium phenylphenate, and methoprene) and the organo-tin pesticides.

Under Subcategory A, 169 individual PAIs were manufactured in 1986; and 8 PAIs were manufactured from 1985-1989, but were not manufactured in 1986. Therefore, a total of 177 individual PAIs were considered for potential regulation. Of these, 120 individual PAIs were selected by the Agency for regulation under either BAT, NSPS, PSES, or PSNS. EPA is not promulgating regulations for 57 individual PAIs. Of the 57 PAIs, all production ceased for 12 PAIs before the Agency could gather data. Analytical methods are unavailable for 14 other PAIs, so the Agency could not gather data. All wastewaters for 14 other PAIs are currently disposed of in deep wells subject to regulation under EPA's Underground Injection Control (UIC) program. EPA decided to develop data and regulations for PAIs with actual discharges to surface waters. For the remaining 17 PAIs, insufficient data exist on their treatability. Either the plants do not monitor for the PAI or the available data are inadequate to demonstrate that the technology in use is the best available technology. In addition, the available bench-scale treatability data are inadequate to demonstrate what technology would be effective and there are no structurally similar PAIs with treatment data which could be transferred. Available toxicity data indicates that these 17 PAIs are less toxic than most of the 120 PAIs for which PAI effluent limitations are proposed.

SECTION 7

TECHNOLOGY SELECTION AND LIMITS DEVELOPMENT

7.0 INTRODUCTION

This section describes the wastewater treatment technologies currently used to reduce or remove conventional pollutants, PAIs and other non-conventional pollutants, and priority pollutants in process wastewaters discharged by pesticide chemicals manufacturing facilities. A summary of the treatment performance achievable by different technologies is presented based on industry submissions and treatability test results. This section also discusses the development of effluent limitations guidelines and standards for PAIs and priority pollutants and identifies how the pollution prevention and recycling practices currently being employed in the industry are incorporated into the final PAI limitations.

Section 7.1 presents a discussion of the pollution prevention and recycle/reuse practices identified in the pesticide chemicals manufacturing industry. This section identifies current pollution prevention and recycling practices for wastewater and non-wastewater streams and discusses how these current practices are incorporated into the final rule.

Section 7.2 presents a summary of the treatment performance databases available to EPA on wastewater control. EPA has compiled three databases; one from industry-submitted data, one from wastewater sampling conducted by EPA, and a third from treatability studies conducted on actual facility wastewaters or synthetic wastewaters containing PAIs.

Section 7.3 presents a description of the in-plant and end-of-pipe technologies used in the pesticide chemicals manufacturing industry to treat wastewaters containing conventional pollutants, PAIs and other non-conventional pollutants, and priority pollutants. This section also discusses the disposal of solid residues that are generated during wastewater treatment.

Section 7.4 presents treatment performance data for BAT technologies and Section 7.5 presents the methodologies used to develop the effluent limitations and standards for the Subcategory A facilities in the pesticide chemicals manufacturing industry. Section 7.5 also presents those cases where limitations require no discharge of process wastewater pollutants and discusses options available for compliance with the zero-discharge standards. Considerations related to the effluent limitations guidelines and standards for Subcategory B PAIs are discussed in Section 14.

7.1 POLLUTION PREVENTION AND RECYCLING PRACTICES

This section addresses how pollution prevention and recycling practices are used in the pesticide chemicals manufacturing industry, and specifically for those PAIs covered by this regulation, by:

- Discussing pollution prevention and recycling practices used in the pesticide chemicals manufacturing industry and describing how these practices were identified;

- Identifying which facilities incorporate these practices;
- Discussing how these practices are incorporated into the final rule;
- Discussing how strict mass-based limitations may promote the implementation of pollution prevention and recycling practices; and
- Discussing why it may not be feasible for all pesticide manufacturing plants to incorporate these practices.

Under Section 6602(b) of the Pollution Prevention Act of 1990, Congress established a national policy stating that:

- Pollution should be prevented or reduced at the source whenever feasible;
- Pollution that cannot be prevented should be recycled in an environmentally safe manner whenever feasible;
- Pollution that cannot be prevented or recycled should be treated in an environmentally safe manner whenever feasible; and
- Disposal or other release into the environment should be employed only as a last resort and should be conducted in an environmentally safe manner.

This policy is a formal embodiment of the Agency's working definition of pollution prevention. It makes clear that prevention is EPA's first priority within the following environmental management hierarchy: 1) prevention, 2) recycling, 3) treatment, and 4) disposal or release. "Prevention" includes in-process recycling, which will be referred to as "recirculation", but does not include out-of-process reuse, which will be referred to as "recycling." For example, a wastewater stream generated in a PAI process may be recycled to the same process step in which it was generated, and this operation is defined as "recirculation." If this same wastewater stream is reused outside the PAI process (e.g., in the formulating/packaging process), this operation is defined as "recycling."

Another important aspect of pollution prevention that will be discussed is the concept of source reduction. Source reduction, as defined by the Pollution Prevention Act of 1990, reduces the generation and release of hazardous substances, pollutants, wastes, releases or residuals at the source, usually within a process. The term includes equipment or technology modifications, process or procedure modifications, reformulation or redesign of products, substitution of raw materials, and improvements in housekeeping, maintenance, training, or inventory control. The term "source reduction" does not include any practice which alters the physical, chemical, or biological characteristics or the volume of a substance, pollutant, or contaminant through a process or activity which itself is not integral to and necessary for the production of a product or the providing of a service. The source reduction activities discussed in this section are recirculation and recycle of water, wastewater, and non-wastewater streams.

Section 7.1.1 provides an overview of the recirculation and recycle practices used in the pesticide chemicals manufacturing industry. Section 7.1.2 discusses recirculation and recycling practices for non-water/wastewater streams. Section 7.1.3 focuses on wastewater sources in the pesticide chemicals manufacturing industry and on current water/wastewater recirculation and recycle practices. Section 7.1.4 discusses how pollution prevention practices have been incorporated into the proposed pesticide chemicals manufacturing rule, and Section 7.1.5 discusses the limitations of applying recirculation and recycling steps being practiced by one facility to other facilities.

7.1.1 Overview of Pollution Prevention and Recycling Practices

The Section 308 pesticide manufacturers' questionnaires (1986 operations), site visit and sampling trip reports, industry comments to the proposed rulemaking, and additional information submitted before or after proposal were reviewed to identify the pollution prevention practices currently employed in the pesticide chemicals manufacturing industry. In the Section 308 questionnaires, facilities were required to identify the pollution prevention and recycling practices employed in their PAI manufacturing processes. In addition, the Agency conducted sampling episodes at 20 PAI manufacturing facilities, conducted site visits to 9 PAI manufacturers which were not sampled, and collected wastewater for treatability studies from 3 PAI manufacturers that were not part of the sampling visits or site visits. During each of these activities, industry personnel were questioned by the Agency concerning the pollution prevention and recycling opportunities applicable to their processes and the status of implementing these practices.

Non-water/wastewater streams currently recirculated or recycled by one or more pesticide chemicals manufacturers include solvents, other organic streams, acids, bases, alcohols, and product recovery streams. EPA has relied on the recirculation and recycle practices for these non-water/wastewater streams as the full or partial technology basis for the limitations for 80 of the 120 regulated PAIs; this count includes 24 PAIs (of the 30 PAIs) with zero-discharge limitations. The extensive recycle of these non-water/wastewater streams represents source reduction of potential waste streams/contaminants and reuse of valuable raw materials. If these streams were not recirculated and recycled, large amounts of highly contaminated wastewaters would be generated, and these wastewaters would require extensive treatment prior to discharge.

Typical waters and wastewaters generated from the manufacture of PAIs include: carrier/reaction media, water of reaction, process stream washes, product washes, equipment washes, pump seal wastewater, steam jet and vacuum pump wastewater, and blowdown from air pollution control scrubbers. EPA has relied on recirculation and recycle practices for these water/wastewater streams as the full or partial technology basis for the limitations for 58 of the 120 regulated PAIs; this count includes 28 PAIs (of the 30 PAIs) with zero-discharge limitations.

There is overlap in the recirculation/recycle counts discussed above. That is, for some PAIs, EPA has relied on the recirculation and recycle practices employed for both wastewater and non-wastewater streams as the full or partial technology basis for the limitations. Either wastewater or non-wastewater recirculation or recycle practices are being relied on by EPA as the full or partial basis for the limitations for 96 of the 120 regulated PAIs; this count includes all 28 PAIs with zero-discharge limitations based on complete recirculation or reuse of all wastewaters. (Two other PAIs have zero discharge based on no water use.)

Although many PAI manufacturing facilities have implemented recirculation, recycle, and source reduction practices, the Agency concluded, in general, that there is no support for generically transferring these practices as the basis for BAT limitations from one PAI process to other, dissimilar PAI processes. However, the final rulemaking implicitly incorporates these pollution prevention and recycling practices where mass limitations are transferred directly from the BAT manufacturer of a PAI to the non-BAT manufacturers of the same PAI or similar PAIs ("BAT manufacturers") are those facilities that have reduced mass discharges to BAT levels through BAT treatment and wastewater flow reduction, where applicable). Where mass limitations were not transferred directly, the mass limitations are expected to influence facilities to implement pollution prevention and recycling practices to the fullest possible extent in their processes. Although process reviews and on-site testing will be required to implement these practices, the utilization of pollution prevention and recycling techniques should enable many facilities to more cost-effectively comply with the limitations in the final rule.

7.1.2 Recirculation and Recycle Practices for Non-Water/Wastewater Streams

The purpose of this section is to identify the types of non-water/wastewater streams being recirculated and recycled in the industry and the plants and PAI processes where these practices are being employed. EPA grouped the non-water/wastewater streams generated during PAI manufacturing into the following categories:

PAI Product: crude PAI product, generally recirculated to the reaction step or to a purification step.

Reactant: non-water stream involved in the reaction process and converted to a PAI product; reactant streams are generally recirculated to the reaction step or to a purification step.

Catalyst: non-water stream involved in the reaction process to form a PAI product, without undergoing a change in chemical structure itself; catalysts are generally recirculated to the reaction step or to a purification step.

Acid/Base: acidic or basic process stream, generally used in PAI processes to maintain pH control during reaction and purification steps (acid/base streams are considered non-water streams for the purpose of this report even though water may constitute the major portion of these streams).

Carrier/Reaction Medium: non-water stream used to transport or support the chemicals involved in the reaction process, usually removed from the PAI product during subsequent purification steps.

Extraction Medium: non-water stream used to remove impurities from process streams, including process streams containing the PAI product.

Miscellaneous Process Solvent: includes non-water streams that could not be placed into one of the above categories due to a lack of detail in the process diagrams.

The recycle of non-water/wastewater streams represents source reduction of potential pollutants in the pesticide chemicals manufacturing industry. A review of the manufacturers' questionnaires (1986 operations), sampling trip reports, and other applicable industry-submitted data identified 37 plants as practicing recirculation and recycle of non-water/wastewater streams during the manufacture of 80 PAIs. The non-water/wastewater streams most often recirculated in the PAI processes or recycled into other, non-PAI processes are reactants and streams serving as carriers or the reaction medium. Table 7-1 presents a breakdown of the types of non-water/wastewater streams being recirculated or recycled. The number of streams shown in Table 7-1 is greater than 80 because some PAI manufacturing processes recirculate or recycle more than one type of non-water/wastewater stream.

Recovery and recirculation of solvents minimizes the purchase of new solvent and reduces the volume of spent solvent that must be disposed. The frequency of solvent recirculation/recycle in PAI manufacturing processes was expected as it represents good engineering design by reducing solvent costs and potential shortages and because solvent disposal may be subject to air, water, or land pollution regulations (Reference 1). Due to a lack of detail on some of the manufacturers' process diagrams, however, it was not possible to categorize all of the recirculated/recycled solvent streams into one of the specific non-water/wastewater types (e.g., carrier, reaction medium, etc.). For these streams, where sufficient detail was not available, a general category was developed and is listed as "miscellaneous process solvent" in Table 7-1.

Table 7-2 presents the regulated PAIs where non-water/wastewater recirculation and/or recycle is currently being practiced. The PAIs are divided into two groups depending on whether the recycle/recirculation practices are closed-loop (100% recycle/recirculation) or non closed-loop (less than 100% recycle/recirculation); zero-discharge limitations are being promulgated for those PAIs in the first group - closed-loop recycle/recirculation. The table also identifies whether the non-water/wastewaters are being recirculated, recycled or both. Table 7-3 presents a list of the plants that manufacture the regulated PAIs listed in Table 7-2 and currently recirculate or recycle non-water/wastewater streams.

Table 7-1

TYPES OF NON-WATER STREAMS THAT ARE RECIRCULATED AND RECYCLED

Non-Water/Wastewater Type	Number of Streams	Percent of Recirculated and/or Recycled Streams*
Product	4	3
Reactant	21	17
Catalyst	2	2
Acid/Base	13	11
Carrier/Reaction Medium	47	38
Extraction Medium	11	9
Miscellaneous Process Solvent **	25	20
TOTAL	123	100

*For example Carrier/Reaction Medium represents 11 streams out of the 123. Therefore the percent of all recycle streams is 11 ÷ 123 x 100 = 9 percent.

**Includes recirculated or recycled non-water/wastewater streams that could not be more specifically categorized due to insufficient detail in the manufacturers' process diagrams.

Table 7-2

PAIS WHOSE MANUFACTURE CURRENTLY INCLUDES RECIRCULATION OR RECYCLE OF NON-WATER STREAMS

PAI Code	Pesticide Name	Recirculation	Recycle
Regulated PAIs Whose Manufacture Includes 100% Non-Water/Wastewater Recirculation and/or Recycle (Closed-Loop)			
016	2,4-D salts and esters (10 S&Es)	X	
017	2,4-DB salts and esters (3 S&Es)	X	
027	MCPA salts and esters (4 S&Es)	X	
030	Dichlorprop salts and esters (3 S&Es)	X	
031	MCPP salts and esters (4 S&Es)	X	
Regulated PAIs Whose Manufacture Includes Non-Water/Wastewater Recirculation and/or Recycle (Non Closed-Loop)			
008	Triadimefon	X	
016	2,4-D	X	
025	Cyanazine	X	
026	Propachlor	X	
035	TCMTB	X	
041	Propanil	X	X
052	Acephate	X	
053	Acifluorfen	X	
054	Alachlor	X	
058	Ametryn	X	
060	Atrazine	X	
062	Benomyl		X
068	Bromacil	X	
069	Bromoxynil/Bromoxynil octonate	X	
070	Butachlor	X	
073	Captafol	X	
075	Carbaryl	X	
082	Chlorothalonil	X	

Table 7-2

(Continued)

PAI Code	Pesticide Name	Recirculation	Recycle
103	Diazinon	X	
110	DCPA	X	
112	Dinoseb	X	
113	Dioxathion	X	
125	Ethalfluralin	X	
126	Ethion	X	
132	Fenarimol	X	X
133	Fenthion	X	
140	Heptachlor	X	
150	Malathion	X	
154	Methamidophos	X	
156	Methomyl	X	X
175	Norfluorazon	X	
178	Benfluralin	X	
182	Fensulfothion	X	
183	Disulfoton	X	
186	Azinphos methyl	X	
192	Organo-tins (3)	X	X
197	Bolstar	X	
203	Parathion	X	
204	Pendimethalin	X	
208	Permethrin	X	
212	Phorate	X	
223	Prometon	X	
224	Prometryn	X	
226	Propazine	X	
230	Pyrethrin I	X	

Table 7-2

(Continued)

PAI Code	Pesticide Name	Recirculation	Recycle
231	Pyrethrin II	X	
236	DEF	X	
239	Simazine	X	
252	Tebuthiuron	X	
254	Terbacil	X	
255	Terbufos	X	
256	Terbuthylazine	X	
257	Terbutryn	X	
264	Trifluralin	X	X

Table 7-3

PLANTS THAT MANUFACTURE PAIS WHOSE PROCESS INCLUDES RECIRCULATION AND RECYCLE OF NON-WATER STREAMS

Plant Name	City	State
Ciba Geigy	McIntosh	AL
duPont	Axis	AL
ICI	Bucks	AL
Monsanto	Anniston	AL
Cedar	West Helena	AR
Chevron	Richmond	CA
Amvac	Los Angeles	CA
Monsanto	Muscatine	IA
Eli Lilly	Lafayette	IN
M&T	Carrollton	KY
Ciba Geigy	St. Gabriel	LA
FMC	Baltimore	MD
Dow Chemicals	Midland	MI
MGK	Minneapolis	MN
American Cyanamid	Hannibal	MO
Monsanto	St. Louis	MO
Mobay	Kansas City	MO
Albaugh	St. Joseph	MO
Hercules	Hattiesburg	MS
Cedar	Vicksburg	MS
American Cyanamid	Linden	NJ
Troy	Newark	NJ
Witco-Argus	Brooklyn	NY
Rhone Poulenc	Portland	OR
Rhone Poulenc	Mt. Pleasant	TN
Rohm & Haas	Knoxville	TN
Velsicol	Memphis	TN

Table 7-3

(Continued)

Plant Name	City	State
Buckman	Memphis	TN
duPont	LaPorte	TX
Rohm & Haas	LaPorte	TX
duPont	Belle	WV
Rhone Poulenc	Institute	WV
ISK Biotech	Houston	TX
Cosan	Carlstadt	NJ
Cumberland	Houston	TX
Sandoz	Charlotte	NC
Riverdale	Chicago	IL

7.1.3 Recirculation and Recycle Practices for Water/Wastewater Streams

The purpose of this section is to identify the types of waters/wastewaters being recirculated and recycled in the industry and the plants and PAI processes where these practices are being employed. Section 5 of this Technical Development Document describes in detail water use and wastewater generation in this industry. EPA grouped water/wastewaters generated from the manufacture of PAIs into the following categories:

> Carrier/Reaction Media: water used to transport or support the chemicals involved in the reaction process, usually removed from the process through a separation stage.
>
> Water of Reaction: water formed during the chemical reaction, such as from the reaction of an acid with a base.
>
> Process Stream Washes: water added to the carrier, spent acid, or spent base which has been separated from the reaction mixture, to purify the stream by washing away the impurities.
>
> Product Washes: water added to the reaction medium to wash away impurities in the intermediate or PAI product, this water is then removed through a separation stage; or water used to wash the crude product after it has been removed from the reaction medium.
>
> Equipment Washes: water used to clean process equipment (e.g., during unit shutdowns).
>
> Pump Seal Wastewater: water used to cool packing and lubricate pumps, which may contact pesticide-containing water through leakage and therefore becomes a pesticide-containing wastewater.
>
> Steam Jet/Vacuum Pump Wastewater: water which contacts the reaction mixture or water stripped from the reaction mixture through the operation of a venturi or vacuum pump.
>
> Air Pollution Control Scrubber Blowdown: water, or acidic or basic solutions, used in air emission control scrubbers to control fumes from reaction vessels, storage tanks, and other process equipment.

Other pesticide wastewater sources include: wastewater from cleaning safety equipment used in pesticide production, laboratory wastewater, and contaminated stormwater.

During the review of available data, 20 plants were identified as practicing recirculation and recycle of process water/wastewater in the manufacture of 51 PAIs. Each water or wastewater recirculation/recycle stream was labelled according to the wastewater categories presented above, and Table 7-4 shows the water/wastewater recirculation and recycle streams broken down by category (Note: the number of streams is greater than 51 because some PAI manufacturing processes recirculate or recycle more than one type of wastewater stream). Based on this categorization, the majority (75%) of

Table 7-4

TYPES OF WATER/WASTEWATER THAT ARE RECIRCULATED AND RECYCLED

Water/Wastewater Type	Number of Streams	Percent of Recirculated and/or Recycled Streams*
Carrier/Reaction Media	2	3
Water of Reaction	11	18
Process Stream Wash	2	3
Product Wash	24	38
Equipment Wash	12	19
Scrubber Water	5	8
Steam/Vacuum Jet Condensate	2	3
Miscellaneous	5	8
TOTAL	63	100

*For example Carrier/Reaction Media represents 2 streams out of the 63. Therefore the percent of all recycle streams is 2 ÷ 63 x 100 = 3 percent.

water/wastewater streams recirculated or recycled are product washes, equipment washes, and water of reaction.

Table 7-5 lists the regulated PAIs whose manufacture currently includes water/wastewater recirculation and/or recycle. The PAIs are divided into two groups depending on whether the recycle/recirculation practices are closed-loop (100% recycle/recirculation) or non closed-loop (less than 100% recycle/recirculation); zero discharge limitations are being promulgated for those PAIs in the first group - closed-loop recycle/recirculation. The table also identifies whether the water/wastewaters are being recirculated, recycled or both. Table 7-6 presents a list of the plants that manufacture the PAIs listed in Table 7-5 and have incorporated water or wastewater recycle/recirculation operations.

7.1.4 Incorporation of Pollution Prevention and Recycling Practices Into the Final Rule

The final effluent limitations guidelines and standards for the pesticide chemicals manufacturing industry incorporate pollution prevention and recycling practices in the following ways:

1. The flow and concentration data used to develop the numeric, non-zero limitations and standards account for plant-specific water, wastewater, and non-wastewater recirculation and recycle practices.

2. Zero-discharge limitations are being promulgated for 28 PAIs based on closed-loop recirculation and recycle practices and in the case of two PAIs, based on no water use in the manufacturing process.

3. The NSPS and PSNS are based on improved, more efficient designs of production processes which include increased recirculation, recycle, and other source reduction techniques. These improvements result in a 28% reduction in the PAI mass discharge standards and guidelines for new facilities, compared to the BAT limitations and PSES.

Additionally, the numerical limitations and standards established in this rule should promote additional source reduction through the incorporation of recirculation and recycle practices. This topic is discussed in detail in Section 7.1.5.

BAT Flow and Concentration Data

BAT limitations for PAIs regulated by this rulemaking were developed using:

- Long-term full-scale BAT treatment performance data submitted by pesticide chemical manufacturers; and

Table 7-5

PAIs WHOSE MANUFACTURE INCLUDES WATER OR WASTEWATER RECIRCULATION AND RECYCLE

PAI Code	Pesticide Name	Recirculation	Recycle
Regulated PAIs Whose Manufacture Includes 100% Water/Wastewater Recirculation and/or Recycle (Closed-Loop)			
016	2,4-D salts and esters (10 S&Es)	X	
17	2,4-DB salts and esters (3 S&Es)	X	
027	MCPA salts and esters (4 S&Es)	X	
030	Dichlorprop salts and esters (3 S&Es)	X	
031	MCPP salts and esters (4 S&Es)	X	
Regulated PAIs Whose Manufacture Includes Water/Wastewater Recirculation and/or Recycle (Non Closed-Loop)			
016	2,4-D	X	
041	Propanil		X
045	Metribuzin	X	
053	Acifluorfen	X	
060	Atrazine	X	
069	Bromoxynil/Bromoxynil octanoate	X	
075	Carbaryl		X
080	Chloroneb	X	
103	Diazinon	X	
112	Dinoseb	X	
125	Ethalfluralin	X	X
150	Malathion	X	
158	Methoxychlor	X	
178	Benfluralin	X	X
192	Organo-tins (2)	X	
212	Phorate	X	
226	Propazine	X	
239	Simazine	X	

Table 7-5

(Continued)

PAI Code	Pesticide Name	Recirculation	Recycle
241	Carbam-S	X	
243	Vapam	X	
252	Tebuthiuron	X	
255	Terbufos	X	
256	Terbuthylazine	X	
259	Dazomet	X	
264	Trifluralin	X	X
268	Ziram	X	

Table 7-6

PLANTS THAT MANUFACTURE PAIs WHOSE PROCESS INCLUDES RECIRCULATION AND/OR RECYCLE OF WATER/WASTEWATER

Plant Identification	City	State
Ciba Geigy	McIntosh	AL
Cedar Chemicals	West Helena	AR
ICI Americas	Richmond	CA
Vinings	Marietta	GA
Eli Lilly	Lafayette	IN
Vanderbilt Chemical	Murray	KY
Ciba Geigy	St. Gabriel	LA
Dow Chemicals	Midland	MI
American Cyanamid	Hannibal	MO
Mobay	Kansas City	MO
Cedar Chemical	Vicksburg	MS
American Cyanamid	Linden	NJ
Rhone Poulenc	Portland	OR
Rhone Poulenc	Mt. Pleasant	TN
Witco-Argus	Brooklyn	NY
Kincaid	Nitro	WV
Cosan	Carlstadt	NJ
Riverdale Chemical	Chicago	IL
Rohm & Haas	LaPorte	TX
Rhone-Poulenc	Charleston	WV

- The transfer of statistical data from the PAIs for which BAT performance data are available to PAIs for which no BAT treatment performance data are available, in combination with the results of treatability studies for the non-BAT PAIs.

The following discussion on BAT limitations development is subdivided into four sections. The first section identifies the PAI processes that have achieved BAT-level mass discharges through treatment and wastewater flow reduction, where applicable, and quantifies how many of these "BAT PAIs" currently employ recirculation and recycling practices in their processes. The next two sections discuss limitations development for the "non-BAT PAIs". The fourth section summarizes the extent to which pollution prevention and recycling practices have been relied on in setting limitations for the regulated PAIs.

BAT PAIs (Group A) -- EPA evaluated long-term effluent data to identify PAI processes that have reduced mass discharges through BAT-level treatment and flow reduction, where applicable, and these data were used as the basis for limitations development. This subsection discusses the pollution prevention and recycling practices implemented by these "BAT PAIs," which will be referred to as the Group A PAIs in this section. Twenty-eight plants manufacturing PAIs regulated under this rulemaking submitted BAT data, and these data were used to develop mass limitations for 86 of the 120 PAIs covered by this rulemaking. These 86 BAT PAIs are listed in Table 7-7. Table 7-7 also indicates which of these BAT PAIs employ recirculation and recycle practices and whether or not zero-discharge limitations are being promulgated.

According to the data, 21 of the 28 BAT plants (75%) have implemented non-water/wastewater recirculation and recycle practices for 56 of the BAT PAIs, including 24 zero discharge PAIs. Fifteen of the 28 BAT plants (54%) are known by the Agency to have implemented water/wastewater recirculation or recycle for 37 of the BAT PAIs, including 24 zero-discharge PAIs. The total count of BAT plants which have implemented pollution prevention and recycling of non-water/wastewater and water/wastewater streams, including zero discharge, is 23 of 28 plants, or 82 percent. EPA has relied on these practices as the basis for limitations for 59 of the 86 BAT PAIs, or 69 percent. There is some overlap in these counts since many of the BAT plants recirculate or recycle both water/wastewater and non-water/wastewater streams. In addition, some of these plants manufacture multiple PAIs and do not incorporate recirculation or recycle practices for every PAI.

Twenty-seven of the 86 BAT PAIs listed in Table 7-7 do not recirculate or recycle water/wastewater or non-water/wastewater streams according to the process diagrams and other information presented in the Section 308 questionnaires. However, the process diagrams and questionnaires often did not contain sufficient detail for the Agency to identify whether pollution prevention and recycling practices had been incorporated. To prepare the counts discussed above and presented in Table 7-7, it was assumed that these practices were not in use, unless other information (e.g., a site visit report) was available to indicate otherwise.

Table 7-7

BAT PAIs (GROUP A)

PAI Code	PAI Name	Water/ Wastewater Recirculation/ Recycle	Non-Water/ Wastewater Recirculation/ Recycle	Zero-Discharge PAI
16	2,4-D	yes	yes	no
16SE	2,4-D S&E (10)	yes	yes	yes
17SE	2,4-DB S&E (3)	yes	yes	yes
53	Acifluorfen	yes	yes	no
54	Alachlor	no	yes	no
55	Aldicarb	no	no	no
60	Atrazine	no	yes	no
186	Azinphos Methyl	no	yes	no
62	Benomyl	no	yes	no
197	Bolstar	no	yes	no
68S	Bromacil Salt	no	no	yes
69	Bromoxynil	yes	yes	no
76	Carbofuran	no	no	no
80	Chloroneb	yes	no	no
82	Chlorothalonil	no	yes	no
86	Chlorpyrifos	no	no	no
25	Cyanazine	no	yes	no
110	DCPA	no	yes	no
236	DEF	no	yes	no
103	Diazinon	yes	yes	no
30SE	Dichlorprop S&E (3)	yes	yes	yes
12	Dichlorvos	no	no	no
112	Dinoseb	yes	yes	no
113	Dioxathion	no	yes	no
183	Disulfoton	no	yes	no

Table 7-7

(Continued)

PAI Code	PAI Name	Water/ Wastewater Recirculation/ Recycle	Non-Water/ Wastewater Recirculation/ Recycle	Zero-Discharge PAI
119	Diuron	no	no	no
123SE	Endothall S&E (3)	no	no	yes
124	Endrin	no	no	no
126	Ethion	no	yes	no
203	Ethyl Parathion	no	yes	no
132	Fenarimol	no	yes	no
182	Fensulfothion	no	yes	no
133	Fenthion	no	yes	no
90	Fenvalerate	no	no	no
140	Heptachlor	no	yes	no
144	Isopropalin	no	no	no
148	Linuron	no	no	no
27SE	MCPA S&E (4)	yes	yes	yes
31SE	MCPP S&E (4)	yes	yes	yes
154	Methamidophos	no	yes	no
156	Methomyl	no	yes	no
158	Methoxychlor	yes	no	no
45	Metribuzin	yes	no	no
22	Mevinphos	no	no	no
173	Naled	no	no	yes
192	Organo-tins (8)	no	no	no
205	PCNB	no	no	no
204	Pendimethalin	no	yes	no
208	Permethrin	no	yes	no
212	Phorate	yes	yes	no

Table 7-7

(Continued)

PAI Code	PAI Name	Water/ Wastewater Recirculation/ Recycle	Non-Water/ Wastewater Recirculation/ Recycle	Zero-Discharge PAI
185	Phosmet, recrystallized	no	no	yes
41	Propanil	yes	yes	no
84	Stirofos	no	no	no
252	Tebuthiuron	yes	yes	no
255	Terbufos	yes	yes	no
262	Toxaphene	no	no	no
8	Triadimefon	no	yes	no
264	Trifluralin	yes	yes	no

PAI Mass Limitations Based on Direct Transfers (Group B) -- Production-based mass limitations were calculated for the BAT PAIs using their average daily flows and production rates and the effluent concentrations determined to be acheivable after BAT-level treatment. These mass limitations are in the form of pounds of PAI allowable discharge per one thousand pounds of PAI production (lb/1,000 lbs PAI production). Because these limitations are mass-based, they incorporate the reductions in wastewater volumes and PAI mass loadings achieved through pollution prevention and recycling practices and the reductions in PAI effluent concentrations achieved by in-plant or end-of-pipe (EOP) BAT treatment technologies. Wastewater flow reductions are accounted for in the mass limitations because these flows, in gallons/1,000 lbs PAI production, are multiplied by the achievable effluent concentrations to calculate the allowable PAI mass discharge. Therefore, wastewater flow reductions acheived through the implementation of pollution prevention and recycling practices are reflected in a reduced production-based mass limitation.

In a number of cases, EPA directly transferred mass limitations developed for BAT PAIs to structurally similar non-BAT PAIs. For example, data are available for alachlor showing that BAT-level mass discharges are being achieved through pollution prevention, recycling and effective EOP treatment. The numerical limitations developed for alachlor were transferred directly to butachlor and propachlor; that is, the same daily and monthly limitations apply to all three PAIs. By directly transferring mass limitations, the pollution prevention and recycling practices used to reduce PAI discharges by the BAT facilities are implicitly incorporated as the basis for the limitations for the structurally similar, non-BAT facilities. In addition, 13 BAT PAIs are also produced at facilities that are not currently achieving BAT levels established in this rulemaking ("non-BAT" facilities). (for example, atrazine is produced at BAT and non-BAT facilities), and the mass limitations developed for these PAIs apply to both the BAT and non-BAT facilities. In this section, the non-BAT PAIs with limitations transferred directly from BAT PAIs are denoted as Group B PAIs.

Limitations could not be directly transferred between PAIs that have dissimilar chemical structures and manufacturing processes. These differences significantly impact wastewater generation and content and the pollution prevention and recycling opportunities that are available. Limitations development for these PAIs (Group C PAIs), where limitations are not directly transferred from BAT PAIs, are discussed later in this section.

EPA was able to directly transfer the mass limitations developed for 7 of the BAT PAIs to 14 structurally similar non-BAT PAIs. Therefore, 100 of the total 120 PAI limitations are based on either data from BAT PAIs (86 PAIs) or on the direct transfers of mass limitations from BAT PAIs to non-BAT PAIs (14 PAIs). Because these mass limitations are being transferred directly (i.e., the same numerical limitations apply to both the BAT and non-BAT PAIs), they implicitly incorporate the pollution prevention and recycling practices discussed above for the BAT PAIs. However, to estimate the economic impacts on the non-BAT facilities, the Agency conservatively assumed that the limitations would be met solely through the operation of BAT treatment technologies, and costs were estimated using the flow rates reported by the non-BAT facilities. The Agency believes, though, that many of the non-BAT facilities will be able to meet the limitations more cost-effectively by integrating the pollution prevention and recycling practices being employed at their counterpart BAT facilities. For this reason, the direct transfer of mass limitations should influence the non-BAT facilities to implement these practices to the extent possible in their processes.

<u>PAI Mass Limitations Not Based on Direct Transfers (Group C)</u> -- As discussed above, mass limitations could not be directly transferred between dissimilar PAIs due to differences in their chemical processes. When BAT mass limitations could not be directly transferred, the PAI limitations were based on the performance of BAT treatment technologies. Limitations for 20 of the 120 regulated PAIs were based on BAT treatment performance rather than direct mass limitation transfers, and these PAIs are denoted as Group C PAIs in this section.

To illustrate the difference between direct and non-direct transfers, assume that the mass limitation developed for BAT PAI "A" is 1.0×10^{-3} lb/1000 lb PAI production. Also assume that PAIs "B" and "C" are structurally similar to PAI "A" and are produced by similar chemical processes, while PAI "D" is a dissimilar PAI produced by a dissimilar chemical process. If the mass limitation for PAI "A" is directly transferred to PAIs "B" and "C", then these PAIs must meet the 1.0×10^{-3} lb/1,000 lb limitation, regardless of their current wastewater discharge flow and PAI effluent concentration. If PAIs "B" and "C" are treating to the same PAI effluent concentration as PAI "A" but generate more wastewater, their PAI mass discharges will be greater than the mass discharge at PAI "A" and, therefore, PAIs "B" and "C" would have to reduce their flows or treat their wastewater more effectively to comply with the 1.0×10^{-3} lb/1,000 lb mass limitation.

In this example, because PAI "D" is produced by a dissimilar chemical process, the mass limitation for PAI "A" (1.0×10^{-3} lb/1,000 lb) cannot be directly transferred to PAI "D". The same flow reduction opportunities through pollution prevention and recycling may not be available to the process producing PAI "D" and, therefore, the PAI "D" process may generate more wastewater, in gallons/1,000 lb of production. However, PAIs "A" and "D" may be amenable to the same BAT treatment technology, such as activated carbon or hydrolysis. In these cases, EPA evaluated the achievable effluent concentration and treatment system variability in the treatment of PAI "A" and applied this BAT treatment performance to non-BAT PAIs like PAI "D." Unlike the direct limitation transfers, however, the discharge flow and production rate at PAI "D" (rather than PAI "A") were used in conjunction with the BAT effluent concentration (demonstrated by PAI "A") to develop the limitation for PAI "D".

As discussed above, when limitations could not be transferred directly, EPA relied on BAT treatment performance as the basis for limitations development. Through review of the long-term data submitted by PAI manufacturing facilities, EPA determined that properly operated BAT technologies will, in most cases, reduce PAI wastewater concentrations to at or near their analytical detection limits. This treatment performance was applied to the non-BAT PAIs, and compliance costs were estimated for upgrading or installing the applicable treatment system so that the BAT-level effluent concentrations could be achieved. However, due to a lack of data, a methodology could not be developed to directly transfer the flow reductions achieved by the the BAT PAIs (Group A) to the non-BAT PAIs (Group C). The process diagrams in the questionnaires were helpful in identifying whether pollution prevention and recyling practices had been integrated into the BAT PAI processes. However, sufficient data are not available from the questionnaires and other information sources to quantify the wastewater flow reduction achieved through these practices on a PAI-by-PAI basis for existing facilities. To quantify these reductions, EPA would have needed detailed information on flows and pollutant loadings both before and after the implementation of the pollution prevention and recycling practices. The required historical data needed to quantify the impact of these practices are seldom available unless the changes were made recently, since only recently have plants begun to track and maintain this information more closely.

Another complication inhibiting the transfer of flow reduction techniques for this industry is the uniqueness of dissimilar PAI processes. Unlike the similar PAI processes involved in the direct limitation transfers, flow reduction techniques available to one PAI process are often not available to an entirely different PAI process. The differences in the chemical processes between dissimilar PAIs can have a significant impact on waste generation and on the pollution prevention and recycling opportunities available for implementation. This process complexity, which is a characteristic of the PAI manufacturing industry, is discussed in more detail in Section 7.1.5.

Although flow reduction techniques were not transferred as part of the technology basis for the BAT mass limitations for the 20 Group C PAIs, the manufacturers of these non-BAT PAIs are expected to implement these techniques, if possible, due to the limitations being established by this rule. Process analysis and testing to evaluate potential pollution prevention and recycling opportunities may help facilities to more cost-effectively meet the regulations for the 20 Group C PAIs. However, EPA does not have sufficient data to quantify the precise flow reductions acheivable by each of these 20 PAI processes.

Regulated PAIs -- As discussed earlier in this section, 120 PAIs are being regulated by this rulemaking. Of these 120 PAIs: Group A - the BAT PAIs - includes 86 PAIs, 30 PAIs with zero-discharge limitations and 56 PAIs with numeric, non-zero limitations; Group B, where limitations are based on the direct transfer of mass limitations from BAT to non-BAT PAIs, includes 14 PAIs; and Group C, where limitations are based on BAT treatment performance, includes 20 PAIs. Table 7-8 lists the 120 regulated PAIs and identifies whether the PAIs are in Group A, B, or C.

Table 7-8 also identifies whether pollution prevention and recycling practices are currently being practiced by the regulated PAIs or if the mass limitations are being directly transferred from BAT PAIs that currently employ pollution prevention and recycling practices. EPA has relied on recirculation and recycle practices for non-wastewater streams as the full or partial technology basis for the limitations for 80 of the 120 regulated PAIs; this count includes 24 PAIs (of the 30 PAIs) with zero-discharge limitations. EPA has relied on recirculation and recycle practices for wastewater streams as the full or partial technology basis for the limitations

Table 7-8

REGULATED PAIs

PAI Code	PAI Name	Group	Wastewater Recirculation and/or Recycle	Non-Wastewater Recirculation and/or Recycle	Zero-Discharge PAI
16	2,4-D	A	yes	yes	no
16SE	2,4-D S&E (10)	A	yes	yes	yes
17SE	2,4-DB S&E (3)	A	yes	yes	yes
52	Acephate	C	no	yes	no
53	Acifluorfen	A	yes	yes	no
54	Alachlor	A	no	yes	no
55	Aldicarb	A	no	no	no
58	Ametryn	B	no	yes	no
60	Atrazine	A	no	yes	no
186	Azinphos Methyl	A	no	yes	no
178	Benfluralin	B	yes	yes	no
62	Benomyl	A	no	yes	no
197	Bolstar	A	no	yes	no
68	Bromacil	C	no	yes	no
68S	Bromacil Salt	A	yes	no	yes
69	Bromoxynil	A	yes	yes	no
69	Bromoxynil Octanoate	B	yes	yes	no
219	Busan 40	C	yes	no	no
218	Busan 85	C	yes	no	no
70	Butachlor	B	no	yes	no
73	Captafol	C	no	yes	no
241	Carbam-S	C	yes	no	no
75	Carbaryl	C	yes	yes	no
76	Carbofuran	A	no	no	no
80	Chloroneb	A	yes	no	no

Table 7-8

(Continued)

PAI Code	PAI Name	Group	Wastewater Recirculation and/or Recycle	Non-Wastewater Recirculation and/or Recycle	Zero-Discharge PAI
82	Chlorothalonil	A	no	yes	no
86	Chlorpyrifos	A	no	no	no
25	Cyanazine	A	no	yes	no
110	DCPA	A	no	yes	no
236	DEF	A	no	yes	no
259	Dazomet	C	yes	no	no
103	Diazinon	A	yes	yes	no
30SE	Dichlorprop S&E (3)	A	yes	yes	yes
12	Dichlorvos	A	no	no	no
112	Dinoseb	.A	yes	yes	no
113	Dioxathion	A	no	yes	no
183	Disulfoton	A	no	yes	no
119	Diuron	A	no	no	no
123SE	Endothall S&E (3)	A	yes	no	yes
124	Endrin	A	no	no	no
125	Ethalfluralin	B	yes	yes	no
126	Ethion	A	no	yes	no
203	Ethyl Parathion	A	no	yes	no
132	Fenarimol	A	no	yes	no
182	Fensulfothion	A	no	yes	no
133	Fenthion	A	no	yes	no
90	Fenvalerate	A	no	no	no
140	Heptachlor	A	no	yes	no
144	Isopropalin	A	no	no	no
220	KN Methyl	C	yes	no	no

Table 7-8

(Continued)

PAI Code	PAI Name	Group	Wastewater Recirculation and/or Recycle	Non-Wastewater Recirculation and/or Recycle	Zero-Discharge PAI
140	Linuron	A	no	no	no
27SE	MCPA S&E (4)	A	yes	yes	yes
31SE	MCPP S&E (4)	A	yes	yes	yes
150	Malathion	C	yes	yes	no
263	Merphos	B	no	yes	no
154	Methamidophos	A	no	yes	no
243	Metham Sodium/ Vapam	C	yes	no	no
156	Methomyl	A	no	yes	no
158	Methoxychlor	A	yes	no	no
45	Metribuzin	A	yes	no	no
22	Mevinphos	A	no	no	no
172	Nabam	C	yes	no	no
118	Nabonate	C	yes	no	no
173	Naled	A	no	no	yes
175	Norflurazon	C	no	yes	yes
192	Organo-tins (8)	A	no	no	no
205	PCNB	A	no	no	no
107	Parathion Methyl	B	no	yes	no
204	Pendimethalin	A	no	yes	no
208	Permethrin	A	no	yes	no
212	Phorate	A	yes	yes	no
185	Phosmet, recrys.	A	no	no	yes
223	Prometon	B	no	yes	no
224	Prometryn	B	no	yes	no

Table 7-8

(Continued)

PAI Code	PAI Name	Group	Wastewater Recirculation and/or Recycle	Non-Wastewater Recirculation and/or Recycle	Zero-Discharge PAI
39	Pronamide	C	no	no	no
26	Propachlor	B	no	yes	no
41	Propanil	A	yes	yes	no
226	Propazine	B	yes	yes	no
230	Pyrethrins I	C	no	yes	no
231	Pyrethrins II	C	no	yes	no
239	Simazine	B	yes	yes	no
84	Stirofos	A	no	no	no
35	TCMTB	C	no	yes	no
252	Tebuthiuron	A	yes	yes	no
254	Terbacil	C	no	yes	no
255	Terbufos	A	yes	yes	no
256	Terbuthylazine	B	yes	yes	no
257	Terbutryn	B	no	yes	no
262	Toxaphene	A	no	no	no
8	Triadimefon	A	no	yes	no
264	Trifluralin	A	yes	yes	no
268	Ziram	C	yes	no	no

for 54 of the 120 regulated PAIs; this count includes 24 PAIs (of the 30 PAIs) with zero-discharge limitations. Either wastewater or non-wastewater recirculation or recycle practices are being relied on by EPA as the full or partial basis for the limitations for 96 of the 120 regulated PAIs; this count includes all 28 PAIs with zero-discharge limitations based on complete recycle/reuse of wastewater.

Zero Discharge Limitations

Zero-discharge limits are being promulgated in this rule for PAIs where compliance can be demonstrated through zero discharge of process wastewaters using a pollution prevention technology such as: closed loop recirculation of process wastewater, 100% recycle of process wastewater to another operation such as pesticide formulation, or zero water addition or generation during manufacture of a PAI. Zero-discharge limitations were set for 30 PAIs under this rulemaking. As discussed earlier, many of the PAIs with numeric, non-zero limitations have been based at least in part on recirculation and recycling practices, but these practices do not represent closed loop recirculation or 100% recycling and so do not eliminate all wastewater discharges. Zero-discharge limitations were not set unless these practices have resulted in no discharge of process waters.

Of the 30 PAIs with zero-discharge limitations, 2 PAIs fall into the category of zero water addition or generation during manufacture, and the remaining 28 zero-discharge PAIs are salts and esters including phenoxy acid salts and esters. The salt and ester PAIs are good examples of how pollution prevention has been incorporated into this rule. There are four plants in the industry which manufacture phenoxy acid salts and esters. Three of these four plants currently are achieving zero discharge by recycling the water generated during the esterification reaction as make-up water for the salt formation process. When production schedules do not allow for immediate use of the esterification process wastewater for salt formation, this wastewater is typically stored until needed. These plants also recover reactants used in the esterification reaction and recycle these reactants into subsequent batches of the same ester. The zero-discharge limitations set for the phenoxy salt and ester PAIs are based on the three plants that currently employ the pollution prevention and recycling practices discussed above. The fourth plant will be subject to the same zero-discharge limitation and will likely need to implement similar pollution prevention and recycling techniques to comply with this limitation.

NSPS and PSNS

NSPS and PSNS regulations for this rulemaking are based the final BAT limitations plus 28% flow reduction. New plants have the opportunity to install the best and most efficient production processes, source reduction techniques, and wastewater treatment technologies. As a result, NSPS and PSNS incorporate the flow reductions demonstrated by newer PAI processes. More detailed discussions of NSPS and PSNS are provided in Sections 7.5.3 and 7.5.5, respectively, and Section V of the preamble to the final rule.

7.1.5 Process Complexity in the Pesticide Chemicals Manufacturing Industry

As discussed in Section 7.1.4, EPA does not believe that the identified pollution prevention and recycling practices can be directly transferred between manufacturers of dissimilar PAIs. For example, it may be possible to recirculate a large portion of a product wash water stream in one PAI process whereas a different PAI process might tolerate very little recycle of the same type of stream without significantly impacting process control or product quality. This is due to the complexity of the processes in the pesticide chemicals manufacturing industry.

For some industries, such as the pesticide formulating, packaging, and repackaging (PFP) industry, there is little diversity in the process operations or the water use and wastewater generation characteristics among different facilities. This is not true, however, for PAI manufacturing facilities. PAIs are complicated organic molecules, and their production requires the operation of sophisticated chemical processes. These processes often involve the addition of multiple reactants and the use of catalysts to promote the formation of the desired PAI product. In addition, a variety of different unit operations are employed to purify the PAI product, recover raw materials and separate wastes from process streams. These operational steps can differ significantly among different PAI manufacturing processes due to the different types of reactants and solvents used and the range of byproducts, coproducts and waste products formed during PAI synthesis.

Contaminants enter into PAI processes or are generated within the PAI processes themselves through a number of mechanisms. Impurities can enter the process in reactants, solvents, and catalysts; commercially available feedstocks and solvents typically contain 0.5% or more impurities (Reference 4). Waste constituents are generated in the process because PAI reaction steps are not 100% efficient. In most all reaction processes, multiple reactions occur; the desired reaction which forms the product PAI and other, usually undesired reactions which account for the formation of byproducts, coproducts, and waste products, such as water of reaction. Stringent process control and the proper use of catalysts can decrease, but not eliminate, the formation of unwanted compounds. Water of reaction, however, cannot be eliminated without changing the process chemistry, since this water is formed due to the combination of the reactants used in the process.

Contaminants, byproducts, coproducts and waste products that enter or are generated in the reaction step are separated from the desired PAI product during downstream processing. Depending on the difficulty of separation, a multitude of processing steps may be required. Water of reaction is sometimes volatilized from the reaction medium using evaporators or separated in centrifuges or decanters based on density differences. This water of reaction, once separated, can be recycled to the reaction step in some but not all processes, depending on the reaction chemistry and the water solubility of the reactants and PAI product. Without very detailed knowledge of the process kinetics, and testing, it is not possible to predict if or how much of this water can be recycled.

Water is also used during downstream processing to remove waste constituents from the PAI product stream or from other process streams so that these process streams can be recycled. Water is effective in these steps because the waste constituents, such as dissolved salts, are more water soluble than the PAI product or the organic constituents in the process stream. However, during these wash steps, some PAI product and organics from the process stream are removed with the wash water. For this reason, these wash waters are often reused in the wash step to minimize the loss of product and desired raw materials. However, as recirculation of wash water increases, there is also an increase in the concentration of waste constituents in the wash water since less clean makeup water is being used. As a result the wash step becomes less efficient and more of the waste constituents may leave with the product or process stream. Operational problems may also occur if the magnitude of the blowdown, or discharge stream, is not sufficient to prevent critical buildup of the waste constituents in the recycled wash water. For example, some waste constituents may precipitate from the wash water stream if their concentration becomes too elevated. Without on-site testing it is not possible to estimate when critical buildup of these constituents will occur due to the range of waste constituents that may be present from one PAI process to another. One PAI process may allow recycle of 25 to 30% of a wash water stream while another PAI process may encounter operational and product quality problems at 10% recycle.

Due to the individuality of each PAI manufacturing process and the impact of these differences on the chemical content and other characteristics of the wastewaters generated, the Agency did not propose generic transfers of recirculation, recycle, and source reduction practices from one PAI process to another. That is, the Agency did not set one generic wastewater discharge rate, in gallons per thousand pounds of PAI production, for all PAI processes. Because of the differences in wastewater generation, recirculation, and recycle capabilities between different PAI processes, no one flow rate was considered applicable to all PAIs.

Facilities not in compliance with the PAI mass limitations have various options to acheive compliance, such as: reduce waste loads from the process; optimize existing in-plant and/or EOP treatment; install additional in-plant and/or EOP treatment; or implement some combination of the above. EPA believes that facilities will choose to integrate recirculation, recycle, and source reduction practices if possible to lessen the economic burden of the effluent limitations and standards. For example, in evaluating a pollution prevention project, a facility may have concluded in the past that the cost of pollution prevention equipment exceeds the benefits of product recovery. Due to the mass limitations, however, the facility must now compare these pollution prevention costs with the cost of upgrading or adding new treatment, and this comparison shows the economic benefits of pollution prevention more clearly. Since wastewater recirculation or recycling may allow a plant to reap the economic benefits of product recovery, the facility would be more apt to invest in the project. In addition, facilities might not consistently meet permit limitations without decreasing the waste load to treatment since the mass limitations will require much smoother wastewater treatment plant operation. One way to decrease this waste load from some processes is to increase product and raw material recovery through the recirculation and recycle of wastewater streams, such as product or process stream washes.

7.2 TREATMENT PERFORMANCE DATABASES

The sources of treatment performance data available for the pesticide chemicals manufacturing industry include: self-monitoring data submitted with the Pesticide Manufacturing Facility Census for 1986; data collected during EPA short-term sampling at pesticide chemicals manufacturing facilities between 1988 and 1991; data generated during EPA sponsored bench-scale treatability tests on selected PAIs; data submitted following the April 10, 1992 proposal of effluent limitations guidelines and standards; and evaluations of existing treatment performance databases, including databases compiled to support other effluent guidelines.

The database on PAI treatment performance was developed primarily from information collected since 1986 as part of this rulemaking effort. The treatment performance database for the conventional pollutant parameters, cyanide, and COD was compiled during the previous rulemaking efforts for the pesticide chemicals industry supplemented by new BOD_5, TSS and COD data submitted by 10 plants in response to the questionnaire. The treatment performance database for all of the priority pollutants, except cyanide, was compiled during the development of regulations for the OCPSF point source category. All of the treatment performance databases identified above are discussed in more detail in Sections 7.2.1 through 7.2.4.

7.2.1 Analytical Data Submitted with the Pesticide Manufacturing Facility Census for 1986

The Pesticide Manufacturing Facility Census for 1986, as described in Section 3.1.3, requested engineering and economic data regarding pesticide manufacturing processes, wastewater generation, treatment, and handling procedures from each plant that received the questionnaire. In addition, the questionnaire requested submittal of all wastewater monitoring data collected in 1986, in the form of individual data points rather than monthly aggregates. The intent of this request was to obtain a full year of daily monitoring data from each respondent, specifically for wastewater streams leaving manufacturing processes and entering and exiting treatment systems. The questionnaire further requested that the respondents identify the sampling points in relation to the process and treatment diagrams submitted with their completed questionnaires.

When the data submitted by a plant were found to be insufficient or required further explanation, EPA requested additional information from the plant. Additional data were obtained from some of the survey respondents following the initial review of their 1986 data, and in many cases the additional data included more recent information than 1986 monitoring data.

The industry-submitted long-term data contained mostly PAI data, and these data were entered into EPA's treatment performance database. Of the 90 pesticide manufacturing plants that responded to the 1986 survey, data from 27 facilities covering 55 PAIs were evaluated for use in determining treatment system performance. EPA relied on these data extensively in the course of developing limitations, as discussed in Section 7.5.

7.2.2 Sampling and Analytical Programs

Between 1988 and 1991, EPA visited 32 of the 90 manufacturing facilities. During each visit, EPA gathered production process information and waste and wastewater generation, treatment and disposal information. Based on these data and the responses to the facility census, EPA conducted wastewater sampling at 20 of the 32 facilities in order to characterize process discharges and treatment system performance. In addition, EPA collected wastewater for bench-scale treatability studies at 7 of the 32 facilities. Four of these seven were among the 20 facilities sampled in order to characterize process discharges and treatment system performance. Therefore, overall, EPA collected wastewater samples at 23 of the 32 facilities visited. The other nine facilities visited were not sampled: two plants do not discharge wastewater (they recycle/reuse their wastewater), two plants had no wastewater treatment, three plants had pesticide manufacturing process wastewater so intimately commingled with wastewater from other manufacturing processes that sampling for characterization was not possible, one plant disposed of wastewater by deep well injection, and the ninth plant was not in production during possible sampling times. (The ninth plant did provide long-term self-monitoring data, however.)

During the sampling activities, raw wastewater from the manufacture of 38 different PAIs were characterized. Samples were also collected to assist in the evaluation of the performance of 62 specific treatment unit operations. EPA initially selected faclities for sampling based on data which indicated that: (1) the wastewater treatment system was effective in removing PAIs, and (2) the PAIs manufactured appeared to be representative of one or more PAI structural categories, such as organophosphate PAIs. Wastewaters containing PAIs in 21 structural groups were sampled.

7.2.3 Treatability Test Data

As part of this rulemaking effort for the pesticide chemicals manufacturing industry, EPA conducted numerous bench-scale treatability studies on both clean water to which PAIs were added ("synthetic wastewaters") and on actual pesticide process wastewaters. Through the treatability studies, EPA analyzed the efficacy of activated carbon adsorption, membrane filtration, hydrolysis and chemical oxidation (alkaline chlorination and UV ozonation) for control of 76 PAIs in synthetic wastewaters. More detailed studies using actual manufacturing process wastewater to develop additional treatment performance data for activated carbon adsorption, hydrolysis, and alkaline chlorination technologies were subsequently conducted. These more detailed studies involved 13 specific PAIs included in today's final rule.

Activated Carbon Adsorption

Activated carbon adsorption isotherm tests were performed on synthetic wastewaters containing 29 selected organic PAIs, chosen from the list of 260 organic PAIs considered for regulation. The carbon isotherm

EPA collected information for the proposed rulemaking; they replaced inadequate treatment or supplemented existing treatment. The new data allow more of the limitations to be based on demonstrated performance of full-scale treatment systems instead of treatment system performance data transferred from other PAIs or estimates from treatability studies of the performance expected of full-scale treatment.

3. Analytical methods used by dischargers to monitor PAIs in discharges, where the commenter believed the proposed EPA methods were different from those currently in use.

4. Additional information identifying specific pollution prevention practices and "out-of-process" recycle/reuse.

In addition, EPA conducted hydrolysis rate studies of pyrethrin I and pyrethrin II as part of its study of the formulator/packager industry. The hydrolysis showed that pyrethrin I and pyrethrin II hydrolyze rapidly under alkaline conditions. EPA has added that data to its database in response to comments.

7.2.5 Existing Treatment Performance Databases

The treatment performance databases used in the analysis of treatment of conventional pollutants (BOD_5, TSS and pH) and COD, include the data submitted in response to the questionnaire, and the pesticide chemicals industry BPT database. The OCPSF database was used for priority pollutants. These databases are not repeated here but can be found in the following documents:

- Development Document for Final Effluent Limitations Guidelines for the Pesticide Chemicals Manufacturing Point Source Category. [EPA 440/1-85/079 (BAT) and EPA 440/1-78/060-e]

- Development Document for Effluent Limitations Guidelines New Source Performance Standards and Pretreatment Standards for the Organic Chemicals and the Plastics and Synthetic Fibers Point Source Category - Volume I and II. EPA 440/1-87/009.

The BOD_5, TSS and COD data from the questionnaire are presented in Section 5.

7.3 WASTEWATER TREATMENT IN THE PESTICIDE CHEMICALS MANUFACTURING INDUSTRY

The major treatment technologies currently employed by plants in the pesticide chemicals manufacturing industry to treat wastewaters on-site are: biological treatment, activated carbon adsorption, on-site incineration, chemical oxidation/chlorination/dechlorination, hydrolysis, steam stripping, resin adsorption, hydroxide precipitation, and solvent extraction. EPA found that pesticide chemicals manufacturing facilities primarily select in-plant physical/chemical treatment, in addition to the pollution prevention and recycle/reuse practices, for the removal of highly concentrated pollutants from process wastewaters. [These in-plant controls are then often followed by biological treatment usually after these streams are combined with other facility wastewaters]. In addition, facilities performing recycle/reuse of treated wastewaters do so in many cases following various in-plant treatment units. End-of-pipe treatment systems employ physical, chemical, and biological treatment and are designed to treat combined process and facility wastewaters. The typical treatment sequence is physical/chemical treatment to remove PAIs, followed by steam stripping to remove volatile priority pollutants, followed by biological treatment to remove non-volatile priority pollutants and other organic pollutants. In a few cases, activated carbon is used as an end-of-pipe treatment step to polish commingled facility wastewaters prior to discharge.

Table 7-9 summarizes the in-plant and end-of-pipe treatment technologies used to control pollutant discharges in pesticide industry process wastewaters. Table 7-9 also presents the number of facilities that reported using each of the technologies according to the Facility Census for 1986 and the number of facilities currently using the technologies. The number of treatment systems currently operating takes into account the new treatment systems that have been installed since 1986, as well as the manufacturing facilities that have closed. It should be noted that many plants use more than one type of treatment technology to effect significant removals of pollutants.

At least some treatment is currently being provided to over 99% of the wastewaters discharged directly and to about 92% of the wastewaters discharged to POTWs. While many plants provide extensive treatment to remove PAIs, priority pollutants, and other pollutants, some plants provide no treatment. The majority of plants have some treatment but that treatment often needs to be upgraded to improve its effectiveness and to remove additional pollutants. The following 14 technologies have been demonstrated to provide treatment of PAIs and/or priority pollutants in the pesticide chemicals manufacturing industry:

- Carbon Adsorption;
- Hydrolysis;
- Chemical Oxidation/Ultraviolet Decomposition;
- Resin Adsorption;
- Solvent Extraction;
- Distillation;
- Membrane Filtration;
- Biological Treatment;
- Evaporation;
- Chemical Precipitation/Filtration;
- Chemical Reduction;
- Coagulation/Flocculation;
- Incineration; and
- Steam Stripping.

A description of each of these technologies is presented in the following paragraphs.

Table 7-9

TREATMENT TECHNOLOGIES USED BY FACILITIES IN THE PESTICIDE CHEMICALS MANUFACTURING INDUSTRY

Treatment Technology	**Total Number of Facilities (1986)**	**Total Number of Facilities (Current[1])**
Biological Treatment	25	24
Carbon Adsorption	14	12
Chemical Precipitation/Filtration	7	5
Chemical Oxidation	11	9
Coagulation/Flocculation	8	6
Distillation	1	2
Evaporation	1	0
Hydrolysis	6	4
Incineration	3	3
Resin Adsorption	2	2
Solvent Extraction	3	3
Steam Stripping	4	6
Ultraviolet Decomposition	2	2

[1] Accounts for facility closures since 1986.

7.3.1 Carbon Adsorption

Adsorption is the primary mechanism for removal of organic pollutants from wastewater by activated carbon. Activated carbon has a very large surface area per unit mass which is available for assimilation of contaminants. The main driving forces for adsorption of a solute on the adsorbent is attraction of the solute (or adsorbate) to the adsorbent and/or a hydrophobic (water-disliking) characteristic of the adsorbate.

Biodegradation of contaminants from microbial growth on the carbon can improve organics removal and reduce the carbon usage rate for certain wastewaters, but adsorption is the primary mechanism for organics removal. Some biologically degradable compounds are difficult to adsorb and prediction of degradation rates is difficult, so biodegradation is not usually considered in the design of activated carbon systems unless an extensive pilot-scale study is conducted.

The carbon adsorption capacity (the mass of the contaminant adsorbed per mass of carbon) for specific organic contaminants is related to the characteristics of the compound, the carbon characteristics, the process design, and the process conditions. In general, adsorption capacity is inversely proportional to the adsorbate solubility. Within a homologous series of organic compounds, adsorption increases with increasing molecular weight since solubility decreases with increasing molecular weight (e.g., parathion is more strongly adsorbed than EPTC). Thus nonpolar, high molecular weight organics with low solubility are adsorbed more readily than polar, low molecular weight organics with high solubilities. Competitive adsorption of other compounds has a major effect on adsorption (i.e., the carbon may begin preferentially adsorbing one compound over another compound and may even begin desorbing the other compound). Process conditions (such as pH and temperature), process design factors (such as granular vs. powdered carbon, contact time, and number of columns in series), and carbon characteristics (such as particle size and pore volume) also effect adsorption capacity.

When the adsorptive capacity of the carbon is exhausted, the spent carbon is either disposed of or regenerated, the choice generally to be determined by economics. The carbon is regenerated by removing the adsorbed organics from the carbon. Three methods for carbon regeneration are steam regeneration, thermal regeneration, and physicochemical regeneration. Thermal and steam regeneration volatilize the organics which are removed from the carbon in the gas phase. Afterburners are required to ensure destruction of the organic vapors and a scrubber may be necessary to remove particulates. Physicochemical regeneration removes the organics by a solvent, which can be a water solution. Thermal and steam regeneration are most commonly used for carbon from wastewater treatment.

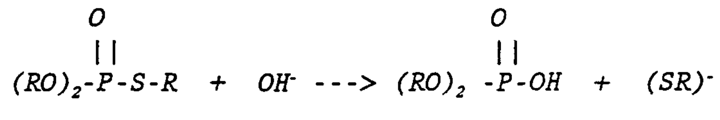
Activated carbon is commonly utilized in the form of granular-carbon columns that operate in either an upflow or downflow mode. Powdered carbon is used less frequently for wastewater treatment due to the difficulty of regeneration and reactor system design considerations although it may be used in conjunction with biotreatment systems. Carbon adsorption is used as both an in-plant and end-of-pipe treatment technology. In-plant carbon adsorption protects treatment downstream from high concentrations of toxic pollutants that could adversely affect system performance. For example, carbon adsorption may remove pollutants which would be toxic to a downstream biological treatment system. In-plant carbon adsorption treatment also enables removal of pollutants from low volume waste streams before they are commingled with other facility wastewaters. Commingling of untreated waste streams contaminates much larger volumes of wastewater, which could then be more difficult and costly to treat. On the other hand, activated carbon may also be applied as end-of-pipe treatment when certain pollutants contained in commingled wastewaters are not effectively removed by previous treatment steps. For example, certain pollutants, although not toxic to a biological treatment system, may not be effectively removed by the biological system and an end-of-pipe activated carbon system may be necessary to treat the pollutants effectively. The biological system may remove other organics which, if not removed, could reduce total adsorptive capacity of the activated carbon system.

In the pesticide manufacturing industry, activated carbon adsorption is or has been used to treat PAIs in the following structural groups: acetamides, aryl halides, benzonitriles, carbamates, phenols, phosphorodithioates, pyridines, pyrethrines, s-triazines, tricyclic, toluidines, and ureas. In addition, EPA and industry treatability studies have demonstrated sufficient treatability of pesticides in the acetanilide, terephthalic acid, and uracil structural groups using carbon to establish this treatment as a basis for control of specific PAIs in these groups. Carbon has also been shown in treatability studies to be an effective polishing control for thiocarbamate PAIs, although insufficient information is currently available to determine the effluent quality achievable by full-scale treatment systems for thiocarbamate PAIs.

In the case of many of the PAIs which are or have been treated using carbon, expediency has appeared to drive treatment system selection rather than optimal system design. For example, wastewaters from the manufacture of carbamate and phosphorothioate PAIs which can be readily hydrolyzed at alkaline conditions have instead been treated using activated carbon. In those cases, carbon may have been chosen originally because of its ability to remove other pollutants of concern from the wastewater, or because of an incomplete assessment of treatment options. Due to the cost of carbon regeneration or replacement, the use of activated carbon to treat high volume streams is often a more expensive option than other physical-chemical treatment methods; therefore an evaluation of other treatment technologies may result in a system which provides equal performance at a lower cost.

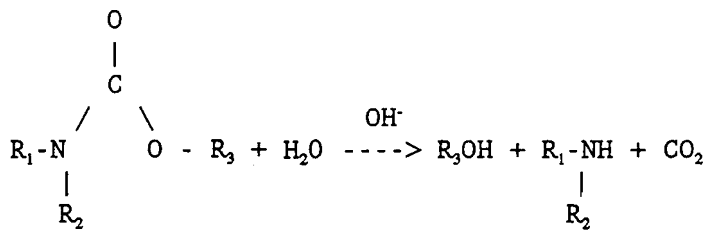
7.3.2 Hydrolysis

Hydrolysis is a chemical reaction which occurs in water, alters the target compound by reaction with water, and is not catalyzed by light or microorganisms. Usually the hydroxyl group (OH^-) is introduced into the reactant, displacing another group:



$$(RO)_2\text{-}\overset{\overset{O}{||}}{P}\text{-}S\text{-}R \;+\; OH^- \;\text{--->}\; (RO)_2\;\text{-}\overset{\overset{O}{||}}{P}\text{-}OH \;+\; (SR)^-$$

Carbamate hydrolysis occurs by the following reaction:



$$R_1\text{-}\underset{\underset{R_2}{|}}{N}\text{-}\overset{\overset{O}{|}}{C}\text{-}O - R_3 + H_2O \xrightarrow{OH^-} R_3OH + R_1\text{-}\underset{\underset{R_2}{|}}{NH} + CO_2$$

The acid hydronium ion can also enter into hydrolysis reactions.

As the reactions above illustrate, hydrolysis is a destructive technology in which the original molecule forms two or more new molecules. In some cases, the reaction continues and other products are formed.

The primary design parameter considered for hydrolysis is the half-life, which is the time required to react 50% of the original compound. The half-life of a reaction is generally dependent on the reaction pH and temperature and the reactant molecule. Hydrolysis reactions can be catalyzed at low pH, high pH, or both, depending on the reactant. In general, an increase in temperature will increase the hydrolysis rate. Improving the conditions for the hydrolysis reaction results in a shorter half-life, and therefore the size of the reaction vessel required is reduced.

Hydrolysis is a treatment technology which should be strongly considered for wastewaters which contain carbamate, phosphate, phosphorothioate, phosphorodithioate, and phosphonothioate PAIs. For virtually all PAIs in these structural groups for which treatability testing was performed, a half-life less than 30 minutes was achieved at high temperature (60°C) and high pH (pH 12). Literature data shows that many of the PAIs in fact react even faster than EPA's study demonstrated. Study conditions were such that the "zero" reaction time was in fact at least 15 minutes (i.e., 15 minutes had elapsed between the time the initial sample was taken and analyzed). In some cases, the PAI had been completely destroyed within that 15 minute period (i.e., the PAI was not detected in the sample). In such cases, the half-life was estimated to be at less than 30 minutes, and a 30-minute half-life was used in calculating reactor sizes and retention times, hence cost, for treatment. Literature data, however, confirms that for PAIs, such as malathion (the half-life of malathion at 60°C and pH 12 is less than one minute) and methomyl (half-life less than 5 minutes), the half-life is much less than 30 minutes.

For many compounds high pH and ambient temperature were enough to result in a half-life less than an hour, especially for the carbamates. Acid hydrolysis was only effective for a small number of compounds tested. However, for organophosphorus and carbamate pesticide hydrolysis, alkaline hydrolysis is usually faster than acid hydrolysis. The urea PAIs tested were not hydrolyzed effectively, so long reaction times would be necessary to treat most urea PAIs.

Acid hydrolysis of dithiocarbamate PAIs can achieve short half-lives; however, this reaction results in evolution of carbon disulfide gas; therefore, hydrolysis is not considered to be feasible for dithiocarbamate PAIs. Hydrolysis has also been used to treat triazine PAIs, but only at high temperature with catalyst because this reaction proceeds very slowly in the normal range of conditions used in wastewater treatment.

7.3.3 Chemical Oxidation/Ultraviolet Decomposition

Chemical oxidation is a reaction process in which one or more electrons are transferred from the oxidizing chemical (electron donor) to the targeted pollutants (electron acceptor) causing their destruction. Oxidants typically used in industry include chlorine, hydrogen peroxide, ozone, and potassium permanganate. Of these oxidants, chlorine is most commonly used under alkaline conditions to destroy such compounds as cyanide (metal finishing, inorganic chemicals, and pesticides industry) and pesticides.

Chemical oxidation has been demonstrated by the pesticide industry to be effective at destroying alkyl halide, DDT-type, phenoxy, phosphorothioate, and dithocarbamate PAIs in manufacturing wastewaters. In a bench-scale alkaline chlorination treatability study by EPA, chlorine dosages equivalent to 50, 100 and 125% of the chlorine demand for specific dithiocarbamate pesticides wastewaters were evaluated. Treatment results indicated alkaline chlorination could reduce the effluent PAI concentration below the analytical detection limit; however, chlorine dosage requirements and reaction times varied for each pesticide evaluated. The major drawback to alkaline chlorination of pesticide manufacturing wastewaters is the production of chlorinated organic compounds which must subsequently be removed by an additional treatment technology. Compounds not present in the raw wastewater but detected in at least two of the test reactors included chloroform, bromodichloromethane, dibromochloromethane, and acetone. Based on the past performance of alkaline chlorination in the pesticide industry and on the bench-scale treatment study, the effluent limitations for dithiocarbamates are based on this technology but with the addition of a treatment technology (steam stripping) to reduce chlorinated organics.

A recent oxidation technology to emerge for the oxidation of dithiocarbamate PAIs is ozone in combination with ultraviolet light. This technology, initially developed for the metal finishing industry to treat iron complexed cyanide, has recently been suggested by EPA as an alternative to chlorine oxidation for treatment of pesticide manufacturing wastewaters. The ozone-UV light process focuses on the production of the highly oxidative hydroxyl radicals from the absorption of UV light (254 nm wavelength) by ozone. These hydroxyl radicals completely oxidize the PAI (e.g., to carbon dioxide, nitrate, sulfate and water) avoiding the formation of halogenated organic compounds such as those produced during alkaline chlorination.

The oxidation of dithiocarbamate pesticides by ozone and UV light has recently been demonstrated by EPA in a bench-scale treatability study. The study, involving five different dithiocarmate PAIs spiked into deionized water, investigated various initial pHs and UV light intensities. Results indicated the PAI concentration could be reduced to levels at or near the analytical limit of detection within minutes at low UV light intensities and at initial pHs between 7 and 9. Optimum treatment conditions have not yet been determined.

The preliminary results of this study indicate that ozone can achieve about the same degree of PAI reduction as chlorine. Chemical oxidation with ozone is usually more expensive than chemical oxidation with chlorine. However, ozone oxidation does not produce volatile toxic pollutants. When the cost of controlling those volatile toxic pollutants is added to the cost of alkaline chlorination, the total cost for chlorination may exceed the cost of ozone oxidation.

7.3.4 Resin Adsorption

Resin adsorption is a separation technology that may be used to extract and, in some cases, recover dissolved organic solutes from wastewater. Resins are typically microporous styrene-divinylbenzenes, acrylic esters, or phenol-formaldehydes. Each type may be produced in a range of densities, void volumes, bulk densities, surface areas, and pore sizes. The formaldehyde resins are granular, and the others are in the form of beads.

Resin adsorption involves two basic steps:

- The liquid waste stream is brought into contact with the resin, allowing the resin to adsorb the solutes from the solution; and
- The resin is regenerated by removing the adsorbed chemicals, often accomplished by simply washing with the proper solvent.

Caustic, formaldehyde, or solvents such as methanol, isopropanol, and acetone can accomplish regeneration of spent resin. Pesticide facilities have used solvents such as methanol. Batch distillation of regenerant solutions separate and return products to the process.

Resin adsorption is applicable for all members of the phenol family as well as amines, caprolactam, benzene, chlorobenzenes, and chlorinated pesticides; however, the cost of this technology may be prohibitive. The adsorption capacity of resins depends on the type and concentration of specific organics in the wastewater as well as the pH, temperature, viscosity, polarity, surface tension, and background concentrations of other organics and salts. As with carbon adsorption, the adsorptive capacity of resins increases as solubility of the pollutant decreases.

Resin adsorption is similar in nature to activated carbon with the main difference being that resins are chemically regenerated while carbon is usually thermally regenerated. A potential advantage of resins is that they are more easily tailored for removal and recovery of specific pollutants. However, resins generally have a lower adsorptive capacity than carbon, and are not likely to be competitive with carbon for the treatment of high volume waste streams containing moderate or high concentrations of mixed wastes with no recovery value. For this reason, resins have generally been restricted to application where few other treatment options have proven useful.

7.3.5 Solvent Extraction

Solvent extraction, also referred to as liquid-liquid extraction, involves the separation of the constituents of a liquid solution by contact with another immiscible liquid for which the impurities have a high affinity. The separation is based on physical differences that affect differential solubility between solvents and may be enhanced by adding reagents to cause a definite chemical reaction, increase the solubility of constituents in the solvent or decrease the solubility of constituents in water.

The end result of solvent extraction is to separate the original solution into two streams--a treated stream and a recovered solute stream (which may contain small amounts of water and solvent). Solvent extraction may thus be considered a recovery process because the solute chemicals are generally recovered for reuse of further treatment and disposal. The process for extracting a solute from solution will typically include three basic steps:

- Mixing of solvent with waste stream;
- Extraction and separation; and
- Recovery of solvent from the treated stream, either by distillation or steam stripping.

Solvent extraction generates a treated wastewater residual, which is discharged, and an extract, which in some cases may be recycled and reused. The use of solvent extraction as a unit process operation is common in the pesticide chemicals industry. Often, the process function and wastewater treatment function of solvent extraction are integrated as water contaminants are returned with the solvent to the process; in these cases, the facility often does not consider the extraction to be a treatment process, although the net result is to reduce total loading of pollutants discharged from the process. Solvent extraction is most effectively applied to segregated process streams where the potential for collecting specific residuals for reuse is greatest.

7.3.6 Distillation

Distillation is the separation of the constituents in a wastewater stream by partial vaporization of the mixture and separate recovery of vapor and residue. The main use of distillation in pesticide manufacturing operations is in the separation of alcohols used in the manufacture of esters of phenoxy-based PAIs from wastewaters. The alcohols can then be reused in future manufacturing, while the wastewater, once separated from alcohols and solvents, can be reused in the manufacture of salts of phenoxy PAIs, or in phenoxy product formulations. In this process, the phenoxy ester product is heated, driving off the alcohol and water. The alcohol is then condensed.

For non-phenoxy PAIs, distillation has been used to separate water from pesticide process streams as a final purification stage. Although the purity of the distillate will be a function of the volatility of the PAI, the distilled wastewater will normally have no detectable concentration of the PAI.

7.3.7 Membrane Filtration

Membrane filtration is a term applied to a group of processes that can be used to separate suspended, colloidal, and dissolved solutes from a process wastewater. Membrane filtration processes utilize a pressure driven, semipermeable membrane to achieve selective separations. Much of the selectivity is established by designations relative to pore size. The pore size of the membrane will be relatively large if precipitates or suspended materials are to be removed, or very small for the removal of inorganic salts or organic molecules. During operation, the feed solution flows across the surface of the membrane, clean water permeates the membrane, and the contaminants and a portion of the feed remain. The clean or treated water is referred to as the permeate or product water stream, while the stream containing the contaminants is called the concentrate, brine, or reject.

In a typical industrial application, the product water steam will either be discharged, or more likely, recycled back to the manufacturing process. The reject stream is normally disposed, but in those situations where the reject does not contain any specifically objectionable materials, it too can potentially be recycled back to the process. As an example, a reject stream from a system treating a wastewater generated from many different processes would likely have to be disposed. However, if the membrane system were used on a process where the wastestream contained only a specific PAI, the reject stream could possible be recycled back to the process. Depending on the characteristics of the wastewater and the type of process used, 50-95% of the feed stream will be recovered as product water.

Types of membrane filtration systems available include microfiltration, ultrafiltration (UF), and reverse osmosis (RO). Microfilters are generally capable of removing suspended and colloidal matter with diameters greater than 0.1 micron (3.94 x 10^{-6} inches). The systems can be operated at feed pressures of less than 50 psig. The feed stream does not require extensive pretreatment, and the membrane is relatively resistant to fouling and can be easily cleaned. A microfiltration system would not be an effective method of treatment unless the PAIs were insoluble or were attached to other suspended material in the wastewater. Microfiltration has been used in the pesticide industry in applications where an adsorbent material and/or flocculent is added prior to the membrane system. The PAIs are adsorbed or become attached to the floc which forms and is ultimately separated by the microfilter. Microfilters are capable of recovering up to 95% of the feed stream as product water.

Ultrafiltration is similar to microfiltration, with the difference being that a UF membrane has smaller pores. The "tightest" UF membrane is typically capable of rejecting molecules having diameters greater than 0.001 micron (3.94 x 10^{-8} inches) or nominal molecular weights greater than 2000. The systems operate at feed pressures of 50-200 psig. Some pretreatment may be necessary to prevent membrane fouling. UF systems would only be effective in removing PAIs which are insoluble or attached to other suspended material (most PAIs have molecular weights from 150 to 500 molecular weight units). For most UF designs, the introduction of adsorbents or flocculants to the feed stream is not recommended since they may plug the membrane module. UF systems are also capable of recovery of up to 90-95% of the feed as product water.

Reverse osmosis systems have the ability to reject dissolved organic and inorganic molecules. For organic (noncharged) molecules such as PAIs, membrane rejection is a function of the membrane pore size. Typically, membranes with a pore size of 0.0001 to 0.001 microns are used to remove PAIs. RO membranes have been shown to be capable of removing the majority of PAIs with molecular weights greater than 200. Unlike microfiltration and ultrafiltration, RO membranes are capable of rejecting inorganic ions. The mechanism for salt rejection is the electro-chemical interaction between the membrane and the constituents in the wastewater. Based on the strength of their ionic charge (valence), the ions are repelled from the charged surface of the membrane and will not pass through the pores. Although RO membranes may be rated based on molecular weight cutoff, they are normally rated on their ability to reject sodium chloride. Typical sodium chloride rejection for an industrial type membrane would be 90-95 percent.

RO systems used in industrial applications are designed to operate a feed pressures of 250-600 psig. RO membranes are very susceptible to fouling and may require an extensive degree of pretreatment. Oxidants which may attack the membrane, particulates, oil, grease, and other materials which could cause a film or scale to form must be removed by pretreatment. The RO product water stream will usually be of very high quality and suitable for discharge, or more importantly, reuse in the manufacturing process. Standard practice is to dispose of the reject stream. Dissolved solids present in the feed stream will be concentrated in the reject and will limit the opportunities for recycle. RO systems will be capable of recovering 50-90% of the feed as product water. The recovery that can be obtained as well as the required feed pressure to operate the system will be a function of the dissolved solids concentration in the feed.

The membranes used in the filtration process are made from a number of different materials. Microfiltration membranes are commonly made from woven polyester or ceramic materials. UF and RO membranes are fabricated from cellulose acetate, polysulfone, polyamide, or other polymeric materials. The most common material is cellulose acetate. Although cellulose acetate membranes are lower cost and not as susceptible to fouling, removal of some low molecular weight PAIs such as carbaryl, fluometuron, chloropropham, and atrazine have been shown to be only marginal. In addition, mass balances conducted for short-term tests have shown a significant amount of the PAI rejection may be due to adsorption to the membrane as opposed to rejection by it.

Bench- and pilot-scale studies have demonstrated excellent rejection (>99%) of a wide range of PAIs using thin-film composite (TFC) reverse osmosis membranes. TFC membranes usually consist of three distinct layers, a polyester support layer, a porous interlayer (polysulfone), and a proprietary ultrathin barrier coating (often polyamide). TFC membranes are more expensive and in some cases, more susceptible to fouling than cellulose acetate. For relatively clean wastestreams (no suspended solids or oil and grease), TFC membranes appear to represent an effective method of removing the target PAIs and producing a high quality product water stream. Bench- and/or pilot-scale testing is, however, recommended for most potential applications to ensure that the system will be properly designed to prevent or minimize membrane fouling which will negatively impact the performance of the system.

7.3.8 Biological Treatment

Biological treatment is a destruction technology in which toxic organic pollutants in wastewaters are degraded by microorganisms. These microorganisms oxidize soluble organics and agglomerate colloidal and particulate solids. This technology generates a waste biosludge.

Common forms of biological treatment include lagoons, activated sludge, and trickling filter systems. In lagoon systems, wastewater is biologically treated to reduce the degradable organics and also reduce suspended solids by sedimentation. The biological process taking place in the lagoon can either be aerobic or anaerobic, depending on the design of the lagoon. The activated sludge process is used primarily for the removal of organic material from wastewater. It is characterized by a suspension of aerobic and facultative microorganisms maintained in a relatively homogenous state by mixing or by turbulence induced by aeration. These microorganisms oxidize soluble organics and agglomerate colloidal and particulate solids in the presence of dissolved molecular oxygen. The trickling filter system is an attached-growth biological system based on trickling wastewater over the surface of a biological growth on solid media (usually rock, wood, or plastic). Trickling filters are effective for the removal of suspended or colloidal materials, but less effective for the removal of soluble organics.

Biological treatment (including aerated lagoons, activated sludge, and trickling filter systems) is most effective on those priority pollutants which are effectively adsorbed onto the suspended solids in the system, where biological activity occurs, and are readily biodegradable. The mechanism of pollutant removal may be one or more of the following:

- Biological degradation of the pollutant;
- Adsorption of the pollutant onto sludge with is separately disposed; or
- Volatilization of the pollutant into the air (in the case of aerated systems).

In the last two cases, the pollutant is simply transferred from one medium to another, rather than actually being "removed." Some pollutants may require specially acclimated biomass and/or longer detention times to be effectively removed by biological treatment. In these cases, in-plant biological treatment can be an effective and potentially less costly alternative to carbon adsorption technology for control of these priority pollutants and PAIs.

7.3.9 Evaporation

Evaporation occurs when a solvent, usually water, vaporizes from a solution or slurry, and completion of the evaporation process results in drying. This technology can be used to vaporize off water, thereby concentrating the solute in the remaining solution, and is related to distillation, sublimation, and stripping, because they are all processes based on the common principles of vaporization.

In spray evaporation, or drying, a wet slurry is converted to a vapor, which is released, and a dry, free flowing powder, which may be recovered as product or disposed of as waste. A spray evaporation/drying treatment system normally consists of a drying chamber. The waste slurry is injected into the chamber through an atomizer which disperses the stream. A cyclone is created by injecting a high flow warm air stream countercurrent to the atomized slurry. In the spray drying chamber, the solids settle out of the air while the moisture is evaporated.

The solids which settle out of the primary and secondary chambers of the spray evaporation system may be either pesticide product ready for formulation and packaging, or a solid waste stream requiring disposal or recycle. The water vapors are extracted from the primary chamber, filtered to further remove particulate in the secondary chamber, and then exhausted to the atmosphere, generating no wastewater. If the solvent is not water, it is necessary to condense or scrub the vapors to prevent hazardous air emissions.

This technology is appropriate for separation of non-volatile and insoluble PAIs from manufacturing wastewaters or from process solvents. It is not appropriate for wastewater streams containing volatile organic priority pollutants or cyanide, unless air pollution control devices are added to the exhaust prior to venting to the atmosphere.

One pesticide manufacturer currently uses spray evaporation for the control of effluents from two pesticide active ingredients. However, sufficient data are not available to estimate the amount of PAI discharge eliminated through the use of this technology.

7.3.10 Chemical Precipitation/Filtration

Chemical precipitation is a separation technology in which the addition of chemicals during treatment results in the formation of insoluble solid precipitates from the organic or inorganic compounds in the wastewater. Polishing filtration then separates the solids formed from the wastewater. Chemical precipitation is generally carried out in four phases:

1. Addition of the chemical to the wastewater;
2. Rapid (flash) mixing to distribute the chemical homogeneously into the wastewater;

3. Slow mixing to promote particle growth by various flocculation mechanisms; and

4. Filtration to remove the flocculated solid particles.

Chemical precipitation is used frequently as a technology to remove metals from industrial wastewaters. Chemical reagents are added to the wastewater during treatment leading to the formation of insoluble solid precipitates from the organic or inorganic compounds in the wastewater. The precipitated metals may then be removed by physical means such as sedimentation, filtration, or centrifugation.

Hydroxide precipitation is the conventional method of removing metals from wastewater. Reagents such as slaked lime ($CA(OH)_2$) or sodium hydroxide are added to the wastewater to adjust the pH to the point where metal hydroxides exhibit minimum solubilities and are precipitated. Sodium hydroxide is more expensive than lime, but generates a smaller volume of hydroxide sludge. Hydrogen sulfide, ferrous sulfide, or soluble sulfide salts, such as sodium sulfide, are used to precipitate many heavy metal sulfides. Because most metal sulfides are even less soluble than metal hydroxides at alkaline pH levels, greater metal removal can often be accomplished through the use of sulfide rather than hydroxide as a chemical precipitant. However, sulfide treatment may be more difficult to use due in part to the possibility of evolution of highly toxic hydrogen sulfide gas. Carbonate precipitation is another method of removing metals from wastewater by adding carbonate reagents such as calcium carbonate to the wastewater to precipitate metal carbonates.

Chemical precipitation is an effective technique for removing metals from industrial wastewaters. This technology operates at ambient conditions and is well suited to automatic control. Hydroxide precipitation removes metal ions such as antimony, arsenic, trivalent chromium, copper, lead, mercury, nickel, and zinc. Sulfide precipitation can be used to remove mercury, lead, and silver while carbonate precipitation removes antimony and lead from wastewater.

7.3.11 Chemical Reduction

Reduction is a chemical reaction in which electrons are transferred to the chemical being reduced from the chemical initiating the transfer (the reducing agent). Sulfur dioxide, sodium bisulfite, sodium metabisulfite, and ferrous sulfate form strong reducing agents in aqueous solution and are often used in industrial waste treatment facilities for the reduction of hexavalent chromium to the trivalent form.

In the pesticides industry, chemical reduction has been used to treat wastewaters containing an alkyl halide PAI. The PAI is reduced with the addition of sodium bisulfite and ultraviolet light (i.e., sunlight).

7.3.12 Coagulation/Flocculation

Coagulation and flocculation are commonly used in conjunction to enhance settling of suspended particles ranging in size from those particles large enough to settle readily to those small enough to remain suspended. Coagulation is the chemical destabilization of the particles and flocculation is the physical process that agglomerates particles (too small for gravitational settling) so that they may be successfully removed in subsequent settling processes such as sedimentation, clarification, or filtration.

Coagulation is the process of destabilizing colloidal particles so that particle agglomeration can occur during flocculation. Chemical coagulants are typically added to the wastewater in a rapid-mix tank to ensure that they are dispersed in the wastewater stream as rapidly as possible. Commonly used coagulants are those which are iron or aluminum-based (such as alum), lime, and polymers. For a given wastewater, optimum coagulation conditions depend on various factors including pH, temperature, chemical composition of the wastewater, mixing conditions, and most importantly, the coagulant used.

Flocculation is a separation technique where the wastewater is agitated in order to cause very small suspended particles to collide and agglomerate into larger, heavier particles or flocs and settle out. A common type of flocculator used today is the paddle flocculator employed in a series of flocculation chambers. The paddle gently agitates the water causing the collision of the floc particles with one another, and the chambers lead to laminar flow conditions to prevent floc destruction while providing sufficient mixing to achieve floc formation.

Coagulation and flocculation are commonly used in the pesticide manufacturing industry to remove metallo-organic PAIs and the metallic byproducts of metallo-organic PAI manufacture from process wastewaters.

7.3.13 Incineration

Incineration is a destruction technology which involves heating wastes to high temperatures in order to destabilize chemical bonds and destroy toxic organic pollutants. Incineration is actually a combination of oxidation and pyrolysis, both of which involve chemical changes resulting from heat. Oxidation involves reaction with oxygen, while pyrolysis refers to rearrangement or breakdown of molecules at high temperatures in the absence of oxygen. A controlled incineration process oxidizes solid, liquid, or gaseous combustible wastes to carbon dioxide, water, and ash. Common types of incinerators are rotary kiln, multiple hearth, liquid injection, fluidized bed, and pyrolysis. This technology typically generates ash and scrubber water, although liquid injection incinerators typically generate only scrubber water.

In the pesticide chemicals industry, incinerators destroy wastes containing compounds such as: hydrocarbons, chlorinated hydrocarbons, sulfonated solvents, and pesticides. Sulfur and nitrogen-containing compounds will produce their corresponding oxides and should not be incinerated without consideration of the effect on air quality. Halogenated hydrocarbons may not only affect the air quality but may also corrode the incinerator surfaces.

7.3.14 Stripping

Steam stripping is a separation technology that removes relatively volatile compounds from a wastewater by the passage of steam through the wastewater. The stripped volatiles are usually processed further by recovery or incineration. This technology generates air emissions from the stripping treatment (which may be condensed to other liquid streams).

Steam stripping is essentially a fractional distillation of volatile components from a wastewater stream. The volatile component may be a gas or an organic compound that is soluble in the wastewater stream. This treatment technology also removes water immiscible compounds such as chlorinated hydrocarbons. Steam stripping employs super-heated steam to remove volatile pollutants of varying solubility in wastewater. Specifically, the technology involves passing super-heated steam through a preheated wastewater stream column packed with heat resistant packing material or metal trays in counter-current fashion. Removal of the volatile compounds of the wastewater stream occurs because the organic volatiles tend to vaporize into the steam until the compound's concentration in the vapor and liquid phases (within the stripper) are in equilibrium.

The amount of volatiles that can be removed and the effluent pollutant concentration levels that can be attained by a steam stripper are a function of the height of the stripping column, the amount of packing material and/or the number of metal trays in the column, and the steam pressure in the column. After the volatile pollutant is extracted from the wastewater into the superheated steam, the steam is condensed to form two layers of immiscible liquids--the aqueous and volatile layers. The aqueous layer is recycled back to the steam stripper influent feed stream because it may still contain low levels of volatile compounds. The volatile layer is recycled to the process or disposed of, depending on the specific plant's requirements.

Steam strippers are designed to remove individual volatile pollutants based on a ratio of their aqueous solubility (tendency to stay in solution) to vapor pressure (tendency to volatilize). This ratio is known as the Henry's Law Constant. The column height and diameter, amount of packing or number of trays, the operating steam pressure, and the temperature of the heated wastewater feed of a steam stripper are varied according to the strippability (using Henry's Law Constant) of the volatile pollutants to be removed. Volatile compounds with lower Henry's Law Constants require greater column height, more trays or packing material, greater steam pressure and temperature, more frequent cleaning, and generally more careful operation than do volatiles with higher strippability. (For a further description of steam stripping technology, see the final OCPSF rule, 52 FR 42540, and Section 7 of the OCPSF Technical Development Document, EPA 440/1-87/009, October 1987).

7.3.15 Pre- or Post-Treatment

The pesticide chemicals manufacturing industry uses equalization, neutralization, and/or filtration to pre- or post-treat process wastewaters.

Equalization

Equalization dampens flow and pollutant concentration variation of wastewater prior to subsequent downstream treatment. By reducing the variability of the raw waste loading, equalization can significantly improve the performance of downstream treatment processes that are more efficient if operated at or near uniform hydraulic, organic, and solids loading rates. Increased treatment efficiency reduces effluent variability associated with slug raw waste loadings. Equalization is accomplished in a holding tank or a pond. The retention time of the tank or pond should be sufficiently long to dilute the effects of any highly concentrated continuous flow or batch discharges on treatment plant performance.

Neutralization

Neutralization adjusts either an acidic or a basic waste stream to a more neutral pH. Neutralization of acidic or basic waste streams is used in the following situations:

- To enhance precipitation of dissolved heavy metals;
- To prevent metal corrosion and damage to other construction materials;
- As a preliminary treatment allowing effective operation of the biological treatment process;
- To provide neutral pH water for recycle uses; and,
- To reduce detrimental effects on a facility's receiving water.

Neutralization may be accomplished in either a collection tank, rapid mix tank, or equalization tank by commingling acidic and alkaline wastes, or by the addition of chemicals. Alkaline wastewaters are typically neutralized by adding sulfuric or hydrochloric acid, or compressed carbon dioxide. Acidic wastewaters may be neutralized with limestone or lime slurries, soda ash, or caustic soda. The selection of neutralizing agents depends upon cost, availability, ease of use, reaction by-products, reaction rates, and quantities of sludge formed. The most commonly used chemicals are lime (to raise the pH) and sulfuric acid (to lower the pH).

Filtration

Filtration is a separation technology designed to remove solids from a wastewater stream by passage of most of the wastewater through a septum or membrane that retains the solids on or within itself. Filters can be classified by the following factors:

- The driving force (i.e., the manner by which the filtrate is induced to flow, either by gravity or pressure);

- The function (i.e., whether the filtrate or the filtered material is the product of greater value);
- The operating cycle (i.e., whether the filter process occurs continuously or batchwise);
- The nature of the solids (i.e., the size of the particles being filtered out); and
- The filtration mechanism (i.e., whether the filtered solids are stopped at the surface of the medium and pile up to form a filter cake or are trapped within the pores or body of the filter medium).

7.3.16 Disposal of Solid Residue from Treatment

Many of the wastewater treatment processes discussed in previous parts of this section generate solid residues (i.e., sludges). Treatment processes generating sludges include biological treatment, chemical precipitation, and coagulation/flocculation treatment. Sludge is treated prior to disposal to reduce its volume and to render it inoffensive (i.e., less odorous). Sludge treatment alternatives include thickening, stabilization, conditioning, and dewatering. Sludge disposal options include combustion and disposal to land.

Sludge Treatment Alternatives

Sludge thickening is the first step in removing water from sludges to reduce their volume. It is generally accomplished by physical means, including gravity settling, flotation, and centrifugation. Stabilization makes sludge less odorous and putrescible, and reduces the pathogenic organism content. The technologies available for sludge stabilization include chlorine oxidation, lime stabilization, heat treatment, anaerobic digestion, and aerobic digestion. Conditioning involves the biological, chemical, or physical treatment of a sludge to enhance subsequent dewatering techniques. The most common methods used to condition sludge are thermal and chemical conditioning. Dewatering is the removal of water from solids to achieve a volume reduction greater than that achieved by thickening. This process is desirable for preparing sludge for disposal and for reducing the sludge volume and mass to achieve lower transportation and disposal costs. Some common dewatering methods include filtration in a vacuum filter, filter press, or belt filter, centrifugation, thermal drying in beds, and drying in lagoons.

Sludge Disposal Alternatives

Combustion serves as a means for the ultimate disposal of organic constituents found in sludge. Some common equipment and methods used to incinerate sludge include fluidized bed reactors, multiple hearth furnaces, atomized spray combustion, flash drying incineration, and wet air oxidation. Environmental impacts of combustion technology that should be considered include discharges to the atmosphere (particles and other toxic or noxious emissions), to surface waters (scrubbing water), and to land (ash).

The disposal of sludge to land may include the application of the sludge on land as a soil conditioner and as a source of fertilizer for plants. This is typically used with sludges from biological treatment systems. In addition, sludge can be stockpiled in landfills or permanent lagoons. In selecting a land disposal site, consideration must be given to guard against pollution of groundwater or surface water supplies.

7.4 TREATMENT PERFORMANCE DISCUSSION

EPA has collected and evaluated data available on potential BAT treatment technologies for the pesticide chemicals manufacturing industry. The following technologies are discussed in more detail, specifically in reference to PAI treatment performance: carbon adsorption, hydrolysis, chemical oxidation/ultraviolet decomposition, resin adsorption, solvent extraction, distillation, biological treatment, oxidation/reduction and physical separation, and incineration.

7.4.1 Carbon Adsorption

In the pesticide manufacturing industry, activated carbon adsorption is or has been used to treat PAIs in the following structural groups: acetanilides, acetamides, benzonitriles, carbamates, phenols, phosphorodithioates, pyridines, pyrethrins, s-triazines, tricyclic, toluidines, and ureas. In addition, EPA and industry treatability studies have demonstrated sufficient treatability of pesticides in the terephthalic acid and uracil structural groups using carbon to establish this treatment as a basis for control of specific PAIs in these groups. Carbon has also been shown in industry treatability studies to be an effective polishing control for thiocarbamate PAIs, although insufficient information currently exists to establish limitations.

Based on long-term concentration data achieved using activated carbon adsorption, final limitations are based on activated carbon adsorption technology for individual PAIs in the following structural groups: acetanilides, aryl halides, benzonitrils, bicyclics, phenols, phosphorothioates, phosphorodithioates, pyrethrins, toluidines, and ureas. Plants incorporating activated carbon adsorption into their PAI treatment train currently achieve an average of 99.97% removal of the PAI loadings from their discharges. These systems currently account for the prevention of the discharge of approximately 430,000 pounds of pesticide active ingredient per year.

One method of evaluating the performance of a treatment system in removing pesticide active ingredients is to compare the long-term mean effluent concentration of the PAI in the treated effluent with the detection limit for the PAI in the sample matrix. For pesticide active ingredients treated using activated carbon adsorption in treatment systems achieving BAT performance levels, the long-term average to detection limit (LTA/MDL) ratio varies from 3.19 to 26.0 (i.e., for these compounds, the average concentration following treatment ranged from 3.19 to 26 times the minimum detection limit for the compound in the effluent). The use of this factor allows for the comparison of different applications of activated carbon treatment. For example, a dedicated activated carbon treatment unit prior to dilution at the process area may achieve excellent percent removals but still have an effluent concentration orders of magnitude higher than the concentration following mixing and dilution with non-pesticide contaminated streams. However, the minimum detection limit for the process discharge will reflect the ability to treat and monitor treatment performance levels in the specific matrix, and therefore indicates the bottom concentration limit at which efficient treatment system operation can be maintained.

Data were collected from plant supplied long-term monitoring data, when activated carbon influent and effluent data were both available, and from EPA sampling data. Removal efficiency by group varies from 99.97% for aryl halides, to 86.3% for synthetic pyrethrins.

In addition to the PAI being treated, a number of factors can affect the efficiency of the carbon systems. Both the efficiency and cost effectiveness of activated carbon can be enhanced if the carbon treats wastewater from a single process, and if PAI contaminated and non-PAI contaminated process streams are further segregated. This is because of the types of competitive effects which will occur between adsorption of various compounds in complex wastewater matrices. In systems where a dedicated activated carbon adsorption step was the first stage used in removing the PAI from the wastewater, an average of 99.2% removal was achieved across all PAIs.

When carbon was used as a polishing treatment following other PAI removal treatment technologies, the average removal dropped to 84.5%, due to the greatly reduced initial concentration of PAI. However, while the calculated efficiency of removing PAIs from less contaminated streams decreases, for those PAIs using carbon as a polishing step very low effluent concentrations were achieved in the carbon effluent.

Using an activated carbon system dedicated to removal of a specific PAI from the undiluted process discharge will also improve efficiency, as the pH and the rate of carbon bed changes can be optimized to remove the targeted compound. For example, for all PAIs being treated in a process-specific carbon system, average removals of 97.4% were achieved, with a median of 99.1% removal. However, when PAI wastewaters were intermingled prior to carbon adsorption, removal average efficiencies fell to 88.9%, with a median of 90.0 percent.

In the case of many of the PAIs which are or have been treated using carbon, expediency has appeared to drive treatment system selection rather than optimal system design. For example, wastewaters from the manufacture of phenoxy, carbamate, and phosphorothioate PAIs which can be readily hydrolized at alkaline conditions have been treated using activated carbon. Industry-wide, 89.15% removal of phosphorothioates is achieved using activated carbon in BAT systems; however, for those phosphorothioates treated in dedicated systems the removal efficiency through the use of activated carbon improves to 99.07 percent. Operating activated carbon treatment systems have achieved removal efficiencies of 99.87 - 99.99% for carbamate PAIs and 99.95% for phenoxy PAIs. However, for both of these groups, BAT data has been collected based on other, less expensive treatment technologies. In those cases, carbon may have been chosen originally because of its ability to remove other pollutants of concern from the wastewater, or because of an incomplete assessment of treatment options. Due to the cost of carbon regeneration or replacement the use of activated carbon to treat high volume streams is often a more expensive option than other physical-chemical treatment methods. Therefore an evaluation of other treatment technologies may result in a system which provides equal performance at a lower cost.

7.4.2 Hydrolysis

Hydrolysis has been identified as the most effective technology for achieving high levels of destruction of pesticide active ingredients in the carbamates and organophosphate structural groups. This technology has been demonstrated at a number of manufacturing facilities, and in both EPA and industry-supplied treatability studies.

Depending on the retention time, the temperature, and the pH, PAI treatment systems based on hydrolysis can have excellent performance. For facilities currently including hydrolysis as a stage in their wastewater treatment system, an average of 99.55% removal of the PAI is achieved through treatment. These systems proved capable of reducing the amount of PAI in wastewater to the extent that the average of the LTA effluent concentrations for facilities using hydrolysis as a PAI treatment technology was 2.69 times the minimum detection limit for the individual PAI. At many of the facilities, no PAI was measured above the detection limit in more than half the sample results reported.

The EPA reviewed published sources for information on hydrolysis, and documented the half-lives and effluent concentrations demonstrated at different temperatures and pHs. In these studies, data with both experimental conditions and half-lives reported were available for 96 of the PAIs covered in this regulatory study. The EPA sponsored treatability studies at more uniformly controlled conditions on PAIs for which hydrolysis appeared to be a potential BAT technology. Hydrolysis proved highly effective in destroying most of the targeted PAIs in aqueous solutions. For 30 of 36 PAIs tested in the phosphate, phosphorothioate, phosphonothioate, and carbamate structural groups, a half-lives of less than 1/2 hour were achieved by treating the PAI at temperatures of 60°C and a pH of 12. Confidential industry data also supports the use of hydrolysis for the treatment of a number of PAIs.

EPA is using hydrolysis as the technology basis for a number of PAIs which are not currently treated using this technology, but for which treatability studies have demonstrated excellent destruction of the PAIs.

7.4.3 Chemical Oxidation/Ultraviolet Decomposition

Chemical oxidation has been demonstrated by industry to be effective at destroying alkyl halide, DDT-type, phenoxy, phosphorothioate, and dithiocarbamate PAIs in manufacturing wastewaters. For those facilities currently incorporating chemical oxidation in their PAI treatment train, an average of 99.42% destruction of PAI is achieved.

While PAIs in a number of these groups may be treated using other technologies, the use of chemical oxidation is an excellent candidate for the treatment of dithiocarbamate PAIs. Based on the EPA treatability studies that were conducted, the dithiocarbamate PAIs do not appear to be uniformly treatable through the use of activated carbon adsorption. While these compounds are readily hydrolyzable at acidic conditions, a byproduct of the acidic hydrolysis reaction is carbon disulfide gas, which could result in dangerous conditions due to the highly flammable nature of this gas.

The EPA performed treatability studies on a number of actual process wastewater samples containing dithiocarbamate PAIs using alkaline chlorination as a treatment technology. All dithiocarbamates tested proved amenable to destruction through alkaline chlorination. However, during sampling at a facility which utilized alkaline chlorination to treat dithiocarbamate PAIs, the EPA found that this treatment technology is capable of generating chlorinated priority pollutants. Therefore, in assessing the economic impacts of the use of alkaline chlorination to treat dithiocarbamates, the EPA projected the use of steam stripping for the removal of chlorinated organics. EPA also conducted treatability studies on technologies which are not currently used in the pesticide manufacturing industry using ozonation and ultraviolet light catalyzed ozonation to initiate oxidation of dithiocarbamates in water. The use of ozonation would prevent the generation of halocarbons, and thus eliminate the need for the use of additional priority pollution control technologies. The ozone and UV catalyzed ozone treatability studies conducted so far indicate that ozone can achieve about the same degree of PAI reduction as chlorine.

7.4.4 Resin Adsorption

Resin adsorption is currently used to treat specific pesticide active ingredients which have not proved amenable to other treatment technologies. The technology is similar to activated carbon, in that the resin removes the pollutant from the wastewater stream, rather than destroying it, and therefore will become saturated with the PAI over time. However, regeneration of resin can be performed in place by washing the resin with a solvent designed to dissolve and remove the PAI from the treatment unit. To ensure adequate performance, it is critical that the resin be regenerated on a sufficient frequency.

BAT treatment systems relying on resin adsorption achieve around 97% removal of the pesticide active ingredient from the water and achieve very low discharge concentrations ranging from 3 to 32 ppb PAI in the treated effluent. BAT is being promulgated based on resin adsorption for those PAIs for which actual plant operating data on resin adsorption is available. Because this technology is very specific to both the PAI and the wastewater matrix being treated (high levels of other contaminants can quickly foul resins and degrade performance), EPA did not select resin adsorption as a BAT technology for those PAIs where no plant performance data currently exists.

7.4.5 Solvent Extraction

Solvent extraction is used by a number of facilities to remove PAIs from high concentration process brines, either prior to additional treatment or by itself. As the use of solvent extraction on wastewaters prior to discharge from the manufacturing unit is often considered a process stage rather than a treatment stage, long-term data does not exist on the treatment performance of these systems. During EPA sampling episodes, the influents and effluents from many solvent extraction systems were sampled; an average PAI removal of 86.1% was achieved.

There were wide differences in performance, as percent removals ranged from 58% to 99.85%, while achievable concentrations ranged from less than 9 ppb up to 50 ppm for individual units. This variation has to do with the mechanism of solvent extraction, the solvents used and PAIs removed, as well as the design factors (contacting method, decanting method, etc.) for each unit. Solubility has the greatest impact on the system performance, as the minimum achievable concentration of PAI in the wastewater is a function of the solubility of the PAI in both the water and the solvent. If the solvent extraction system has sufficient contact time between the solvent and the wastewater, a very consistent effluent concentration will be achieved, as the system will reach an equilibrium between the PAI concentration in the wastewater and solvent phases. The EPA received data on one PAI which demonstrated that solvent extraction alone, without other downstream treatment technologies, could achieve BAT performance levels. Because sufficient contact time must be maintained to ensure optimal system performance, the EPA has projected costs for additional equalization capacity where necessary for those facilities expected to comply with BAT/PSES guidelines through the use of existing solvent extraction systems.

As the effective use of solvent extraction as a treatment stage is highly dependent on the configuration of the process and the type of PAI, the EPA is not promulgating solvent extraction as a technology basis for any PAIs not currently being treated through extraction. However, in a proper application solvent extraction has the potential for reducing the loading to other treatment systems, as well as to achieve economic benefits through the recovery of product and raw materials.

7.4.6 Distillation

Distillation is the separation of the constituents in a wastewater stream by partial vaporization of the mixture and separate recovery of vapor and residue. The main use of distillation in pesticide manufacturing operations is in the separation of alcohols used in the manufacture of esters of phenoxy-based PAIs from wastewaters. The alcohols can then be reused in future manufacturing, while the wastewater, once separated from alcohols and solvents, can be reused in the manufacture of salts of phenoxy PAIs or salts of other PAIs where any possible residual of the phenoxy PAI would not interfere with the maketability of the other PAI, or in phenoxy product formulations. In this process, the phenoxy ester product is heated, driving off the alcohol and water, and the alcohol is then condensed separately from the water. Currently operational systems have demonstrated the ability to generate a water stream containing the phenoxy product which is almost completely free of alcohol, and can therefore either alone or through blending meet the water specifications necessary for use in product formulations.

For non-phenoxy PAIs, distillation has been used to separate water from pesticide process streams as a final purification stage. Although the purity of the distillate will be a function of the volatility of the PAI, the distilled wastewater will normally contain no detectable concentrations of the

PAI. The remaining solution can then be recycled into the process, or disposed as a hazardous waste.

The EPA received no effluent monitoring data for use in evaluating the performance of systems using distillation to eliminate the discharge of pesticide wastewaters. In systems where distillation and complete recycle is practiced, no wastewater is discharged from the process, and therefore no monitoring is required. For those facilities relying on distillation to separate PAI from the wastewater so that the water may be discharged, monitoring pesticide concentrations in the wastewater is not currently required.

7.4.7 Biological Treatment

In the case of one pesticide active ingredient, biological treatment has been demonstrated to achieve PAI removals of greater than 98% PAI during biological oxidation. EPA does not have data demonstrating that activated carbon, hydrolysis or other physical-chemical treatment will achieve significant additional removals of that PAI. Therefore, EPA selected biological treatment as BAT technology for that PAI. However, few PAIs demonstrate this amount of biodegradability. This level of success using biological treatment in treating pesticide wastewaters required the proper acclimatization of the biomass to the PAI being controlled, as well as significant attention to design and maintenance of proper hydraulic loading rates to the biological treatment system.

7.4.8 Oxidation/Reduction and Physical Separation

For wastewaters contaminated with pesticides based on metal ions, removal of the PAI can often be best achieved through the addition of chemicals which enhance the ability of the PAI to be removed through physical separation technologies such as settling or filtration. In the case of wastewaters containing organo-tin compounds, this can be achieved through reacting the organo-tin complex with an oxidizing agent, thereby creating a tin molecule which will settle out as a solid. In addition, the oxidizing agents may react with other metals in the wastewater, thereby creating other insoluble metal complexes which will scavenge unoxidized organotin compounds during settling. Removal of organo-tins can also be enhanced through the use of cationic polymers in combination with the oxidation step.

Industry treatability and operating data demonstrates that oxidation/settling is an effective method for treating organo-tin compounds. Removal efficiencies of up to 99.5% have been achieved on a long-term basis using this technology.

7.4.9 Incineration

A number of pesticide manufacturing facilities currently utilize on-site incineration as the primary method for disposing of all PAI contaminated wastewaters. Properly operated incineration systems can be capable of achieving 99.99% destruction of the PAI in wastewater streams. While the PAIs and other pollutants of concern are virtually destroyed, an effluent stream is generated from the scrubber on the incinerator overheads. Trace amounts of PAIs remain in the scrubber discharges.

7.5 EFFLUENT LIMITATIONS DEVELOPMENT FOR PAIs

This section discusses the development of effluent limitations guidelines and standards for PAIs in Subcategory A of the pesticide chemicals manufacturing industry. This section also presents those cases where limitations requiring no discharge of process wastewater pollutants are contained in the final rule and discusses options available for compliance with these zero-discharge standards.

EPA identified two regulatory options for consideration to reduce the discharge of PAIs by organic pesticide chemicals manufacturers. Option 1 would base BAT, NSPS, PSES and PSNS limitations on the efficacy of hydrolysis, activated carbon, chemical oxidation, resin adsorption, biological treatment, solvent extraction, and/or incineration to control the discharge of PAIs in wastewater, as demonstrated by either industry monitoring data or by treatability studies. Also, certain PAIs would be subject to zero-discharge limitations based on closed-loop recycling or on no water use or generation in the process. Option 2 would require zero discharge of pesticide manufacturing wastewater pollutants by PAI manufacturers, based on the use of on-site or off-site incineration and/or recycle and reuse.

The Agency is promulgating the BAT and PSES limitations for Subcategory A plants based upon Option 1. Option 1 will greatly reduce pollutants discharged into the environment while avoiding cross-media transfer of pollutants that might occur under Option 2 and incorporating recycle/reuse technologies where possible. The pollutants that are removed under this option (and that are not recycled or reused) will be removed or destroyed by the BAT treatment technologies. This option will have minimal economic impacts and is deemed to be economically achievable.

The Agency rejected Option 2 because it was determined not to be economically achievable and because of the cross-media implications of the transfer of pollutants for off-site disposal that might occur through industry's efforts to meet a zero discharge limitation for all PAIs. However, a zero discharge requirement is promulgated for certain PAIs under Option 1 where zero discharge has been demonstrated to be achievable through water recycle/reuse or the lack of water use.

The new source performance standards (NSPS and PSNS) are based on Option 1 as is BAT and PSES, however, the limitations are also based on a 28% flow reduction for most PAIs. The Agency found that an average wastewater volume flow reduction of 28% has been demonstrated at newer facilities for similar production processes (see Section 7.5.3).

Sections 7.5.1 through 7.5.6 provide a detailed discussion of the steps followed in the determination of effluent limitations guidelines and standards for PAIs. These steps include:

- Statistical analysis of long-term self-monitoring data (Section 7.5.1);
- Calculation of effluent limitations guidelines under BAT (Section 7.5.2);
- Calculation of effluent limitations guidelines under NSPS (Section 7.5.3);
- Analysis of POTW pass-through for PAIs (Section 7.5.4); and
- Calculation of effluent limitations guidelines under PSES and PSNS (Section 7.5.5).

Where long-term self-monitoring data are available, the calculation for the daily production-based limitation was performed by: (1) fitting daily PAI concentration data to a modified delta-lognormal distribution, the same statistical procedure that was used in the OCPSF rulemaking, (2) estimating the 99th percentile of PAI concentration from the fitted distribution of daily concentration measurements, (3) multiplying the estimated 99th percentile of concentration by daily average flow, and (4) dividing the result by daily average production to give the daily production-based limitation. The 4-day average production-based limitation was calculated similarly except that, by definition for 4-day average limitations, the 95th percentile of the distribution of 4-day average values was substituted for the 99th percentile of daily concentration measurements. The 4-day average is equivalent to the monthly average because EPA assumed weekly (four times per month) monitoring to demonstrate compliance. These procedures are discussed in the following section.

7.5.1 Statistical Analysis of Long-Term Self-Monitoring Data

This subsection describes the statistical approach that was applied to the industry-submitted long-term pesticides pollutant data to estimate long-term averages and variability factors.

Many manufacturers who responded to the Facility Census submitted data on concentrations of PAIs measured in process wastewater. To develop concentration-based limitations and variability factors, EPA modeled the concentration data for each plant-PAI combination using a modification of the delta-lognormal distribution. This distribution was chosen because the data for most PAIs consisted of a mixture of measured (i.e., detected) values and nondetects. The modified delta-lognormal assumes that all nondetects occur at the detection limit and that the measured concentrations follow a lognormal distribution (i.e., the logarithms of the measured data are normally distributed). The modified delta-lognormal[1] distribution is identical to a lognormal distribution if there are no nondetects in the data.

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[1] This modification of the delta-lognormal distribution was used by EPA in establishing limitations for the Organic Chemicals, Plastics, and Synthetic Fibers point source category.

The mean, variance, 99th percentile, daily variability factor, and the four-day variability factor were estimated by fitting the concentration data to the modified delta-lognormal distribution. The estimated 99th percentile of the distribution provides the concentration-based daily maximum limitation for each plant-PAI combination. The daily variability factor is a statistical quantity that is defined as the ratio of the estimated 99th percentile of a distribution divided by the expected value of the distribution. Similarly, the four-day variability factor is defined as the estimated 95th percentile of the distribution of four-day means divided by the expected value of the four-day mean.

The modified delta-lognormal model is a mixture distribution in which all the detected concentrations follow a standard lognormal distribution (i.e., the logarithm of the concentration is normally distributed with mean μ and standard deviation σ), and all the nondetects are assumed to have a concentration value equal to the detection limit. The cumulative distribution function, which gives the probability that an observed concentration (C) is less than or equal to some specified level (c), can be expressed as a function of the following quantities:

D = the detection limit,

δ = the probability of a nondetect,

I(c-D) = an indicator function which equals 1 for c ≥ D and 0 otherwise,

μ = the mean of the distribution of log transformed concentrations,

σ = the standard deviation of the distribution of log transformed concentrations,

y = variable of integration.

The equation of the cumulative distribution function is as follows:

$$F(c) = P(C \le c) = \delta I(c-D) + (1-\delta)\frac{1}{\sqrt{2\pi\sigma^2}}\int_0^c \frac{1}{y}\exp\left(-\frac{(\ln(y)-\mu)^2}{2\sigma^2}\right)dy. \tag{1}$$

The expected value E(C) of the concentration under this distribution function is given by

$$E(C) = \delta D + (1-\delta)\exp\left(\mu+\frac{\sigma^2}{2}\right), \tag{2}$$

and the variance V(C) is given by the following expression:

$$V(C) = (1-\delta)\exp(2\mu+\sigma^2)[\exp(\sigma^2)-(1-\delta)] + \delta(1-\delta)D[D-2\exp(\mu+\frac{\sigma^2}{2})]. \tag{3}$$

The 99th percentile of the distribution can be expressed in terms of μ, σ, and the inverse normal cumulative distribution function (Φ^{-1}), as follows:

$$C_{99} = \max\left(D, \exp\left(\mu+\sigma\Phi^{-1}\left(\frac{0.99-\delta}{1-\delta}\right)\right)\right). \tag{4}$$

Finally, the daily variability factor VF(1) is defined as the 99th percentile divided by the mean:

$$VF(1) = \frac{C_{99}}{E(C)} \tag{5}$$

To estimate daily variability factors for each plant-PAI dataset, the following calculations were performed. The estimate, $\hat{\mu}$, of the log mean was calculated by taking the arithmetic average of the log transformed detects. The estimate, $\hat{\sigma}$, of the log standard deviation was calculated by taking the sum of the squared differences between the log concentrations and $\hat{\mu}$, divided by the number of detects minus one. The estimated probability of a nondetect, $\hat{\delta}$, was calculated by dividing the number of nondetects by the number of observations. These quantities were then substituted into equations (2) and (4) to give estimates $\hat{E}(C)$ and $\hat{C}_{99}$ of the mean concentration and the 99th percentile, respectively. Finally, the resulting estimated mean and 99th percentile were substituted into equation (5) to yield the daily variability factor estimate, $\hat{V}F(1)$.

In developing limitations, EPA used statistical estimates of upper percentiles of the distributions fit to the concentration data sets.[2] For the daily maximum limitation, EPA used the product of the estimated 99th percentile of the distribution of the daily concentration data, and the average daily flow, divided by the average daily production. For the monthly average limitation, EPA used the product of the 95th percentile of the distribution 4-day averages of the concentration data, and the average daily flow, divided by the average daily production. [The variability factor is not used in determining the limitation. However, in these cases, it is possible

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[2] For two PaIs, EPA estimated the production-normalized mass limitations using the daily mass data reported by the facilities. The percentiles of the mass data were estimated using the same statistical methodology as was used for the concentration data for the other PAIs. The limitations were estimated by dividing the percentiles by the production.

to compute variability factors for the pesticides effluent data by merely dividing the limitations by the long term average for a particular PAI. For example, if the limitation has a value of 15 mg/l and the long term average has a value of 5 mg/l, the variability factor is 3.]

The value of VF(4) can be estimated from the daily concentration data by exploiting the statistical properties of the four-day mean, C_4, and approximating the distribution of C_4 by the modified delta-lognormal model (this approximation can be shown to be close to the actual distribution). To develop the estimate of VF(4), first note that the logarithm of C_4 is normally distributed with unknown mean and standard deviation denoted by μ_4 and σ_4, respectively. Also, $E(C_4) = E(C)$ because the expected value of a sum of random variables divided by a constant is equal to the sum of their expectations divided by that constant. And $V(C_4) = V(C)/4$ because the variance of a sum of independent random variables divided by a constant is equal to the sum of their variances divided by the square of that constant. Finally, the probability that C_4 is a nondetect is δ^4, since the mean of four independent concentrations is a nondetect only if all four are nondetects, and the probability of this occurring is equal to the product of the component probabilities, or δ^4 if the daily nondetect probability is δ.

The following equations therefore hold:

$$E(C_4) = E(C) = \delta^4 D + (1-\delta^4)\exp\left(\mu_4+\frac{\sigma_4^2}{2}\right), \tag{6}$$

$$V(C_4) = \frac{1}{4}V(C) = (1-\delta^4)\exp(2\mu_4+\sigma_4^2)\left(\exp(\sigma_4^2)-(1-\delta^4)\right)+\delta^4(1-\delta^4)D\left(D-2\exp\left(\mu_4+\frac{\sigma_4^2}{2}\right)\right), \tag{7}$$

and

$$C_{95}(4) = \max\left(D, \exp\left(\mu_4+\sigma_4\Phi^{-1}\left(\frac{0.95-\delta^4}{1-\delta^4}\right)\right)\right). \tag{8}$$

Equations (6) and (7) can be algebraically solved for σ_4 in terms of the mean and variance of the daily concentrations, the probability of a nondetect, and the detection limit. This expression is as follows:

$$\sigma_4 = \ln\left(1+\frac{V(C)}{4(E(C)-\delta^4 D)^2}-\frac{\delta^4(1-\delta^4)D^2}{(E(C)-\delta^4 D)^2}+\frac{2\delta^4 D}{E(C)-\delta^4 D}\right)+\ln(1-\delta^4). \tag{9}$$

To derive an estimate, $\hat{\sigma}_4$, of the left-hand side of equation (9), each quantity on the right-hand side was replaced by its estimate computed from the daily concentration data; i.e., $E(C)$ was replaced by $\hat{E}(C)$, $V(C)$ by $\hat{V}(C)$, and δ by $\hat{\delta}$. Next, the estimated $\hat{\sigma}_4$ together with $\hat{\delta}$ and $\hat{E}(C)$ were substituted into (6), which was solved to yield an estimate $\hat{\mu}_4$ of μ_4. Finally, μ_4 and σ_4 in (8) were replaced by their estimates to yield an estimated value of the 95th percentile of the distribution of the four-day mean, and this estimate was divided by $\hat{E}(C)$ to give the estimated variability factor $\hat{V}F(4)$.

Most plants provided a single detection limit for each PAI. However, seven plant-PAI combinations reported multiple detection limits. Because the modified delta-lognormal distribution is based on a single detection limit, EPA had to select the detection limit to be used for the statistical analyses in these cases.

When multiple detection limits were reported for a plant-PAI dataset, the detection limit associated with the greatest number of nondetects was used to estimate limitations. Daily limitations would not have changed significantly if alternative detection limits had been selected. This can be seen by examining equation (4), which shows that the daily limitation equals the maximum of two terms: detection limit D, and a second term independent of D. When this equation was evaluated, the second term exceeded D for all alternative detection limits, showing that the daily limitation was independent of the detection limit.

The estimated four-day limitation value is affected, but only minimally, by the choice of detection limit, as seen by equation (8), which shows that the limitation is the maximum of two terms: the detection limit D, and a second term that is itself a function of D. To determine how the four-day limitation values vary with changes in D, they were calculated for each reported alternative detection limit. The results showed that the four-day limitation is highly insensitive to changes in the assumed detection limit.

A change in detection limit affects the values of both the daily and four-day variability factors, which are defined as the ratios of the respective limitations to the mean concentration. The numerator of the ratio for the daily variability factor does not depend on D, but the denominator (see equation (2)) is an increasing function of D. This means that selection of a higher detection limit would have resulted in a lower estimated daily variability factor.

Changes in detection limit have a lesser effect on estimated four-day variability factors than on daily variability factors, because both the numerator and denominator of the four-day variability factor ratio increase when D increases.

7.5.2 Calculation of Effluent Limitations Under BAT

The Agency based BAT limitations for organic PAIs on the performance of hydrolysis, activated carbon, chemical oxidation, biological treatment, solvent extraction, resin adsorption, and/or incineration treatment systems. Limitations development was based on:

- Long-term data obtained on PAIs with BAT performance data; and

- The transfer of statistical data in combination with the results of treatability studies for PAIs for which there are no BAT performance data.

Where long-term data were available, production-based mass limitations were calculated using daily average production (in pounds per day) and mass discharge. For the PAIs without BAT treatment performance data, BAT treatment performance for PAIs having similar chemical structures were established and then compared for applicability.

EPA segregated the 260 PAIs into 69 structural groups. These groups and the PAIs in them are listed in Table 7-10. The final rule contains numerical or zero-discharge limitations for 120 organic (Subcategory A) PAIs in 32 of the structural groups, including 105 PAIs that were left unregulated by the 1978 BPT effluent limitations. Fifteen PAIs of the 120 PAIs are part of the 49 PAIs already regulated under BPT as total pesticides. These are: endrin, heptachlor, methoxychlor, PCNB, toxaphene, trifluralin, azinphos methyl, diazinon, disulfoton, malathion, parathion methyl, carbaryl, diuron, linuron, and 2,4-D. A list of the 120 PAIs being regulated and the basis for their limitations is contained in Table 7-11.

The final BAT limitations and costs for organic PAIs are based on the same BAT technologies as were identified in the proposal--i.e., hydrolysis, activated carbon, chemical oxidation, resin adsorption, biological treatment, solvent extraction and/orincineration treatment systems. In addition, pollution prevention and recycle/reuse practices are incorporated into many of the PAI limitations as previously discussed in Section 7.1

At each stage of BAT limitations development, the Agency attempted to obtain data from pesticide chemicals manufacturing plants with treatment systems representing BAT performance to provide coverage as complete as possible for the PAIs and priority pollutants discharged by the pesticide chemicals manufacturing industry. The final PAI numeric limitations are based, wherever possible, on actual industry monitoring data on the concentrations of PAIs in wastewaters treated by the full-scale BAT treatment systems. Where actual full-scale data are not available, the final BAT limitations are based on a transfer of treatment system performance data between structurally similar PAIs, supported by data from EPA or industry bench-scale treatability studies. In some cases, the final BAT limitations might require that existing PAI treatment technologies currently in place at facilities be improved by enhanced operations, such as hydrolysis with increased retention time, carbon adsorption with increased retention time, and additional PAI monitoring.

For 55 PAIs the mass limitations are based on full-scale BAT data (including 5 PAIs for which incinerator scrubber water data were used), submitted by the manufacturers; for 30 PAIs the limitations are set at zero discharge based on recirculation, recycle/reuse and/or no water use or excess from the process; for one PAI the limitations take into consideration the discharge from the production of an intermediate which is measured by the same analytical method; and for 34 PAIs limitations are based on technology transfer. The 55 PAIs with limitations based on full-scale data reflecting

Table 7-10

PAI STRUCTURAL GROUPS

Structural Group	PAI #	PAI Name	Limit Type
Phenoxy Acid	14	2,3,6-T, S&E	Reserved - Not Mfg in 1986
Phenoxy Acid	15	2,4,5-T	Reserved - Not Mfg in 1986
Phenoxy Acid	15	2,4,5-T, S&E	Reserved - Not Mfg in 1986
Phenoxy Acid	16	2,4-D, S&E (10)*	No Discharge (Closed Loop)
Phenoxy Acid	16	2,4-D	Numerical
Phenoxy Acid	17	2,4-DB, S&E (3)*	No Discharge (Closed Loop)
Phenoxy Acid	27	MCPA, S&E (4)*	No Discharge (Closed Loop)
Phenoxy Acid	30	Dichlorprop, S&E (3)*	No Discharge (Closed Loop)
Phenoxy Acid	31	MCPP, S&E (4)*	No Discharge (Closed Loop)
Phenoxy Acid	34	Chlorprop, S&E	Reserved - Not Mfg in 1986
Phenoxy Acid	46	CPA, S&E	Reserved - Not Mfg in 1986
Phenoxy Acid	47	MCPB, S&E	Reserved - Not Mfg in 1986
Phenoxy Acid	238	Silvex	Reserved - Not Mfg in 1986
Acetamide	115	Diphenamide	Reserved
Acetamide	136	Fluoroacetamide	Reserved - Not Mfg in 1986
Acetate salt	242	Sodium monofluoroacetate	Reserved - Not Mfg in 1986
Acetanilide	26	Propachlor	Numerical
Acetanilide	54	Alachlor	Numerical
Acetanilide	70	Butachlor	Numerical
Acetanilide	165	Metolachlor	Reserved - Not Mfg in 1986
Alcohol	36	HAE	Reserved No Data
Alkyl Acid	227	Propionic acid	Reserved No Data
Alkyl Halide	81	Chloropicrin	Reserved No Data
Alkyl Halide	92	Dalapon	Reserved - Not Mfg in 1986
Alkyl Halide	160	Methyl bromide	Reserved - (Regulated as a Priority Pollutant)
Aryl Amine	116	Diphenylamine	Reserved - Not Mfg in 1986
Aryl Halide	20	Dichloran	Reserved - Not Mfg in 1986
Aryl Halide	80	Chloroneb	Numerical
Aryl Halide	98	Dicamba	Reserved - Deep Well
Terephathalic acid ester	110	DCPA	Numerical
Aryl Halide	129	Chlorobenzilate	Reserved - (Not mfg. since 1986)

Table 7-10

(Continued)

Structural Group	PAI #	PAI Name	Limit Type
Aryl Chloride	205	PCNB	Numerical
Benzeneamine	204	Pendimethalin	Numerical
Benzoic Acid	53	Acifluorfen	Numerical
Benzoic Acid	78	Chloramben	Reserved - Not Mfg in 1986
Benzonitrile	69	Bromoxynil	Numerical
Benzonitrile	69	Bromoxynil octanoate	Numerical
Bicyclic	123	Endothall	Reserved - No Data
Bicyclic	123	Endothall, S&E (3)*	No Discharge - (Closed Loop)
Bicyclic	177	MGK 264	Reserved - No Data
Multiring Halide	262	Toxaphene	Numerical
Carbamate	13	Landrin 2	Reserved - Not Mfg in 1986
Carbamate	38	Landrin 1	Reserved - Not Mfg in 1986
Carbamate	40	Methiocarb	Reserved - Not Mfg in 1986
Carbamate	42	3-Iodo-2-propanyl butylcarbamate	Reserved - No Data
Carbamate	48	Aminocarb	Reserved - Not Mfg in 1986
Carbamate	55	Aldicarb	Numerical
Carbamate	61	Bendiocarb	Reserved - Not Mfg in 1986
Carbamate	62	Benomyl	Numerical
Carbamate	75	Carbaryl	Numerical
Carbamate	76	Carbofuran	Numerical
Carbamate	77	Carbosulfan	Reserved - Not Mfg in 1986
Carbamate	95	Desmedipham	Reserved - Not Mfg in 1986
Carbamate	100	Thiophanate ethyl	Reserved - Not Mfg in 1986
Carbamate	145	Propham	Reserved - Not Mfg in 1986
Carbamate	156	Methomyl	Numerical
Carbamate	166	Mexacarbate	Reserved - Not Mfg in 1986
Amide	170	Napropamide	Reserved
Carbamate	195	Oxamyl	Reserved - Not Mfg in 1986
Carbamate	260	Thiophanate methyl	Reserved - Not Mfg in 1986
Carbamate	272	Chloropropham	Reserved - Not Mfg since 1986
Carbamate/Urea	146	Karbutilate	Reserved - Not Mfg in 1986
Chlorobenzamide	39	Pronamide	Numerical
Chlorophene	9	Hexachlorophene	Reserved - Not Mfg in 1986
Chlorophene	10	Tetrachlorophene	Reserved - Not Mfg in 1986

Table 7-10

(Continued)

Structural Group	PAI #	PAI Name	Limit Type
Chlorophene	11	Dichlorophene	Reserved - Not Mfg since 1986
Chloropropionanilide	41	Propanil	Numerical
Phthalonitrile	82	Chlorothalonil	Numerical
Hydroxycoumarin	43	Coumafuryl	Reserved - Not Mfg in 1986
Hydroxycoumarin	265	Warfarin	Reserved - Not Mfg in 1986
Cyclic Ketone	91	Cycloheximide	Reserved
DDT	1	Dicofol	Reserved - Not Mfg in 1986
DDT	101	Perthane	Reserved - Not Mfg in 1986
DDT	158	Methoxychlor	Numerical
Dithiocarbamate	23	Sulfallate	Reserved - Not Mfg in 1986
Dithiocarbamate	87	Mancozeb	Reserved - Not Mfg in 1986
Dithiocarbamate	102	EXD	Reserved - Not Mfg in 1986
Dithiocarbamate	134	Ferbam	Reserved - Not Mfg in 1986
Dithiocarbamate	151	Maneb	Reserved - Not Mfg in 1986
Dithiocarbamate	152	Manganous dimethyldithiocarbamate	Reserved - Not Mfg in 1986
Dithiocarbamate	167	Metiram	Reserved - Not Mfg in 1986
Dithiocarbamate	172	Nabam	Numerical
Dithiocarbamate	218	Busan 85	Numerical
Dithiocarbamate	219	Busan 40	Numerical
Dithiocarbamate	220	KN Methyl	Numerical
Dithiocarbamate	241	Carbam-S	Numerical
Dithiocarbamate	243	Vapam (Metham Sodium)	Numerical
Dithiocarbamate	261	Thiram	Reserved - Not Mfg in 1986
Dithiocarbamate	267	Zineb	Reserved - Not Mfg in 1986
Dithiocarbamate	268	Ziram	Numerical
EDB	3	EDB	Reserved - Deep Well
EDB	5	Dichloropropene	Reserved - (Regulated as Priority Pollutant)
EDB	97	DBCP	Reserved - Not Mfg in 1986
Ester	64	Benzyl benzoate	Reserved - Not Mfg in 1986
Ester	117	MGK 326	Reserved - No Data
Ester	157	Methoprene	Reserved - Deep Well
Ester	216	Piperonyl butoxide	Reserved - No Data
Aryl Halide	93	Dienochlor	Reserved - Not Mfg in 1986

Table 7-10

(Continued)

Structural Group	PAI #	PAI Name	Limit Type
Heterocyclic	28	Octhilinone	Reserved - No Data
Heterocyclic	32	Thiabendazole	Reserved - No Data
Heterocyclic	35	TCMTB	Numerical
Heterocyclic	49	Etridiazole	Reserved - No Data
Heterocyclic	175	Norflurazon	Numerical
Heterocyclic	210	Phenothiazine	Reserved - No mfg. currently
Heterocyclic N,S	240	Sodium bentazon	Reserved - Not Mfg in 1986
Heterocyclic	259	Dazomet	Numerical
Hydrazide	2	Maleic Hydrazide	Reserved - Not Mfg in 1986
Imidamide	59	Amitraz	Reserved - Not Mfg in 1986
Indandione	114	Diphacinone	Reserved - Not Mfg in 1986
Isocyanate	118	Nabonate	Numerical
Aryl Halide	63	Benzene Hexachloride	Reserved - Not Mfg in 1986
Aryl Halide	147	Lindane	Reserved - Not Mfg in 1986
Miscellaneous	21	Busan 90	Reserved - No Data
Indandione	29	Pindone	Reserved - Not Mfg in 1986
Indandione	37	Chlorophacinone	Reserved - Not Mfg in 1986
Miscellaneous	71	Giv-gard	Reserved - No Data
Benzeneacetic Acid Ester	90	Fenvalerate	Numerical
Dithiocarbamate	96	Amobam	Reserved - Not Mfg in 1986
Acetamide	153	Mefluidide	Reserved - Not Mfg in 1986
Heterocyclic	164	Quinomethionate	Reserved - Not Mfg in 1986
Miscellaneous	196	Oxyfluorfen	Reserved - No Data
Carbamate	201	Propoxur	Reserved - Not Mfg in 1986
Carbamate	209	Phenmedipham	Reserved - Not Mfg in 1986
Phosphate	214	Phosphamidon	Reserved - Not Mfg in 1986
Miscellaneous	221	Metasol J26	Reserved - No Data
Miscellaneous	225	Propargite	Reserved - Not Mfg in 1986
Carbamate	228	Promamocarb and Promamocarb HCl	Reserved - Not Mfg in 1986
Miscellaneous	235	Rotenone (Mexide)	Reserved - Not Mfg in 1986
Heterocyclic	244	Sulfoxide	Reserved - Not Mfg in 1986
Thiocarbamate	269	Triallate	Reserved - Not Mfg in 1986

Table 7-10

(Continued)

Structural Group	PAI #	PAI Name	Limit Type
Cyclopropane carboxylic Acid	270	Phenothrin	Reserved - Not Mfg in 1986
Ammonium	7	Dowicil 75	Reserved - No Data
Ammonium	56	Hyamine 3500	Reserved - No Data
Ammonium	105	Benzethonium chloride	Reserved - Not Mfg in 1986
Ammonium	120	Metasol DGH	Reserved - No Data
Ammonium	121	Dodine	Reserved - Not Mfg in 1986
Ammonium	149	Malachite Green	Reserved - Not Mfg in 1986
R4N	159	Methyl benzethonium chloride	Reserved - Not Mfg in 1986
Ammonium	162	Hyamine 2389	Reserved - Not Mfg in 1986
Ammonium	217	PBED (Busan 77)	Reserved - Not Mfg in 1986
Nitrobenzoate	66	Bifenox	Reserved - No Data
Organoarsenic	6	Phenarsazine Oxide	Reserved - Not Mfg in 1986
Organoarsenic	72	Cacodylic acid	Reserved - Not Mfg in 1986
Organoarsenic	161	Methylarsonic acid, salts and esters	Reserved - Subcategory B
Organoarsenic	188	Organo-Arsenic	Reserved - Not Mfg in 1986
Organocadmium	189	Organo-Cadmium	Reserved - Not Mfg in 1986
Organocopper	88	Copper 8-hydroxyquinoline	Reserved - Subcategory B
Organocopper	89	Copper EDTA	Reserved - Not Mfg in 1986
Organocopper	190	Organo-Copper	Reserved - Subcategory B
Organomercury	191	Organo-Mercury	Reserved - Subcategory B
Tin alkyl	192	Organo-Tins (8)*	Numerical
Organo-zinc	266	Zinc MBT	Reserved - Not Mfg in 1986
Phenol	44	DNOC	Reserved - Not Mfg in 1986
Phenol	112	Dinoseb	Numerical
Phenol	206	PCP; sodium salt	Reserved
Phenol	206	PCP	Reserved - Deep Well
Phenol	211	Phenylphenol	Reserved - No Data
Phenol	258	Tetrachlorophenol	Reserved - Not Mfg in 1986
Phenylcrotonate	19	Dinocap	Reserved - Not Mfg in 1986
Phophorodithioate	94	Demeton	Reserved - Not Mfg in 1986
Phosphate	12	Dichlorvos	Numerical

Table 7-10

(Continued)

Structural Group	PAI #	PAI Name	Limit Type
Phosphate	22	Mevinphos	Numerical
Phosphate	24	Chlorfenvinfos	Reserved - Not Mfg in 1986
Phosphate	84	Stirofos	Numerical
Phosphate	108	Dicrotophos	Reserved - Not Mfg in 1986
Phosphate	109	Crotoxyphos	Reserved - Not Mfg in 1986
Phosphate	173	Naled	No Discharge - No Water Use
Phosphonate	111	Trichlorofon	Reserved - Not Mfg in 1986
Phosphoroamidate	128	Fenamiphos	Reserved - Not Mfg in 1986
Phosphoroamidate	138	Glyphosate, S&E	Reserved - No Data
Phosphoroamidate	138	Glyphosate	Reserved - No Data
Phosphoroamidate	139	Glyphosine	Reserved - No Data
Phosphoroamidothioate	52	Acephate	Numerical
Phosphoroamidothioate	143	Isofenphos	Reserved - Not Mfg in 1986
Phosphoroamidothioate	154	Methamidophos	Numerical
Phosphorodithioate	106	Dimethoate	Reserved - Not Mfg in 1986
Phosphorodithioate	113	Dioxathion	Numerical
Phosphorodithioate	126	Ethion	Numerical
Phosphorodithioate	127	Ethoprop	Reserved - Deep Well
Phosphorodithioate	150	Malathion	Numerical
Phosphorodithioate	155	Methidathion	Reserved - Not Mfg in 1986
Phosphorodithioate	183	Disulfoton	Numerical
Phosphorodithioate	185	Phosmet, recrystallized	No Discharge - No Water Use
Phosphorodithioate	185	Phosmet	Reserved - Deep Well
Phosphorodithioate	186	Azinphos Methyl (Guthion)	Numerical
Phosphorodithioate	197	Bolstar	Numerical
Phosphonothioate	199	Santox (EPN)	Reserved - Not Mfg in 1986
Phosphorodithioate	200	Fonofos	Reserved - Deep Well
Phosphorodithioate	212	Phorate	Numerical
Phosphorodithioate	213	Phosalone	Reserved - Not Mfg in 1986
Phosphorodithioate	251	Bensulide	Reserved - No Data
Phosphorodithioate	255	Terbufos	Numerical
Phosphorothioate	85	Chlorpyrifos methyl	Reserved - Not Mfg in 1986
Phosphorothioate	86	Chlorpyrifos	Numerical
Phosphorothioate	103	Diazinon	Numerical

Table 7-10

(Continued)

Structural Group	PAI #	PAI Name	Limit Type
Phosphorothioate	107	Parathion methyl	Numerical
Phosphorothioate	131	Famphur	Reserved - Not Mfg in 1986
Phosphorothioate	133	Fenthion	Numerical
Dithiopyrophosphate	179	Sulfotepp	Reserved - Not Mfg in 1986
Dithiopyrophosphate	180	Aspon	Reserved - Not Mfg in 1986
Phosphorothioate	181	Coumaphos	Reserved - Not Mfg in 1986
Phosphorothioate	182	Fensulfothion	Numerical
Phosphorothioate	184	Fenitrothion	Reserved - Not Mfg in 1986
Phosphorodithioate	187	Oxydemeton methyl	Reserved - Not Mfg in 1986
Phosphorothioate	198	Suprofos oxon	Reserved - Not Mfg in 1986
Phosphorothioate	203	Parathion ethyl	Numerical
Phosphorothioate	222	Profenofos	Reserved - Not Mfg in 1986
Phosphorothioate	234	Ronnel	Reserved - Not Mfg in 1986
Phosphorothioate	253	Temephos	Reserved - Deep Well
Phosphorotrithioate	236	DEF	Numerical
Phosphorotrithioate	263	Merphos	Numerical
Phthalamide	176	Naptalam	Reserved - No Data
Phthalimide	73	Captafol	Numerical
Phthalimide	74	Captan	Reserved - Deep Well
Phthalimide	137	Folpet	Reserved - Not Mfg in 1986
Cyclopropane carboxylic Acid	57	Allethrin	Reserved - Not Mfg in 1986
Cyclopropane carboxylic Acid	208	Permethrin	Numerical
Cyclopropane carboxylic Acid	229	Pyrethrin coils	Reserved - Not Mfg in 1986
Cyclopropane carboxylic Acid	230	Pyrethrum I	Numerical
Cyclopropane carboxylic Acid	231	Pyrethrum II	Numerical
Cyclopropane carboxylic Acid	232	Pyrethrins	Reserved - Not Mfg in 1986
Cyclopropane carboxylic Acid	233	Resmethrin	Reserved - Not Mfg in 1986
Cyclopropane carboxylic Acid	271	Tetramethrin	Reserved - Not Mfg in 1986

Table 7-10

(Continued)

Structural Group	PAI #	PAI Name	Limit Type
Pyridine	215	Picloram	Reserved - No Data
Pyridine	215	Picloram, S+E	Reserved - No Data
Pyrimidine	132	Fenarimol	Numerical
Quinolin	50	Ethoxyquin	Reserved - Not Mfg in 1986
Quinolin	51	Quinolinol sulfate	Reserved - Not Mfg in 1986
Quinone	99	Dichlone	Reserved - Not Mfg in 1986
Sulfanilamide	194	Oryzalin	Reserved - Not Mfg in 1986
Sulfonamide	207	Perfluidone	Reserved - Not Mfg in 1986
Thiocarbamate	130	Butylate	Reserved - Deep Well
Cyclopropane carboxylic Acid	141	Cycloprate	Reserved - Not Mfg in 1986
Thiocarbamate	245	Cycloate	Reserved - Deep Well
Thiocarbamate	246	EPTC	Reserved - Deep Well
Thiocarbamate	247	Molinate	Reserved - Not Mfg since 1986
Thiocarbamate	248	Pebulate	Reserved - Not Mfg in 1986
Thiocarbamate	249	Vernolate	Reserved - Deep Well
Thiocyanate	65	Lethane 60	Reserved - Not Mfg in 1986
Thiocyanate	163	Methylene bisthiocyanate	Reserved - No Data
Thiosulphonate	250	HPTMS	Reserved - No Data
Toluamide	171	Deet	Reserved - No Data
Toluidine	125	Ethalfluralin	Numerical
Toluidine	144	Isopropalin	Numerical
Toluidine	178	Benfluralin	Numerical
Toluidine	264	Trifluralin	Numerical
Triazine	45	Metribuzin	Numerical
Multiring Halide	79	Chlordane	Reserved - Not Mfg in 1986
Multiring Halide	122	Endosulfan	Reserved - Not Mfg in 1986
Multiring Halide	124	Endrin	Numerical
Multiring Halide	140	Heptachlor	Numerical
Uracil	68	Bromacil; lithium salt	No Discharge (closed loop)
Uracil	68	Bromacil	Numerical
Uracil	254	Terbacil	Numerical
Urea	83	Chloroxuron	Reserved - Not Mfg in 1986
Urea	104	Diflubenzuron	Reserved - Not Mfg in 1986

Table 7-10

(Continued)

Structural Group	PAI #	PAI Name	Limit Type
Urea	119	Diuron	Numerical
Urea	135	Fluometuron	Reserved - No Data
Urea	148	Linuron	Numerical
Urea	168	Monuron TCA	Reserved - Not Mfg in 1986
Urea	169	Monuron	Reserved - Not Mfg in 1986
Urea	174	Norea	Reserved - Not Mfg in 1986
Urea	237	Siduron	Reserved - Not Mfg in 1986
Urea	252	Tebuthiuron	Numerical
s-Triazine	4	Vancide TH	Reserved
Triazine	8	Triadimefon	Numerical
s-Triazine	18	Anilazine	Reserved - Not Mfg in 1986
s-Triazine	25	Cyanazine	Numerical
Triazine	33	Belclene 310	Reserved - Not Mfg in 1986
s-Triazine	58	Ametryn	Numerical
s-Triazine	60	Atrazine	Numerical
s-Triazine	142	Hexazinone	Reserved - No Data
s-Triazine	223	Prometon	Numerical
s-Triazine	224	Prometryn	Numerical
s-Triazine	226	Propazine	Numerical
s-Triazine	239	Simazine	Numerical
s-Triazine	256	Terbuthylazine	Numerical
s-Triazine	257	Terbutryn	Numerical

Table 7-11

PAIs AND PAI STRUCTURAL GROUPS WITH PAI LIMIT DEVELOPMENT METHODOLOGIES

Structural Group	PAI #	PAI Name	Limit Basis	BAT Technology	Notes
2,4-D	16	2,4-D	Full-Scale Data	SE, CO	1
2,4-D	16	2,4-D, S&E (10)	No Discharge	DIS/REC/ND	2, 8
Phenoxy acid	17	2,4-DB, S&E (3)	No Discharge	DIS/REC/ND	2, 8
Phenoxy acid	27	MCPA, S&E (4)	No Discharge	DIS/REC/ND	2, 8
Phenoxy acid	30	Dichlorprop, S&E (3)	No Discharge	ND	2, 8
Phenoxy acid	31	MCPP, S&E (4)	No Discharge	DIS/REC/ND	2, 8
Acetanilide	26	Propachlor	Technology Transfer	AC	12
Acetanilide	54	Alachlor	Full-Scale Data	AC	1
Acetanilide	70	Butachlor	Technology Transfer	AC	12
Aryl Halide	80	Chloroneb	Full-Scale Data	CO	4
Terephthalic acid esters	110	DCPA	Full-Scale Data	AC, BO	4
Aryl Chloride	205	PCNB	Full-Scale Data	AC	4
Benzeneamine	204	Pendimethalin	Full-Scale Data	IN	1
Benzoic Acid	53	Acifluorfen	Full-Scale Data	SE	1
Benzonitrile	69	Bromoxynil	Full-Scale Data	AC	4
Benzonitrile	69	Bromoxynil octanoate	Technology Transfer	AC	9
Bicyclic	123	Endothall, S&E (3)	No Discharge	ND	2, 8
Multiring Halon	262	Toxaphene	Full-Scale Data	AC	4
Carbamate	55	Aldicarb	Full-Scale Data	HD	4

Table 7-11

(Continued)

Structural Group	PAI #	PAI Name	Limit Basis	BAT Technology	Notes
Carbamate	62	Benomyl	Full-Scale Data	HD	6
Carbamate	75	Carbaryl	Technology Transfer	HD	13
Carbamate	76	Carbofuran	Full-Scale Data	HD	4
Carbamate	156	Methomyl	Full-Scale Data	HD	4
Chlorobenzamide	39	Pronamide	Technology Transfer	AC	7
Chloropropionanilide	41	Propanil	Full-Scale Data	BO	4
Phthalonitrilic	82	Chlorothalonil	Full-Scale Data	BO	4
DDT	158	Methoxychlor	Full-Scale Data	CO	4
Dithiocarbamate	172	Nabam	Technology Transfer	CO	11
Dithiocarbamate	218	Busan 85	Technology Transfer	CO	11
Dithiocarbamate	219	Busan 40	Technology Transfer	CO	11
Dithiocarbamate	220	KN Methyl	Technology Transfer	CO	11
Dithiocarbamate	241	Carbam-S	Technology Transfer	CO	11
Dithiocarbamate	243	Vapam (Metham Sodium)	Technology Transfer	CO	11
Dithiocarbamate	268	Ziram/Cynate	Technology Transfer	CO	11
Heterocyclic	35	TCMTB	Technology Transfer	HD	10
Heterocyclic	175	Norflurazon	Technology Transfer	AC	7
Heterocyclic	259	Dazomet	Technology Transfer	CO	11
Isocyanate	118	Nabonate	Technology Transfer	CO	11

Table 7-11

(Continued)

Structural Group	PAI #	PAI Name	Limit Basis	BAT Technology	Notes
Benzeneacetic acid ester	90	Fenvalerate	Full-Scale Data	HD, BO, SE	4
Organo-tin	192	Organo-Tins (8)	Full-Scale Data	CO, CL	4
Phenol	112	Dinoseb	Full-Scale Data	AC	4
Phosphate	12	Dichlorvos	Full-Scale Data	HD	4
Phosphate	22	Mevinphos	Full-Scale Data	HD	4
Phosphate	84	Stirofos	Full-Scale Data	HD	4
Phosphate	173	Naled	No Discharge	ND	16
Phosphoroamidothioate	52	Acephate	Technology Transfer	IN	3
Phosphoroamidothioate	154	Methamidophos	Full-Scale Data	HD, AC	4
Phosphorodithioate	113	Dioxathion	Full-Scale Data	HD, AC	4
Phosphorodithioate	126	Ethion	Full-Scale Data	AC	1
Phosphorodithioate	150	Malathion	Technology Transfer	HD	14
Phosphorodithioate	183	Disulfoton	Full-Scale Data	HD, BO, AC	4
Phosphorodithioate	185	Phosmet, recrystallized	No Discharge	ND	16
Phosphorodithioate	186	Azinphos Methyl (Guthion)	Full-Scale Data	HD, BO, AC	4
Phosphorodithioate	197	Bolstar	Full-Scale Data	HD, BO, AC	4
Phosphorodithioate	212	Phorate	Full-Scale Data	IN	1
Phosphorodithioate	255	Terbufos	Full-Scale Data	IN	1
Phosphorothioate	86	Chlorpyrifos	Full-Scale Data	CO	1

Table 7-11

(Continued)

Structural Group	PAI #	PAI Name	Limit Basis	BAT Technology	Notes
Phosphorothioate	103	Diazinon	Full-Scale Data	AC	4
Phosphorothioate	107	Parathion methyl	Technology Transfer	HD, BO	17
Phosphorothioate	133	Fenthion	Full-Scale Data	HD, BO, AC	4
Phosphorothioate	182	Fensulfothion	Full-Scale Data	HD, BO, AC	4
Phosphorothioate	203	Parathion ethyl	Full-Scale Data	HD, BO	4
Phosphorotrithioate	236	DEF	Full-Scale Data	HD, BO, AC	4
Phosphorotrithioate	263	Merphos	Technology Transfer	HD, BO, AC	15
Phthalimide	73	Captafol	Technology Transfer	IN	3
Cyclopropane Carboxylic Acid	208	Permethrin	Full-Scale Data	AC, RA	4
Cyclopropane Carboxylic Acid	230, 231	Pyrethrum I and II	Technology Transfer	HD	10
Cyclopropane Carboxylic Acid	132	Fenarimol	Full-Scale Data	IN	4
Toluidine	125	Ethalfluralin	Technology Transfer	AC	18
Toluidine	144	Isopropalin	Full-Scale Data	IN	4
Toluidine	178	Benfluralin	Technology Transfer	AC	18
Toluidine	264	Trifluralin	Full-Scale Data	AC	4
Triazathione	45	Metribuzin	Full-Scale Data	HD, AC	4
Multiring Halide	124	Endrin	Full-Scale Data	RA	4
Multiring Halide	140	Heptachlor	Full-Scale Data	RA	4
Uracil	68	Bromacil	Technology Transfer	AC	7

Table 7-11

(Continued)

Structural Group	PAI #	PAI Name	Limit Basis	BAT Technology	Notes
Uracil	68	Bromacil; lithium salt	No Discharge	ND	8
Uracil	254	Terbacil	Technology Transfer	AC	7
Urea	119	Diuron	Full-Scale Data	AC, BO	4
Urea	148	Linuron	Full-Scale Data	AC, BO	4
Urea	252	Tebuthiuron	Full-Scale Data	IN	4
Triazine	8	Triadimefon	Full-Scale Data	HD, AC	4
s-Triazine	25	Cyanazine	Full-Scale Data	HD, BO	1
s-Triazine	58	Ametryn	Technology Transfer	AC	5
s-Triazine	60	Atrazine	Full-Scale Data	HD, BO	1
s-Triazine	223	Prometon	Technology Transfer	AC	5
s-Triazine	224	Prometryn	Technology Transfer	AC	5
s-Triazine	226	Propazine	Technology Transfer	AC	5
s-Triazine	239	Simazine	Technology Transfer	AC	5
s-Triazine	256	Terbuthylazine	Technology Transfer	AC	5
s-Triazine	257	Terbutryn	Technology Transfer	AC	5

AC = Activated Carbon
BO = Biological Oxidation
CL = Clarification
CO = Chemical Oxidation
DIS = Distillation
HD = Hydrolysis
IN = Incineration
ND = No Discharge
RA = Resin Adsorption
REC = Recycle

Table 7-11

(Continued)

SE = Solvent Extraction

1. Mass discharge limitations based on BAT data submitted by the manufacturer. Limitations were revised following proposal using new BAT data submitted by the manufacturer of this PAI.

2. Zero discharge achieved through closed loop recycle/recirculation of all process wastewater.

3. Mass discharge limitations developed using the manufacturer's detection limit for this PAI and by transferring the average variability factors from pendimethalin, phorate, terbufos, tebuthiuron, and fenarimol (Incineration Transfer).

4. Mass discharge limitations based on BAT data submitted by the manufacturer. Final mass discharge limitations equal the proposed mass discharge limitations.

5. Direct transfer of average of atrazine and cyanazine mass discharge limitations.

6. Mass discharge limitations revised following proposal to include carbendazim production rates.

7. Mass discharge limitations developed using the manufacturer's detection limit for this PAI and by transferring the average LTA/MDL ratio and average variability factors from ethion, permethrin, alachlor, diazinon, dinoseb, toxaphene, bromoxynil, trifluralin (SP5, monitoring point following the activated carbon unit), and PCNB (Activated Carbon Transfer).

8. Zero-discharge PAI, all water added during manufacture remains with the salt product.

9. Direct transfer of bromoxynil mass discharge limitations.

10. Mass discharge limitations developed using the manufacturer's detection limit for this PAI and by transferring the LTA/MDL ratio and variability factors from benomyl (Hydrolysis Transfer).

11. Direct transfer of average of nabam, carbam-S, and dazomet mass discharge limitations (Dithlocarbamate Chemical Oxidation Transfer).

12. Direct transfer of alachlor mass discharge limitations.

13. Mass discharge limitations developed using a treatability study LTA and by transferring the average LTA/MDL ratio and average variability factors from aldicarb and methomyl.

Table 7-11

(Continued)

14. Mass discharge limitations developed using the manufacturer's detection limit for this PAI and by transferring the average LTA/MDL ratio and average variability factors from stirofos, ethyl parathion, dioxathion, and DEF (Structural Group Transfer).

15. Direct transfer of DEF mass discharge limitations.

16. Zero discharge achieved through zero water addition or generation during the manufacturing processes for this PAI.

17. Direct transfer of parathion ethyl mass discharge limitations.

18. Direct transfer of trifluralin mass discharge limitations.

their BAT treatment (and in some cases planned improvements to that treatment) are: 2,4-D, cyanazine, acifluorfen, alachlor, atrazine, chlorpyrifos, ethion, pendemethalin, phorate, terbufos, triadimefon, dichlorvos, mevinphos, propanil, metribuzin, aldicarb, bromoxynil, carbofuran, chloroneb, chlorothalonil, stirofos, fenvalerate, diazinon, DCPA, dinoseb, dioxathion, diuron, endrin, fenarimol, fenthion, heptachlor, isopropalin, linuron, methamidophos, methomyl, methoxychlor, fensulfothion, disulfoton, azinphos-methyl, the 8 organo-tins, bolstar, parathion-ethyl, PCNB, permethrin, DEF, tebuthiuron, toxaphene, and trifluralin.

For another 30 PAIs, zero-discharge BAT limitations have been set. For 28 of these 30, zero discharge is based on either closed loop recycle/reuse or recirculation of all process wastewater or on the fact that all water added to the process remains with the salt product. These 28 (of the 30) PAIs are: the 10 salts and esters of 2,4-D, 3 salts and esters of 2,4-DB, 3 salts and esters of dichlorprop, 4 salts and esters of MCPA, 4 salts and esters of MCPP, 3 salts and esters of endothall, and the lithium salt of bromocil. For one PAI, naled, zero-discharge limitations are set based on no water use in the manufacturing process. Also, the purification of the PAI phosmet, by either single or double recrystalization, involves no water use, and that part of the manufacturing process only is regulated at zero discharge.

For one PAI, benomyl, the BAT limitations are based on full-scale data that include carbendazim's production (ie., pounds of PAIs per 1,000 pounds of benomyl and carbendazim produced) since the analytical method does not differentiate between the two; data that eliminate the loadings from the formulating and packaging operations at the facility; and data that account for additional removals by the end-of-pipe biological treatment system following hydrolysis. The remaining 34 PAIs with limitations in the final rule have their limitations based on technology transfer. Fourteen of these 34 PAIs received mass limitations by "direct transfer" of mass limitations (i.e., the numeric production-based mass limitations for one PAI, such as "1 x 10^{-3} pound of pollutants per 1,000 pounds of product produced," are also established for a second PAI based on a direct transfer based on similar chemical structure and treatability). These PAIs are: ametryn, prometon, prometryn, propazine, simazine, terbuthylazine, and terbutryn from the average of the mass limitations for atrazine and cyanazine; bromoxymil octanoate from bromoxynil; propachlor and butachor from alachlor; merphos from DEF; parathion methyl from parathion ethyl; and ethalflurin and benfluralin from trifluralin.

The remaining 20 (of the 34) PAIs have limitations based on technology transfer using data from other PAIs with full-scale BAT treatment system information but not "directly" transferring the mass limitations. For these 20 PAIs, direct transfers of mass limits were not made because in general there were no other PAIs that were sufficiently similar structurally and for which data were available. EPA did, however, have information on which technologies were effective in removing these PAIs. Therefore, EPA in effect transferred data on the level of treatment system performance that these technologies achieve with respect to other PAIs. These other PAIs are not necessarily structurally similar to these 20 PAIs but are susceptible to treatment by the same types of technologies. Specifically, the limitations for these PAIs were generated by: (1) setting achievable long-term average (LTA) concentrations for each PAI based on the demonstrated performance for other PAIs using the same BAT technology; (2) applying average variability factors for each group by the associated BAT treatment technology; and (3) determining the production-based mass limitations for each plant and PAI combination by multiplying the long-term average (annual) flow by the concentration-based limitation value determined under Parts (1) and (2) and dividing this quantity by the average production for the specific PAI.

In evaluating data for PAIs with treatment system performance data, the Agency noted that those PAIs subjected to similar treatment systems achieved similar ratios of long-term average effluent concentrations to their respective analytical method detection limit (the LTA/MDL ratio). EPA also noted that the technology in use at plants with long-term data typically reduced the PAI concentration to average levels close to the detection limit. Accordingly, EPA limitations based on transfer of the LTA/MDL ratio require the same degree of treatment for PAIs with similar treatment systems. By knowing the hydrolysis rate, chemical oxidation rate or carbon adsorption ratio (carbon usage per pound of PAI removed), the cost for full-scale treatment can be determined.

The following describes in more detail the procedure used by the Agency to determine limitations for PAIs without sufficient full-scale treatment data.

The Agency calculated the ratio of the LTA to the MDL for each PAI with long-term full-scale treatment system performance data. These data were also used to determine daily and monthly variability factors for each PAI. The Agency then calculated the average LTA/MDL ratio and average variability factors for each set of PAIs that use the same treatment technology. For PAIs with no full-scale or bench-scale treatability data the long-term mean effluent concentration level achievable was estimated by the product of the average LTA/MDL ratio for the set of PAIs and the MDL for the PAI. The daily and monthly limitation concentration values for the PAI were then calculated by the product of the estimated LTM for the PAI and the average variability factors for each structural group related to the appropriate BAT treatment technology.

For a few PAIs subjected to hydrolysis treatment where data were used to transfer limitations to PAIs without similar chemical structures the PAI with the highest LTA/MDL ratio and variability of that PAI were used. Finally, the production-based mass limitations were determined by multiplying the long-term average flow from the PAI manufacturing process by the transferred concentration-based limitation value and dividing this quantity by the average daily production of the PAI.

For 2 of the 20 PAIs that have limitations based on this technology transfer methodology, acephate and captafol, the limitations were based on using the concentration at the minimum detection level (i.e., LTA/MDL ratio = 1), and transferring the average variability factors based on full-scale incinerator scrubber water data for the incineration of pendimethalin, phorate, terbufos, tebuthiuron, and fenarimol because all available data from incineration treatment of acephate and captafol were reported as not detected. For four PAIs, norflurazon, pronamide, bromacil, and terbacil, the BAT limitations are based on using their MDL and multiplying the average LTA/MDL data and average variability factors from activated carbon treatment of ethion, permethrin, alachlor, diazinon, dinoseb, toxaphene, bromoxymil, trifluralin, and PCNB. For three PAIs, TCMTB, pyrethrin I, and pyrethrin II, BAT limitations are based on their MDL in conjunction with the LTA/MDL ratio and variability factors from hydrolysis treatment of benomyl which has a slower hydrolysis rate than any of these other three PAIs. (Other PAIs subjected to hydrolysis treatment hydrolyze either faster than or at about the same rate as TCMTB, pyrethrin I and pyrethrin II. Therefore, transfer of the average LTA/MDL ratio and average variability factors could overestimate the effectiveness of hydrolysis technology for TCMTB, pyretherin I and pyrethrin II.) For one PAI, carbaryl, limitations were transferred from aldicarb and methomyl using full-scale hydrolysis treatment average LTA/MDL data and average variability factors. For nine PAIs (nabonate, nabam, busan 85, busan 40, KN methyl, carbam-S, vapam, dazomet, and ziram), BAT limitations are based on transfer of variability factors using full-scale performance data from one facility and bench-scale treatability test results to demonstrate the BAT level LTA for all of these nine (dithiocarbamates) PAIs. For the last of the 20 PAIs using this technology transfer methodology, malathion, the limitations were based on its MDL and transferring the average LTA/MDL ratio and average variability factors from a similar structural group of PAIs, stirofos, parathion-ethyl, dioxathion, triadimefom, and DEF treated using hydrolysis.

A number of PAI limitations were revised for the final rule, based on new data received by the Agency. Specifically, a number of pesticide manufacturing facilities indicated to EPA in their comments that they are using treatment systems that are new and improved compared to the systems on which EPA's proposed regulations were based. These commenters provided additional and supplemental full-scale treatment system data giving updated results for the pollutant levels that could be achieved using their new or improved treatment systems.

The limitations in the final rule were revised for 29 PAIs overall since proposal. The 29 PAIs with revised limitations in the final rule are: 2,4-D; cyanazine; acifluorfen; alachlor; atrazine; chlorpyrifos; ethion; pendemethalin; phorate; terbufos; acephate; captofol; ametryn; prometon; promotryn; propazine; simazine; terbuthylazine; terbutryn; benomyl; pronamide; bromacil; terbacil; TCMTB; pyrethrin I; pyrethrin II; propachlor; butachlor; and norflurazon.

The bases for the revised limitations for the 29 PAIs are as follows: For 7 PAIs (the first 7 the of 29 listed above--2,4-D through ethion) limitations were revised as a result of new full-scale data submitted by manufacturers. More specifically the limitations for acifluorfen have been revised to take into account changes in the production rate and to base limitations more on additional source reduction rather than solely on additional treatment.

Limitations for atrazine and cyanazine are revised based on new full-scale data supplied by a manufacturer of atrazine and cyanazine for a much longer period of time than was previously available (six years versus one year). Those new data show that the treatment system experiences more variability than was apparent from the earlier data. Thus, the final limitations have been increased from the proposed limitations to account for this higher variability.

Limitations for 2,4-D are revised based on full-scale data reflecting the use of a solvent recovery system. Limitations are revised for alachlor based on long-term full-scale data submitted after the proposal by a manufacturer. These full-scale data replace the treatability study data used at proposal. Limitations for ethion were also revised based on the submittal of full-scale BAT treatment data following the proposal. At proposal, EPA lacked full-scale long-term data and therefore had proposed limitations for ethion based on a transfer of the limitations set for other pollutants. The final limitations for ethion are based on these new data and not on BAT technology transfer as was proposed. The final limitations are greater than the limitations that were proposed for ethion.

The average LTA/MDL ratio and average variability factors used to calculate the proposed transferred limitations for ethion were based on both full-scale and bench-scale data for PAIs that are treated by activated carbon. EPA notes that when these values are recalculated to consider only cases in which full-scale treatment data are available, the recalculated limitations are approximately equal to the final limitations for ethion, which are based on full-scale data. The agreement of these values serves to validate this methodology for deriving transferred limitations in the other cases in which it was used (e.g., in the cases of bromacil and terbacil, for which data from structurally similar PAIs were not available). Limitations for pendimethalin have been revised to reflect the higher flows based on treatment by two incinerators because both can and do operate at the same time. Limitations for phorate and terbufos are revised to account for higher flows per production unit than originally considered. The limitations for chlorpyrifos are revised based on submittal of longer term full-scale treatment data.

For seven PAIs, ametryn, prometon, prometryn, terbutryn, propazine, simazine, and terbuthylazine, EPA transferred data on BAT level removals from PAIs atrazine and cyanazine. These technology transfers, at the time of proposal, were supported by EPA and industry treatability tests. Limitations in the final rule are revised based on using the new full-scale data for atrazine and cyanazine discussed above.

The limitations for benomyl are revised to account for the fact that much of the benomyl-containing wastewater not currently treated in the in-plant hydrolysis treatment system is formulating/packaging process wastewater rather than manufacturing process wastewater; to account for more of the production of the the intermediate, carbendazim, which is treated by the in-plant hydrolysis treatment and cannot be distinguished from benomyl by the current analytical methods; and to include additional removals by the end-of- pipe biological treatment system that were not considered in the proposed regulations. Limitations for TCMTB, pyrethrin I, and pyrethrin II were also revised based on transfer of the BAT treatment data on hydrolysis from benomyl and using the LTA/MDL ratio and variability factors data. Two PAIs, butachlor and propachlor, have limitations revised based on new full-scale data submitted on alachlor.

At proposal, EPA derived achievable concentration levels by using bench-scale treatability study data for activated carbon treatment for three PAIs, (alachor, butachlor, and propachlor). The new full-scale data submitted on the BAT treatment of alachlor (discussed above) have also been used to set limits for these two other, structurally similar PAIs manufactured at the same plant and treated in the same treatment system (those two PAIs, butachlor and propachlor were not at full production during the time the new data were collected, so performance data for those PAIs could not be obtained). In addition, the Agency deferred establishing final limitations for one PAI, glyphosate salt.

The proposed limitation for glyphosate salt, which is a product manufactured from another PAI, glyphosate, was zero discharge. At proposal, there were insufficient data to establish limitations for glyphosate, however, the portion of the manufacturing process which gave glyphosate salt had no discharge. Thus zero-discharge limitations were proposed for that portion of the process. Since proposal, the manufacturer has significantly changed the manufacturing process in order to reduce overall pollutant releases to all media. However, unlike the previous process, the new process that produces glyphosate salt has a water discharge. New information was submitted following the proposal, reflecting effluent levels following biological treatment of the total process wastewaters. After reviewing the effluent data, EPA cannot determine whether the data represent BAT level treatment or whether other control technologies should be identified as BAT. Because there was insufficient time to conduct additional treatment studies, and because this PAI (and its salt) has low toxicity, regulation is being deferred at this time.

Based on the reevaluation of the data set for use in transferring variability factors for ethion, discussed above, EPA revised the limitations transfer procedure to eliminate using variability data from treatability studies for activated carbon. This revised procedure resulted in final limitations for four PAIs (bromacil, terbacil, norflurazon, and pronamide) that are higher than the proposed limitations for those four PAIs.

In addition, the Agency proposed effluent limitations requiring zero discharge of process wastewater pollutants for 37 pesticide active ingredients (PAIs) based on total recycle and reuse of all process wastewater for 29 PAIs, no water use for 1 PAI, all data reported as "not detected" for 2 PAIs, no current discharge for 2 PAIs (one of which was biphenyl), and EPA's estimated lowest cost treatment of off-site disposal by incineration for 2 PAIs. Also, the Agency proposed requiring zero discharge of process wastewater pollutants for the purification of phosmet by re-crystallization based on recycle/reuse of all water, which was the only part of the phosmet manufacturing process for which the Agency proposed any limitations.

Commenters stated that the data reported as "not detected" were measured by current analytical methods, and show only that the pollutant levels were below the detection limit; the data do not necessarily show "zero discharge." Further, today's methods may eventually be replaced by methods with lower detection limits, and so a "non-detect" value today may show up as a detectable (measured) value in the future. The Agency agrees with these comments. Commenters also stated that achieving zero discharge to surface waters involves an increase in total plant discharges to other media, such as air emissions or solid waste disposal if the process wastewater cannot be reused effectively. The Agency generally agrees that this could be the case in some circumstances.

Therefore, EPA has revised its determination of the PAIs that should be subject to a zero-discharge limitation. As proposed, the final rule promulgates zero-discharge limitations for the 28 PAIs as to which zero discharge was based on total recycle and reuse of all process wastewater and for the one PAI that is manufactured without water and a no water use portion of the process for one other PAI. For 5 PAIs (of the 29 PAIs with revised limitations), acephate, captafol, norflurazon, pyrethrin I, pyrethrin II for which EPA proposed a "zero discharge" requirement based either on data that were below the current detection limit, no current discharge, or off-site disposal, EPA is promulgating numeric limitations in response to comments. To derive these limitations, EPA used the technology transfer procedures described above (utilizing LTA/MDL ratios and average variability factors) since performance data were unavailable (all data were below the current detection limit or there was no treatment or there was no treated effluent because the wastewaters were transported off-site for disposal).

Norflurazon was discussed previously as having revised limitations based on transfer of data from other PAIs treated with activated carbon; pyrethrin I and pyrethrin II, discussed earlier, have limitations based on hydrolysis treatment of benomyl; and acephate and captafol have revised limitations based on the transfer of full-scale incinerator scrubber wastewater discharge data. As discussed previously, regulation of glyphosate salt has been deferred and the last of the proposed zero-discharge PAIs, biphenyl, as discussed previously, has been dropped from coverage of this rule.

7.5.3 Calculation of Effluent Limitations Guidelines Under NSPS

NSPS represents the most stringent numerical values attainable through the application of the best available demonstrated treatment technologies. The achievability of costs to implement the best treatment technologies for new plants is considered when setting NSPS limitations. The pesticide chemicals industry is unique, however, in that expansion or changes in the industry are not likely to occur through the manufacture of currently-produced PAIs at new facilities. Instead, it is more likely that only new PAIs will be manufactured at new facilities. Since the nature of the treatability of new PAIs cannot be readily predicted, the Agency does not believe it is possible to develop NSPS limitations for new PAIs. However, EPA is setting NSPS limitations for all the PAIs which are covered by BAT limitations.

The Agency considered four options for NSPS limitations. Two options are the same as the two BAT options discussed previously: basing limitations on the demonstrated efficacy of BAT control technologies and requiring zero discharge. The other two options include basing limitations on the treatment performance data available for BAT technologies modified to reflect the capability for wastewater flow reduction at new facilities, and basing limitations on BAT treatment, flow reduction, and application of membrane filtration technology for further pollutant reduction.

As part of EPA's evaluation of options for NSPS and PSNS, the Agency investigated trends in reduction of contaminated wastewater discharges by newer manufacturing facilities. The Agency compared wastewater generation and discharge practices at these more recently built (i.e., newer) pesticide manufacturing plants with those at older plants. Specifically, EPA looked at the practices for manufacturing PAIs for which BAT regulations are being promulgated, most of which are produced at the older plants. The Agency compared the practices at the older plants to those practices used for similar production processes at the more modern plants. That is, the comparison involved a similar production process at the newer plant but not necessarily production of the same PAI. In many cases, the comparison was to the production of a PAI that is not covered by the final regulations due to lack of an analytical method for the new PAI and lack of BAT treatment performance data. The Agency found that an average wastewater volume flow reduction of 28% has been demonstrated at the newer facilities for similar production processes. This flow reduction has been achieved by increased recycle/reuse of wastewater and, in many cases, specific identifiable source reduction steps, such as increased source segregation of process streams to allow for more direct recycle within the process, and increased use of closed loop recovery systems with or without treatment.

The flow reduction evaluation consisted of reviewing the questionnaire responses to determine contaminated wastewater discharge flow rates and process age; comparing process wastewater discharge rates for each facility with their pesticide process starting and last modification dates for the PAI production process; and normalizing the discharge volume by dividing it by the annual PAI production volume. Although this analysis revealed a flow reduction trend, the dates reflected plant level startup or modification rather than startup of individual processes; these data were therefore too general to be used. A second evaluation looked at overall industry data comparing the 1977 and 1986 Manufacturers' Census. However, this method of evaluation also proved to be too general to be satisfactory since there was not sufficient process identification with respect to changes reflected in the different flow levels. The final evaluation method consisted of identifying which PAI manufacturing processes were in operation in 1986 that were not in operation during 1977, using the Manufacturers' Census for both years. Metallo-organic pesticides processes were excluded since they were required to meet zero discharge by the 1978 BPT rules and their process water needs are significantly different from those of organic pesticides processes.

Certain PAI processes (for organic pesticides) were also excluded from the analysis because they are associated with unique wastewater generation characteristics. Excluded were those processes which manufacture PAIs from other registered PAIs, either through the amination or esterification of 2,4-D compounds, bromacil, bromoxomyl, pentachlorophenol, endothall, or glyphosate, or through the purification of hexazinone, phosmet or malathion. Also excluded were instances where process wastewater was disposed of primarily by deepwell injection or incineration since deepwell disposal does not provide much of an incentive to reduce flows, and the incinerator flows represent scrubber water flows which cannot be further reduced on a daily discharge basis.

Out of a total of 36 processes (at 29 facilities) that were started-up since 1977, 25 processes (at 23 facilities) were identified in the flow per unit production analysis as "new plants". Two analyses of flow per unit production were made: first, all wastewater discharge volumes to treatment for each process were totaled to determine flow rates per process; and second, those wastewater discharges which resulted from specifically identified and quantified contact process streams (excluding scrubber blowdowns, stripper or distillation overheads, and contaminated stormwater) were totaled to estimate total discharge volumes from segregated, PAI-contaminated streams. While contaminated stormwater may also contain PAIs, it was excluded from the second analysis because control of stormwater reflects housekeeping and facility design more than process design.

Between the "Old" and "New" plants, there is a difference in total wastewater discharges of 0.44 (from 1.55 to 1.11) gallons per pound of PAI produced, representing a 28% reduction in flow. The difference between discharges of contact wastewater are even greater - - this analysis suggests that in newer processes only 52% of all wastewater discharged results from unsegregated process streams, as opposed to 70% in older facilities. This reduction reflects both the higher degree of source segregation practiced in newer processes, as well as a trend toward processes generating only scrubber or stripper overheads through the use of closed loop, solvent recovery systems. However, not included in this analysis was a determination of the degree of segregation between contact streams resulting from pre-PAI formation steps and post-PAI formation steps in the processes, a practice which is also more common in the newer facilities. Selective treatment, using PAI destruction/removal technologies of only contaminated wastewater streams could also reduce the flow to and therefore the cost of PAI treatment processes.

Based on these flow reduction data, it is evident that newer facilities have redesigned their processes and minimized their flows in significant ways compared to older facilities. Moreover, a number of manufacturers have provided evidence that even since the time of EPA's information collection for this rulemaking, plants have been doing more to achieve a reduction in effluent flow volume. Specifically, in their comments on the proposed regulations, two companies provided information on flow reduction measures (resulting from source reduction practices) that have been implemented at three existing plants since 1990. Four other commenters gave details of their intentions to implement further source reduction measures to achieve flow reduction in the near future at four facilities.

EPA's finding that a 28% average flow reduction has been achieved at newer plants is based not just on reducing the volume of water used in the production process, but also on source reduction techniques that reduce the mass of pollutants in the effluent. These source reduction techniques reduce both the volume of effluent and the mass of pollutants discharged. There are a number of different ways in which the newer generation of plants are already achieving source reduction. Some examples are presented below (these examples reflect techniques that have actually been employed at one or more of the newer generation of existing plants, as reflected in the record for this rulemaking):

- Redesign (reordering) of the steps undertaken to manufacture PAIs can reduce the overall amount of solvents and water needed in the production process as reaction and carrier media. This leads to a lower amount of spent solvents and wastewaters that need to be disposed of;

- New facilities can be designed to reduce the amount of piping between chemical process reactors and other equipment, such as storage tanks. Newer plants have the opportunity to locate pesticide chemical reactor vessels and other equipment closer together to reduce the amount of piping. Because there is a smaller amount of piping to wash periodically, there is a smaller volume of effluent generated due to equipment washing and a smaller mass of pollutants in the effluent;

- Solvents rather than water can be used to perform equipment washing. Generally, solvents are much more effective than water at washing because they absorb much greater levels of impurities (the solubility levels of pollutants in solvents are usually much higher than they are in water). Therefore, lower volumes of solvents can be used for equipment washes compared to water, and the solvents can be reused to a much greater degree than wash water can. Further, solvent washes that are no longer usable may be burned (i.e., used as a fuel). Contaminated water from equipment washes, however, has very little fuel value and can be incinerated only at a high cost. Equipment wash water therefore is more likely to have been discharged by older plants. (Because older plants may not have been designed and equipped to cope with flammability and explosion concerns that may be present when using solvent washes, they may have no choice but to use water rather than solvent washes.); and

- The manufacturing equipment can be designed and configured at newer plants to lead to greater recovery of equipment wash water and spills of reaction materials before they are contaminated, either through contact with the ground or through commingling with other wastestreams. Therefore, a greater portion of these flows can be reused rather than discharged (impurities introduced into these flows from ground contact or from commingling can render them unfit for reuse).

Moreover, even without employing source reduction practices, reducing the volume of water itself will lead to a related reduction in the mass of pollutants discharged because of more efficient wastewater treatment. It may well be that some water (or even source) reduction will, in some cases, lead to an increase in the pollutant concentration in wastewaters (for example, where process wastewater streams are segregated from non-contact streams, reducing dilution of the process wastewater streams). However, in such cases, because the volume of wastewater has been reduced, the treatment systems can be operated more efficiently and will ultimately remove a larger overall portion (mass) of the pollutants in the wastewaters than was removed prior to flow reduction. The data in fact show that the BAT control technologies, when properly operated, will generally reduce the level of pollutants to similar concentrations both before and after flow reduction. This phenomenon holds true for all of the control technologies identified in this rule as BAT technologies (i.e., hydrolysis, activated carbon, chemical oxidation, and biological treatment).

For example, assume that a unit of PAI production generates 1,000 gallons of wastewater with 100 ppb of pollutant, and that the control technology will reduce this level of pollutant to 1 ppb in the effluent. If the flow were reduced to 750 gallons of wastewater and the mass of pollutants were not reduced, the concentration of pollutants in the influent would increase to 133 ppb. The data show, though, that after treatment, a level of approximately 1 ppb can still be achieved in the effluent due to more efficient operation of the treatment system. As a result, a greater mass of pollutants has been removed by treatment in the latter case.

Therefore, to set NSPS limitations for PAIs, EPA used the BAT limitations and applied a 28% wastewater flow reduction to arrive at the mass-based NSPS (except as described below for three PAIs). This flow reduction was applied where BAT limitations are based on the flows at older facilities (of course, where the BAT is a zero-discharge limitation, NSPS is also set at zero discharge). At proposal there were two PAIs (carbofuran and DEF) with non-zero BAT limitations that were being produced at the more modern plants (also, limits for a third PAI, merphos, were based on technology transfer from DEF, one of the other two). Because these are newer plants, EPA assumes that they have both achieved flow reductions of at least 28% compared to older plants. Because there were insufficient data to quantify further flow reductions that might be possible, EPA proposed to set the NSPS limits for these three PAIs equal to the BAT limits. EPA received no further information from commenters on this approach for these three PAIs, and therefore the final NSPS limits for these PAIs are being promulgated as proposed.

7.5.4 <u>Analysis of POTW Pass-Through for PAIs</u>

Indirect dischargers in the pesticide manufacturing industry, like the direct dischargers, use as raw materials and produce as products or byproducts, many nonconventional pollutants (including PAIs) and priority pollutants. As in the case of direct dischargers, they may be expected to discharge many of these pollutants to POTWs at significant mass or concentration levels, or both. EPA estimates that indirect dischargers of organic pesticides annually discharge approximately 27,000 pounds of PAIs and 22,000 pounds of priority pollutants to POTWs.

EPA determines which pollutants to regulate in PSES on the basis of whether or not they pass through, interfere with, or are incompatible with the operation of POTWs (including interference with sludge practices). The Agency evaluates pollutant pass through by comparing the pollutant percentage removed by POTWs with the percentage removed by BAT technology applied by direct dischargers. A pollutant is deemed to pass through POTWs when the average percentage removed nationwide by well-operated POTWs (those meeting secondary treatment requirements) is less than the percentage removed by directly discharging pesticides manufacturing facilities applying BAT for that pollutant.

There is very little empirical data on the PAI removals actually achieved by POTWs. Therefore, the Agency is relying on lab data to estimate the PAI removal performance that would be achieved by biotreatment at well-operated POTWs applying secondary treatment. The results of this laboratory study are reported in 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.

For each of these PAI structural groups, the DSS shows that BAT removal efficiencies are considerably greater than the PAI removals achieved by biotreatment under laboratory conditions (99% removal by BAT versus an optimistic estimate of 50% or less removal by the POTW as reported in the DSS). Results of this analysis indicate that organic PAIs that could be efficiently removed by pretreatment technologies would pass through the treatment systems at POTWs.

As described in more detail below with respect to the priority pollutants, two OCPSF rulemaking notices describe additional pass through considerations that were recently evaluated by EPA with respect to the OCPSF pollutants (57 FR 56883, December 1, 1992, and 58 FR 36872, July 9, 1993). As explained there, EPA initially found that removals of two OCPSF priority pollutants were greater at BAT plants than at POTWs. Subsequently, EPA determined that this conclusion was strictly an artifact of lower influent levels at the POTWs -- i.e., the removals from these low levels down to the analytical minimum level appeared to be less than the removals by BAT plants, even though the actual removals by POTWs and BAT plants might be about the same. In light of this artifact of the removal calculations, and a chemical and engineering analysis focusing on the high biodegradability of these two priority pollutants, the Agency concluded that these two priority pollutants do not actually pass through POTWs.

Even under these additional pass through considerations, EPA continues to conclude that all of the 120 PAIs being regulated in this rulemaking do pass through POTWs. As described above, to compare removals at well-operated POTWs versus BAT-level plants, EPA relied on laboratory data to estimate the removal of POTWs. These were controlled experiments that were not subject to the low influent concentrations that may be present in the case of actual full-scale data at POTWs. In fact, as noted, EPA believes that these laboratory data were optimistic in that they tended to overestimate the removals of the PAIs at well-operated POTWs. Therefore, there is no basis for altering EPA's findings under the traditional pass through methodology that these PAIs do pass through POTWs.

In addition to pass-through, may of the pollutants in pesticide manufacturing wastewaters are present at concentrations which may inhibit biodegradation in POTW operations. In some cases, discharges into POTWs have caused severe upsets at POTWs resulting in documented pass-through of PAIs and operational problems at the POTWs (a more detailed analysis is presented in the public record - DCN 4002).

7.5.5 Calculation of Effluent Limitations Guidelines Under PSES and PSNS

Based on the results of the pass-through analysis, EPA is promulgating PSES limitations for the same PAIs that are receiving BAT limitations. Since indirect discharging organic pesticide manufacturing facilities generate wastewaters with similar pollutant characteristics as direct discharging facilities, the same treatment technologies discussed previously for BAT are considered applicable for PSES. The Agency considered the same two limitation development options as for BAT: basing limitations on the demonstrated efficacy of BAT control technologies and requiring zero discharge. In the final rule, PSES limitations are based on the first option; setting PSES equal to BAT. Under this option, PSES for organic PAIs would be set equal to BAT guidelines based on the use of hydrolysis, activated carbon, chemical oxidation, resin adsorption, solvent extraction, and/or incineration, and zero discharge for selected PAIs. This option is economically achievable and greatly reduces pollutants discharged into the environment, since pollutants not recycled or reused are destroyed by treatment. As with BAT and NSPS, Option 2 is rejected because of its economic unachievability and the significant cross-media implications of the transfer of pollutants off-site for treatment of the total wastewater volumes.

Pretreatment standards for new sources were based on the pass-through analysis utilized in the development of the PSES limitations and on the flow reduction methodology utilized in the development of NSPS limitations. The pass-through analysis demonstrated the need for pretreatment standards for PAIs equivalent to the standards set for direct discharging pesticide manufacturing facilities. The flow reduction methodology demonstrated the 28% reduction in wastewater flow generated by "new" (post-1977) pesticide manufacturing facilities/processes. Since new indirect discharging facilities, like new direct discharging facilities, have the opportunity to incorporate the best available demonstrated technologies, including process changes, in-plant controls, and end-of-pipe treatment technologies, the PSNS limitations should be equivalent with NSPS limitations. The same technologies discussed previously for BAT, NSPS, and PSES are available as the basis for PSNS. PSNS for Subcategory A are based on the PSES technologies, modified to reflect the flow reduction capable at most new facilities. EPA also considered the zero-discharge option, but it was rejected for the same reasons as under NSPS (i.e., its economic unachievability and the cross-media pollution impacts).

7.6 EFFLUENT LIMITATIONS DEVELOPMENT FOR PRIORITY POLLUTANTS

This section discusses the development of effluent limitations guidelines and standards for priority pollutants discharged in Subcategory A wastewaters of the pesticide chemicals manufacturing industry. As discussed in Section 14, EPA is reserving further regulations for priority pollutants in Subcategory B wastewaters.

The final rule contains effluent limitations for 28 priority pollutants. For 23 of these 28 priority pollutants, EPA is relying on the

OCPSF database to set limitations that are identical to the limitations set for these pollutants in the OCPSF guidelines. For four other priority pollutants, which are the brominated priority pollutants, and were not regulated under the OCPSF guidelines, there are no treatment performance data. Thus EPA is using limitations set in the OCPSF guidelines for other priority pollutants that are deemed to have similar "strippabilities". Final limitations for these pollutants are based on the average data for each subgroup of volatile organic priority pollutants, with respect to "strippability." This is the same procedure used in the OCPSF rulemaking for developing limitations when performance data were lacking for certain priority pollutants. Final limitations for one priority pollutant, cyanide, are based on actual long-term full-scale data from pesticide and organic chemicals manufacturing facilities.

For the 23 priority pollutants for which the Agency is transferring BAT limitations from the OCPSF category, the basis for this transfer is the similarity in wastewaters, other than the PAIs which are usually removed from the wastewaters prior to treatment for the priority pollutants. As discussed earlier in Section 3, at least 46 of the 75 pesticide chemicals manufacturing facilities also manufacture compounds regulated under the OCPSF category. Typically, wastewaters from the pesticide manufacturing processes are commingled with OCPSF wastewaters generated at the site and treated in the same end-of-pipe wastewater treatment systems. Even though pesticide wastewaters may be pre-treated to remove PAIs, their priority pollutants are removed in the same EOP treatment system that removes priority pollutants from OCPSF wastewaters.

7.6.1 Calculation of Effluent Limitations Guidelines Under BAT

In the OCPSF rulemaking, EPA identified treatment technologies that have been shown to be effective and the best available for removing priority pollutants from commingled OCPSF and pesticide manufacturing wastewater streams. EPA has determined that 23 priority pollutants (22 volatile and semi-volatile organic priority pollutants and lead) regulated in the OCPSF guidelines also may be found in wastewater streams from pesticide chemicals manufacturing, and that these streams are commingled and treated with OCPSF wastewaters. Therefore, the BAT limitations for these 23 pollutants are being directly transferred to the pesticide chemicals manufacturing category as BAT effluent limitations guidelines. Four priority pollutants (bromomethane, tribromomethane, bromodichlormethane, and dibromochloromethane), detected at significant concentrations in pesticide manufacturing wastewaters, were not regulated under the BAT limitations for the OCPSF category. The final rule sets BAT effluent limitations for those four pollutants by transferring OCPSF limitations reflecting the average data within the grouping of volatile pollutants that have similar strippabilities. BAT limitations for cyanide are based on treatment data from pesticide and OCPSF manufacturing facilities.

Volatile and Semi-Volatile Organic Pollutants

In the OCPSF rulemaking, EPA based its BAT limitations and costs for volatile organic priority pollutants on in-plant steam stripping alone for plants without end-of-pipe biological treatment. In the OCPSF rulemaking, for the volatiles limited in the end-of-pipe biological treatment subcategory, the combination of steam stripping and end-of-pipe biological treatment were used for limitations and costing. The data used to derive these limits for the end-of-pipe biological treatment subcategory were taken from plants which exhibited good volatile pollutant reduction across the entire wastewater treatment system. To establish limits for the non-end-of-pipe biological treatment subcategory, EPA used steam stripping data for volatile organic pollutants collected from plants that either did not have end-of-pipe biological treatment or provided data on the separate performance of the in-plant steam stripping treatment technology.

Steam stripping employs super-heated steam to remove volatile pollutants of varying solubility in wastewater. Specifically, the technology involves passing super-heated steam through a preheated wastewater stream column packed with heat resistant packing materials or metal trays in counter-current fashion. Stripping of the organic volatiles constituents of the wastewater stream occurs because the organic volatiles tend to vaporize into the steam until their concentrations in the vapor and liquid phases (within the stripper) are in equilibrium.

Steam strippers are designed to remove individual volatile pollutants based on a ratio (Henry's Law Constant) of their aqueous solubility (tendency to stay in solution) to vapor pressure (tendency to volatilize). The column height, amount of packing or number of trays, the operating steam pressure and temperature of the heated feed (wastewater) are varied according to the strippability (using Henry's Law Constant) of the volatile pollutants to be stripped. Volatiles with lower Henry's Law Constants require greater column height, more trays or packing material, greater steam pressure and temperature, more frequent cleaning and generally more careful operation than do volatiles with higher strippability. (See the final OCPSF rule, 52 FR 42540, and the OCPSF Technical Development Document, EPA 440/1-87/009, for a further description of steam stripping technology).

The final OCPSF data consisted of performance results from 7 steam strippers at 5 plants for 15 volatile organic pollutants. The data were edited to ensure only data representing BAT level design and operation were used to develop limitations.

The Agency also identified two other treatment technologies as the technology basis for the removal of certain semi-volatile organic pollutants under the OCPSF regulations. These two technologies are activated carbon adsorption and in-plant biological treatment. EPA also relied on the ability of end-of-pipe biological treatment to achieve some additional pollutant removal beyond carbon adsorption and in-plant biological treatment. See 52 FR 42543-44 for a discussion of these technologies and a description of the data that EPA relied on for setting the OCPSF limitations on these semi-volatile organic pollutants. Two of the pollutants (phenol and 2,4-dimethylphenol) are among the 22 OCPSF organic priority pollutants that also occur in pesticides manufacturers wastewaters and for which EPA is setting limitations for BAT and NSPS that are transferred from the OCPSF rule.

For some of the OCPSF volatile and semi-volatile pollutants (including some of the ones for which limitations are also being set in the final rule for pesticide chemicals manufacturers), the available effluent data consisted of measurements so low that very few exceeded the analytical threshold level (10 ppb, the minimum level for most pollutants - see Section X, Comment 7 of the OCPSF final rule, 52 FR 42562, November 5, 1987). Since variability factors could not be calculated directly for these pollutants, in the OCPSF rule, EPA transferred variability factors from related pollutants (see 52 FR 42541). EPA determined that the data from these plants provided an adequate basis to set limitations for the OCPSF industry.

EPA finds that it is appropriate to transfer the limitations for volatile and semi-volatile organic pollutants in the OCPSF industry to this rulemaking to set limitations on the same pollutants in the wastestreams of pesticides manufacturers. The technologies identified (steam stripping technology, in-plant biological treatment, and activated carbon adsorption, combined in some cases with end-of-pipe biological treatment) are available at pesticides manufacturing plants (these technologies are all already in use at certain pesticides manufacturing plants or combined OCPSF/pesticides manufacturing plants). In addition, these technologies will be capable of removing from pesticides manufacturers' wastewaters the amounts of volatile and semi-volatile pollutants necessary to meet the transferred limitations. Specifically, EPA finds that applying these technologies to pesticides manufacturers' wastewaters will result in treatability levels for volatile and semi-volatile organic pollutants that are similar to the treatability levels of these same pollutants in OCPSF wastewaters. EPA stated in the OCPSF rule that although the degree to which a compound is stripped can depend to some extent upon the wastewater matrix, the basis for the design and operation of steam strippers is such that matrix differences were taken into account for the compounds the Agency evaluated. A sort of the strippability data confirmed that process wastewater matrices in the OCPSF industry generally do not preclude compliance with the concentration levels established in the OCPSF rulemaking (52 FR 42540-41). The wastewater matrices in the pesticides manufacturers' industry are generally similar to those in the OCPSF industry, and so they generally would not preclude compliance with the concentration levels being promulgated for volatile pollutants.

As explained above, the final rule does not derive limits independently for 23 priority pollutants but expressly relies on the OCPSF rulemaking and accompanying record for setting these limits. In the litigation over the OCPSF rule, an issue arose over EPA's methodology for setting these priority pollutant limits. Specifically, the issue concerned EPA's decision to establish one set of priority pollutant limits for direct discharger plants that do not use end-of-pipe biological treatment and a different set of limits for those direct dischargers that do.

Some, but not all, OCPSF plants use end-of-pipe biological treatment to meet their limitations on conventional pollutants. These plants rely on other technologies to reduce their priority (toxic) pollutants; however, the biological treatment has the incidental effect of removing some further amount of the priority pollutants. The OCPSF rule, therefore, accounts for this further removal of toxics by the end-of-pipe biotreatment systems by establishing one set of priority pollutant limitations for those facilities that do not use end-of-pipe biotreatment (the OCPSF "Subpart J" limitations) and a different, generally more stringent set of limitations for those plants that do (the OCPSF "Subpart I" limitations).

This methodology for setting limitations was challenged in the OCPSF litigation, and the court remanded the issue to EPA. EPA's recent response to the OCPSF remand explains in detail the Agency's reasons for adopting this approach (58 FR 36881-85 and supporting record). The Agency explained there that it is not feasible, necessary or desirable to eliminate or limit the applicability of the non-EOP biological treatment limitations for priority pollutants. EPA stated its belief that the Clean Water Act does not require the Agency to develop a scheme that is not technically defensible and which would create undesirable treatment incentives within the regulated community.

EPA also discussed three alternatives to EPA's scheme that were suggested in the litigation. The first suggested alternative was to develop a BOD_5 "floor" (i.e., a minimum BOD_5 level) to limit the applicability of the non-EOP biotreatment limitations. EPA found, however, that the development of a floor would be technically infeasible due to the lack of a theoretical minimum BOD_5 level for sustaining biological treatment and the great variability of OCPSF production and wastewater characteristics. These reasons generally hold true with respect to the pesticides manufacturing industry as well. Although a given pesticides manufacturing plant may be able to operate a biological system at a certain long-term average BOD_5 level, that does not assure that another plant with the same long-term average BOD_5 level, but with a different waste stream composition or varying BOD_5 levels, will also be able to operate a biological system. In addition, plants that need to achieve significant BOD_5 reductions will generally be motivated by economic considerations to install biotreatment systems over the more costly alternatives. Moreover, as explained in the OCPSF preamble, EPA believes that a BOD_5 floor would be undesirable in that it would likely result in irrational and undesirable wastewater treatment and waste management decisions (i.e., it would create incentives to maximize BOD_5 loads at the end-of-pipe).

The second alternative suggested was that EPA limit the applicability of the non-EOP biotreatment limitations to those processes for which there has been an adequate showing of low-BOD_5 wastewater. In fact, low BOD_5 wastewater seldom occurs in the pesticides manufacturing industry. In any event, as noted, there are only two direct discharger plants that do not have EOP biological treatment and therefore will be subject to the non-EOP biological treatment limitations on priority pollutants, and EPA expects few new sources to be built that will manufacture the regulated PAIs.

The third alternative was that EPA could eliminate the non-EOP biotreatment limitations and address low-BOD_5 situations through fundamentally different factors ("FDF") variances (or maintain the limitations but apply them only where a site-specific showing of necessity is made). (FDF variances are not available to new sources.) As discussed in the OCPSF preamble, however, maintaining the option of non-EOP biotreatment limitations is desirable in that it encourages source control and other in-plant waste management techniques. EPA's decision to provide two sets of limitations instead of accounting for low BOD_5 through the FDF process is a rational exercise of its discretion under the Act.

EPA notes that setting less stringent limitations in these regulations for plants without EOP biological treatment will result in virtually no actual increase in priority pollutant discharges to surface waters. There are only two direct discharging pesticide chemicals manufacturing plants that will be subject to the non-EOP biological treatment limitations. One of these plants incinerates all of its wastewaters; since only scrubber wastewater remains, there would be nothing left to treat in a biological treatment system. The second plant has very low loadings of priority pollutants after applying BAT physical/chemical treatment technologies. Both of these facilities also perform some recycling/reuse of either non-wastewater streams or wastewater streams. Together, EPA estimates that these two plants will discharge less than one pound per year of priority pollutants to surface waters after meeting the non-EOP biological treatment limitations on priority pollutants. Imposing limitations on the second plant based on EOP biological treatment would remove only a trivial additional amount of priority pollutants.

The final rule for the pesticides chemicals manufacturers, by using limitations for priority pollutants that are directly transferred from the OCPSF rulemaking, follows the OCPSF approach of setting two sets of limitations, one for plants that use end-of-pipe biological treatment and one for plants that do not. Some pesticide chemicals manufacturers fall into each category. The final rule contains this approach in order to be consistent with what was promulgated (and now recently reaffirmed) for the OCPSF point source category. Moreover, consistency with the OCPSF regulations is necessary in some cases to avoid having two different sets of limitations (and regulatory approaches) applicable to the same pollutant being discharged by a single combined OCPSF/pesticides plant.

EPA notes that there are two priority pollutants (2-chlorophenol and 2,4-dichlorophenol) for which limitations are included for plants that use end-of-pipe biological treatment but for which limitations are not included for plants that do not use end-of-pipe biological treatment. This reflects the approach used in the OCPSF rulemaking. In the OCPSF rule, limitations for these two priority pollutants were not included for plants without end-of-pipe biological treatment because of a lack of treatability data and because a transfer of limitations was not possible (see the OCPSF Technical Development Document, Section 7).

In this final rule for pesticide chemicals manufacturers, even for those plants that use end-of-pipe biological treatment, the costs of that treatment were not counted as part of the costs of meeting BAT. This is because end-of-pipe biological treatment is already being applied by these plants to meet their existing BPT limitations.

EPA concluded in the December, 1991 OCPSF re-proposal and in the July 9,1993 final amendments that the OCPSF point source category was too complex for the Agency to approach perfect plant-specific knowledge of the industry. The Agency noted, however, that in a smaller, less complex industry it might be possible to assess more completely the intricacies of each plant's or each plant category's treatment system. The pesticides manufacturing industry does contain a fewer number of plants than the OCPSF industry, but the types of products and processes are nevertheless varied and complex. EPA therefore finds that, as with the OCPSF rulemaking, plant-specific knowledge of pesticides manufacturing plants is similarly infeasible and it is thus appropriate to follow the OCPSF rulemaking approach in this final rule.

Brominated Organic Pollutants

Four priority pollutants (bromomethane, tribromomethane, bromodichlormethane, and dibromochloromethane), detected at significant concentrations in pesticide manufacturing wastewaters, were not regulated for BAT under the OCPSF category. This final rule contains BAT effluent limitations for those four pollutants using as a basis the transfer of OCPSF limitations based on the average data within groups of volatile pollutants that have similar strippabilities.

Of the four brominated organic compounds found in pesticide manufacturing process wastewaters, one, bromomethane, was excluded from consideration under OCPSF guidelines because it was determined to be uniquely related to specific sources. The other three, tribromomethane, bromodichloromethane, and dibromochlormethane, were excluded because they were only detected in trace amounts and therefore not expected to result in toxic effects. However, all 4 of these priority pollutants may be expected in the discharge from processes which manufacture brominated PAIs such as bromacil and bromoxynil, and one or more were detected in 7 of 23 EPA sampling episodes between 1988 and 1990.

Under the OCPSF methodology, volatile priority pollutants were divided into high and medium strippabilty groups based on the Henry's Law Constants. For each strippability group, a LTA concentration was developed based on the volatile priority pollutants where steam stripping effluent data were available. The LTA concentration for pollutants with no data in each strippability group was determined by the highest of the LTAs within each of the strippability groups, based on the 15 pollutants for which the Agency had data. Following this methodology, the Agency obtained a high strippability LTA of 64.5 μg/L and a medium strippability LTA of 64.7 μg/L.

For the purpose of transferring variability factors (VFs), the Agency maintained the separation of volatile priority pollutants into the high and medium strippabilty groups. For each subgroup, the Agency averaged the VFs for those pollutants with data in that subgroup and transferred these average VFs to the volatile priority pollutants without data in that subgroup. The average VFs are 5.88383 (daily max VF) and 2.18759 (monthly max avg VF) for the high strippability group and 12.2662 (daily max VF) and 3.02524 (monthly max avg) for the medium strippability group.

Based on comparisons of Henry's Law coefficients for the brominated priority pollutants with other volatile priority pollutants which were regulated under OCPSF, it appears that all of the brominated priority pollutants may be removed by steam stripping. Two of them, bromomethane and bromodichloromethane, are identified as "highly strippable" under the criteria utilized during OCPSF compliance costing, while the other two, dibromochoromethane and tribromomethane, are identified as "medium strippable." Following the OCPSF methodology for transferring the average LTA concentration and average VFs to pollutants within the same strippabilty subgroups, limitations were developed for the four brominated priority pollutants:

Brominated Priority Pollutant	**Henry's Law Constant**	**Strippability Group**	**Effluent Limitations**	
			Daily Max	**Monthly Max Avg**
Bromomethane	8.21	High	380	142
Bromodichloromethane	0.10	High	380	142
Tribromomethane	0.023	Medium	794	196
Dibromochloromethane	0.041	Medium	794	196

Lead

The final rule applies only to non-complexed lead-bearing wastewaters generated by organic pesticide chemical manufacturing processes. The OCPSF rule set a concentration-based limitation on lead, to be applied only to the flows discharged from metals-bearing process wastewaters (see 58 FR 36872). Compliance could be monitored in-plant or, after accounting for dilution by nonmetal-bearing process wastewater and non-process wastewaters, at the outfall. The OCPSF rule stated that the permit writer may, on a case-by-case basis, provide additional discharge allowances for metals in non-OCPSF process or other wastewaters where they are present at significant levels. When BAT limits have not been established, these allowances must be based upon the permit writer's best professional judgment of BAT.

The OCPSF concentration limits for lead were based on the use of hydroxide precipitation technology, which is the standard metals technology that forms the basis for virtually all of EPA's BAT metals limitations for metal-bearing wastewaters. Because very little OCPSF data on the effectiveness of hydroxide precipitation technology were available, EPA decided to transfer data for this technology from the Metal Finishing Industry.

EPA finds that it is appropriate to transfer the limitations for lead in the OCPSF industry to this final rulemaking to set limitations on lead in the wastestreams of pesticides manufacturers. The technology identified, hydroxide precipitation, is available at pesticides manufacturing plants. In addition, this technology will be capable of removing from pesticides manufacturers wastewaters the amounts of lead necessary to meet the transferred limitations.

Specifically, EPA finds that applying this technology to pesticides manufacturers' wastewaters will result in a treatability level for lead that is similar to the treatability level of lead in OCPSF wastewaters. The concentrations of lead in pesticides manufacturers' wastewaters are generally in the range found at OCPSF plants. As discussed in the OCPSF rule, this transfer of technology and limitations from the Metal Finishing Industry Category to the OCPSF rule, and now to the pesticides manufacturers' rule, is further supported by the principle of precipitation. Given sufficient retention time and the proper pH (which is achieved by the addition of hydroxide, frequently in the form of lime), and barring the binding up of metals in strong organic complexes (which are generally not present in pesticides manufacturers wastewaters), a metal exceeding its solubility level in water can be removed to a particular level - that is, the effluent can be treated to a level approaching its solubility level for each constituent metal. This is a physical/chemical phenomenon that is relatively independent of the type of wastewater (barring the presence of strong complexing agents).

Cyanide

The final limitations for cyanide apply only to non-complexed cyanide-bearing wastewaters generated by organic pesticide chemical manufacturing processes. For cyanide, the discharge quantity (mass) shall be determined by multiplying the concentrations listed in the applicable tables in this subpart times the flow from non-complexed cyanide-bearing waste streams for total cyanide. Discharges of cyanide in cyanide-bearing waste streams are not subject to the cyanide limitation and standards if the permit writer or control authority determines that the cyanide limitations and standards are not achievable due to elevated levels of non-amenable cyanide (i.e., cyanide that is not oxidized by chlorine treatment) that result from the unavoidable complexing of cyanide at the process source of the cyanide-bearing waste stream and establishes an alternative total cyanide or amenable cyanide limitation that reflects the best available technology economically achievable. The determination must be based upon a review of relevant engineering, production, and sampling and analysis information, including measurements of both total and amenable cyanide in the waste stream, based on the foregoing information, and its impact on cyanide treatability shall be set forth in writing and, for direct dischargers, be contained in the fact sheet required by 40 CFR 124.8.

These final limitations are not transferred from OCPSF but instead are based on the median values of the effluent data from treatment systems incorporating chemical oxidation and biological treatment at two pesticide manufacturing facilities and five organic chemicals manufacturing facilities, along with effluent data from one pesticides manufacturing facility with biological treatment only. The effluent data are:

Plant Type	Treatment	# Analyses (# > MDL)	Effluent Long-Term Average (mg/L)
A	BO	703 (703)	0.7398
A	CO/BO	2 (1)	0.0750
A	CO/BO	3 (1)	0.0147
B	CO/BO	6 (6)	0.2960
B	CO/BO	1 (0)	0.0100
B	CO/BO	4 (4)	0.4576
B	CO/BO	1 (0)	0.0100
B	CO/BO	25 (23)	0.0959
		Median = 0.0854 mg/L Daily VF = 7.4 Four-Day VF = 2.6	Daily Limit = 0.64 mg/L Monthly Limit = 0.22 mg/L

Footnotes:

A - Pesticide Manufacturing Plant	BO - Biological Oxidation
B - Organic Chemical Manufacturing Plant	CO - Chemical Oxidation

7.6.2 Calculation of Effluent Limitations Guidelines Under NSPS

The final rule contains NSPS limitations set equal to BAT for priority pollutants discharged by Subcategory A pesticide manufacturing plants because the limitations are concentration-based. The capability of reduced wastewater flow at new plants would be taken into account by the permit writer to arrive at mass-based permit limits.

7.6.3 Calculation of Effluent Limitations Guidelines Under PSES

To evaluate the need for PSES for the priority pollutants, EPA is relying on the methodology and analysis originally done to support the OCPSF regulations and the revised pass through analysis completed for the amendments to the OCPSF regulations as a result of the remand. (See Section 6 of the October 1987 OCPSF Technical Development Document, Section III of the May 1993 Supplement to the Technical Development Document, and 58 FR 36872, July 9, 1993).

Prior to promulgation of the OCPSF effluent guidelines, EPA conducted a study of well-operated POTWs that use biological treatment (the "50-Plant Study"). The 50-Plant study determined the extent to which priority pollutants are removed by POTWs. The principal means by which the Agency evaluated pollutant pass-through was to compare the pollutant percentage removed by POTWs with the percentage removed to comply with BAT limitations.

Because some of the data collected for evaluating POTW removals included influent levels of priority pollutants that were close to the detection limit, the POTW data were edited to eliminate influent levels less than 100 ppb and the corresponding effluent values, except in cases where none of the influent concentrations exceeded 100 ppb. In the latter case, where there were no influent data exceeding 100 ppb, the data were edited to eliminate influent values less than 20 ppb and the corresponding effluent values. These editing rules were used to allow for the possibility that low POTW removals simply reflected the low influent levels.

EPA then averaged the remaining influent data and also averaged the remaining effluent data for the POTWs. The percent removal achieved for each priority pollutant was determined from these averaged influent and effluent levels. This percent removal was then compared to the percent removal achieved by BAT treatment technology. Based on this analysis, EPA determined that 47 priority pollutants of the 63 priority pollutants regulated under OCPSF passed-through POTWs. Not all of these priority pollutants are present in pesticides manufacturers wastewaters. As noted, 23 of the priority pollutants present in OCPSF wastewaters are also present in pesticides manufacturers wastewaters. The OCPSF pass through analysis originally showed that 21 of those 23 priority pollutants pass through; the only priority pollutants of those 23 that were determined not to pass through were 2-chlorophenol and 2,4-dichlorophenol. As described below, and in more detail in a later OCPSF rulemaking (58 FR 36872), EPA has now determined that two more priority pollutants, phenol and 2,4-dimethylphenol, also do not pass through a POTW.

Consistent with the OCPSF rulemaking, EPA is setting the pretreatment standards for existing sources for the priority pollutants equal to the set of BAT limitations that applies to plants that do not have end-of-pipe biological treatment. In the OCPSF pass-through analysis for setting pretreatment standards, POTW removals were compared to BAT-level removal at plants that did not have end-of-pipe biological treatment.

The number of priority pollutants that are covered by the final PSES regulations is based on EPA's pass-through methodology as described in two OCPSF rulemaking notices published on December 1, 1992 (57 FR 56883) and July 9, 1993 (58 FR 36872) (the "OCPSF notices"). A detailed description of this methodology is contained in the OCPSF notices (at 57 FR 56886-87 and 58 FR 36885-88).

Those notices explain the following: In general, EPA is continuing to apply its traditional pass-through methodology, which considers the median percent removals of a pollutant by direct dischargers and by POTWs to determine pass through. This approach has been upheld in litigation as an appropriate, conservative means of determining pass through (CMA v. EPA, 870 F.2d 177, 243-48 (5th Cir. 1989)) and EPA continues to believe it is the correct approach as a general matter. However, the traditional approach is overly conservative for two priority pollutants, phenol and 2,4-dimethylphenol. EPA's analysis focused first on the data relating to phenol removals. A comparison of median removals by BAT technologies and at POTWs indicated that phenol and 2,4-dimethylphenol do pass through POTWs. It became apparent, however, that the pass-through conclusion was strictly an artifact of the higher influent concentrations for direct dischargers in EPA's database. (Specifically, the calculated removals from lower influent concentrations at POTWs down to the analytical minimum level are less than the calculated removals from the higher influent concentrations for direct dischargers down to the analytical minimum level, even though the POTWs and direct dischargers might actually be achieving about the same removals.) The

OCPSF notices state that viewing the data as a whole, EPA found that POTWs appear to achieve removals of the phenols that are essentially equivalent to those achieved by direct dischargers.

As also explained in the OCPSF notices, a chemical and engineering analysis indicates that the two phenols are highly biodegradable due to their simple chemical structures, and EPA finds that a pollutant's estimated biodegradation rate is the best theoretical indicator of whether it will pass through POTW biological treatment systems. Under all the above considerations, EPA concluded that phenol and 2,4-dimethylphenol do not pass through POTWs. EPA's decision to modify its traditional pass-through methodology for phenol and 2,4-dimethylphenol was based on the Agency's conclusion that both the data available for these two pollutants and the chemical and engineering analysis performed by EPA indicate that the traditional pass-through methodology is overly conservative for these pollutants.

For the pesticides manufacturers' rulemaking, EPA had proposed to set categorical pretreatment standards for 26 priority pollutants, including phenol and 2,4-dimethylphenol, based on a determination that they pass through POTWs. However, in the notice published on December 1, 1992, EPA indicated that for both the OCPSF and pesticides manufacturers rulemakings, the Agency was considering not setting pretreatment standards for phenol and 2,4-dimethylphenol for the above reasons. In the notice published on July 9, 1993, EPA finalized its decision not to set pretreatment standards for phenol and 2,4-dimethylphenol in the OCPSF rulemaking. In today's final pesticides manufacturers' rule, consistent with the OCPSF rule, EPA has similarly deleted these two pollutants from the list of pollutants that are covered by pretreatment standards. For the reasons articulated more fully in the December 1, 1992 and July 9, 1993 notices, EPA has determined for today's final rule that phenol and 2,4-dimethylphenol do not pass through POTWs.

Therefore, the final rule sets pretreatment standards for 24 priority pollutants instead of 26 pollutants as proposed. As the proposal indicated, EPA has determined under its traditional pass-through methodology that these 24 pollutants do pass through POTWs. Further, even under the additional pass-through considerations described above, EPA still finds that these 24 pollutants do pass through. Of these 24 priority pollutants, 17 are volatile organics as to which EPA would have applied the "volatile override" to determine that they pass through if the percent removal analysis had not shown pass through. (The 17 pollutants in question are all of the 24 pollutants listed in Table 6 of the regulations except for naphthalene, cyanide, lead, and the four brominated compounds: bromomethane, tribromomethane, dibromochloromethene, and bromodichloromethane.) These pollutants have overall volatilization rates comparable to the rates for which EPA has applied the volatile override in the past (see, e.g., OCPSF rule, 58 FR 36886-88, July 9, 1993). Based on their Henry's Law constants, these are all highly volatile compounds. Because much of the "removal" of these pollutants prior to and during POTW biological treatment is likely the result of volatilization, EPA continues to conclude, based on its traditional methodology, that these 17 pollutants pass through POTWs.

One of the remaining pollutants, naphthalene, is also a volatile organic pollutant as to which EPA would have applied the "volatile override" to determine that it passes through if the percent removal analysis had not shown pass through. EPA is mentioning naphthalene separately because, unlike the case of the 17 pollutants discussed above, biological treatment has been identified in this rulemaking as part of the BAT basis for naphthalene limitations. This indicated that naphthalene's biodegradability might be important for pass through purposes. However, EPA continues to conclude, as stated in the OCPSF rulemaking, that naphthalene is chemically more complex than the phenols and therefore less readily biodegradable in POTWs. The volatile override would control EPA's finding of pass through in any event for naphthalene. (See 58 FR 36887 - determination in the OCPSF remand notice that naphthalene does pass through POTWs).

As stated in the proposal, there is very little data to determine POTW removals for the four brominated priority pollutants: bromomethane, bromoform (tribromomethane), dibromochloromethane, and bromodichloromethane. However, these pollutants are structurally very similar to chloromethane and chloroform (trichloromethane), which were shown to pass through by the OCPSF analysis. In addition, EPA sampling at pesticide plants where the brominated priority pollutants are found shows that extensive volatilization of these pollutants occurs in sewers rather than removal via treatment, and the Agency expects that similar volitilization would occur when the pollutants are discharged to a POTW. This volatilization would not occur with BAT treatment, which removes (and destroys or recycles) the pollutants from the wastewater before volatilization can occur. Therefore, EPA has determined that pass-through does occur for these four brominated priority pollutants.

The 2 remaining priority pollutants out of 24 are cyanide and lead. The determination of pass through for cyanide is based on actual full-scale data showing very high removals for cyanide at BAT-level plants (over 99%), compared to an average removal level for cyanide of 54% at well-operated POTWs, as determined in the 50-plant study. For lead, as the proposal explained, the BAT concentration limits were based on the use of hydroxide precipitation technology. EPA transferred data for this technology from the Metal Finishing industry for purposes of both the OCPSF and pesticides manufacturers' rulemakings. It is clear that the data, which show much greater removals of cyanide and lead by BAT technologies than by POTWs, are not merely an artifact of different influent levels. Cyanide and lead also are not readily biodegradable compounds. EPA therefore continues to conclude that cyanide and lead do pass through POTWs.

Based upon the above considerations, EPA has concluded that PSES regulations are warranted for all of the pollutants regulated under BAT for direct dischargers, except 2-chlorophenol, 2,4-dichlorophenol, phenol, and 2,4-dimethylphenol.

7.6.4 Calculation of Effluent Limitations Guidelines Under PSNS

The Agency is setting PSNS limitations for 24 of the 28 priority pollutants addressed under NSPS. As discussed under PSES, four priority pollutants, 2-chlorophenol 2,4-dichlorophenol, phenol, and 2,4-dimethylphenol have not been shown to pass through a POTW and, therefore, are not being regulated under PSNS. The final rule contains concentration-based PSNS limitations equal to the PSES limitations.

7.7 EFFLUENT LIMITATIONS DEVELOPMENT FOR CONVENTIONAL POLLUTANTS AND COD

BPT limitations set in 1978 for Subcategory A PAIs control the discharge of COD, BOD_5, TSS, and pH when their presence in wastewaters results from the manufacture of any PAIs, except for 25 PAIs specifically exempted. As discussed in Section 9, EPA is amending the BPT applicability provision for Subcategory A PAIs to include 14 of these 25 previously excluded PAIs, as well as the organo-tin pesticides. As part of the industry study for the development of this final rule, the Agency collected effluent data on 15 organic PAIs within the group of 25 PAIs and classes of PAIs that were exempted from BPT. These data were originally collected by the manufacturing facilities themselves in order to monitor their discharges. The 15 organic PAIs for which EPA now has treatment data are: ametryn, prometon, prometryn, terbutryn, cyanazine, atrazine, propazine, simazine, terbuthylazine, glyphosate, phenylphenol, hexazinone, sodium phenylphenate, biphenyl, and methoprene. EPA has also developed analytical methods and collected effluent data for organo-tin pesticides, which were not covered in BPT guidelines. EPA stated in the proposal that the available treatment data demonstrated that dischargers manufacturing these PAIs are meeting NPDES permit limitations equivalent to the current BPT guidelines. Therefore, EPA proposed to extend the applicability of the BPT effluent guidelines to cover all of these PAIs.

The effect of this revision, as proposed, would have been to set the BPT limitations at the performance level currently being achieved at facilities under their NPDES permits and to establish a baseline on which to evaluate incremental costs of candidate BCT technologies. At proposal, EPA believed that the manufacturing facilities were in compliance with their NPDES BPT permit limitations for pH, BOD_5, TSS and COD. Thus, EPA projected in the proposal that there would be no costs incurred by any of these facilities in connection with the proposed extension of BPT applicability in the national effluent guidelines.

In the final rule, EPA is amending the BPT applicability provision as proposed, with certain changes. First, for 3 of these 15 PAIs (phenylphenol, sodium phenylphenate, and methoprene), the BPT limitations for BOD_5, TSS, pH, and COD are being promulgated in today's final rule as proposed.

Second, for 11 of the remaining 12 PAIs (i.e., all except biphenyl), EPA is promulgating BPT limitations as proposed for BOD_5, TSS, and pH, but is not promulgating COD limitations. The 11 PAIs at issue are ametryn, prometon, prometryn, terbutryn, cyanazine, atrazine, propazine, simazine, terbuthylazine, glyphosate and hexazinone. Manufacturers of these PAIs submitted comments and explanatory data demonstrating that, although their discharges do meet the existing BPT limitations for pH, BOD_5, and TSS, they do not and cannot meet the BPT guidelines for COD because of high COD loadings and high salt contents of their wastewaters.

EPA agrees with these comments. The wastewater treatment technologies installed at the facilities manufacturing these 11 PAIs are equivalent to the BPT technology, i.e., the technologies include both in-plant treatment to control PAIs and end-of-pipe biological treatment to control BOD_5 and TSS. Because these manufacturers are meeting the BPT-level limitations on BOD_5, TSS and pH, it appears that these technologies are being well-operated. The data show, however, that the production of these 11 PAIs generates wastestreams with significantly higher COD loadings (and higher salt content) than are contained in the wastestreams of the facilities on which the BPT regulations were based. The higher salt content reduces the ability of the BPT treatment technologies to remove COD. Therefore, there is no basis on which to make the existing BPT regulations on COD applicable to the manufacture of these 11 compounds.

In addition, EPA does not have data on which COD limitations could be derived for facilities that manufacture these 11 compounds. To derive COD limitations, EPA would require treatment technology performance data and/or process source reduction information related to reductions in COD in the discharges from the production of these compounds. This information was not available to support this rulemaking. These 11 PAIs represent a small number of PAIs manufactured at a small number of facilities. In the absence of a national regulation, COD loading from the manufacturing of these 11 PAIs may be regulated by permit writers on a technology basis using best professional judgment (BPJ) or as necessary to meet water quality standards. Moreover, compliance by manufacturers with the individual PAI and priority pollutant limitations established in today's rule may result in additional COD reductions over what these manufacturers are currently achieving. Accordingly, the final regulations require the manufacturers of these 11 PAIs to comply with the existing BPT limitations on BOD_5, TSS and pH but not the COD limitations.

The remaining pollutant from the group of 15 is biphenyl. Since the time of the proposal of this rule, EPA has revoked the registration of biphenyl as a pesticide. (Letter from Linda J. Fisher, Assistant Administrator, Office of Pesticides and Toxic Substances for EPA, "Notice of Cancellation", November 12, 1992, Product Registration #005412-00005). Therefore, because biphenyl can no longer be used as a pesticide, it is not covered by the pesticide chemical effluent limitations guidelines and standards, and EPA is not promulgating any regulations today covering biphenyl. See 40 CFR 455.10 and 455.21 (regulations cover "pesticides," defined as substances intended to prevent, destroy, repel or mitigate pests). Instead, biphenyl is subject to the OCPSF effluent limitations guidelines and standards at 40 CFR Part 414, Subpart H (Specialty Organic Chemicals). (Note that biphenyl manufacturing is classified under SIC Code 2869.) EPA also notes that all existing manufacturers of biphenyl already have NPDES permits covering biphenyl (among other organic chemical manufacturing operations) based on the OCPSF effluent guidelines.

As discussed in Section 13, no BCT treatment technologies were identified that passed the BCT cost test. As a result, the Agency is setting the BCT limitations for Subcategory A PAIs equal to the BPT limitations.

NSPS limitations for conventional pollutants and COD are based on the BPT limitations but adjusted to reflect the 28% reduction in wastewater flow at newer facilities (as described above for PAIs).

SECTION 8

ENGINEERING COSTS

8.0 INTRODUCTION

This section discusses the treatment technology costs for the pesticide chemicals manufacturing industry for compliance with the final BAT, NSPS, and PSES/PSNS effluent limitations guidelines. This section also describes the engineering costing methodology for specific treatment technologies.

8.1 ENGINEERING COSTING

This section describes the costing methodologies used to develop treatment costs for the treatment technology options upon which the final effluent limitations guidelines are based. The costing approach and methodology used are the same as those used to determine the costs for the 1992 proposal.

8.1.1 Cost Methodologies

First, the processes of each plant were evaluated to determine the level of pollutant discharges based on current treatment (if any). These levels were then compared with the effluent concentration levels that would result in the case of each of the two regulatory options considered: Option 1, numeric effluent concentration levels identified based on the use of the best available treatment technologies; and Option 2, no discharge of process wastewater pollutants. Then, the specific treatment technology additions or treatment technology sequence upon which the effluent concentration levels are based was selected and sized for each individual process. The cost--both purchase price (capital cost) and annual operation and maintenance cost (annual O&M cost)--was then calculated for the additional treatment based on the concentration reductions required and volumes of wastewater to be treated.

8.1.2 Cost Procedures

Figures 8-1 and 8-2 diagram the procedures followed in designing additional treatment systems for individual pesticide manufacturing facilities and calculating the costs for each system. Figure 8-1 presents the flowchart used to determine treatment costs for PAIs, and Figure 8-2 presents the flowchart used to determine treatment costs for priority pollutants.

Pesticide Active Ingredients

As presented in Figure 8-1, a treatment system has been designed for each plant handling a PAI that requires additional treatment. For plants that have multiple PAIs requiring additional treatment, the methodology

Figure 8-1

FLOWCHART USED TO DETERMINE TREATMENT COSTS FOR PAIS

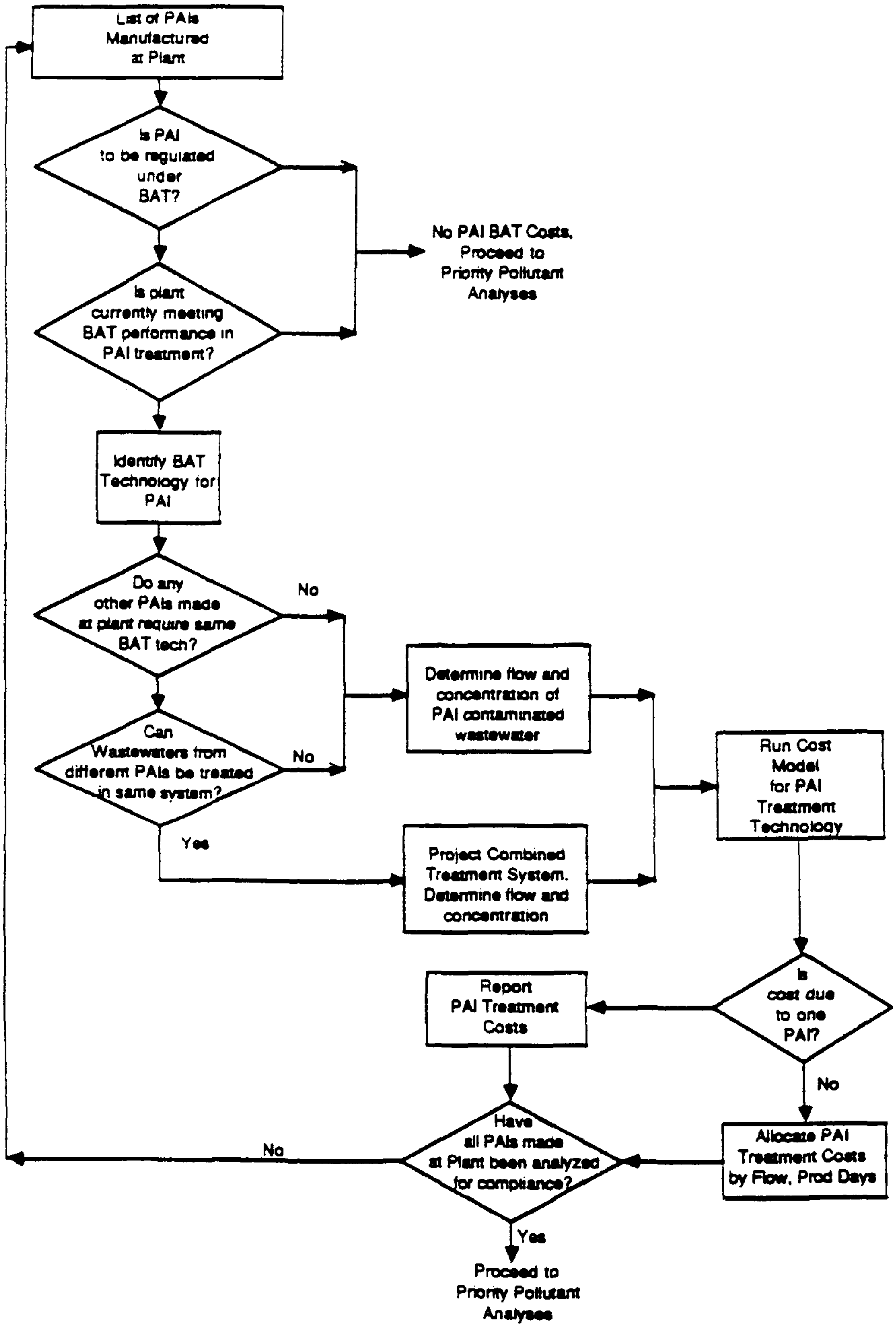
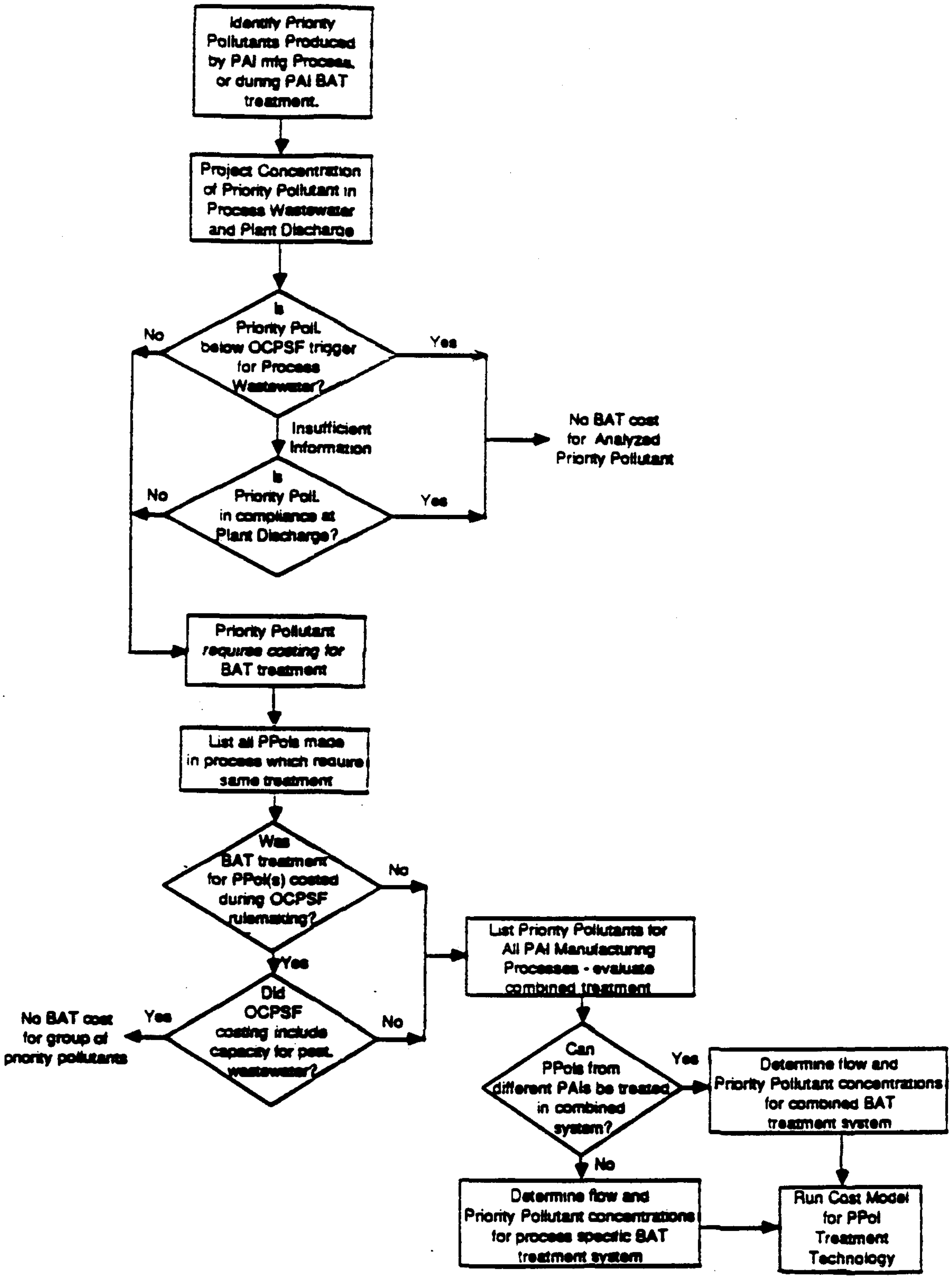


Figure 8-2

FLOWCHART USED TO DETERMINE TREATMENT COSTS FOR PRIORITY POLLUTANTS



assumes the design of one or more treatment trains as required. PAI -contaminated wastewaters requiring the same type of treatment (such as activated carbon) are assumed to be commingled and put through the same system. This train is then sized based on the wastewater flow rate through the system and the PAI removal efficiencies required to meet the limitations, and costs are calculated for the resulting design. The cost estimates are based on a computer-based cost model containing independent modules which represent the individual treatment processes. The model links the individual treatment units (modules) together to represent an entire wastewater treatment system. The modules represent treatment technologies in use in the pesticide chemicals manufacturing industry, and are useful and credible in providing accurate costs.

This design and cost process is repeated for any other PAIs that require treatment at the facility. The total treatment costs are then summed for the facility, and individual PAI treatment costs are allocated by dividing the applicable set of treatment costs by the PAI wastewater contribution, which is based on daily average wastewater flow rates and annual production days. Finally, BAT/PSES compliance monitoring costs are calculated for each pesticide manufacturing facility that does not currently monitor for a PAI or priority pollutant. These monitoring costs will be incurred regardless of whether a plant will require additional treatment. EPA included monitoring costs for those plants not currently monitoring for which the final regulations impose additional PAI and priority pollutant limitations.

Priority Pollutants

Additional treatment system design specifications and costs for the removal of priority pollutants for individual pesticide manufacturing facilities are calculated using the same procedure as the one used to calculate treatment system design specification and costs for the removal of PAIs. Because the priority pollutant limitations are transferred from the regulations established for OCPSF manufacturers, the methodology assumes that plants will apply the BAT technologies identified in the OCPSF rulemaking as the bases for these limitations. In some cases, the current priority pollutant loadings for an individual facility might not exceed OCPSF limits; however, the treatment technology installed to bring the PAI levels within BAT/PSES compliance may actually increase one or more of the priority pollutant loadings to levels exceeding OCPSF limits. One example of this is the application of alkaline chlorination (chemical oxidation to remove dithiocarbamate PAIs; this treatment may result in elevated levels of chlorinated hydrocarbon priority pollutants). In these instances, additional treatment was designed and costed to bring these priority pollutant levels into compliance with OCPSF limits. In the example above, plants costed for alkaline chlorination were also costed for steam stripping, which was designed to remove the resulting chlorinated hydrocarbons.

8.2 COST MODELING

This section provides a discussion of the cost model concept used to calculate the compliance costs of the various treatment technologies. This section also discusses the evaluation criteria, the cost models evaluated by the Agency, and presents an in-depth explanation of the selected cost model.

8.2.1 Model Evaluation

Cost Model Concept

Cost estimates of wastewater treatment systems are required to determine the economic impact of the regulations. One method of estimating costs would be to design the anticipated treatment system for each plant and estimate the costs based on actual vendor quotes for that design. Multiple designs and vendor price quotes would be gathered to estimate the costs for each treatment technology represented within the industry. This procedure, however, is labor intensive for more than a few plants. A more practical (yet still accurate) method to estimate costs is to develop a mathematical cost model. In a cost model, design and vendor information is combined to develop equations which describe costs as a function of system parameters. This method permits iterative cost estimates to be calculated without requiring detailed design and quote information for each iteration.

EPA developed a computer-based cost model to estimate the cost for pesticide manufacturers to comply with the wastewater effluent guidelines. EPA designed the model to be:

- Capable of calculating the compliance costs for the guidelines;
- Computer-based and capable of multiple iterations to cost various treatment options needed to evaluate and support the regulation;
- Detailed enough to calculate compliance costs for all the plants and active ingredients impacted by BAT and PSES guidelines;
- Capable of estimating compliance costs for all the BAT treatment technologies over a range of characteristic flow rates; and,
- Capable of representing various treatment processes individually or in combination. The model contains independent modules to represent individual wastewater treatment processes. The model is able to link the modules together to represent an entire wastewater treatment system.

EPA supplemented this cost model with Lotus 1-2-3 spreadsheets designed to calculate treatment costs for individual plants requiring activated carbon, hydrolysis, and chemical oxidation treatment units. Lotus spreadsheets were also used to calculate compliance monitoring costs.

Evaluation Criteria

A computer-based cost model incorporates design and cost equations which represent the desired treatment processes. Several models currently exist which estimate compliance costs for wastewater treatment facilities. EPA investigated the applicability of these models to the pesticide manufacturing industry. These models were chosen because they are either available in the public domain and are used for costing wastewater treatment facilities, or they have been used by EPA to estimate compliance costs for other wastewater effluent guidelines.

EPA used the following criteria to evaluate seven existing cost models for their potential use as the pesticide industry cost model:

(1) Does the model contain modules to represent wastewater treatment technologies in use or planned for use in the pesticide industry, and are the modules representative of the flow rates for that industry?

(2) Can the model be adapted to represent the wastewater treatment processes in use or planned for use in the pesticide industry?

(3) Can the base year for costs calculated in the model be changed?

(4) Has the model been successfully used to estimate costs for actual wastewater treatment facilities?

(5) Is sufficient documentation available, regarding the assumptions and sources of data, such that the model is credible and defensible?

(6) Is the model structured in a manner that is usable for the pesticide industry, or are only the basic design and cost equations usable?

Each model evaluated is discussed below.

Models Evaluated

1. CAPDET

The Computer Assisted Procedure for the Design and Evaluation of Wastewater Treatment Systems (CAPDET) was developed by the U.S. Army Corps of

Engineers. The model is intended to provide planning level cost estimates to analyze alternate design technologies for wastewater treatment plants. The model includes modules which represent physical, chemical, and biological unit treatment processes. Equations in the modules are based on rigorous engineering principles historically used for wastewater treatment system design. The user may link the modules into trains which represent entire treatment systems. The model then designs and costs various treatment trains and ranks them with respect to present worth, capital, operating, or energy cost.

Several of the modules within CAPDET (carbon adsorption, biological treatment, clarification) represent treatment processes in use in the pesticide industry. Although originally designed to cost municipal wastewater treatment facilities, these modules are adaptable for the pesticide manufacturing industry by entering design parameter values that are representative of actual data from industry.

The cost basis for CAPDET relies on an input block of data labelled unit costs. These data include construction cost indices (Marshall and Swift, Engineering News Record) and unit costs for typical construction and operating items (concrete, piping, operator labor, basic chemical feedstocks) which can be entered for any desired time frame. The program uses these data to calculate the costs for the various modules. The cost output can therefore be referenced to any year for which the data can be obtained.

EPA encourages the use of CAPDET in facilities planning and provides for the acceptance of CAPDET generated cost estimates for POTWs. Significant documentation (1,600 page design manual, 300 page users manual) supports the CAPDET methodology. Design equations for each module are clearly stated with references and examples provided. For these reasons, EPA selected CAPDET as the primary model to estimate compliance costs for the pesticide chemicals manufacturing industry. The individual modules were modified to account for wastewater flows encountered at pesticide facilities.

2. OCPSF

The model developed by EPA to support the Organic Chemicals and Plastics and Synthetic Fibers (OCPSF) industry effluent guidelines consists of three Lotus 1-2-3 spreadsheets, one each for the BPT/BAT/PSES treatment technologies. Each spreadsheet contains cost equations for the treatment processes which represent these technologies.

The cost equations were developed in the following manner. For each treatment process, EPA selected a design module from a previously available cost model. For example, CAPDET was used for carbon adsorption and biological treatment, while a Water General Corporation cost estimation method was used for steam stripping. EPA then collected and averaged data (pollutant type and loading, design constants and physical parameters) from the OCPSF industry to use as input values for the significant design parameters involved in the selected modules. Using industry-specific data as input, EPA ran the chosen module for typical wastewater flow rates and generated cost curves as a function of flow. Cost equations were then derived from these curves. EPA compared the estimated costs calculated from these equations to actual industry costs and modified the cost equations as necessary to match the actual data. The base year for the cost data was 1982. EPA then used these modified equations in the spreadsheets.

Although the equations in the OCPSF model represent treatment processes found in the pesticide industry, the equations were not used directly in the pesticide cost model because they were derived using OCPSF data and 1982 costs.

3. Wastewater Treatment System Design and Cost Model

The Wastewater Treatment System Design and Cost Model was developed by the EPA/EAD Metals Industry Branch. The model was used to determine the cost of compliance for effluent guidelines for point source categories for the following industries: aluminum forming, copper forming, coil coating, non-ferrous metal forming, non-ferrous metal manufacturing (phases I and II) and battery manufacturing.

One module (carbon adsorption) directly represents a treatment process commonly used in the pesticide industry; the other modules represent treatment processes which deal primarily with the precipitation and separation of metals from aqueous streams. The direct application of these other modules is therefore generally limited to metallo-organic pesticides. The cost data were obtained from vendors using 1982 as a base year, and no method of changing this base is provided.

Both this model and CAPDET represent actual wastewater treatment systems by a combination of modules and they generate design and cost information using this building block approach. Although EPA followed this approach for the pesticide industry cost model, EPA did not use the individual cost modules included in this model because they were developed primarily for the Metals Industry.

4. CORA

The Cost of Remedial Action Model (CORA), created by the EPA Office of Emergency and Remedial Response, provides order of magnitude cost estimates for remedial actions at Superfund sites. The model consists of two parts: an expert system and a cost calculation program. The expert system helps users select technologies for sites where physical data are not available and where a specific remedial plan has not been established. The costing program calculates capital, first-year operation, and site preparation costs for various containment, removal, treatment, and disposal technologies (modules) included in the model library.

Because CORA was developed as a model for Superfund remedial actions, many of the individual modules are not applicable to the pesticide industry. Moreover, the modules which represent treatment technologies that are potentially applicable to the pesticide manufacturing industry, such as carbon adsorption, biological treatment, and off-site landfill, are not designed to handle flow rates and wastewater characteristics typical in the pesticide manufacturing industry. For these reasons, EPA did not use this model to estimate compliance costs for the pesticide manufacturing industry.

5. ESE Cost Estimation Method

Previous work in developing effluent guidelines for the pesticide industry included cost of compliance estimates. The estimates consisted of a set of sizing and cost equations for each of the treatment processes used in the pesticide industry.

However, no direct sources of data were provided for the sizing and cost equations, nor was a method provided to vary the equations for a different time period. For these reasons, EPA did not use these cost of compliance estimates to develop the pesticide industry model.

6. RCRA Risk-Cost Model

The RCRA Risk-Cost Model was developed by EPA. The model is designed to facilitate the development of regulations governing hazardous waste treatment, storage, and disposal facilities. The model consists of a database which can be viewed as a three-dimensional matrix. Each cell within the matrix contains information related to a combination of wastes, an environment, and a management practice (not facility).

Although the technologies for the model include carbon adsorption and biological treatment, the equations for design and costing are too general to be of specific use for the pesticide industry. Therefore, EPA did not use this model to develop the pesticide industry cost model.

7. ASPEN

The Advanced System for Process Engineering (ASPEN) was developed at the Massachusetts Institute of Technology. The model is a computer-aided design package for chemical plants that performs engineering calculations to either design a system or evaluate an existing one. Because the model is primarily intended as a process simulation tool, it requires too much detailed site-specific information for its design calculations to be useful in developing the overall cost estimates which will be required from the pesticide cost model. In addition, steam stripping is the only applicable unit process for the pesticide industry. For these reasons, EPA did not use ASPEN in the development of the new pesticide cost model.

8.2.2 CAPDET

Based on the evaluation of existing models, CAPDET was judged to be the most suitable for use in the development of a cost model for the pesticide industry. EPA supplemented the CAPDET modules with Lotus 1-2-3 spreadsheets set up to calculate treatment costs for plants requiring activated carbon, hydrolysis, and chemical oxidation treatment units. CAPDET does not contain modules for hydrolysis nor chemical oxidation, and the Lotus spreadsheet developed to estimate costs associated with activated carbon systems is better suited to the pesticide industry than the CAPDET module.

General Structure

The general structure of CAPDET includes independent programs called modules which design and estimate the cost for various individual wastewater treatment technologies. The model can combine these individual modules to represent an entire treatment system and can estimate the costs for that system. The model can also design several different systems and can rank these systems with respect to construction, capital, annual operating, or energy costs. The model includes input data files for influent and effluent stream characteristics, cost data, and process specifications for individual treatment technologies to further define the physical system which is to be modelled. This general structure meets the requirements for the pesticide industry cost model.

Design Methodology

Each module within CAPDET represents a specific wastewater treatment technology. For each technology, the representative module is based on specific equipment that accomplishes the desired treatment. Each module includes a set of process design equations which mathematically represents the physical and chemical processes which occur in the technology. The module then calculates the number and size of the specific equipment, structural, building, and piping items necessary to perform the physical and chemical processes. These equations are based on general engineering principles related to the individual treatment technology.

For example, a typical carbon adsorption system includes two steel towers, filled with granular activated carbon, arranged in series flow. These towers and associated feed, backwash, and carbon handling equipment comprise the physical system required to perform carbon adsorption treatment of wastewater. The CAPDET module for carbon adsorption therefore includes this equipment. Based on the input data for a given system and the design equations, the module determines the number of parallel pairs of adsorbers required and sizes the individual towers. The module also designs the feed, backwash, and carbon handling equipment. After the equipment is designed, the module generates a cost estimate. (This methodology was followed in the Lotus spreadsheets used to calculate activated carbon treatment costs for some of the PAIs.)

Cost Methodology

The CAPDET model estimates the costs of purchasing, constructing, operating, and maintaining wastewater treatment systems. To determine these costs, CAPDET uses a combination of parametric and unit cost estimating techniques. Parametric cost estimation calculates costs based on the price of similar equipment at other locations, using equations in which the costs of different sizes of equipment are calculated as a function of the wastewater flow rate. Unit cost estimation calculates costs for individual elements by multiplying the unit price for the element by the quantity of that element used in the specific treatment technology, and then totalling the costs for all of the various elements. For example, if CAPDET determines that multiple hydrolysis vessels are required at a plant, the model will estimate the cost of one vessel based on the plant flow rate and multiply that cost by the number of vessels required.

In CAPDET, the costs of constructing a wastewater treatment facility are divided into three categories: unit process construction costs, other direct construction costs, and indirect project costs. Unit process construction costs account for the purchase and construction of all the equipment and associated structures and buildings for a treatment technology within battery limits. The battery limits are assumed to be the physical dimensions of the treatment technology plus 5 feet. For example, the battery limits for the activated carbon module include the carbon adsorption towers and the feed, backwash and carbon handling systems. The unit process construction costs for activated carbon therefore include the purchase and construction of these items. Other direct construction costs are site-specific items used to connect treatment technologies together to form a total facility. Unit process construction costs and other direct construction costs account for total construction costs. Indirect project costs are non-construction costs including planning, design, administrative and legal services, and other contingency factors. Indirect project costs are calculated as a percentage of total construction costs.

To estimate unit process construction costs, CAPDET uses the results of the process design calculations discussed in the design methodology section. For each module, these calculations identify the following major items: (1) concrete and structures, (2) installed equipment, (3) buildings and housings, and (4) piping and insulation. These items comprise approximately 75% of the unit process construction costs, therefore, each of these items is estimated separately. Electrical, control systems, and other facilities costs are calculated as a factor of the major costs.

Concrete and structural items include reinforced concrete, earthwork removal, and structural steel. CAPDET estimates these items by multiplying the quantities required by the appropriate unit costs. Equipment items include the purchase and installation of individual pieces of equipment, along with the minor electrical work, minor piping, foundations, and painting required for a complete installation. CAPDET uses parametric cost equations to estimate the cost of equipment items. Buildings are based on the area required for the given equipment. The area required multiplied by the unit costs then provides the building cost estimate. Piping items include the purchase and installation of piping, valves, fittings, and insulation. CAPDET estimates these costs by multiplying the quantities required by the unit costs.

CAPDET also calculates the operation and maintenance costs for a facility after construction. The following items for each treatment technology are considered: (1) labor requirements, (2) electrical energy for operation, (3) materials, (4) chemicals and other supplies, and (5) the replacement schedule. For each item in each technology, an equation relates the amount of the item required to the flow rate used for the technology. CAPDET then multiplies the unit costs for the items by the calculated quantity of the items to estimate operating and maintenance costs for a treatment technology. For example, if CAPDET determines that 500 man-hours are required annually to operate an activated carbon system at a specific flow rate, an estimated hourly salary will be multiplied by 500 to account for annual labor costs.

CAPDET accounts for cost changes over time using two methods. First, if the actual costs for a specific item at a specific time are known, the user may enter these costs in the model. These costs will then be used in the cost estimating equations. Second, for unit costs that are not entered by the user, the model multiplies the default value of the unit cost by a ratio of a construction index. This ratio uses the values of the index for a desired year and the default year. By multiplying the unit cost by this ratio, CAPDET adjusts the default information to the base year desired by the user. The following is a list of sources of where current, or relevant, year data may be obtained:

(1) Dodge Guide for Estimating Public Works Construction Costs;

(2) Means Building Construction Cost Data;

(3) "Chemical Engineering," a bi-weekly magazine;

(4) "Journal Water Pollution Control Federation;" and

(5) "Engineering News Record."

Input/Output

Various types of input data are required for the model to design and estimate costs for wastewater treatment systems. To operate the model, a user enters information into eight different input sections, which are:

(1) Facility selection: CAPDET design and cost modules are separated by flow rate: large facilities that generate wastewater at flow rates greater than 0.5 million gallons per day (MGD), and small facilities that generate wastewater at flow rates below 0.5 MGD. The two flow ranges include some but not all of the same modules. The user must select the applicable facility size.

(2) Unit process specification: The CAPDET model contains design and costing modules for 69 treatment technologies for large facilities and 27 treatment technologies for small facilities (Tables 8-1 and 8-2) (The pesticide cost model only uses a subset of these treatment technologies.) The model labels these technologies "unit processes." In this section of input data, the user may enter specific values for the design parameters in the design equations for each of the individual modules. Because each module has its own set of design equations, each module also has its own list of parameters. If design parameter values are not entered by the user, default data are provided by the module.

(3) Title card: The user may select a title for individual computer runs and enter this title in this section of input data. The output data sheets will then be identified by this title.

(4) Scheme descriptions: In this data section, the user may combine several unit processes which, when taken together, simulate an entire wastewater treatment system. The model will design and cost this combination of unit processes as one scheme. If desired, a user may enter a total of four different schemes for design and costing at one time.

(5) Waste influent characteristics: The CAPDET model manipulates and tracks 20 characteristics of the wastewater as the treatment system is designed (Table 8-3). The user may enter specific values for these characteristics in the influent stream, or the model will enter default data based on municipal wastes. The user must enter a value for the influent flow rate, as no default value for this characteristic is provided.

(6) Desired effluent characteristics: The same 21 characteristics that are discussed above may also be used to specify the effluent. The user may specify values for these characteristics in the effluent if desired, otherwise the values for them will be determined during the design of the system. No default data are provided by the model for effluent stream characteristics.

(7) Unit cost data: The user may enter values for a total of 38 different cost indices, construction unit costs, operating unit costs, and indirect cost category parameters (Table 8-4). Default values are provided for each of these parameters, with the values being valid for 1989 in the current version of the CAPDET program. The base year for the cost estimates for the regulation is 1986; EPA therefore entered 1986 data for these unit costs.

Table 8-1

CAPDET LARGE FACILITY UNIT PROCESSES

1.	Flotation thickening
2.	Secondary clarification (activated sludge)
3.	Aerated lagoon
4.	Aerobic digestion
5.	Anaerobic digestion
6.	Anion exchange
7.	Attached growth denitrification
8.	Belt filter for sludge dewatering
9.	Carbon adsorption
10.	Cation exchange
11.	Centrifugation
12.	Chlorination
13.	Secondary clarification (user-specified)
14.	Coagulation
15.	Comminution
16.	Complete mix activated sludge
17.	Contact stabilization activated sludge
18.	User-specified costs for unit processes
19.	Counter current ammonia stripping
20.	Cross current ammonia stripping
21.	Denitrification (suspended growth)
22.	Secondary clarification (suspended growth denitrification)
23.	Drying beds
24.	User-specified liquid process
25.	Equalization
26.	Extended aeration activated sludge
27.	Filtration

Table 8-1 (Continued)

CAPDET LARGE FACILITY UNIT PROCESSES

28.	First stage recarbonation (lime treatment)
29.	Flocculation
30.	Flotation
31.	Filter press
32.	Fluidized bed incineration
33.	Gravity thickening
34.	Grit removal
35.	Sludge hauling and land filling
36.	High rate activated sludge
37.	Primary clarification (two-step lime clarification)
38.	Lagoons (stabilization ponds)
39.	Microscreening
40.	Multiple hearth incineration
41.	Secondary clarification (suspended growth nitrification)
42.	Neutralization
43.	Nitrification (suspended growth)
44.	Nitrification (rotating biological contactor)
45.	Nitrification (trickling filter)
46.	Secondary clarification (oxidation ditch)
47.	Overland flow land treatment
48.	Oxidation ditch
49.	Plug flow activated sludge
50.	Postaeration
51.	Primary clarification
52.	Secondary clarification (pure oxygen)
53.	Intermediate pumping
54.	Pure oxygen activated sludge

Table 8-1 (Continued)

CAPDET LARGE FACILITY UNIT PROCESSES

55.	Rapid infiltration land treatment
56.	Raw sewage pumping
57.	Rotating biological contactor
58.	Recarbonation
59.	Secondary clarification (RBC)
60.	Screening
61.	Second stage recarbonation (lime treatment)
62.	Slow infiltration land treatment
63.	Sludge drying lagoons
64.	Step aeration activated sludge
65.	Secondary clarification (trickling filters)
66.	Trickling filtration
67.	User-specified sludge process
68.	Vacuum filtration
69.	Wet oxidation

Table 8-2

CAPDET SMALL FACILITY UNIT PROCESSES

1.	Activated sludge
2.	Aerated lagoon
3.	Bar screens
4.	Chlorination
5.	Coagulation
6.	User-specified costs for unit processes
7.	Drying beds
8.	User-specified liquid process
9.	Equalization
10.	Filtration
11.	Flotation
12.	Intermittent sand filtration
13.	Lagoons
14.	Secondary clarification (oxidation ditch)
15.	Overland flow land treatment
16.	Oxidation ditch
17.	Postaeration
18.	Primary clarification
19.	Intermediate pumping
20.	Rapid infiltration land treatment
21.	Raw sewage pumping
22.	Secondary clarification (trickling filter)
23.	Septic tanks and tile fields
24.	Slow infiltration land treatment
25.	Sludge drying lagoons
26.	Trickling filtration
27.	User-specified sludge process

Table 8-3

WASTE INFLUENT CHARACTERISTICS

Characteristics	Units	Default Values[1]
Minimum Flow	MGD	---
Average Flow Final/Initial	MGD	---
Maximum Flow	MGD	---
Temperature Summer/Winter	DEG C	23/10
Suspended Solids	MG/L	200
Volatile Solids	% of Suspended	60
Settleable Solids	ML/L	15
BOD_5	MG/L	250
$SBOD_5$ (Soluble)	MG/L	75
COD	MG/L	500
SCOD (Soluble)	MG/L	400
pH	MG/L	7.6
Cations	MG/L	160
Anions	MG/L	160
PO4 (as P)	MG/L	18
TKN (as N)	MG/L	45
NH3 (as N)	MG/L	25
NO2 (as N)	MG/L	0
NO3 (as N)	MG/L	0
Oil and Grease	MG/L	80

[1] Default values are from original CAPDET model, based on municipal waste. Default values were used if the default values accurately represented the actual wastewater characteristics. Where the actual wastewater characteristics were significantly different, the actual characteristics were used instead of the default values.

Table 8-4

UNIT COST DATA

	Unit Cost	1986 Value
1.	Building Cost	$51.39/sf
2.	Excavation	4.19/cy
3.	Wall Concrete	477.37/cy
4.	Slab Concrete	105.04/cy
5.	Marshall & Swift Index	797.6
6.	Crane Rental	112.09/hr
7.	EPA Construction Cost Index	403.0
8.	Canopy Roof	8.61/sf
9.	Labor Rate	19.52/hr
10.	Operator Class II Labor Rate	16.32/hr
11.	Electricity	0.049/kWh
12.	Lime	0.03/lb
13.	ENR Cost Index	4,290.51
14.	Handrail	40.94/lf
15.	Pipe Cost Index	373.4
16.	Pipe Installation Labor Rate	22.16/hr
17.	8" Cast Iron Pipe	36.00/lf
18.	8" Cast Iron Pipe Bend	131.09 ea
19.	8" Cast Iron Pipe Tee	156.09 ea
20.	8" Cast Iron Plug Valve	1,104.63 ea
21.	Small City EPA Index	228.7
22.	Land Cost	*
23.	Miscellaneous Nonconstruction Cost	5.00%
24.	Administrative/Legal Cost	2.00%
25.	201 Planning Cost	3.50%
26.	Inspection Cost	2.00%

Table 8-4 (Continued)

UNIT COST DATA

	Unit Cost	1986 Value
27.	Contingency Cost	8.00%
28.	Profit and Overhead Cost	22.00%
29.	Technical Cost	2.00%
30.	Aluminum	**
31.	Iron	**
32.	Polymer	**
33.	Blowers, rotary positive displacement	**
34.	Blowers, multistage centrifugal	**
35.	Blowers, single stage centrifugal	**
36.	Replacement life for blowers (33)	**
37.	Replacement life for blowers (34)	**
38.	Replacement life for blowers (35)	**

*Land costs are calculated using a separate Lotus spreadsheet.

**These items are included in CAPDET, but are not required for pesticide wastewater treatment modules.

(8) Program control: The last section of input data provides the user with a choice of determining the types of output that the model will generate for a particular run (Table 8-5). The user may select various control statements that will then provide the desired output data. Material balance information, design information for the individual unit processes, and summaries of cost information can all be generated by the model. After the user enters the above data, the model executes the design and cost estimating programs and generates the requested output.

8.2.3 Pesticide Industry Cost Model

After EPA evaluated the CAPDET model and determined that it could serve as a suitable basis for the pesticide industry cost model, the Agency adapted CAPDET to estimate costs for the installation of treatment technologies in the pesticide manufacturing industry. EPA developed and added modules for treatment technologies that were not part of the original CAPDET model but were applicable treatment technologies for wastewater treatment in the pesticide manufacturing industry. EPA also created three Lotus 1-2-3 spreadsheets for use in calculating treatment technology costs for activated carbon, chemical oxidation, and hydrolysis systems. EPA also created a Lotus spreadsheet for use in calculating compliance monitoring costs.

EPA obtained the necessary input data, design parameters, and unit costs from industry sources, engineering references, and the public domain and entered them into the model to generate the cost estimates for the pesticide industry.

The following sections describe the design and cost methodologies for the treatment technologies used in the pesticide manufacturing industry.

8.3 TREATMENT TECHNOLOGIES

Section 7 identified and described the wastewater control and treatment technologies used or available for use to reduce or remove PAIs and priority pollutants from wastewater discharged by pesticide chemical manufacturers. This section describes how the cost model represents each of these treatment technologies. Specific assumptions regarding equipment used, flow ranges, input and design parameters, design and cost calculations, and disposal cost estimates for each technology are included for the following technologies:

- Activated carbon;
- Biological treatment;
- Chemical oxidation;
- Contract hauling and incineration;
- Distillation;
- Equalization;

Table 8-5

PROGRAM CONTROL/OUTPUT SELECTION

Statement	Output
Analyze	Prints unit process design data as program is executed.
List Total	1. Prints schematic of trains. 2. Prints total costs of trains.
Present Worth	Prints unit process design data and expected effluent data for different trains, ranked by present worth cost.
Construction	Prints unit process design data and expected effluent data for different trains, ranked by total construction costs.
Project	Prints unit process design data and expected effluent data for different trains, ranked by total project costs.
Energy	Prints unit process design data and expected effluent data for different trains, ranked by total energy costs.
Operation and Maintenance	Prints unit process design data and expected effluent data for different trains, ranked by operation and maintenance costs.
Output Quantities	Prints calculated quantities used to estimate costs for each unit process.
Summary	Suppresses printing of design data, prints only influent and effluent data and the cost summary of each train.
GO	No output is generated; however, this card initiates the execution of the program and it must be included as program control input.

- Filtration;
- Hydrolysis;
- Hydroxide precipitation;
- Resin adsorption; and
- Steam stripping.

This section also discusses how EPA estimated monitoring costs for compliance.

Individual plant treatment costs associated with the final rule are listed in Table 8-6. The table lists the treatment costs estimated for each plant, broken down by capital, operating and maintenance (including monitoring costs), land, and residual waste disposal costs.

8.3.1 Activated Carbon

Activated carbon adsorption is a physical separation process in which highly porous carbon particles remove a variety of substances from water. Activated carbon can be used both as an in-plant process for the recovery of organics from individual waste streams and as an end-of-pipe treatment for the removal of dilute concentrations of organics from wastewaters prior to discharge or recycle. Activated carbon can be used to remove both PAIs and priority pollutants.

Physical Equipment

The activated carbon module in the pesticide industry cost model is based on vendor information for packaged activated carbon adsorption units. The module includes a packaged unit which consists of three skid-mounted adsorption towers and the necessary pumps and piping for filling, feeding, backwashing, and emptying the towers. In addition to the packaged equipment, the module includes a feed tank for wastewater influent and a separate tank for treated water to be stored for backwashing requirements.

Input and Design Parameters

EPA used the CAPDET activated carbon module to calculate costs for activated carbon treatment systems designed to remove priority pollutants, and the Lotus spreadsheet module to calculate costs for activated carbon treatment systems designed to remove PAIs. The CAPDET activated carbon module uses influent flow rate and influent and effluent Chemical Oxygen Demand (COD) concentrations as input for the cost estimation methodology. The Lotus spreadsheet module uses influent flow rates and PAI concentrations (labelled "COD" in the module) from the Facility Census submittals or from EPA sampling data as input for the cost estimation methodology. Effluent COD concentrations were set at the detection limit for the specific PAI in the treated matrix. The adsorber capacity and the empty bed residence time were used as design parameters. Values for empty bed residence time (EBRT) and adsorption capacities were obtained from treatability studies, on waters containing the specific PAI to be removed.

Table 8-6

PESTICIDES OPTION 1 - TOTAL COSTS BY PLANT

Plant ID	Total Capital Cost($)	Total O&M Cost ($/yr)	Total Land Cost ($/yr)	Residual Waste Disposal Cost ($/yr)
0028[a]	2,866,451	2,506,648	8,250	481,762
0046	0	40,730	0	0
0064[a]	0	11,439	0	0
0180	0	31,785	0	0
0288	0	13,680	0	0
0402	468,626	57,470	17,176	134,534
0448	0	83,690	0	0
0563	0	47,200	0	0
0705	0	4,760	0	0
1063	450,379	35,193	7,695	26,000
1189[a]	1,020,201	1,119,656	1,134	102,200
1287[b]	0	0	0	0
1562	0	55,550	0	0
1606	0	1,180	0	0
1624	0	6,540	0	0
1820[b]	0	0	0	0
1848[a,c]	0	0	0	0
1848[a,d]	16,000,000	5,000,000	0	0
1900	0	34,860	0	0
2008[a]	0	85,540	0	0
2080	0	25,880	0	0
2160[a]	0	55,220	0	0
2302[a]	486,875	39,337	2,592	7,028
2446	0	35,580	0	0

Table 8-6 (Continued)

PESTICIDES OPTION 1 - TOTAL COSTS BY PLANT

Plant ID	Total Capital Cost($)	Total O&M Cost ($/yr)	Total Land Cost ($/yr)	Residual Waste Disposal Cost ($/yr)
2507	2,546,993	1,162,428	17,853	633,374
2543	1,026,950	1,176,142	5,400	107,062
2561	23,402	10,189	0	0
2605[b]	0	0	0	0
2767	0	21,160	0	0
2847	0	22,660	0	0
2865	0	6,160	0	0
3043	0	42,380	0	0
3061[b]	0	0	0	0
3141[b]	0	0	0	0
3169[b]	0	0	0	0
3187[b]	0	0	0	0
3285[b]	0	11,514	0	0
3560	0	26,660	0	0
3329[b]	0	0	0	0
3560	0	26,660	0	0
3668	0	21,580	0	0
3828	0	7,440	0	0
3864	446,229	48,415	6,480	77,132
3908[b]	0	0	0	0
3944	0	33,080	0	0
3962	1,464,209	248,361	9,740	104,448
4024	0	2,860	0	0
4060	596,408	69,344	3,588	1,398

Table 8-6 (Continued)

PESTICIDES OPTION 1 - TOTAL COSTS BY PLANT

Plant ID	Total Capital Cost($)	Total O&M Cost ($/yr)	Total Land Cost ($/yr)	Residual Waste Disposal Cost ($/yr)
4168[b]	0	0	0	0
4220	925,987	300,262	4,050	6,169
4284[a]	600,060	158,012	4,133	120,888
4462[a]	1,420,219	2,771,624	5,115	0
4505[a]	3,305	39,555	0	0
4863	0	1,180	0	0
4881[a]	555,136	40,180	0	0
4989	175,015	62,351	2,403	0
5005	45,734	82,413	3,856	75,189
5247	2,346,222	367,481	1,492	0
5461	0	27,340	0	0
5504	0	10,620	0	0
5522	0	31,605	0	0

[a] Compliance cost were revised following proposal based on new information applicable to the PAIs manufactured at this plan.

[b] Plant or PAI product line closure identified following proposal. Compliance costs for the closed PAI product lines set equal to zero.

[c] Compliance costs reflect Agency estimates using revised wastewater flow and PAI loading information.

[d] Plant estimate submitted following proposal. A revised economic impact analysis for this plant using the plant cost estimates indicates no significant adverse economic impact.

The modules determine the size of the activated carbon system as a function of flow rate, influent and effluent concentrations, and empty bed residence time. Adsorber capacity is used to determine the exhaustion rate of the carbon given the flow rate and concentration difference. After the system is sized, the modules then estimate the cost of the system, including auxiliaries.

Cost Calculations

The modules calculate the capital and O&M costs of the activated carbon system components as a function of the size of the system. Parametric equations relate tower cost, pump costs, etc. to the system flow rate. The results of the design calculations provide the sizes of the packaged unit and auxiliary equipment. Vendor supplied information was used to generate equations that set costs as a function of size for these pieces of equipment. With the sizes of the equipment determined from the design calculations, the individual equipment costs were then calculated. The modules then summed the individual costs and multiplied the total by a contingency factor to account for miscellaneous other costs. These overall totals were the capital and operation costs for the activated carbon system.

In these analyses, the activated carbon system capital costs include influent surge tank and pumps; package granular activated carbon system; backwash system and pumps, and enclosure for system. The O&M costs account for operation and maintenance labor, energy requirements, materials and supplies, and replacement carbon. The costs for each of these elements of the O&M cost were developed from the vendor data associated with specific activated carbon pre-packaged units. The activated carbon O&M costs include operation and maintenance labor; maintenance materials; electricity or other energy requirements; and replacement activated carbon (including regeneration or disposal). Operation and maintenance costs were calculated on a PAI basis and summed for total O&M cost.

8.3.2 Biological Treatment

Biological treatment is used in industrial wastewater treatment to remove organic chemicals from wastewater streams through the use of biological media. The biological treatment process used to develop compliance costs for the pesticide industry cost model is an extended aeration activated sludge system.

Physical Equipment

The CAPDET module for extended aeration activated sludge was used to calculate the compliance costs for the installation and operation and maintenance of biological treatment processes for the pesticide chemical manufacturers. In the extended aeration activated sludge module, the CAPDET model assumes that a package unit can be provided to accomplish the entire treatment process. The unit includes the necessary components, such as the aeration tank, settling tank, sludge recycle equipment, and aeration piping to perform the treatment. Foundations are not included in the package unit; however, the module calculates these costs independently and adds them to the cost for the package unit. The extended aeration activated sludge process is better suited for facilities with small flow rates as it is easier to operate than other modifications of the activated sludge process and does not require as highly skilled operators.

Input and Design Parameters

For the extended aeration activated sludge module, the input values are influent stream characteristics, including; flow rate, Biological Oxygen Demand (BOD_5), Chemical Oxygen Demand (COD), suspended solids, volatile suspended solids, non-biodegradable fraction of volatile suspended solids, pH, acidity, nitrogen, phosphorous, oil and grease, toxic or special characteristics, heavy metals, and temperature. Design parameters include hydraulic and solid detention times, a metabolism constant, a synthesis factor, the endogenous respiration factor, and a temperature correction coefficient. Values for the flow rate were obtained from census data from the specific plant sites. Influent BOD_5 concentrations were obtained from the census data or from data generated during sampling activities at the facilities. Values for the remaining input data and design parameters were taken from average values developed for the same cost module for the OCPSF industry. Since no better data are available for the pesticide industry, the Agency is using the average values from the OCPSF industry data for these design parameters. The design parameters for the biological treatment module are presented in Table 8-7.

Design Calculations

The CAPDET module for extended aeration activated sludge determines the size of the packaged system as a function of the input data and design parameters. The volume of the aeration tank is calculated from the detention time and flow rate. Solids generation, sludge recycle requirements, and effluent conditions are calculated as functions of the design parameters and the calculated aeration tank volume. After these variables have been calculated, the module uses them to estimate the costs of a package biological treatment unit.

Cost Calculations

For the packaged extended aeration system, the costs are determined parametrically, based on vendor information for standard sized packaged units.

The total capital costs include the packaged unit and the necessary foundations. The operation and maintenance costs include:

- Operation and Maintenance Labor;
- Materials;
- Energy;

Table 8-7

DESIGN PARAMETERS FOR THE BIOLOGICAL TREATMENT
COST MODULE

Design Parameter	Units	Default Values
Reaction rate contant	L/mg/hr	0.00135
Fraction BOD_5 synthesized		0.73
Fraction BOD_5 oxidized		0.52
Air requirement	scfm/1,000 gal	20
Endogenous respiration rate (sludge basis)	L/day	0.057
Endogenous respiration rate (oxygen basis)	L/day	0.15
Nonbiodegradabe fraction of volatile suspended solids in influent		0.5
Oxygen transfer ratio		0.53
Oxygen saturation ratio	hp/1,000 gal	0.9
Horsepower	lb BOD_5/lb MLVSS	0.9
Food/microorganism ratio	lg 02/hp hr	0.5
Standard transfer efficiency		6

- Sludge Disposal O&M costs; and
- Sludge Disposal.

The capital costs for the extended aeration system are expressed as a function of flow rate and tank volume and the operation and maintenance costs are expressed as a function of flow rate. The costs for the foundations are determined from the size of the foundation (calculated in the design calculations section) and the unit cost of concrete. Other miscellaneous costs are assumed to be a factor of the calculated costs. Land costs are the product of the regional unit price per acre cost and the amount of land required.

Sludge Disposal from Biological Treatment

The use of biological treatment as a wastewater treatment technology results in the generation of wasted biological treatment sludge from the clarification step. Dewatering equipment costs were calculated for plants with a flowrate greater than 50,000 gpd. In the cost estimation module for the pesticide industry, packaged rotary drum vacuum filters are used as the mechanical dewatering equipment for sludges generated by the packaged extended aeration system. EPA determined that it is not cost efficient for plants with a wastewater flow rate less than 50,000 gpd to install dewatering equipment and, therefore, costs were estimated for these facilities to transport sludge without dewatering. Off-site incineration is the sludge disposal method since the volumes of sludge generated are below the volumes needed to justify the capital investment of an on-site incinerator.

The cost for sludge disposal for plants with a flowrate greater than 50,000 gpd includes the capital cost for the mechanical dewatering equipment, the O&M costs for the mechanical dewatering equipment, and the disposal costs at an off-site incinerator. The packaged rotary drum vacuum filters are skid-mounted units that include filter, vacuum pump, filtrate pump, pre-coat mix tank with agitator, and dust collection for the pre-coat (pre-coat material is usually diatomaceous earth). The packaged unit does not include equipment for storage or slurry of feed sludge. Base prices for the packaged dewatering units were obtained from vendors and are a function of the sludge generation rate from the extended aeration system.

Operation and maintenance costs include labor and supervision, energy, chemical conditioning, maintenance and miscellaneous overhead for operating the filter on a continuous basis. Disposal of the sludge after mechanical dewatering will require shipment to an off-site incinerator. For the pesticide industry biological treatment cost module, the sludges are considered hazardous. The disposal costs include transportation costs and the disposal fee.

8.3.3 Chemical Oxidation

For the pesticide manufacturing industry, a packaged chemical oxidation-alkaline chlorination system is used. The model specifies chlorine as the oxidizing agent because chlorine is frequently used and sufficient data is available to calculate cost estimates. Costs were developed for this module based on a vendor quote from an application developed for the organic chemicals, plastics, and synthetic fiber industry. Parametric equations were developed based on capital and O&M costs calculated at different flows for flow rates above 5,000 gpd. Capital costs for plants with wastewater flow rates below 5,000 gpd were assumed to be the same as those for the 5,000 gpd system. However, O&M costs were adjusted based on the actual flow rate.

The physical equipment included in this application are a chlorinator, bulk storage tank, chemical feed pump, caustic feed module, and electric control panel. Design parameters for this module include influent flow rate, reactor retention time, and chemical feed system size.

Capital costs include the purchase and installation costs of the alkaline chlorination system and auxiliary equipment. The base purchase costs are multiplied by factors to adjust for indirect costs and cost indices to bring the costs to 1986 basis. O&M costs for continuously operating systems include operating labor, maintenance, power, miscellaneous, and chemical costs. O&M costs for batch systems are the same as continuous systems, except that they are multiplied by a ratio of the actual flow rate to the minimum flow rate for continuous operation, 5,000 gpd.

8.3.4 Off-Site Incineration

The off-site incineration module consists of cost estimate calculations for storage on-site, transportation to an incineration facility, and incinerator/disposal costs.

Assumptions for the off-site incineration disposal module include the following:

- All wastes are treated as hazardous liquids and are disposed of by incineration;
- 5,000 gallon tank trucks are used for hauling wastewater to a disposal site, and only one tank truck will visit a site at a time;
- Wastes are stored on-site no longer than 45 days in a 10,000 gallon storage tank; and,
- The pumping station is only operated while loading the tank truck.

Capital equipment costs and operational and maintenance costs are determined parametrically through the use of cost curves. Transportation and disposal costs are determined by multiplying the calculated quantities of wastewaters by appropriate transportation and disposal fees.

Physical Equipment

Equipment for storing the waste on-site includes a 10,000-gallon vertical atmospheric tank (tank containing liquid with an approximate vapor pressure of 15 psia). The tank is made of carbon steel with a flat top and bottom. A package high service pumping station is used to transfer liquids from the storage tank to the hauling vehicle. A 70 gpm pump is used because it can empty a 10,000-gallon tank in approximately two hours. Equipment used in the operation and maintenance of the tank and the transportation and disposal of the waste are factored into those specific costs.

Storage time is determined by dividing tank size (5,000 gallons) by the flow rate in gallons per day. If storage time is less than 45 days per year (flows greater than 111 gal/day), costs are calculated based on a 5,000 gallon tank truck hauling waste away once every interval of the storage time. If storage time is greater than 45 days (flows less than 111 gal/day), then costs are calculated based on the wastes being stored in 55 gallon drums and the drums being hauled away once every interval of storage time with a maximum storage time of 90 days.

The RCRA limit for storing hazardous wastes is 90 days. The division between whether a facility will use drum storage or tank storage is whether there is enough wastewater to fill up one tank truck within 45 days. If a facility can fill a tank truck within 45 days, then the pesticide manufacturing facility would have a 10,000-gallon tank and a pumping system, and the waste would be hauled in tanker trucks. If not, the facility would store the waste in 55-gallon drums. A truck would stop by when there were enough drums to fill a truck, at least once every 90 days.

Input Data/Design Parameters

The only input for this module is waste water flow in million gallons per day (MGD). Design parameters include size of equipment, time of operation, distance travelled, and unit prices. Equipment size parameters include the size of the storage tank and tank truck, the capacity of the pumping station, and drum capacity per truck load. Operation time parameters include the number of production days for the plant, the time to connect and disconnect the pump and tank truck, and the time to inspect the equipment. Travel distance parameters are the unloaded distance from the disposal site to the pesticide manufacturing facility and the loaded distance from the facility to the disposal site. The module uses the default value of 500 miles for travel distance. Cost parameters include the drum purchase price, bulk and drum disposal fees, demurrage fee, tank truck costs and sample analysis fees.

Design Calculations

The storage time was determined by dividing the capacity of the truck by the wastewater flow rate of the facility. With a 5,000 gallon tank truck, a facility would need a flow of at least 111 gallons per day to require a 10,000-gallon tank. If a facility can use drum storage, the storage time was determined by dividing drum capacity by the wastewater flow rate. The maximum allowable storage time was 90 days.

Cost Calculations

Compliance costs are made up of capital and annual costs. Capital costs include the purchase of equipment. Annual costs include operation and maintenance of equipment, and transportation and disposal of the waste.

No capital costs were calculated for facilities storing their waste in 55-gallon drums. Capital costs for plants storing their wastes in 10,000-gallon tanks include in the purchase of the tanks and pumping systems. Costs for this equipment are determined parametrically by cost curves dependent on capacity, tank capacity, and pumping capacity.

Annual costs for plants storing their waste in 55-gallon drums includes drum replacement, drum inspection, drum transportation, drum disposal, labor, and disposal by incineration. Annual costs for plants storing their waste in 10,000-gallon tanks includes operation and maintenance of tanks, pumping station, and trucks; labor; transportation of waste; and disposal by incineration.

Costs for the operation and maintenance of equipment are determined parametrically by cost equations dependent on the capacity of the equipment. These costs account for inspection, operation, energy usage, upkeep, and repair of the equipment.

Transportation costs include the loading and distance costs multiplied by the frequency of trips. Loading costs are equal to the time it takes to load the truck multiplied by a demurrage fee. Distance costs include both the unloaded travel to the pesticide manufacturing plant and the loaded return to the disposal facility.

Disposal costs are the costs to sample and incinerate the waste multiplied by the frequency of trips. Disposal and sampling fees are dependent on the quantities and type of waste disposal.

8.3.5 Distillation

A small distillation system, designed to handle solvent recovery, can be used in the separation of water and alcohol to facilitate the reuse of esterification reaction water. Distilling reaction wastewater by controlling the temperatures used during evaporation of solvent and water from the reaction mixture yields water suitable for use in salt formations. Plants can reduce or even eliminate their discharge of pesticide active ingredients and alcohol contaminated wastewater by reusing the esterification wastewater.

The contaminant mixture is first pumped into the distillation chamber. The unit then burns thermal oil to heat the mixture and vaporize the solvent. During heating, a pure solvent vapor, consisting of the alcohol used in manufacturing the specific phenoxy ester, enters the water cooled condenser and is liquefied. The purified alcohol is then piped to storage drums while the water remains in the distillation chamber and is automatically discharged and available for reuse. Reuse of the esterification reaction waste water is dependent upon the separation of the alcohol from the water.

It has been demonstrated at several pesticide manufacturing plants that distillation of esterification reaction water to recover alcohols for recycle in the esterification process and reuse of the water recovered from the distillation is technically feasible.

Distillation capital costs included purchase and installation of equipment. Installation includes electrical hookups for control panel in nonhazardous area, transportation, assembly, and initial labor to install the equipment. Operation and maintenance costs include energy, electricity for power supply, thermal oil for heating, labor, and supplies. Land costs are negligible.

8.3.6 Equalization

Flow equalization design calculations consisted of determining the required additional capacity, sizing the feed tank, and calculating capital, O&M, and land costs.

The required equalization capacity was determined by multiplying the maximum daily feed rate by the required storage time. The required number of feed tanks was determined by dividing required storage time by the largest feed tank size available.

The capital cost includes purchase and installation of the feed tanks and is calculated by multiplying the number of feed tanks by the net cost of each tank. Additional operation and maintenance costs due to the feed tanks was assumed negligible in comparison with overall plant operations and maintenance cost. Land cost was calculated by multiplying the unit land cost for the respective state by the required area.

8.3.7 Filtration

Filtration is the removal of suspended solids through a porous medium. For the pesticide manufacturing industry, two types of filters were costed for wastewater treatment: multimedia filtration, and filter presses.

Physical Equipment

In general, the equipment required for a filtration system includes the filter frame (usually concrete or steel) and the filtration media (usually sand). In addition, the filter press requires a plate shifter, the press itself, a conveyor system, and a roof to prevent rain from contacting the squeezed cake.

Input and Design Parameters

The input parameter for the multimedia filter cost estimates from CAPDET was the wastewater flow rate. Default values were used for other design parameters, such as hydraulic loading rate, sand size and shape, bed size, and filter media characteristics. Design parameters for the filter press were specified in a treatability study for the plant.

Design and Cost Calculations

Design calculations for the filters were based on the filter requirements; effluent characteristics; quantities of supplies, materials, and equipment; energy and other operation and maintenance requirements. Capital costs for the multimedia filter were based on purchase and installation costs for the filter and auxiliary equipment. Capital costs for the filter press were based on vendor quotes. O&M costs for the multimedia filter and the filter press were based on purchasing filter supplies and material and running the equipment. Additional land costs were assumed negligible in comparison to existing wastewater treatment systems at the plant.

8.3.8 Hydrolysis

Treatment of pesticide active ingredients by hydrolysis is common in the pesticide industry. This wastewater treatment technology uses hydroxyl ions to catalyze hydrolysis of the PAIs in the wastewater. The Facility Census shows that hydrolysis treatment may be conducted either continuously or on a batch basis.

A typical hydrolysis system consists of a hydrolysis vessel, a storage and delivery system for caustic, heat exchange equipment, and associated pumps and piping. The wastewater is heated to 60°C (140°F) either prior to treatment or during treatment to increase the rate of reaction. Sodium hydroxide is added to the wastewater to increase the pH to approximately 12. Many plants use higher temperatures and higher pH to further increase the rate of hydrolysis. After the desired retention time in the hydrolysis vessel at basic pH and high temperature, the treated wastewater is then pumped out of the hydrolysis vessel and discharged for further treatment or disposal.

Physical Equipment

The Agency was unable to identify an existing cost model that provided adequate design and cost information for hydrolysis treatment. A costing module was therefore developed using existing operating hydrolysis units for reference. The design is based on treatment of wastewater at elevated temperatures and at a basic pH. The successful reduction of PAI concentrations from actual influent to desired effluent requires the wastewater to be maintained at the temperature and pH conditions for a sufficient period of time. This residence time is determined by the kinetics of the hydrolysis chemical reaction and the influent and effluent concentrations. A more detailed discussion of hydrolysis is presented in Section 7.0.

Input and Design Parameters

The hydrolysis module requires wastewater flow rates for design and costing. Design parameters such as rate constants for the hydrolysis reactions for individual active ingredients, batch cycle time, influent concentrations, desired effluent concentrations, and the mode of operation (continuous or batch) are also required. Other parameters such as caustic and steam addition rates (to bring the wastewater to a pH of 12 and a temperature of 60°C) are fixed in the module.

Design Calculations

The hydrolysis cost module calculates the vessel volume as a function of the wastewater flow rate and the necessary residence time. The length of the residence time is a function of influent concentrations, pollutant half-lifes, rate constants, and the desired effluent concentrations. The module calculates the necessary residence time to achieve the very low effluent levels, and accordingly determines the size and number of hydrolysis vessels based on the batch flow rate and batch cycle time of wastewater. Other equipment in the system are sized as a function of the wastewater flow rate.

Cost Calculations

After the individual equipment items are designed, the hydrolysis module calculates the costs for each item. For each item, parametric cost equations were either obtained from existing literature sources or developed from vendor data. These parametric equations calculate the capital cost of the equipment as a function of the size of the equipment. The costs for each item were then added together and multiplied by a factor to include other miscellaneous capital costs not specifically calculated. The resulting total represents the capital cost of a hydrolysis system. The hydrolysis capital costs include sodium hydroxide storage and delivery systems; heat exchanger; hydrolysis vessel(s); pumps (including feed and transfer pumps); and other miscellaneous items including structural steel, concrete, piping, electrical supply, etc.

Operating and maintenance costs were calculated by first determining the quantity of utilities, manpower, materials, and supplies required for the operation of the design hydrolysis system. The quantities were then multiplied by their respective unit costs and summed to generate a total O&M cost. The O&M costs include operation and maintenance labor; maintenance materials; steam; energy; and supplies/chemicals.

8.3.9 Hydroxide Precipitation

Precipitation using lime (or NaOH) is used for removal of metals from solution. Metal ions in solution react with the hydroxyl ions as the pH is raised to form insoluble metal hydroxides. Polymer is added to aid the flocculation of the precipitate.

Three operating modes of the hydroxide precipitation process are accommodated by the computer model: continuous, batch, and low-flow batch. Selection of the appropriate treatment mode is based on the magnitude of the influent flow rate. Because of the low flow rates at PAI plants requiring this technology, compliance costs for this treatment technology were estimated using only the low-flow batch regime. In low-flow batch chemical precipitation, sufficient retention time is allowed for solids settling to occur in the reaction vessel. Therefore, the treated effluent stream is the clarified overflow from the reaction vessel. Another stream requiring disposal is the underflow (settled solids), which are dewatered and subsequently disposed as a hazardous waste.

Equations for this module were based on the chemical precipitation module used in developing compliance costs for the metals and machinery branch effluent guidelines. Inputs into the module include the wastewater flow rate and the number of wastewater productions days. Design parameters include the residence time and the design safety factor. Computations made include the volume and rate of lime addition, size of physical equipment, and sludge disposal costs.

Capital costs are the purchase and installation costs of the fiberglass batch tank, agitators, and pumps multiplied by factors for engineering/administration/legal and contingencies/contractor costs. Operation and maintenance costs are the cost of the lime, the labor, and maintenance on the physical equipment, and insurance costs. Land costs were assumed to be negligible because of the low wastewater flows and size of equipment. Sludge production was a factor of the volume of lime added to the process multiplied by a unit disposal cost.

8.3.10 Resin Adsorption

Compliance costs were estimated for resin adsorption at a specific plant to increase the frequency of regeneration of the resin column. Regeneration of the resin bed is done through washing the bed with methanol. Additional resin bed regeneration can be completed with existing equipment. Therefore, no additional capital or land costs will be incurred as a result of increasing the frequency of regeneration. Additional methanol and methanol disposal will be required to increase the frequency of regeneration. For this reason, additional operation and maintenance costs will be incurred. Purchase price of the methanol was calculated by determining the amount of additional methanol needed and multiplying by a unit cost for methanol. Additional disposal cost was calculated by multiplying the quantity of additional methanol needed by a unit disposal cost. Additional purchase and disposal costs were summed to yield the additional O&M cost.

8.3.11 Steam Stripping

Steam stripping is used in industrial chemical production for recovery and/or recycle and in industrial waste treatment to remove volatile organic chemicals from wastewater streams by discharging steam into a tray or packed distillation column. For the pesticide manufacturing industry, steam stripping is used to remove volatile priority pollutants from pesticide wastewater.

Physical Equipment

EPA used the Water General Corporation model (Process Design Manual for the Stripping of Organics, EPA-600/2-84-139) for the design of the steam stripping systems for the pesticide industry. EPA previously used this model to design steam stripping systems for the development of effluent guidelines for the Organic Chemicals and Plastics and Synthetic Fibers (OCPSF) industry. This model defines the steam stripping process as a steam stripping column (tray or packed), the associated heat transfer equipment (reboiler, condenser, and feed heat exchanger), and fluid transfer equipment (pumps). Although packed towers are less expensive than sieve tray columns, sieve tray columns operate more efficiently, can operate for a wider range of liquid flow rates, and are more easily cleaned. For these reasons, costs were estimated for steam stripping systems with sieve tray columns. Feed tanks for the equalization of wastewater influent are also included for this model. To satisfy practical design constraints, a minimum column diameter of 1 foot and a minimum column height of 10 feet was established.

The minimum column size of 1 foot in diameter and 10 feet in height corresponds to a daily flow rate of approximately 35,000 gallons of wastewater influent per day. For plants with flow rates below 35,000 gallons per day, the module calculated capital costs for the minimum sized system, 35,000 gallons and decreased the operation costs by a ratio of the actual flow to the minimum flow.

Input and Design Parameters

Twenty-two input variables are used in the Water General Corporation steam stripping model, including physical properties such as specific heat, activity coefficients, densities and viscosities; operating characteristics such as feed flow rate, steam flow rate, and temperature; and mechanical characteristics such as column tray type. The feed flow rate and influent and effluent concentrations affect the size of the steam stripping system; these variables were therefore used as input parameters for the plants costed.

An important characteristic that determines the effectiveness of steam stripping and the design of the column is the relative volatility or vapor pressure of the organic(s) that is being stripped form the wastewater. About one third of the 126 priority pollutant chemicals have vapor pressures high enough to be effectively stripped from aqueous waste streams. For aqueous mixtures, this vapor-liquid equilibrium can be expressed by Henry's Law Constant. The Water General design uses a stripping factor (S) to determine the tower specifications; this factor is related to the Henry's Law Constant of the pollutant to be stripped, as shown below.

$$S = \frac{KV}{L} = \frac{\text{Henry's Law Constant}}{\text{Tower Operating Pressure}}$$

V = Vapor Rate (lb/hr)
L = Liquid Rate (lb/hr)
Tower Operating Pressure = 1.0 atm

Given the direct relationship between tower dimensions and pollutant Henry's Law Constant, and the relationship between tower dimensions and costs, EPA decided to divide the priority pollutants into two groups (high strippability and medium strippability) by their Henry's Law Constant values for the purposes of costing (see Table 8-8). A representative pollutant from each group was used in the cost study; benzene represents the high Henry's Law Constant pollutants, and hexachlorobenzene represents the medium Henry's Law Constant pollutants.

The design parameters for the steam stripping cost module and the parameter values for the representative high and medium Henry's Law Constant pollutants are presented in Table 8-9. The Agency used these values for the design parameters for the steam stripping module.

Design Calculations

The Water General steam stripping module methodology designs the stripping column and auxiliary equipment by determining a material and energy balance for the system, the number of equilibrium stages required for the separation, the stage efficiency, and the pressure drop across the column. The method follows standard distillation column design practice and provides the results of a column diameter and height that will accomplish the separation and achieve the required effluent quality.

Cost Calculations

EPA obtained size and cost information for actual steam stripping units within the OCPSF industry. To provide a basis for the development of steam stripping costs, data were extracted from the OCPSF Supplemental 308 Questionnaires submitted by those facilities utilizing steam strippers on their waste streams. The capital and O&M costs taken from the Questionnaires were scaled up using the appropriate economic indices. Where installation costs were not provided, they were assumed to be 50% of the capital costs.

EPA analyzed these data to determine the relationship between the capital and O&M costs and significant steam stripper design parameters. The

Table 8-8

PRIORITY POLLUTANTS DIVIDED INTO GROUPS ACCORDING TO HENRY'S LAW CONSTANT VALUES

High 3 x 10^{2} to 10^{-1}	**Medium** 10^{-2} to 10^{-3}
Benzene	Acenaphthene
Carbon Tetrachloride	Acrylonitrile
Chlorobenzene	1,2-Dichloroethane
1,1,1-Trichloroethane	Hexachloroethane
Chloroethane	1,1,2-Trichloroethane
1,1-Dichloroethane	1,1,2,2-Tetrachloroethane
Chloroform	Methylene Chloride
Chloromethane	1,2-Dichloropropane
Toluene	1,3-Dichloropropene
Vinyl Chloride	1,1,1-Tribromoethane
1,1-Dichloroethene	Bis(2-Chloroisopropyl) Ether
1,2-Trans-dichloroethene	4-Chlorophenyl Phenyl Ether
Trichloroethene	4-Bromophenyl Phenyl Ether
Tetrachloroethene	1,2-Dichlorobenzene
Hexachloro-1,3-butadiene	1,2,4-Trichlorobenzene
Hexachlorocyclopentadiene	Hexachlorobenzene
Bromomethane	4-Nitrophenol
Dichlorobromomethane	4,6-Dinitro-o-cresol
1,3-Dichlorobenzene	Acenaphthylene
1,4-Dichlorobenzene	Anthracene
Ethylbenzene	Benzo(k)fluoranthene
Fluorene	
Naphthalene	
Phenanthrene	
Dimethyl Nitrosamine	
Diphenyl Nitrosamine	

Henry's Law constant units are mg/m^3/mg/m^3.

Table 8-9

STEAM STRIPPING DESIGN PARAMETERS FOR HENRY'S LAW CONSTANT PARAMETERS

Design Parameter	Units	Medium Strippability	High Strippability
Representative Pollutant		Hexachlorobenzene	Benzene
CP = Specific heat of reflux	cal/g-°K	1.0	1.0
DIFL = Liquid-phase diffusivity	ft^2/hr	9.918×10^{-5}	1.623×10^{-4}
DIFV = Gas-phase diffusivity of pollutant into water vapor	ft^2/hr	0.311	0.501
FC = Final concentration of organic	mg/l	Option I = 1.0 Option II = 0.01	Option I = 1.0 Option II = 0.01
G = Steam rate into tower	MGD	0.10 x L	0.10 x L
GAMD = Activity coefficient of pollutant in aqueous phase	unitless	1.0	1.0
GAMS = Activity coefficient of pollutant in aqueous phase	unitless	3.775×10^{6}	660
IC = Initial concentration of organic	mg/l	390	390
K = Vapor-liquid equilibrium constant	atm/atm	37.3	253.3
L = Liquid feed into tower	MGD	0.01-1.00	0.01-1.00
LPRIM = Latent heat of steam	cal/g	542.0	542.0
MU = Gas-phase viscosity	lb/ft-hr	294.3×10^{-3}	294.3×10^{-3}
PSI = Fractional entrainment mass fraction	mole/mole	0.008	0.008
PR = Operating pressure of column	atm	1.0	1.0
REFLUX = Reflux ratio	unitless	0.0	0.0
RHOG = Vapor density	lb_m/ft^3	0.037	0.037
RHOL = Liquid density	lb_m/ft^3	60	60
SAFE = Safety factor for Vm	unitless	0.75	0.75
SIGL = Liquid surface tension	dyne/cm	58.9	58.9

Table 8-9

(Continued)

Design Parameter	Units	Medium Strippability	High Strippability
TB = Boiling point of aqueous reflux	°C	100	100
TR = Reflux temperature	°C	9	9
XPRF = Tray construction indicator	unitless	Perforated	Perforated

analysis shows that capital costs are best related to the diameter (D) and height (H) of the distillation column, while O&M costs are best related to the diameter of the distillation column and wastewater flow (F).

The costs calculated by these equations are then converted to the 1986 year basis by multiplying them by the ratio of cost indices for 1982 and 1986.

In these analyses, the steam stripper capital costs include purchase and installation for a feed tank (with approximately a 24-hour detention time); a feed heat exchanger; a reboiler; a distillation column (tray type); a condenser; and pumps.

The steam stripper operation and maintenance costs include operation and maintenance labor; maintenance materials; steam energy; electricity; and steam stripper overhead disposal costs.

For plants with flow rates below 35,000 gallons per day, the O&M costs were multiplied by the ratio of the actual flow to 35,000 gal/day. This reduction in O&M cost reflect the operation of the minimum sized column (1 foot in diameter, 10 feet in height) on a batch basis. EPA assumed that plants with small wastewater streams requiring steam stripping would install the minimum sized system and operate it batchwise as the wastewater accumulated.

Steam Stripping Overhead Disposal Cost Estimates

The use of steam stripping as a wastewater treatment technology results in the generation of an organic stream from the column overhead. This organic waste stream must be disposed of, and this disposal represents additional costs for the operation of the steam stripper. Based on steam stripper manufacturers' information, this overhead waste stream flow is estimated to be 1% of the total waste stream flow. For the pesticide industry, disposal of the organic stream from steam stripping is based on off-site incineration, as the size of the stripping units does not require an on-site incinerator. Estimates of the cost incurred for the disposal of steam stripper overhead were developed based on vendor quotations.

For plants utilizing steam stripping at higher flow rates (>50,000gpd), costs for disposing the steam stripper overhead were very high. While disposal costs increase directly with increasing flow, capital costs of steam strippers increase at a much slower rate with increasing flows. EPA determined that it is therefore cost efficient to install a second-stage steam stripper to treat the overhead from the primary steam stripper. Although capital costs essentially doubled, disposal costs decreased by a factor of 100. The net result of the second steam stripper represented a substantial savings.

8.3.12 Monitoring for Compliance

To ensure compliance with the regulations, plants will be required to sample effluent from their wastewater treatment systems and analyze these samples for the regulated pollutants. Analytical test methods have been developed and promulgated for all PAIs covered by the final rule. The monitoring costs incurred by facilities depend on the method employed to analyze their effluent wastewaters and the number of times monitoring occurs annually. The analytical methods listed in Section 16 for each regulated PAI were used to estimate monitoring costs. Costs for analytical methods for individual PAIs do not vary significantly; thus, in cases where a choice of several analytical methods is available, EPA estimated monitoring costs assuming one method would be used. For the priority pollutants, EPA assumed that Methods 624 and 625 will be used to analyze volatile and semivolatile pollutants, respectively, Method 200.7 is assumed to be used for lead, and Method 335 is assumed to be used for cyanide. EPA assumed that the permitting authority would require monitoring of regulated PAIs and limited priority pollutants at least once per week of production. The cost of each method of analysis was determined in 1986 dollars by using cost indices to factor current costs back to 1986. The annual cost for each facility was determined by multiplying the cost of each method by the frequency of each method used at that facility. Then the costs for each method of analysis were summed. To be conservative, EPA estimated monitoring costs for all plants regardless of whether a plant already conducted monitoring of PAIs or priority pollutants.

SECTION 9

BEST PRACTICABLE CONTROL TECHNOLOGY (BPT)

9.0 INTRODUCTION

The Agency promulgated effluent limitations based on the best practicable control technology (BPT) currently available for the Pesticide Chemicals Point Source Category on April 25, 1978 (43 FR 17776) and September 29, 1978 (43 FR 44846). BPT effluent limitations guidelines promulgated in 1978 for Subcategory A are presented in Table 9-1, and these guidelines excluded from coverage discharges resulting from the manufacture of 25 PAIs and classes of PAIs. These PAIs, presented in Table 9-2, were excluded from coverage due to a lack of treatment data available in 1978. Since then, the Agency has collected effluent data on 15 organic PAIs within the group of 25 PAIs and classes of PAIs. EPA has also developed analytical methods and collected effluent data for organo-tin pesticides, which were not covered in BPT guidelines. At the time of proposal, the Agency intended to amend the applicability of BPT to include these 15 organic PAIs and organo-tin PAIs. However, for the final rule, EPA is amending the BPT applicability as proposed, but with certain changes. EPA is dropping BPT coverage that was proposed for one of the 15 PAIs (biphenyl) because it is no longer manufactured as a pesticide chemical. Also, EPA is not promulgating COD limitations for facilities that manufacture 11 of the 14 remaining PAIs because EPA concluded that the data do not support setting such limitations, as pointed out by commenters.

9.1 BPT APPLICABILITY

9.1.1 Revisions to BPT

Effluent data were originally collected by the manufacturing facilities themselves in order to monitor their discharges. The organic PAIs for which EPA has collected these data are ametryn, prometon, prometryn, terbutryn, cyanazine, atrazine, propazine, simazine, terbuthylazine, glyphosate, phenylphenol, hexazinone, sodium phenlyphenate, biphenyl, and methoprene. As previously stated, EPA has also developed analytical methods and data for organo-tin pesticides, which were not covered in the BPT guidelines. This section discusses the rationale behind the revisions to the proposed BPT limitation for the above PAIs.

First, for three of these 15 PAIs (phenylphenol, sodium phenylphenate, and methoprene), the BPT limitations for BOD_5, TSS, pH, and COD are being promulgated in today's final rule as proposed. Plants manufacturing two of these PAIs (sodium phenylphenate and methoprene) are currently meeting BPT limitations through no discharge of process wastewater. Both plants use water, but do not discharge any wastewater generated to waters of the United States. The third plant is currently meeting these limitations with biological treatment.

Table 9-1

EXISTING BPT EFFLUENT LIMITATIONS FOR THE PESTICIDE CHEMICALS POINT SOURCE CATEGORY (40 CFR PART 455)

ORGANIC PESTICIDE CHEMICALS MANUFACTURING SUBCATEGORY:

Effluent Characteristic	Maximum for any 1 day**	Average of daily values for 30 consecutive days shall not exceed **
COD	13.000	9.0000
BOD_5	7.400	1.6000
TSS	6.100	1.8000
Total Pesticides	0.010	0.0018
pH	*	*

*Within the range 6.0 to 9.0.

**Metric units: Kilogram/1,000 kg of PAI produced; English units: Pound/1,000 lb of PAI produced; established on the basis of pesticide production.

METALLO-ORGANIC PESTICIDE CHEMICALS MANUFACTURING SUBCATEGORY:

There shall be no discharge of process wastewater pollutants to navigable waters.

PESTICIDE CHEMICALS FORMULATING AND PACKAGING SUBCATEGORY:

There shall be no discharge of process wastewater pollutants to navigable waters.

Table 9-2

ORGANIC PESTICIDE CHEMICALS EXCLUDED FROM THE 1978 BPT SUBCATEGORY A GUIDELINES

PAI Code	PAI
057	Allethrin
064	Benzyl Benzoate
067	Biphenyl
---	Bisethylxanthogen[1]
037	Chlorophacinone
043	Coumafuryl
---	Dimethyl Phthalate[1]
114	Diphacinone
123	Endothall Acid
102	EXD (Herbisan)
---	Gibberellic Acid[1]
138	Glyphosate
157	Methoprene
---	Naphthalene Acetic Acid[1]
211	Phenylphenol
216	Piperonyl Butoxide
225	Propargite
---	1, 8-Naphthalic Anhydride[1]
164	Quinomethionate
233	Resmethrin
235	Rotenone
244	Sulfoxide
211.05	Sodium Phenylphenate
---	Triazines[2]
265	Warfarin

[1] Not included in the list of 270 PAIs considered for this regulation.

[2] Includes 14 specific triazine PAIs.

Second, for 11 of the remaining 12 PAIs (i.e., all except biphenyl), EPA is promulgating BPT limitations as proposed for BOD_5, TSS, and pH, but is not promulgating COD limitations. The 11 PAIs at issue are ametryn, prometon, prometryn, terbutryn, cyanazine, atrazine, propazine, simazine, terbuthylazine, glyphosate and hexazinone. Manufacturers of these PAIs submitted comments and explanatory data demonstrating that, although their discharges do meet the existing BPT limitations for pH, BOD_5, and TSS, they do not and cannot meet the BPT guidelines for COD because of high COD loadings and high salt contents of their wastewaters.

EPA agreed with these comments. The wastewater treatment technologies installed at the facilities manufacturing these 11 PAIs are equivalent to the BPT technology, i.e., the technologies include both in-plant treatment to control PAIs and end-of-pipe biological treatment to control BOD_5 and TSS. Because these manufacturers are meeting the BPT-level limitations on BOD_5, TSS and pH, it appears that these technologies are being well-operated. The data show, however, that the production of these 11 PAIs generates wastestreams with significantly higher COD loadings (and higher salt content) than are contained in the wastestreams of the facilities on which the BPT regulations were based. The higher salt content reduces the ability of the BPT treatment technologies to remove COD. Therefore, there is no basis on which to make the existing BPT regulations on COD applicable to the manufacture of these 11 compounds.

In addition, EPA does not have data on which COD limitations could be derived for facilities that manufacture these 11 compounds. To derive COD limitations, EPA would require treatment technology performance data and/or process source reduction information related to reductions in COD in the discharges from the production of these compounds. This information was not available to support this rulemaking. These 11 PAIs represent a small number of PAIs manufactured at a small number of facilities. In the absence of a national regulation, COD loading from the manufacturing of these 11 PAIs may be regulated by permit writers on a technology basis using best professional judgment (BPJ) or as necessary to meet water quality standards. Moreover, compliance by manufacturers with the individual PAI and priority pollutant limitations established in this final rule may result in additional COD reductions over what these manufacturers are currently achieving. Accordingly, the final regulations require the manufacturers of these 11 PAIs to comply with the existing BPT limitations on BOD_5, TSS and pH but not the COD limitations.

The remaining pollutant from the group of 15 is biphenyl. Since the time of the proposal of this rule, EPA has revoked the registration of biphenyl as a pesticide. (Letter from Linda J. Fisher, Assistant Administrator, Office of Pesticides and Toxic Substances for EPA, "Notice of Cancellation", November 12, 1992, Product Registration #005412-00005). Therefore, because biphenyl can no longer be used as a pesticide, it is not covered by the pesticide chemical effluent limitations guidelines and standards, and EPA is not promulgating any regulations today covering biphenyl. See 40 CFR 455.10, 455.21 (regulations cover "pesticides," defined as substances intended to prevent, destroy, repel or mitigate pests). Instead, biphenyl is subject to the OCPSF effluent limitations guidelines and standards at 40 CFR Part 414, Subpart H (Specialty Organic Chemicals). (Note that biphenyl manufacturing is classified under SIC Code 2869.) EPA also notes that all existing manufacturers of biphenyl already have NPDES permits covering biphenyl (among other organic chemical manufacturing operations) based on the OCPSF effluent guidelines.

9.1.2 Applicability of Final BPT Limitations

EPA believes that 14 of the 15 organic PAIs discussed for BPT coverage in the proposal and the organo-tin pesticides should be covered by BPT, as discussed above, because the NPDES permits for these facilities reflect a BPTlevel of treatment; and the data and engineering judgement indicate the facilities are capable of achieving the limitations.

EPA is therefore amending the BPT applicability provision for Subcategory A to include 14 previously excluded PAIs listed in Section 9.0 and the organo-tin pesticides. Table 9-3 presents these 14 PAIs and the organo-tin PAIs.

In the final rule, as in the proposal, EPA is not making the BPT total pesticide limitations guideline for the organic pesticide chemicals manufacturing subcategory (which applies to the combined discharge of 49 specified PAIs) applicable to these PAIs, because new BAT limitations are being proposed today that will apply to each of them individually.

Table 9-3

ADDITIONAL 14 PAIs INCLUDED IN FINAL RULE UNDER BPT

PAI Code	PAI
025	Cyanazine *
058	Ametryn *
060	Atrazine *
138	Glyphosate *
142	Hexazinone *
157	Methoprene
192	Organo-tin Pesticides
211	Phenylphenol
211.05	Sodium Phenylphenate
223	Prometon *
224	Prometryn *
226	Propazine *
239	Simazine *
256	Terbuthylazine *
257	Terbutryn *

* Under BPT, these PAIs do not have COD limitations, only BOD_5, TSS and pH.

SECTION 10

BEST AVAILABLE TECHNOLOGY ECONOMICALLY ACHIEVABLE (BAT)

10.0 INTRODUCTION

The factors considered in establishing the best available technology economically achievable (BAT) level of control include: the age of process equipment and facilities, the processes employed, process changes, the engineering aspects of applying various types of control techniques, the costs of applying the control technology, non-water quality environmental impacts such as energy requirements, air pollution and solid waste generation, and such other factors as the Administrator deems appropriate (Section 304(b)(2)(B) of the Act). In general, the BAT technology level represents the best existing economically achievable performance among plants with shared characteristics. Where existing wastewater treatment performance is uniformly inadequate, BAT technology may be transferred from a different subcategory or industrial category. BAT may also include process changes or internal plant controls which are not common industry practice.

This section summarizes the final BAT guidelines. Specific discussions regarding their development are included in Section 6 (Pollutant Selection), Section 7 (Technology Selection and Limits Development), and Section 8 (Cost and Effluent Reduction Benefits).

10.1 SUMMARY OF BAT EFFLUENT LIMITATIONS GUIDELINES

The Agency considered 126 priority pollutants and 144 PAIs and classes of PAIs (178 individual PAIs) for regulation under the BAT effluent limitations guidelines for the organic pesticide chemicals manufacturing subcategory. A complete discussion of pollutant selection for BAT are discussed in Sections 6.2 and 6.3. Of the PAIs and classes of PAIs considered for regulation, EPA is promulgating limitations for 120 individual PAIs and 28 priority pollutants. (Note, however, that the limitations on priority pollutant discharges apply to the manufacturing of all 177 PAIs (biphenyl is no longer considered a pesticide chemical - see section 9.1).

The Agency considered two regulatory options in developing BAT effluent limitations: (1) limitations based on the use of hydrolysis, activated carbon, chemical oxidation, resin adsorption, biological treatment, solvent extraction and/or incineration; and (2) no discharge of process wastewater pollutants. The BAT limits established must be economically achievable. In making this determination, the Agency takes into consideration factors such as plant closures, product line closures, and total cost effectiveness (dollar per pound-equivalent removal). Although costs are considered in this manner, the primary determinant of BAT is the effluent reduction capability of the control technology. A complete discussion of the two options considered for BAT are discussed in Sections 7.4.2 and 7.5.2, along with the option selected for regulation.

As described in Section 8, the Agency estimated the engineering cost of compliance with the proposed BAT effluent limitations guidelines options and the associated pollutant reduction benefits. For Option 1, which has been chosen by the Agency for promulgation, EPA estimates that the BAT regulation will result in the incremental removal (beyond that achieved by BPT) of 147,000 pounds per year (lbs./yr.) of PAIs and 14,000 lbs./yr. of priority pollutants. EPA estimates that costs for compliance with the proposed Option 1 BAT are capital costs of $24.9 million and annualized costs of $18.2 million (in 1986 dollars). There are no plant closures anticipated as a result of the BAT regulation. Two facilities are projected to close product lines as a result of the regulation, with job losses equivalent to 31 full-time employees. (See "Economic Impact Analysis of Effluent Limitations and Standards of the Pesticide Manufacturers").

10.2 IMPLEMENTATION OF THE BAT EFFLUENT LIMITATIONS GUIDELINES

10.2.1 National Pollutant Discharge Elimination System (NPDES) Permit Limitations

The BAT effluent limitations guidelines for organic PAIs are mass-based limitations. Facilities that manufacture PAIs that have a limitation of zero discharge have achieved zero by using a closed-loop recycle/reuse process and must be able to demonstrate compliance through inspection by the local permitting authority. In some instances where facilities provide employee showers and laundry facilities, which are not covered by this rule, the permit writer or POTW may need to require in plant monitoring of PAI process wastewaters prior to commingling with these other streams to effectively determine compliance. In the case where a facility may manufacture a parent acid with a numerical limit, such as 2,4-D, and a salt or ester of that PAI, with a limitation of no discharge, compliance might be determined by a total plant limit based solely on the 2,4-D acid limit (since the method for 2,4-D does not differentiate between 2,4-D and its salts and esters).

PAIs that have numerical limits may be monitored for compliance either in plant or at end-of-pipe (EOP) as determined by the permit writer or local control authority. In 40 CFR 122.45(h) permit writers are given the authority to impose internal monitoring and compliance locations in NPDES permits when limitations imposed at the point of dicharge are impractical or infeasible. See also 40 CFR 403.6 concerning pretreaters. EPA notes that the clarification in the final regulation of which streams are considered to be "process wastewater flow" should be helpful to permit writers in their determination of appropriate monitoring locations (See 455.21(d) of the final regulation). Compliance at EOP is calculated as the mass limitation multiplied by the facility's daily production while in operation, to determine the acceptable daily mass discharge.

The final BAT effluent limitations guidelines for priority pollutants are concentration-based limits and the permit writer must use a reasonable estimate of pesticide plant process wastewater flow for each PAI and the concentration limitations to develop mass limitations. In most cases, plants that manufacture more than one regulated PAI do not manufacture them simultaneously. The permit writer should ascertain what production has been demonstrated to occur simultaneously and sum those flows. The limit can then be calculated by multiplying the concentration-based limitation by flow and the appropriate conversion factors to obtain the acceptable daily mass discharge.

For facilities that also generate process wastewater from OCPSF operations (more than half of the pesticide plants), 23 of the regulated priority pollutants are the same. For those priority pollutants that are different, the discharger should provide additional priority pollutant characterization data to show which wastestreams (pesticides or OCPSF) are dilution water.

These BAT limitations, once promulgated, will be included in the NPDES permit issued to direct dischargers [see 40 CFR §122.44(a)]. The final NPDES permit limitations will include mass effluent limitations for pesticide chemicals manufacturing, as well as non-pesticide chemicals manufacturing and nonprocess wastewater discharges.

10.2.2 NPDES Monitoring Requirements

The NPDES regulations provide guidelines setting forth minimum monitoring and reporting requirements for NPDES dischargers. Section 122.48 requires that each permit specify requirements regarding monitoring type, intervals, and frequency sufficient to yield data that are representative of the monitored activity. Sections 122.41, 122.44, and 122.48 contain numerous other requirements concerning monitoring and reporting. Therefore, this final rule does not establish monitoring requirements. As stated in Section 8, EPA assumed a monitoring frequency of once per week for all limited PAI pollutants and once per month for all limited priority pollutants in estimating monitoring costs.

10.3 BAT EFFLUENT LIMITATIONS GUIDELINES

10.3.1 Revisions to BAT Limitations

The limitations in the final rule were revised for 29 PAIs overall since proposal. The 29 PAIs with revised limitations in the final rule are: 2,4-D, cyanazine, acifluorfen, alachlor, atrazine, chlorpyrifos, ethion, pendemethalin, phorate, terbufos, acephate, captofol, ametryn, prometon, promotryn, propazine, simazine, terbuthylazine, terbutryn, benomyl, pronamide, bromacil, terbacil, TCMTB, pyrethrin I, pyrethrin II, propachlor, butachlor, and norflurazon.

The bases for the revised limitations for the 29 PAIs are as follows: For 7 PAIs (the first 7 the of 29 listed above--2,4-D through ethion) limitations were revised as a result of new full-scale data submitted by manufacturers. More specifically the limitations for acifluorfen have been revised to take into account changes in the production rate and to base limitations more on additional source reduction rather than solely on additional treatment.

Limitations for atrazine and cyanazine are revised based on new full-scale data supplied by a manufacturer of atrazine and cyanazine for a much longer period of time than was previously available (six years versus one year). Those new data show that the treatment systems experience more variability than was apparent from the earlier data. Thus, the final limitations have been increased from the proposed limitations to account for this higher variability.

Limitations for 2,4-D are revised based on full-scale data reflecting the use of a solvent recovery system. Limitations are revised for alachlor based on long-term full scale data submitted after the proposal by a manufacturer. These full-scale data replace the treatability study data used at proposal. Limitations for ethion were also revised based on the submittal of full-scale BAT treatment data following the proposal. At proposal, EPA lacked full-scale long-term data and therefore had proposed limitations for ethion based on a transfer of the limitations set for other pollutants. The final limitations for ethion are based on these new data and not on BAT technology transfer as was proposed. The final limitations are greater than the limitations that were proposed for ethion.

The average LTA/MDL ratio and average variability factors used to calculate the proposed transferred limitations for ethion were based on both full-scale and bench-scale data for PAIs that are treated by activated carbon. EPA notes that when these values are recalculated to consider only cases in which full-scale treatment data are available, the recalculated limitations are approximately equal to the final limitations for ethion, which are based on full-scale data. The agreement of these values serves to validate this methodology for deriving transferred limitations in the other cases in which it was used (e.g., in the cases of bromacil and terbacil, for which data from structurally similar PAIs were not available). Limitations for pendimethalin have been revised to reflect the higher flows based on treatment by two incinerators because both can and do operate at the same time. Limitations for phorate and terbufos are revised to account for higher flows per production unit than originally considered. The limitations for chlorpyrifos are revised based on submittal of longer term full-scale treatment data.

For 7 PAIs, ametryn, prometon, prometryn, terbutryn, propazine, simazine, and terbuthylazine, EPA transferred data on BAT level removals from PAIs atrazine and cyanazine. These technology transfers, at the time of proposal, were supported by EPA and industry treatability tests. Limitations in the final rule are revised based on using the new full-scale (variability) data for atrazine and cyanazine discussed above.

The limitations for benomyl are revised to account for the fact that much of the benomyl-containing wastewater not currently treated in the in-plant hydrolysis treatment system is formulating/packaging process wastewater rather than manufacturing process wastewater; to account for more of the production of the the intermediate, carbendazim, which is treated by the in-plant hydrolysis treatment and cannot be distinguished from benomyl by the current analytical methods; and to include additional removals by the end-of-pipe biological treatment system that were not considered in the proposed regulations. Limitations for TCMTB, pyrethrin I, and pyrethrin II were also revised based on transfer of the BAT treatment data on hydrolysis from benomyl and using the LTA/MDL ratio and variability factors data. Two PAIs, butachlor and propachlor, have limitations revised based on new full-scale data submitted on alachlor.

At proposal, EPA derived achievable concentration levels by using performance data, including bench-scale treatability study data for activated *carbon treatment for three PAIs, (alachlor, butachlor, and propachlor). The* full-scale data submitted on the BAT treatment of alachlor (discussed above) have also been used to set limits for these two other, structurally similar PAIs manufactured at the same plant and treated in the same treatment system (those two PAIs, butachlor and propachlor were not at full production during the time the new data were collected, so performance data for those PAIs could not be obtained).

The Agency deferred establishing final limitations for one PAI, glyphosate salt. The proposed limitation for glyphosate salt, which is a product manufactured from another PAI, glyphosate, was zero discharge. At proposal, there were insufficient data to establish limitations for glyphosate, however, the portion of the manufacturing process which produces glyphosate salt had no discharge. Thus zero discharge limitations were proposed for that portion of the process. Since proposal, the manufacturer has significantly changed the manufacturing process in order to reduce overall pollutant releases to all media. However, unlike the previous process, the new process that produces glyphosate salt has a water discharge. New information was submitted following the proposal, reflecting effluent levels following biological treatment of the total process wastewaters. After reviewing the effluent data, EPA cannot determine whether the data represent BAT level treatment or whether other control technologies should be identified as BAT. Because there was insufficient time to conduct additional treatment studies, and because this PAI (and its salt) has low toxicity, regulation is being deferred at this time.

Based on the reevaluation of the data set for use in transferring variability factors for ethion, discussed above, EPA revised the limitations transfer procedure to eliminate using variability data from treatability studies for activated carbon. This revised procedure resulted in final limitations for four PAIs (bromacil, terbacil, norflurazon, and pronamide) that are higher than the proposed limitations for those four PAIs.

In addition, the Agency proposed effluent limitations requiring zero discharge of process wastewater pollutants for 37 PAIs based on total recycle and reuse of all process wastewater for 29 PAIs, no water use for one PAI, all data reported as "not detected" for 2 PAIs, no current discharge for two PAIs (one of which was biphenyl), and EPA's estimated lowest cost treatment of off-site disposal by incineration for 2 PAIs. Also, the Agency proposed requiring zero discharge of process wastewater pollutants for the purification of phosmet by re-crystallization based on recycle/reuse of all water, which was the only part of the phosmet manufacturing process for which the Agency proposed any limitations.

Commenters stated that the data reported as "not detected" were measured by current analytical methods, and show only that the pollutant levels were below the detection limit; the data do not necessarily show "zero discharge." Further, today's methods may eventually be replaced by methods with lower detection limits, and so a "non-detect" value today may show up as a detectable (measured) value in the future. The Agency agrees with these comments. Commenters also stated that achieving zero discharge to surface waters involves an increase in total plant discharges to other media, such as air emissions or solid waste disposal if the process wastewater cannot be reused effectively. The Agency generally agrees that this could be the case in some circumstances.

Therefore, EPA has revised its determination of the PAIs that should be subject to a zero discharge limitation. As proposed, the final rule promulgates zero discharge limitations for the 28 PAIs as to which zero discharge was based on total recycle and reuse of all process wastewater and for the one PAI that is manufactured without water and a no water use portion of the process for one other PAI. For five PAIs (of the 29 PAIs with revised limitations), acephate, captafol, norflurazon, pyrethrin I, pyrethrin II for which EPA proposed a "zero discharge" requirement based either on data that were below the current detection limit, no current discharge, or off-site disposal, EPA is promulgating numeric limitations in response to comments. To derive these limitations, EPA used the technology transfer procedures described above (utilizing LTA/MDL ratios and average variability factors) since performance data were unavailable (all data were below the current detection limit or there was no treated effluent because the wastewaters were transported off-site for disposal).

Norflurazon was discussed previously as having revised limitations based on transfer of data from ethion; pyrethrin I and pyrethrin II, discussed earlier, have limitations based on hydrolysis treatment of benomyl; and acephate and captafol have revised limitations based on the transfer of full-scale incinerator scrubber wastewater discharge data. As discussed previously, regulation of glyphosate salt has been deferred and the last of the proposed zero discharge PAIs, biphenyl, as discussed previously, has been dropped from coverage of this rule.

The final BAT effluent limitations for organic PAIs and classes of PAIs and priority pollutants under the organic pesticide chemicals manufacturing subcategory (Subcategory A) are listed in Tables 10-1, 10-2, and 10-3.

The Agency is reserving BAT for the metallo-organic pesticide chemicals manufacturing subcategory (Subcategory B).

Table 10-1

ORGANIC PESTICIDE ACTIVE INGREDIENT EFFLUENT LIMITATIONS BEST AVAILABLE TECHNOLOGY ECONOMICALLY ACHIEVABLE (BAT)

BAT Limitations*

	BAT/PSES effluent limitations		
Organic Pesticide Active Ingredient (PAI)	**Daily Maximum Shall Not Exceed**	**Monthly Average Shall Not Exceed**	**Notes**
2, 4-D	1.97×10^{-3}	6.40×10^{-4}	
2, 4-D salts and esters	No discharge of process wastewater pollutants		
2,4-DB salts and esters	No discharge of process wastewater pollutants		
Acephate	6.39×10^{-4}	1.97×10^{-4}	
Acifluorfen	2.45	9.3×10^{-1}	
Alachlor	5.19×10^{-3}	1.54×10^{-3}	
Aldicarb	7.23×10^{-4}	3.12×10^{-4}	
Ametryn	7.72×10^{-3}	2.53×10^{-3}	
Atrazine	5.12×10^{-3}	1.72×10^{-3}	
Azinphos Methyl	2.74×10^{-2}	1.41×10^{-2}	
Benfluralin	3.22×10^{-4}	1.09×10^{-4}	1
Benomyl and Carbendazim	3.50×10^{-2}	8.94×10^{-3}	2
Bolstar	1.69×10^{-2}	8.72×10^{-3}	
Bromacil, lithium	No discharge of process wastewater pollutants		
Bromacil	3.83×10^{-1}	1.16×10^{-1}	
Bromoxynil	3.95×10^{-3}	1.27×10^{-3}	
Bromoxynil octanoate	3.95×10^{-3}	1.27×10^{-3}	
Busan 40 [Potassium N-hydroxymethyl-N-methyldithiocarbamate]	5.74×10^{-3}	1.87×10^{-3}	

Table 10-1

(Continued)

Organic Pesticide Active Ingredient (PAI)	BAT/PSES effluent limitations		Notes
	Daily Maximum Shall Not Exceed	Monthly Average Shall Not Exceed	
Busan 85 [Potassium dimethyldithiocarbamate]	5.74×10^{-3}	1.87×10^{-3}	
Butachlor	5.19×10^{-3}	1.54×10^{-3}	
Captafol	4.24×10^{-6}	1.31×10^{-6}	
Carbam S [Sodium dimethyldithiocarbamate]	5.74×10^{-3}	1.87×10^{-3}	
Carbaryl	1.60×10^{-3}	7.30×10^{-4}	
Carbofuran	1.18×10^{-4}	2.80×10^{-5}	
Chloroneb	8.16×10^{-2}	3.31×10^{-2}	
Chlorothalonil	1.51×10^{-3}	4.57×10^{-4}	
Chlorpyrifos	8.25×10^{-4}	2.43×10^{-4}	
Cyanazine	1.03×10^{-2}	3.33×10^{-3}	
Dazomet	5.74×10^{-3}	1.87×10^{-3}	
DCPA	7.79×10^{-2}	2.64×10^{-2}	
DEF	1.15×10^{-2}	5.58×10^{-3}	
Diazinon	2.82×10^{-3}	1.12×10^{-3}	
Dichlorprop, salts and esters	No discharge of process wastewater pollutants		
Dichlorvos	9.60×10^{-5}	2.95×10^{-5}	
Dinoseb	4.73	1.43	
Dioxathion	3.40×10^{-2}	1.29×10^{-2}	
Disulfoton	7.33×10^{-3}	3.79×10^{-3}	
Diuron	3.15×10^{-2}	1.40×10^{-2}	

Table 10-1

(Continued)

Organic Pesticide Active Ingredient (PAI)	BAT/PSES effluent limitations		Notes
	Daily Maximum Shall Not Exceed	Monthly Average Shall Not Exceed	
Endothall, salts and esters	No discharge of process wastewater pollutants		
Endrin	2.20 x 10^{-2}	5.10 x 10^{-3}	
Ethalfluralin	3.22 x 10^{-4}	1.09 x 10^{-4}	1
Ethion	5.51 x 10^{-3}	1.57 x 10^{-3}	
Fenarimol	1.02 x 10^{-1}	3.61 x 10^{-2}	
Fensulfothion	1.48 x 10^{-2}	7.64 x 10^{-3}	
Fenthion	1.83 x 10^{-2}	9.45 x 10^{-3}	
Fenvalerate	5.40 x 10^{-3}	2.08 x 10^{-3}	
Heptachlor	8.80 x 10^{-3}	2.90 x 10^{-3}	
Isopropalin	7.06 x 10^{-3}	2.49 x 10^{-3}	
KN Methyl	5.74 x 10^{-3}	1.87 x 10^{-3}	
Linuron	2.69 x 10^{-3}	1.94 x 10^{-3}	
Malathion	2.35 x 10^{-4}	9.55 x 10^{-5}	
MCPA salts and esters	No discharge of process wastewater pollutants		
MCPP salts and esters	No discharge of process wastewater pollutants		
Merphos	1.15 x 10^{-2}	5.58 x 10^{-3}	
Methamidophos	1.46 x 10^{-2}	7.53 x 10^{-3}	
Methomyl	3.82 x 10^{-3}	1.76 x 10^{-3}	
Methoxychlor	3.23 x 10^{-3}	1.31 x 10^{-3}	
Metribuzin	1.36 x 10^{-2}	7.04 x 10^{-3}	
Mevinphos	1.44 x 10^{-4}	5.10 x 10^{-5}	
Nabam	5.74 x 10^{-3}	1.87 x 10^{-3}	

Table 10-1

(Continued)

Organic Pesticide Active Ingredient (PAI)	BAT/PSES effluent limitations		Notes
	Daily Maximum Shall Not Exceed	Monthly Average Shall Not Exceed	
Nabonate	5.74×10^{-3}	1.87×10^{-3}	
Naled	No discharge of process wastewater pollutants		
Norflurazon	7.20×10^{-4}	3.10×10^{-4}	
Organotins	1.72×10^{-2}	7.42×10^{-3}	3
Parathion Ethyl	7.72×10^{-4}	3.43×10^{-4}	
Parathion Methyl	7.72×10^{-4}	3.43×10^{-4}	
PCNB	5.75×10^{-4}	1.90×10^{-4}	
Pendimethalin	1.17×10^{-2}	3.62×10^{-3}	
Permethrin	2.32×10^{-4}	6.06×10^{-5}	
Phorate	3.12×10^{-4}	9.37×10^{-5}	
Phosmet	No discharge of process wastewater pollutants		4
Prometon	7.72×10^{-3}	2.53×10^{-3}	
Prometryn	7.72×10^{-3}	2.53×10^{-3}	
Pronamide	6.64×10^{-4}	2.01×10^{-4}	
Propachlor	5.19×10^{-3}	1.54×10^{-3}	
Propanil	1.06×10^{-3}	4.84×10^{-4}	
Propazine	7.72×10^{-3}	2.53×10^{-3}	
Pyrethrin I and Pyrethrin II	1.24×10^{-2}	3.33×10^{-3}	
Simazine	7.72×10^{-3}	2.53×10^{-3}	
Stirofos	4.10×10^{-3}	1.35×10^{-3}	
TCMTB	3.89×10^{-3}	1.05×10^{-3}	

Table 10-1

(Continued)

Organic Pesticide Active Ingredient (PAI)	BAT/PSES effluent limitations		Notes
	Daily Maximum Shall Not Exceed	Monthly Average Shall Not Exceed	
Tebuthiuron	9.78×10^{-2}	3.40×10^{-2}	
Terbacil	3.83×10^{-1}	1.16×10^{-1}	
Terbufos	4.92×10^{-4}	1.26×10^{-4}	
Terbuthylazine	7.72×10^{-3}	2.53×10^{-3}	
Terbutryn	7.72×10^{-3}	2.53×10^{-3}	
Toxaphene	1.02×10^{-2}	3.71×10^{-3}	
Triadimefon	6.52×10^{-2}	3.41×10^{-2}	
Trifluralin	3.22×10^{-4}	1.09×10^{-4}	1
Vapam [Sodium methyldithiocarbamate]	5.74×10^{-3}	1.87×10^{-3}	
Ziram [Zinc dimethyldithiocarbamate]	5.74×10^{-3}	1.87×10^{-3}	

*Limitations are in Kg/kkg (lb/1,000 lb) i. e., kilograms of pollutant per 1,000 kilograms product (pounds of pollutant per 1,000 lbs product).

[1] Monitor and report as total toluidine PAIs, as Trifluralin.

[2] Pounds of product include Benomyl and any Carbendazim production not converted to Benomyl.

[3] Monitor and report as total tin.

[4] Applies to purification by recrystallization portion of the process.

Table 10-2

BAT EFFLUENT LIMITATIONS FOR PRIORITY POLLUTANTS FOR DIRECT DISCHARGE POINT SOURCES THAT USE END-OF-PIPE BIOLOGICAL TREATMENT

	BAT effluent limitations		
Priority Pollutant	Maximum for Any One Day (µg/L)	Maximum for Monthly Average (µg/L)	Notes
Benzene	136	37	
Tetrachloromethane	38	18	
Chlorobenzene	28	15	
1,2-Dichloroethane	211	68	
1,1,1-Trichloroethane	54	21	
Trichloromethane	46	21	
2-Chlorophenol	98	31	
1,2-Dichlorobenzene	163	77	
1,4-Dichlorobenzene	28	15	
1,1-Dichloroethylene	25	16	
1,2-trans-Dichloroethylene	54	21	
2,4-Dichlorophenol	112	39	
1,2-Dichloropropane	230	153	
1,3-Dichloropropene	44	29	
2,4-Dimethylphenol	36	18	
Ethylbenzene	108	32	
Dichloromethane	89	40	
Chloromethane	190	86	
Bromomethane	380	142	
Tribromomethane	794	196	
Bromodichloromethane	380	142	
Dibromochloromethane	794	196	
Naphthalene	59	22	
Phenol	26	15	

Table 10-2

(Continued)

Priority Pollutant	BAT effluent limitations		Notes
	Maximum for Any One Day (µg/L)	Maximum for Monthly Average (µg/L)	
Tetrachloroethylene	56	22	
Total Cyanide	640	220	1
Total Lead	690	320	1

[1] Lead and total cyanide limitations apply only to noncomplexed lead-bearing or cyanide-bearing waste streams. Discharges of lead from complexed lead-bearing process wastewater or discharges of cyanide from complexed cyanide-bearing process wastewater are not subject to these limitations.

Table 10-3

BAT EFFLUENT LIMITATIONS FOR PRIORITY POLLUTANTS FOR DIRECT DISCHARGE POINT SOURCES THAT DO NOT USE END-OF-PIPE BIOLOGICAL TREATMENT

	BAT effluent limitations		
Priority Pollutant	Maximum for Any One Day (µg/L)	Maximum for Monthly Average (µg/L)	Notes
Benzene	134	57	
Tetrachloromethane	380	142	
Chlorobenzene	380	142	
1,2-Dichloroethane	574	180	
1,1,1-Trichloroethane	59	22	
Trichloromethane	325	111	
1,2-Dichlorobenzene	794	196	
1,4-Dichlorobenzene	380	142	
1,1-Dichloroethylene	60	22	
1,2-trans-Dichloroethylene	66	25	
1,2-Dichloropropane	794	196	
1,3-Dichloropropene	794	196	
2,4-Dimethylphenol	47	19	
Ethylbenzene	380	142	
Dichloromethane	170	36	
Chloromethane	295	110	
Bromomethane	380	142	
Tribromomethane	794	196	
Bromodichloromethane	380	142	
Dibromochloromethane	794	196	
Naphthalene	47	19	
Phenol	47	19	

Table 10-3

(Continued)

Priority Pollutant	BAT effluent limitations		Notes
	Maximum for Any One Day (µg/L)	Maximum for Monthly Average (µg/L)	
Tetrachloroethylene	164	52	
Toluene	74	28	
Total Cyanide	640	220	1
Total Lead	690	320	1

[1] Lead and total cyanide limitations apply only to noncomplexed lead-bearing or cyanide-bearing waste streams. Discharges of lead from complexed lead-bearing process wastewater or discharges of cyanide from complexed cyanide-bearing process wastewater are not subject to these limitations.

SECTION 11

NEW SOURCE PERFORMANCE STANDARDS (NSPS)

11.0 INTRODUCTION

New source performance standards (NSPS) under Section 306 of the Clean Water Act represent the most stringent numerical values attainable through the application of the best available demonstrated control technology for all pollutants (conventional, nonconventional, and priority pollutants).

This section summarizes the proposed NSPS guidelines. The specific discussions regarding their development are included in Section 6 (Pollutant Selection), Section 7 (Technology Selection and Limit Development) and Section 8 (Cost and Effluent Reduction Benefits).

11.1 SUMMARY OF NSPS EFFLUENT LIMITATIONS GUIDELINES

The Agency based NSPS for conventional pollutants and COD on the promulgated BPT limitations and for organic PAIs and priority pollutants on the performance of BAT technologies. The Agency determined that limitations that are more stringent than BAT limitations for existing plants can be achieved and are justified in some cases; in the remaining cases, NSPS is set equal to BAT. BAT limits were modified to reflect the capability for wastewater flow reduction at new facilities. The Agency is promulgating the organic pesticide chemicals manufacturing subcategory NSPS for 23 priority pollutants by transferring them from the OCPSF point source category and has developed NSPS for four brominated priority pollutants and total cyanide.

The Agency considered four technology options in developing NSPS: basing NSPS on the BAT limits with no additional flow reduction, transference of BAT limits for organic PAIs after incorporation of a 28% flow reduction, flow reduction plus membrane filtration, and no discharge of process wastewater pollutants. In the assessment of these NSPS options, the Agency considered the reasonableness of costs to implement these treatment technologies. EPA is promulagating Option 1 for NSPS effluent limitations guidelines, as was proposed (although the final rule includes changes to some of the individual PAI limitations as discussed below). A complete discussion of the four options considered for NSPS are discussed in Sections 7.4.4 and 7.5.4, along with the option selected for regulation.

11.1.1 Revisions to New Source Performance Standards

For most PAIs, the basis for the final NSPS is not changed from the proposal. However, PAIs benfluralin, ethalfuralin, trifluralin, pendimethalin, phorate, terbufos, acephate, and captafol, have final BAT limitations based on incineration. The only discharge from the PAI manufacturing process at these facilities is the incinerator scrubber water used to clean the incinerator gases prior to emission to the atmosphere. Comments received from manufacturers correctly pointed out that a reduction in the process wastewater volume will not reduce the need for or the amount of scubber water used to clean the incinerator gases. Therefore, EPA has revised NSPS to be equal to the BAT limitations for these eight PAIs.

The proposed NSPS limitations for pyrethrin I and pyrethrin II, like the proposed BAT limitations, were set at zero discharge. The final BAT limitations for those two PAIs are based on hydrolysis technology transfer, and therefore, the final NSPS limitations for those two PAIs are based on hydrolysis and a 28 percent reduction of process wastewater flow. The proposed BAT limitations for norflurazon were set at zero discharge; however, the final limitations are numeric limitations based on technology transfer from activated carbon treatment systems. The norflurazon plant did not begin operations until 1986 and is therefore a new plant, and EPA has information that this plant has already incorporated source reduction. Therefore, the final NSPS for norflurazon are set equal to the final BAT limitations.

11.2 IMPLEMENTATION OF THE NSPS EFFLUENT LIMITATIONS GUIDELINES

11.2.1 National Pollutant Discharge Elimination System (NPDES) Permit Limitations

The NSPS for conventional pollutant parameters, COD, and organic PAIs are mass-based limitations and the NSPS for priority pollutants are concentration-based limits. Limitations should be developed using guidance given for the implementation of BAT effluent limitations guidelines (see Section 10.2.1).

At the time of promulgation these NSPS will be included in the National Pollutant Discharge Elimination System (NPDES) permit issued to direct dischargers [see 40 CFR §122.44(a)]. The final NPDES permit limitations will include mass effluent limitations for pesticide chemicals manufacturing, as well as non-pesticide chemicals manufacturing and non-process wastewater discharges.

11.2.2 Monitoring Requirements

The NPDES regulations provide guidelines setting forth minimum monitoring and reporting requirements for NPDES dischargers. Section 122.48 requires that each permit specify requirements regarding monitoring type, intervals, and frequency sufficient to yield data that are representative of the monitored activity. Sections 122.41, 122.44, and 122.48 contain numerous other requirements concerning monitoring and reporting. Therefore, this final rule does not establish monitoring requirements. As stated in Section 8, EPA assumed a monitoring frequency of once per week for all limited PAI pollutants and once per month for all limited priority pollutants in estimating monitoring costs.

11.3 NEW SOURCE PERFORMANCE STANDARDS (NSPS)

The NSPS for conventional pollutants, organic PAIs and classes of PAIs, and priority pollutants under the organic pesticide chemicals manufacturing subcategory (Subcategory A) are listed in Tables 11-1, 11-2, 11-3, and 11-4.

The Agency is reserving NSPS for the metallo-organic pesticide chemicals manufacturing subcategory (Subcategory B).

Table 11-1

NSPS EFFLUENT LIMITATIONS FOR CONVENTIONAL POLLUTANTS AND COD

Effluent Characteristic	Maximum for Any 1 Day	Average of Daily Values for 30 Consecutive Days Shall Not Exceed**
COD	9.36	6.48
BOD_5	5.33	1.15
TSS	4.39	1.30
pH	*	*

[1] These standards incorporate a 28 percent flow reduction achievable by new sources.

*Within the range 6.0 to 9.0.

**Metric units: Kilogram/1,000 kg of PAI produced; English units: Pound/1,000 lb of PAI produced; established on the basis of pesticide production.

Table 11-2

NSPS EFFLUENT LIMITATIONS FOR ORGANIC PESTICIDES ACTIVE INGREDIENTS (PAIs)

NSPS Effluent Limitations*

Organic Pesticide Active Ingredient	NSPS Effluent Limitations		Notes
	Daily Maximum Shall Not Exceed	Monthly Average Shall Not Exceed	
2, 4-D	1.42×10^{-3}	4.61×10^{-4}	
2, 4-D salts and esters	No discharge of process wastewater pollutants		
2,4-DB salts and esters	No discharge of process wastewater pollutants		
Acephate	6.39×10^{-4}	1.97×10^{-4}	
Acifluorfen	1.77	6.69×10^{-1}	
Alachlor	3.74×10^{-3}	1.11×10^{-3}	
Aldicarb	5.21×10^{-4}	2.25×10^{-4}	
Ametryn	5.56×10^{-3}	1.82×10^{-3}	
Atrazine	3.69×10^{-3}	1.24×10^{-3}	
Benfluralin	3.22×10^{-4}	1.09×10^{-4}	1
Benomyl and Carbendazim	2.52×10^{-2}	6.44×10^{-3}	2
Bolstar	1.22×10^{-2}	6.28×10^{-3}	
Bromacil, lithium	No discharge of process wastewater pollutants		
Bromacil	2.76×10^{-1}	8.36×10^{-2}	
Bromoxynil	2.84×10^{-3}	9.14×10^{-4}	
Bromoxynil octanoate	2.84×10^{-3}	9.14×10^{-4}	
Busan 40	4.14×10^{-3}	1.35×10^{-3}	
Busan 85	4.14×10^{-3}	1.35×10^{-3}	
Butachlor	3.74×10^{-3}	1.11×10^{-3}	
Captafol	4.24×10^{-6}	1.31×10^{-6}	
Carbam S	4.14×10^{-3}	1.35×10^{-3}	
Carbaryl	1.18×10^{-3}	5.24×10^{-4}	

Table 11-2

(Continued)

Organic Pesticide Active Ingredient	NSPS Effluent Limitations		Notes
	Daily Maximum Shall Not Exceed	Monthly Average Shall Not Exceed	
Carbofuran	1.18 x 10^{-4}	2.80 x 10^{-5}	
Chloroneb	5.87 x 10^{-2}	2.39 x 10^{-2}	
Chlorothalonil	1.09 x 10^{-3}	3.29 x 10^{-4}	
Chlorpyrifos	5.94 x 10^{-4}	1.75 x 10^{-4}	
Cyanazine	7.42 x 10^{-3}	2.40 x 10^{-3}	
Dazomet	4.14 x 10^{-3}	1.35 x 10^{-3}	
DCPA	5.61 x 10^{-2}	1.90 x 10^{-2}	
DEF [S,S,S-Tributyl phosphorotrithioate]	1.15 x 10^{-2}	5.58 x 10^{-3}	
Diazinon	2.05 x 10^{-3}	8.13 x 10^{-4}	
Dichlorprop, salts and esters	No discharge of process wastewater pollutants		
Dichlorvos	6.88 x 10^{-5}	2.13 x 10^{-5}	
Dinoseb	3.41	1.03	
Dioxathion	2.54 x 10^{-2}	9.31 x 10^{-3}	
Disulfoton	5.28 x 10^{-3}	2.72 x 10^{-3}	
Diuron	2.27 x 10^{-2}	1.01 x 10^{-2}	
Endothall, salts and esters	No discharge of process wastewater pollutants		
Endrin	1.57 x 10^{-2}	3.69 x 10^{-3}	
Ethalfluralin	3.22 x 10^{-4}	1.09 x 10^{-4}	
Ethion	3.97 x 10^{-3}	1.33 x 10^{-3}	
Fenarimol	1.02 x 10^{-1}	3.61 x 10^{-2}	
Fensulfothion	1.06 x 10^{-2}	5.50 x 10^{-3}	

Table 11-2

(Continued)

Organic Pesticide Active Ingredient	NSPS Effluent Limitations		Notes
	Daily Maximum Shall Not Exceed	Monthly Average Shall Not Exceed	
Fenthion	1.32×10^{-2}	6.79×10^{-3}	
Fenvalerate	3.91×10^{-3}	1.50×10^{-3}	
Guthion	1.97×10^{-2}	1.02×10^{-2}	
Heptachlor	6.31×10^{-3}	2.06×10^{-3}	
Isopropalin	5.07×10^{-3}	1.82×10^{-3}	
KN Methyl	4.14×10^{-3}	1.35×10^{-3}	
Linuron	1.94×10^{-3}	1.40×10^{-3}	
Malathion	1.69×10^{-4}	6.88×10^{-5}	
MCPA salts and esters	No discharge of process wastewater pollutants		
MCPP salts and esters	No discharge of process wastewater pollutants		
Merphos	1.15×10^{-2}	5.58×10^{-3}	
Methamidophos	1.05×10^{-2}	5.42×10^{-3}	
Methomyl	2.75×10^{-3}	1.27×10^{-3}	
Methoxychlor	2.34×10^{-3}	9.25×10^{-4}	
Metribuzin	9.80×10^{-3}	5.06×10^{-3}	
Mevinphos	1.03×10^{-4}	3.69×10^{-5}	
Nabam	4.14×10^{-3}	1.35×10^{-3}	
Nabonate	4.14×10^{-3}	1.35×10^{-3}	
Naled	No discharge of process wastewater pollutants		
Norflurazon	7.20×10^{-4}	3.10×10^{-4}	
Organotins	1.25×10^{-2}	5.36×10^{-3}	3
Parathion Ethyl	5.56×10^{-4}	2.45×10^{-4}	
Parathion Methyl	5.56×10^{-4}	2.45×10^{-4}	

Table 11-2

(Continued)

Organic Pesticide Active Ingredient	NSPS Effluent Limitations		Notes
	Daily Maximum Shall Not Exceed	Monthly Average Shall Not Exceed	
PCNB	4.16×10^{-4}	1.38×10^{-4}	
Pendimethalin	1.17×10^{-2}	3.62×10^{-3}	
Permethrin	1.68×10^{-4}	4.39×10^{-5}	
Phorate	3.12×10^{-4}	9.37×10^{-5}	
Phosmet	No discharge of process wastewater pollutants		4
Prometon	5.56×10^{-3}	1.82×10^{-3}	
Prometryn	5.56×10^{-3}	1.82×10^{-3}	
Pronamide	4.78×10^{-4}	1.45×10^{-4}	
Propachlor	3.74×10^{-3}	1.11×10^{-3}	
Propanil	7.63×10^{-4}	3.48×10^{-4}	
Propazine	5.56×10^{-3}	1.82×10^{-3}	
Pyrethrin I and Pyrethrin II	8.91×10^{-3}	2.40×10^{-3}	
Simazine	5.56×10^{-3}	1.82×10^{-3}	
Stirofos	2.95×10^{-3}	9.72×10^{-4}	
TCMTB	2.80×10^{-3}	7.54×10^{-4}	
Tebuthiuron	9.78×10^{-2}	3.41×10^{-2}	
Terbacil	2.76×10^{-1}	8.36×10^{-2}	
Terbufos	4.92×10^{-4}	1.26×10^{-4}	
Terbuthylazine	5.56×10^{-3}	1.82×10^{-3}	
Terbutryn	5.56×10^{-3}	1.82×10^{-3}	
Toxaphene	7.35×10^{-3}	2.67×10^{-3}	
Triadimefon	4.69×10^{-2}	2.46×10^{-2}	

Table 11-2

(Continued)

Organic Pesticide Active Ingredient	NSPS Effluent Limitations		Notes
	Daily Maximum Shall Not Exceed	Monthly Average Shall Not Exceed	
Trifluralin	3.22×10^{-4}	1.09×10^{-4}	1
Vapam [Sodium methyldithiocarbamate]	4.14×10^{-3}	1.35×10^{-3}	
Ziram [Zinc dimethyl-dithiocarbamate]	4.14×10^{-3}	1.35×10^{-3}	

*Limitations are in Kg/kkg (lb/1,000 lb) i.e., kilograms of pollutant per 1,000 kilograms product (pounds of pollutant per 1,000 lbs product).

Notes

[1] Monitor and report as total Trifluralin.
[2] Pounds of product shall include Benomyl and any Carbendazim production not converted to Benomyl.
[3] Monitor and report as total tin.
[4] Applies to purification by recrystallization portion of the process.

Table 11-3

NSPS FOR PRIORITY POLLUTANTS FOR PLANTS WITH END-OF-PIPE BIOLOGICAL TREATMENT

Priority Pollutant	NSPS effluent limitations		Notes
	Maximum for Any One Day (µg/L)	Maximum for Monthly Average (µg/L)	
Benzene	136	37	
Tetrachloromethane	38	18	
Chlorobenzene	28	15	
1,2-Dichloroethane	211	68	
1,1,1-Trichloroethane	54	21	
Trichloromethane	46	21	
2-Chlorophenol	98	31	
1,2-Dichlorobenzene	163	77	
1,4-Dichlorobenzene	28	15	
1,1-Dichloroethylene	25	16	
1,2-trans-Dichloroethylene	54	21	
2,4-Dichlorophenol	112	39	
1,2-Dichloropropane	230	153	
1,3-Dichloropropene	44	29	
2,4-Dimethylphenol	36	18	
Ethylbenzene	108	32	
Dichloromethane	89	40	
Chloromethane	190	86	
Bromomethane	380	142	
Tribromomethane	794	196	
Bromodichloromethane	380	142	
Dibromochloromethane	794	196	
Naphthalene	59	22	
Phenol	26	15	

Table 11-3

(Continued)

Priority Pollutant	NSPS effluent limitations		Notes
	Maximum for Any One Day (µg/L)	Maximum for Monthly Average (µg/L)	
Tetrachloroethylene	56	22	
Total Cyanide	640	220	1
Total Lead	690	320	1

[1] Lead and total cyanide limitations apply only to noncomplexed lead-bearing or cyanide-bearing waste streams. Discharges of lead from complexed lead-bearing process wastewater or discharges of cyanide from complexed cyanide-bearing process wastewater are not subject to these limitations.

Table 11-4

NSPS FOR PRIORITY POLLUTANTS FOR PLANTS THAT DO NOT HAVE END-OF-PIPE BIOLOGICAL TREATMENT

Priority Pollutant	BAT effluent limitations		Notes
	Maximum for Any One Day (µg/L)	Maximum for Monthly Average (µg/L)	
Benzene	134	57	
Tetrachloromethane	380	142	
Chlorobenzene	380	142	
1,2-Dichloroethane	574	180	
1,1,1-Trichloroethane	59	22	
Trichloromethane	325	111	
1,2-Dichlorobenzene	794	196	
1,4-Dichlorobenzene	380	142	
1,1-Dichloroethylene	60	22	
1,2-trans-Dichloroethylene	66	25	
1,2-Dichloropropane	794	196	
1,3-Dichloropropene	794	196	
2,4-Dimethylphenol	47	19	
Ethylbenzene	380	142	
Dichloromethane	170	36	
Chloromethane	295	110	
Bromomethane	380	142	
Tribromomethane	794	196	
Bromodichloromethane	380	142	
Dibromochloromethane	794	196	
Naphthalene	47	19	

Table 11-4

(Continued)

Priority Pollutant	BAT effluent limitations		Notes
	Maximum for Any One Day (µg/L)	Maximum for Monthly Average (µg/L)	
Phenol	47	19	
Tetrachloroethylene	164	52	
Toluene	74	28	
Total Cyanide	640	220	1
Total Lead	690	320	1

[1] Lead and total cyanide limitations apply only to noncomplexed lead-bearing or cyanide-bearing waste streams. Discharges of lead from complexed lead-bearing process wastewater or discharges of cyanide from complexed cyanide-bearing process wastewater are not subject to these limitations.

SECTION 12

PRETREATMENT STANDARDS FOR EXISTING SOURCES (PSES) AND PRETREATMENT STANDARDS FOR NEW SOURCES (PSNS)

12.0 INTRODUCTION

Section 307(b) of the Clean Water Act (CWA) calls for EPA to promulgate pretreatment standards for existing sources (PSES). PSES is designed to prevent the discharge of pollutants that pass through, interfere with, or are otherwise incompatible with the operation of publicly owned treatment works (POTWs). The legislative history of the Clean Water Act of 1977 indicates that pretreatment standards are to be technology-based, and analogous to the best available technology economically achievable for direct dischargers.

Section 307(c) of the CWA calls for EPA to promulgate pretreatment standards for new sources (PSNS) at the same time that it promulgates new source performance standards (NSPS). New indirect discharging facilities, like new direct discharging 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 plant site selection to ensure adequate treatment system installation.

General pretreatment regulations applicable to all existing and new source indirect dischargers appear at 40 CFR Part 403. These regulations describe the Agency's overall policy for establishing and enforcing pretreatment standards for new and existing users of a POTW, and delineate the responsibilities and deadlines applicable to each party in this effort. In addition, 40 CFR Part 403, Section 403.5(b), outlines prohibited discharges that apply to all users of a POTW.

Indirect dischargers in the pesticide manufacturing industry, like the direct dischargers, use as raw materials, and produce as products or byproducts many nonconventional pollutants (including PAIs) and priority pollutants. As in the case of direct dischargers, they may be expected to discharge many of these pollutants to POTWs at significant levels. EPA estimates that indirect dischargers of organic pesticides annually discharge 27,000 pounds of PAIs and 22,000 pounds of priority pollutants to POTWs.

This section summarizes the final PSES and PSNS guidelines. Specific discussions regarding their development are included in Section 6 (Pollutant Selection), Section 7 (Technology Selection and Limits Development), and Section 8 (Cost and Effluent Reduction Benefits).

12.1 SUMMARY OF PSES AND PSNS

The Agency considered pollutants to regulate in PSES and PSNS on the basis of whether or not they pass through, cause an upset, or otherwise interfere with the operation of a POTW. EPA has developed PSES and PSNS for 24 of the 28 priority pollutants and for the same 91 PAIs and classes of PAIs being promulgated under BAT and NSPS. At proposal, the OCPSF pass through analysis showed that only two priority pollutants do not pass through (2-chlorophenol and 2,4-dichlorophenol). However, as described in detail in the preamble to the OCPSF final rule (58 FR 36872), EPA has since determined that two more priority pollutants, phenol and 2,4-dimethylphenol, also do not pass through a POTW. Therefore, PSES and PSNS are not being set for these four pollutants.

The Agency considered the same technologies discussed for BAT and NSPS since indirect dischargers are expected to generate wastewaters with the same pollutant characteristics. However, end-of-pipe biological treatment would not be required for priority pollutants, since the primary function of biological treatment is to reduce BOD_5 loadings, whether at the plant or at a POTW. A complete discussion of the options considered for PSES and PSNS are included in Sections 7.4.6 and 7.5.6, along with the options selected for regulation.

12.1.1 Revisions to PSES and PSNS

In setting PSES and PSNS limitations for PAIs, EPA made the same changes from proposal previously described for PAI limitations under BAT and NSPS (including flow reduction). See Sections 10 and 11 of this document for revisions to BAT and NSPS. Also, as stated above, EPA is excluding two additional priority pollutants from promulgation of PSES and PSNS that were included in the proposal.

EPA estimates that the PSES regulation will result in the incremental removal of 25,000 pounds per year of pesticide active ingredients, and 21,000 pounds per year of priority pollutants. EPA estimates that cost for compliance with the proposed PSES are capital costs of $8.7 million and annualized costs of just over $5.1 million (1986 dollars). There are no plant closures or line closures anticipated as a result of the PSES regulation. No additional firms are expected to experience significant financial impacts as a result of compliance with PSES. (See "Economic Impact Analysis of Effluent Limitations and Standards of the Pesticide Manufacturers".)

12.2 PRETREATMENT STANDARDS FOR EXISTING AND NEW SOURCES (PSES/PSNS)

The pretreatment standards for existing and new sources (PSES/PSNS) for organic PAIs and classes of PAIs and priority pollutants under the organic pesticide chemicals manufacturing subcategory (Subcategory A) are listed in Tables 12-1, 12-2 and 12-3. The Agency is reserving PSES and PSNS for Subcategory B.

12.3 COMPLIANCE DATE

EPA is establishing a deadline for compliance with PSES to be as soon as possible, but no later than three years after the date of publication of the final rule in the Federal Register.

Table 12-1

ORGANIC PESTICIDE ACTIVE INGREDIENT EFFLUENT LIMITATIONS PRETREATMENT STANDARDS FOR EXISTING SOURCES (PSES)

PSES Limitations*

Organic Pesticide Active Ingredient (PAI)	PSES effluent limitations		Notes
	Daily Maximum Shall Not Exceed	Monthly Average Shall Not Exceed	
2, 4-D	1.97×10^{-3}	6.40×10^{-4}	
2, 4-D salts and esters	No discharge of process wastewater pollutants		
2,4-DB salts and esters	No discharge of process wastewater pollutants		
Acephate	6.39×10^{-4}	1.97×10^{-4}	
Acifluorfen	2.45	9.3×10^{-1}	
Alachlor	5.19×10^{-3}	1.54×10^{-3}	
Aldicarb	7.23×10^{-4}	3.12×10^{-4}	
Ametryn	7.72×10^{-3}	2.53×10^{-3}	
Atrazine	5.12×10^{-3}	1.72×10^{-3}	
Azinphos Methyl	2.74×10^{-2}	1.41×10^{-2}	
Benfluralin	3.22×10^{-4}	1.09×10^{-4}	1
Benomyl and Carbendazim	3.50×10^{-2}	8.94×10^{-3}	2
Bolstar	1.69×10^{-2}	8.72×10^{-3}	
Bromacil, lithium	No discharge of process wastewater pollutants		
Bromacil	3.83×10^{-1}	1.16×10^{-1}	
Bromoxynil	3.95×10^{-3}	1.27×10^{-3}	
Bromoxynil octanoate	3.95×10^{-3}	1.27×10^{-3}	
Busan 40 [Potassium N-hydroxymethyl-N-methyldithiocarbamate]	5.74×10^{-3}	1.87×10^{-3}	

Table 12-1

(Continued)

Organic Pesticide Active Ingredient (PAI)	PSES effluent limitations		Notes
	Daily Maximum Shall Not Exceed	Monthly Average Shall Not Exceed	
Busan 85 [Potassium dimethyldithiocarbamate]	5.74×10^{-3}	1.87×10^{-3}	
Butachlor	5.19×10^{-3}	1.54×10^{-3}	
Captafol	4.24×10^{-6}	1.31×10^{-6}	
Carbam S [Sodium dimethyldithiocarbamate]	5.74×10^{-3}	1.87×10^{-3}	
Carbaryl	1.60×10^{-3}	7.30×10^{-4}	
Carbofuran	1.18×10^{-4}	2.80×10^{-5}	
Chloroneb	8.16×10^{-2}	3.31×10^{-2}	
Chlorothalonil	1.51×10^{-3}	4.57×10^{-4}	
Chlorpyrifos	8.25×10^{-4}	2.43×10^{-4}	
Cyanazine	1.03×10^{-2}	3.33×10^{-3}	
Dazomet	5.74×10^{-3}	1.87×10^{-3}	
DCPA	7.79×10^{-2}	2.64×10^{-2}	
DEF	1.15×10^{-2}	5.58×10^{-3}	
Diazinon	2.82×10^{-3}	1.12×10^{-3}	
Dichlorprop, salts and esters	No discharge of process wastewater pollutants		
Dichlorvos	9.60×10^{-5}	2.95×10^{-5}	
Dinoseb	4.73	1.43	
Dioxathion	3.40×10^{-2}	1.29×10^{-2}	
Disulfoton	7.33×10^{-3}	3.79×10^{-3}	
Diuron	3.15×10^{-2}	1.40×10^{-2}	

Table 12-1

(Continued)

Organic Pesticide Active Ingredient (PAI)	PSES effluent limitations		Notes
	Daily Maximum Shall Not Exceed	Monthly Average Shall Not Exceed	
Endothall, salts and esters	No discharge of process wastewater pollutants		
Endrin	2.20 x 10^{-2}	5.10 x 10^{-3}	
Ethalfluralin	3.22 x 10^{-4}	1.09 x 10^{-4}	1
Ethion	5.51 x 10^{-3}	1.57 x 10^{-3}	
Fenarimol	1.02 x 10^{-1}	3.61 x 10^{-2}	
Fensulfothion	1.48 x 10^{-2}	7.64 x 10^{-3}	
Fenthion	1.83 x 10^{-2}	9.45 x 10^{-3}	
Fenvalerate	5.40 x 10^{-3}	2.08 x 10^{-3}	
Heptachlor	8.80 x 10^{-3}	2.90 x 10^{-3}	
Isopropalin	7.06 x 10^{-3}	2.49 x 10^{-3}	
KN Methyl	5.74 x 10^{-3}	1.87 x 10^{-3}	
Linuron	2.69 x 10^{-3}	1.94 x 10^{-3}	
Malathion	2.35 x 10^{-4}	9.55 x 10^{-5}	
MCPA salts and esters	No discharge of process wastewater pollutants		
MCPP salts and esters	No discharge of process wastewater pollutants		
Merphos	1.15 x 10^{-2}	5.58 x 10^{-3}	
Methamidophos	1.46 x 10^{-2}	7.53 x 10^{-3}	
Methomyl	3.82 x 10^{-3}	1.76 x 10^{-3}	
Methoxychlor	3.23 x 10^{-3}	1.31 x 10^{-3}	
Metribuzin	1.36 x 10^{-2}	7.04 x 10^{-3}	
Mevinphos	1.44 x 10^{-4}	5.10 x 10^{-5}	
Nabam	5.74 x 10^{-3}	1.87 x 10^{-3}	

Table 12-1

(Continued)

Organic Pesticide Active Ingredient (PAI)	PSES effluent limitations		Notes
	Daily Maximum Shall Not Exceed	Monthly Average Shall Not Exceed	
Nabonate	5.74×10^{-3}	1.87×10^{-3}	
Naled	No discharge of process wastewater pollutants		
Norflurazon	7.20×10^{-4}	3.10×10^{-4}	
Organotins	1.72×10^{-2}	7.42×10^{-3}	3
Parathion Ethyl	7.72×10^{-4}	3.43×10^{-4}	
Parathion Methyl	7.72×10^{-4}	3.43×10^{-4}	
PCNB	5.75×10^{-4}	1.90×10^{-4}	
Pendimethalin	1.17×10^{-2}	3.62×10^{-3}	
Permethrin	2.32×10^{-4}	6.06×10^{-5}	
Phorate	3.12×10^{-4}	9.37×10^{-5}	
Phosmet	No discharge of process wastewater pollutants		4
Prometon	7.72×10^{-3}	2.53×10^{-3}	
Prometryn	7.72×10^{-3}	2.53×10^{-3}	
Pronamide	6.64×10^{-4}	2.01×10^{-4}	
Propachlor	5.19×10^{-3}	1.54×10^{-3}	
Propanil	1.06×10^{-3}	4.84×10^{-4}	
Propazine	7.72×10^{-3}	2.53×10^{-3}	
Pyrethrin I and Pyrethrin II	1.24×10^{-2}	3.33×10^{-3}	
Simazine	7.72×10^{-3}	2.53×10^{-3}	
Stirofos	4.10×10^{-3}	1.35×10^{-3}	
TCMTB	3.89×10^{-3}	1.05×10^{-3}	

Table 12-1

(Continued)

	PSES effluent limitations		
Organic Pesticide Active Ingredient (PAI)	Daily Maximum Shall Not Exceed	Monthly Average Shall Not Exceed	Notes
Tebuthiuron	9.78×10^{-2}	3.40×10^{-2}	
Terbacil	3.83×10^{-1}	1.16×10^{-1}	
Terbufos	4.92×10^{-4}	1.26×10^{-4}	
Terbuthylazine	7.72×10^{-3}	2.53×10^{-3}	
Terbutryn	7.72×10^{-3}	2.53×10^{-3}	
Toxaphene	1.02×10^{-2}	3.71×10^{-3}	
Triadimefon	6.52×10^{-2}	3.41×10^{-2}	
Trifluralin	3.22×10^{-4}	1.09×10^{-4}	1
Vapam [Sodium methyldithiocarbamate]	5.74×10^{-3}	1.87×10^{-3}	
Ziram [Zinc dimethyldithiocarbamate]	5.74×10^{-3}	1.87×10^{-3}	

*Limitations are in Kg/kkg (lb/1,000 lb) i. e., kilograms of pollutant per 1,000 kilograms product (pounds of pollutant per 1,000 lbs product).

[1] Monitor and report as total toluidine PAIs, as Trifluralin.

[2] Pounds of product include Benomyl and any Carbendazim production not converted to Benomyl.

[3] Monitor and report as total tin.

[4] Applies to purification by recrystallization portion of the process.

Table 12-2

PSES AND PSNS FOR PRIORITY POLLUTANTS

Priority Pollutant	PSES/PSNS Effluent Limitations		Notes
	Maximum for Any One Day (μg/L)	Maximum for Monthly Average (μg/L)	
Benzene	134	57	
Tetrachloromethane	380	142	
Chlorobenzene	380	142	
1,2-Dichloroethane	574	180	
1,1,1-Trichloroethane	59	22	
Trichloromethane	325	111	
1,2-Dichlorobenzene	794	196	
1,4-Dichlorobenzene	380	142	
1,1-Dichloroethylene	60	22	
1,2-Trans-Dichloroethylene	66	25	
1,2-Dichloropropane	794	196	
1,3-Dichloropropene	794	196	
Ethylbenzene	380	142	
Dichloromethane	170	36	
Chloromethane	295	110	
Bromomethane	380	142	
Tribromomethane	794	196	
Bromodichloromethane	380	142	
Dibromochloromethane	794	196	
Naphthalene	47	19	
Tetrachloroethylene	164	52	
Toluene	74	28	
Total Cyanide	640	220	1
Total Lead	690	320	1

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[1] Lead and total cyanide limitations apply only to noncomplexed lead-bearing or cyanide-bearing waste streams. Discharges of lead from complexed lead-bearing process wastewater or discharges of cyanide from complexed cyanide-bearing process wastewater are not subject to these limitations.

Table 12-3

PSNS EFFLUENT LIMITATIONS FOR ORGANIC PESTICIDES ACTIVE INGREDIENTS (PAIs)

PSNS Effluent Limitations*

Organic Pesticide Active Ingredient	PSNS Effluent Limitations		Notes
	Daily Maximum Shall Not Exceed	Monthly Average Shall Not Exceed	
2, 4-D	1.42×10^{-3}	4.61×10^{-4}	
2, 4-D salts and esters	No discharge of process wastewater pollutants		
2,4-DB salts and esters	No discharge of process wastewater pollutants		
Acephate	6.39×10^{-4}	1.97×10^{-4}	
Acifluorfen	1.77	6.69×10^{-1}	
Alachlor	3.74×10^{-3}	1.11×10^{-3}	
Aldicarb	5.21×10^{-4}	2.25×10^{-4}	
Ametryn	5.56×10^{-3}	1.82×10^{-3}	
Atrazine	3.69×10^{-3}	1.24×10^{-3}	
Benfluralin	3.22×10^{-4}	1.09×10^{-4}	1
Benomyl and Carbendazim	2.52×10^{-2}	6.44×10^{-3}	2
Bolstar	1.22×10^{-2}	6.28×10^{-3}	
Bromacil, lithium	No discharge of process wastewater pollutants		
Bromacil	2.76×10^{-1}	8.36×10^{-2}	
Bromoxynil	2.84×10^{-3}	9.14×10^{-4}	
Bromoxynil octanoate	2.84×10^{-3}	9.14×10^{-4}	
Busan 40	4.14×10^{-3}	1.35×10^{-3}	
Busan 85	4.14×10^{-3}	1.35×10^{-3}	
Butachlor	3.74×10^{-3}	1.11×10^{-3}	
Captafol	4.24×10^{-6}	1.31×10^{-6}	
Carbam S	4.14×10^{-3}	1.35×10^{-3}	
Carbaryl	1.18×10^{-3}	5.24×10^{-4}	

Table 12-3

(Continued)

Organic Pesticide Active Ingredient	PSNS Effluent Limitations: Daily Maximum Shall Not Exceed	PSNS Effluent Limitations: Monthly Average Shall Not Exceed	Notes
Carbofuran	1.18×10^{-4}	2.80×10^{-5}	
Chloroneb	5.87×10^{-2}	2.39×10^{-2}	
Chlorothalonil	1.09×10^{-3}	3.29×10^{-4}	
Chlorpyrifos	5.94×10^{-4}	1.75×10^{-4}	
Cyanazine	7.42×10^{-3}	2.40×10^{-3}	
Dazomet	4.14×10^{-3}	1.35×10^{-3}	
DCPA	5.61×10^{-2}	1.90×10^{-2}	
DEF [S,S,S-Tributyl phosphorotrithioate]	1.15×10^{-2}	5.58×10^{-3}	
Diazinon	2.05×10^{-3}	8.13×10^{-4}	
Dichlorprop, salts and esters	No discharge of process wastewater pollutants		
Dichlorvos	6.88×10^{-5}	2.13×10^{-5}	
Dinoseb	3.41	1.03	
Dioxathion	2.54×10^{-2}	9.31×10^{-3}	
Disulfoton	5.28×10^{-3}	2.72×10^{-3}	
Diuron	2.27×10^{-2}	1.01×10^{-2}	
Endothall, salts and esters	No discharge of process wastewater pollutants		
Endrin	1.57×10^{-2}	3.69×10^{-3}	
Ethalfluralin	3.22×10^{-4}	1.09×10^{-4}	
Ethion	3.97×10^{-3}	1.33×10^{-3}	
Fenarimol	1.02×10^{-1}	3.61×10^{-2}	
Fensulfothion	1.06×10^{-2}	5.50×10^{-3}	

Table 12-3

(Continued)

Organic Pesticide Active Ingredient	PSNS Effluent Limitations		Notes
	Daily Maximum Shall Not Exceed	Monthly Average Shall Not Exceed	
Fenthion	1.32×10^{-2}	6.79×10^{-3}	
Fenvalerate	3.91×10^{-3}	1.50×10^{-3}	
Guthion	1.97×10^{-2}	1.02×10^{-2}	
Heptachlor	6.31×10^{-3}	2.06×10^{-3}	
Isopropalin	5.07×10^{-3}	1.82×10^{-3}	
KN Methyl	4.14×10^{-3}	1.35×10^{-3}	
Linuron	1.94×10^{-3}	1.40×10^{-3}	
Malathion	1.69×10^{-4}	6.88×10^{-5}	
MCPA salts and esters	No discharge of process wastewater pollutants		
MCPP salts and esters	No discharge of process wastewater pollutants		
Merphos	1.15×10^{-2}	5.58×10^{-3}	
Methamidophos	1.05×10^{-2}	5.42×10^{-3}	
Methomyl	2.75×10^{-3}	1.27×10^{-3}	
Methoxychlor	2.34×10^{-3}	9.25×10^{-4}	
Metribuzin	9.80×10^{-3}	5.06×10^{-3}	
Mevinphos	1.03×10^{-4}	3.69×10^{-5}	
Nabam	4.14×10^{-3}	1.35×10^{-3}	
Nabonate	4.14×10^{-3}	1.35×10^{-3}	
Naled	No discharge of process wastewater pollutants		
Norflurazon	7.20×10^{-4}	3.10×10^{-4}	
Organotins	1.25×10^{-2}	5.36×10^{-3}	3
Parathion Ethyl	5.56×10^{-4}	2.45×10^{-4}	
Parathion Methyl	5.56×10^{-4}	2.45×10^{-4}	

Table 12-3

(Continued)

Organic Pesticide Active Ingredient	PSNS Effluent Limitations		Notes
	Daily Maximum Shall Not Exceed	Monthly Average Shall Not Exceed	
PCNB	4.16×10^{-4}	1.38×10^{-4}	
Pendimethalin	1.17×10^{-2}	3.62×10^{-3}	
Permethrin	1.68×10^{-4}	4.39×10^{-5}	
Phorate	3.12×10^{-4}	9.37×10^{-5}	
Phosmet	No discharge of process wastewater pollutants		4
Prometon	5.56×10^{-3}	1.82×10^{-3}	
Prometryn	5.56×10^{-3}	1.82×10^{-3}	
Pronamide	4.78×10^{-4}	1.45×10^{-4}	
Propachlor	3.74×10^{-3}	1.11×10^{-3}	
Propanil	7.63×10^{-4}	3.48×10^{-4}	
Propazine	5.56×10^{-3}	1.82×10^{-3}	
Pyrethrin I and Pyrethrin II	8.91×10^{-3}	2.40×10^{-3}	
Simazine	5.56×10^{-3}	1.82×10^{-3}	
Stirofos	2.95×10^{-3}	9.72×10^{-4}	
TCMTB	2.80×10^{-3}	7.54×10^{-4}	
Tebuthiuron	9.78×10^{-2}	3.41×10^{-2}	
Terbacil	2.76×10^{-1}	8.36×10^{-2}	
Terbufos	4.92×10^{-4}	1.26×10^{-4}	
Terbuthylazine	5.56×10^{-3}	1.82×10^{-3}	
Terbutryn	5.56×10^{-3}	1.82×10^{-3}	
Toxaphene	7.35×10^{-3}	2.67×10^{-3}	
Triadimefon	4.69×10^{-2}	2.46×10^{-2}	

Table 12-3

(Continued)

Organic Pesticide Active Ingredient	PSNS Effluent Limitations		Notes
	Daily Maximum Shall Not Exceed	Monthly Average Shall Not Exceed	
Trifluralin	3.22×10^{-4}	1.09×10^{-4}	1
Vapam [Sodium methyldithiocarbamate]	4.14×10^{-3}	1.35×10^{-3}	
Ziram [Zinc dimethyl-dithiocarbamate]	4.14×10^{-3}	1.35×10^{-3}	

*Limitations are in Kg/kkg (lb/1,000 lb) i.e., kilograms of pollutant per 1,000 kilograms product (pounds of pollutant per 1,000 lbs product).

Notes

[1] Monitor and report as total Trifluralin.
[2] Pounds of product shall include Benomyl and any Carbendazim production not converted to Benomyl.
[3] Monitor and report as total tin.
[4] Applies to purification by recrystallization portion of the process.

SECTION 13

BEST CONVENTIONAL POLLUTANT CONTROL TECHNOLOGY (BCT)

13.0 INTRODUCTION

The 1977 Amendments to the Clean Water Act added Section 301(b)(2)(E), establishing "best conventional pollutant control technology" (BCT) for the discharge of conventional pollutants from existing industrial point sources. Section 304(a)(4) designated the following as conventional pollutants: BOD_5, TSS, fecal coliform, pH, and any additional pollutants defined by the Administrator as conventional. On July 30, 1979 (44 FR 44501), the Administrator designated oil and grease as a conventional pollutant.

The BCT effluent limitations guidelines are not additional guidelines, but instead, replace guidelines based on the application of the "best available technology economically achievable" (BAT) for the control of conventional pollutants. BAT effluent limitations guidelines remain in effect for nonconventional and toxic pollutants. Effluent limitations based on BCT may not be less stringent than the limitations based on "best practicable control technology currently available" (BPT). Thus, BPT limitations are a "floor" below which BCT limitations cannot be established.

In addition to other factors specified in Section 304(b)(4)(B), the CWA requires that the BCT effluent limitations guidelines be assessed in light of a two-part "cost-reasonableness" test [see American Paper Institute v. EPA, 660 F 2d 954 (4th Cir. 1981)]. The first test compares the cost for private industry to reduce its discharge of conventional pollutants with the cost to publicly owned treatment works (POTWs) for similar levels of reduction in their discharge of these pollutants. The second test examines the cost-effectiveness of additional industrial treatment beyond BPT. EPA must find that the limitations are "reasonable" under both tests before establishing them as BCT. If the BCT technology fails the first test, there is no need to conduct the second test, because the technology must pass both tests. EPA promulgated a methodology for establishing BCT effluent limitations guidelines on July 9, 1986 (51 FR 24974).

13.1 JULY 9, 1986 BCT METHODOLOGY

The BCT methodology promulgated in 1986 addressed the costs that the EPA must consider when deciding whether to establish BCT effluent limitations guidelines. EPA evaluates BCT candidate technologies (those that are technologically feasible) by applying a two-part cost test including: (1) the POTW test; and (2) the industry cost effectiveness test.

To "pass" the POTW test, EPA must determine that the cost per pound of conventional pollutant removed by industrial dischargers in upgrading from BPT to a BCT candidate technology is less than the cost per pound of conventional pollutant removed in upgrading POTWs from secondary treatment to advanced secondary treatment. The upgrade cost to industry must be less than the POTW benchmark of $0.25 per pound in 1976 dollars for industries whose cost per pound is based on long-term performance data (Tier I POTW benchmark), or less than $0.14 per pound for industries whose cost per pound is not based on long-term performance data (Tier II POTW benchmark).

If a candidate technology passes the POTW cost test, the industry cost-effectiveness test is then applied. For each industry subcategory, EPA computes a ratio of two incremental costs. The first is the cost per pound of conventional pollutants removed by the BCT candidate technology relative to BPT; the second is the cost per pound of conventional pollutants removed by BPT relative to no treatment (i.e., the second cost compares raw wasteload to pollutant load after application of BPT). The ratio of the first cost divided by the second is a measure of the candidate technology's cost-effectiveness. The ratio is compared to an industry cost benchmark, which is based on POTW cost and pollutant removal data. The benchmark, like the measure for a candidate technology, is a ratio of two incremental costs: the cost per pound to upgrade a POTW from secondary treatment to advanced secondary treatment divided by the cost per pound to initially achieve secondary treatment from raw wasteload. If the industry ratio is lower than the benchmark, the candidate technology passes the industry cost-effectiveness test. The Tier I benchmark for industries whose ratio is based on long-term performance data is 1.29. The Tier II benchmark for industries whose ratio is not based on long-term performance data is 0.68.

In calculating this ratio, EPA considers any BCT cost per pound less than $0.01 to be the equivalent of zero costs. There may be cases where the numerator for the industry cost ratio and therefore the entire ratio is taken to be zero. EPA believes any zero cost per pound for a candidate BCT technology meets Congressional intent concerning the concept of reasonableness for purpose of the second test.

If a candidate technology fails the POTW test or passes the POTW test and fails the industry cost-effectiveness test, then that technology is not used as the basis of BCT.

13.2 BCT TECHNOLOGY OPTIONS

The primary technology option the Agency identified to attain further TSS and BOD_5 reduction for the organic pesticide chemicals subcategory was the addition of multi-media filtration to existing BPT systems.

The Agency also considered the options of carbon adsorption, membrane filtration, incineration, evaporation, additional biological oxidation (above the level required to meet BPT), and clarification through the use of settling ponds.

Both carbon adsorption and membrane filtration require filtration of wastewater prior to treatment; therefore, the cost of filtration plus carbon adsorption or membrane filtration would be more than the cost of filtration alone. In addition, while these two technologies can be effective in removing specific compounds from wastewater, they may not be particularly effective in removing those materials exerting biochemical oxygen demand. Incineration and evaporation were projected to have much higher costs than multi-media filtration due to the need to purchase fuel. Therefore, due to their costs, the Agency excluded both incineration and evaporation from further consideration. Biological oxidation and clarification were used as the basis for BPT, and there are no data to demonstrate that higher effluent quality could be achieved for PAI manufacturing wastewaters by increasing biological residence time, increasing mixed liquor suspended solids, or through the addition of settling ponds, and so these options were rejected. Finally, the Agency studied the use of polymers and coagulants to enhance clarification. While some facilities use these chemical agents on specific pesticide-containing wastewaters to enhance treatment system performance, there was no data available to demonstrate additional removal of the conventional pollutants. Therefore, this option was rejected for lack of data. Therefore, only multi-media filtration was considered further as a BCT technology upgrade for the organic pesticide subcategory.

EPA is reserving BCT for Subcategory B because BPT limitations already require zero discharge of process wastewater pollutants. This is the most stringent limitation possible; there is no need for BCT regulations reflecting more stringent control techniques.

13.3 BCT COST TEST ANALYSIS

The Agency evaluated multi-media filtration technology to determine whether it passed the POTW test (and if necessary the industry cost effectiveness test).

13.3.1 The POTW Cost Test

To determine the cost per pound of conventional pollutants removed for a technology upgrade from BPT to BCT for the organic pesticide chemicals subcategory, the Agency calculated:

The increase in the total annual cost for the BPT to BCT technology upgrade. Total annual costs include capital costs, interest, and operation and maintenance costs. Capital costs are amortized over 30 years at a 10 percent interest rate. The cost estimates were indexed to 1976 dollars for a consistent comparison to the POTW benchmark. (51 FR 24982)

The increase in the removal of conventional pollutants for the BPT to BCT technology upgrade. The increase in removal is expressed as the yearly increase in the total pounds of BOD_5 and TSS removed, due to the upgrade. Conventionals considered in the total include BOD_5 and TSS.

The increase in the total annual cost was then divided by the increase in conventionals removed and this result ($/lb) was compared to the Tier I ($0.25 per pound) POTW benchmark.

13.3.2 Application to the Organic Pesticide Chemicals Manufacturing Subcategory

The Agency used the CAPDET cost model for costing the multi-media filtration technology upgrade considered for BCT. Input parameters to the filtration module include:

- Flow;
- Influent BOD_5 and TSS concentrations; and
- Effluent BOD_5 and TSS concentrations.

The module runs in two modes; high flow (flow greater than 0.5 million gallons per day (MGD)) and low flow (flow less than 0.5 MGD). The unit cost of treatment would be lower at the high flow plant due to economics of scale.

Pesticide facilities with information on PAI wastewater flows and PAI production rates were split into either the high flow or low flow categories. A median flow and yearly PAI production rate were then determined for each flow category. Only one facility fell into the high flow category; the remaining facilities fell into the low flow category.

Long-term BPT data for BOD_5 and TSS were used to determine the influent BOD_5 and TSS concentrations to the multi-media filter. Since these BOD_5 and TSS data are mass based (i.e. 1.12 lb. BOD_5/1000 lbs. of production and 1.31 lb. TSS/1000 lbs. of production), the high flow and low flow production values and flows were used with the mass-based long-term data to determine BOD_5 and TSS influent concentrations.

To determine the effluent BOD_5 and TSS concentrations for the CAPDET module, BOD_5 and TSS removal efficiencies through a multi-media filter were estimated from available sampling data on a filtration unit (Pesticide Sampling Episode 1332). These removal data represent a settling pond followed by a sand filter system. It was assumed, for the purpose of this analysis, that all of the BOD_5 and TSS removal that occurred was due to the sand filter; this assumption provides the sand filter with the best chance of passing the cost test (since during the sampling episode, some removal probably occurred due to the settling pond). This assumption will overestimate the removal efficiency of the sand filter and will also yield a cost effectiveness for the filter that is as low as possible since the cost of the sand filter alone must be less than the cost of a sand filter plus a settling pond. The BOD_5 and TSS removals from the combined sand filter/settling pond system during sampling were 48 percent BOD_5 removal and 53 percent TSS removal.

Using the flows and the influent and effluent BOD_5 and TSS concentrations discussed above in the CAPDET module, annualized costs (in 1976 dollars) for the technology upgrade from BPT to BCT were calculated. The yearly pounds of conventional pollutants removed by the technology upgrade from BPT to BCT was then determined for both the high and low flow categories. The conventionals considered in this calculation were BOD_5 and TSS.

Finally, a removal cost ($/lbs. of conventional pollutants removed) was determined by dividing the incremental annual cost by the BOD_5 and TSS removal for each flow category. Since long-term data were available for Subcategory A, the removal costs for each flow scenario were compared to the Tier I POTW test value of $0.25/lb. of conventional pollutants removed. The results of the POTW cost test, including the annual costs ($/yr), BOD_5 and TSS removals (lb/yr), and removal costs ($/lb), are presented in Table 13-1.

13.4 CONCLUSIONS

As seen in Table 13-1 multi-media filtration, fails the POTW cost test. Therefore, multi-media filtration is not a technology basis for BCT in the organic pesticide chemicals manufacturing subcategory and the Agency is setting BCT equal to BPT for this subcategory.

EPA is reserving BCT for the metallo-organic pesticide chemicals manufacturing subcategory.

Table 13-1

POTW COST TEST RESULTS FOR THE
ORGANIC PESTICIDE CHEMICALS MANUFACTURING SUBCATEGORY

Facility Type	($/yr) Annual Cost 1976 $	(lb/yr) BOD$_5$ & TSS Removal	($/lb) Removal Cost	POTW Test Pass/ Fail*
High Flow	87,622	200,800	0.44	Fail
Low Flow	45,116	23,061	1.96	Fail

*The removal costs ($/lb.) were compared against $0.25/lb. of conventional pollutant removed. This POTW removal cost represents the Tier I value which is used when long-term data are available for an industry.

SECTION 14

METALLO-ORGANIC PESTICIDE CHEMICALS MANUFACTURING SUBCATEGORY

The Agency is reserving BCT, BAT, NSPS, PSES, and PSNS for the metallo-organic pesticide chemicals manufacturing subcategory. In 1986, there were only eight facilities producing pesticides in this subcategory, and no facility was manufacturing organo-cadmium pesticides. Since 1986, three facilities producing pesticides in this subcategory have ceased manufacturing metallo-organic active ingredients. Current BPT requires no discharge of process wastewater pollutants from facilities producing metallo-organic pesticides containing arsenic, copper, cadmium, or mercury. Therefore, BCT, BAT and NSPS regulations for Subcategory B are unnecessary.

Metallo-organic pesticide processes generate much smaller volumes of wastewater than organic pesticide processes. As discussed in Section 5, Subcategory B processes generated only about 3 million gallons of wastewater in 1986 compared to about 1.5 billion gallons from Subcategory A processes. Only about 5,000 gallons of this Subcategory B wastewater were discharged to POTWs. In addition, the Agency estimates that current discharges of metallo-organic PAIs and priority pollutants in Subcategory B wastewaters total only 0.3 pounds per year. (Since there are no analytical methods for the specific metallo-organic PAIs, these compounds are monitored by measuring the amount of total arsenic, copper, or mercury present in the wastewater.)

For Subcategory B plants, EPA considered imposing PSES equal to the existing BPT (i.e., requiring no discharge of process wastewater pollutants), but determined that the only way the facilities could achieve this standard is by off-site disposal (incineration). Off-site disposal was determined not to be economically achievable because one of the two facilities in this subcategory is projected to close if forced to meet that standard. Other options, such as imposing treated discharge requirements, were considered unnecessary since the existing indirect dischargers are subject to locally imposed pretreatment limits which EPA believes provide adequate protection for the POTW and the environment. The two existing facilities are treating their discharges in accordance with these limits and together are discharging only 0.3 pounds of priority pollutants and PAIs annually. Further, imposing the control technologies that are the bases for the BAT limitations being proposed today (i.e., Option 1, physical/chemical treatment) would result in the additional removal of only less than 0.3 pounds annually of priority pollutants and PAIs from these two facilities. In light of the small amount of pollutants being discharged, as well as the economic unachievability of off-site disposal, EPA is not establishing regulations for existing indirect dischargers in the metallo-organic pesticides manufacturing subcategory.

One commenter asserts that EPA should have set PSES limitations for Subcategory B, because local limits are not within EPA's control and might be relaxed by local authorities. EPA does not agree that PSES limitations should be set. Current discharges subject to current local limits are insignificant (only about 0.3 pounds per year), and imposing PSES limits is projected to remove only de minimis additional amounts of pollutants (less than 0.27 pound per year). Information concerning the two POTWs involved indicates that they had previous problems with pesticide discharges, and because of that are unlikely to relax their local requirements. Moreover, three of the five Subcategory B facilities that EPA identified at proposal as indirect dischargers have closed. Finally, even if the two POTWs removed their local limits on these pollutants entirely, the total annual discharge from the two plants would only be about 14 pounds per year, which is an insignificant amount. Accordingly, EPA is not setting PSES limitations for Subcategory B.

Under Subcategory B, the Agency is reserving PSNS. The Agency believes it is unlikely that there will be any new manufacturers of the metallo-organic pesticides currently being manufactured. New manufacturing plants, to the extent there are any, would very likely produce only new pesticides not registered in 1986. Unlike organic pesticide chemicals, where new producers of currently manufactured pesticides are possible, EPA believes that new producers are unlikely, because there have been no new plants in the metallo-organic pesticide industry for more than 20 years and because the current PAIs produced are the same as those produced over the past 20 years (i.e., there have been no new metallo-organic PAIs in 20 years). In addition, three of the eight organo-metallic pesticide manufacturing plants that were operating in 1986 have closed and no new plants have begun operating. Therefore, the Agency does not believe there will be any new sources, and there is no need for PSNS for Subcategory B.

SECTION 15

NON-WATER QUALITY ENVIRONMENTAL IMPACTS

15.0 INTRODUCTION

The elimination or reduction of one form of pollution may create or aggravate other environmental problems. Therefore, Sections 304(b) and 306 of the Clean Water Act call for EPA to consider the non-water quality environmental impacts of effluent limitations guidelines and standards. Accordingly, EPA has considered the effect of these regulations on air pollution, solid waste generation, and energy consumption.

The non-water quality environmental impacts associated with these regulations are described in subsections 15.1 to 15.3.

15.1 AIR POLLUTION

Pesticide facilities generate wastewaters that contain significant concentrations of organic compounds, some of which are also on the list of Hazardous Air Pollutants (HAP) in Title 3 of the Clean Air Act Amendments (CAAA) of 1990. These wastewaters typically pass through a series of collection and treatment units that are open to the atmosphere and allow wastewaters containing organic compounds to contact ambient air. Atmospheric exposure of these organic-containing wastewaters may result in significant volatilization of both volatile organic compounds (VOC), which contribute to the formation of ambient ozone, and HAP from the wastewater.

VOCs and HAPs are emitted from wastewater beginning at the first air/water interface. Thus, VOCs and HAPs from wastewater may be of concern immediately as the wastewater is discharged from the process unit. Emissions occur from wastewater collection units such as process drains, manholes, trenches, sumps, junction boxes, and from wastewater treatment units such as screens, settling basins, equalization basins, biological aeration basins, air or steam strippers lacking air emission control devices, and any other units where the wastewater is in contact with the air.

Today's final regulations are based on the use of steam stripping rather than air stripping as an in-plant technique for controlling volatile organic compounds. Also, steam strippers are included in conjunction with chemical oxidation systems as a combined BAT-level technology to prevent air emissions of chlorinated priority pollutants from the chemical oxidation effluent.

Some increased air emissions could result from generation of the additional energy necessary to operate steam strippers, and from the incineration of the small volumes of wastewater or residuals from treatment systems (spent activated carbon, steam stripper overheads, wastewater treatment solids). However, the overall amounts of the air emissions are expected to significantly decrease due to compliance by pesticide manufacturers with the final rule. Based on raw wastewater loading estimates, air emissions of volatile priority pollutants would decrease by up to six million pounds per year due to the use of steam stripping. The final regulation, however, does not require steam stripping or any specific technology, but only establishes the amount of pollutant that can be discharged to navigable waters. The Agency in the OCPSF rule concluded that the issue of volatile air emissions is best addressed under laws that specifically direct EPA to control air emissions. (EPA notes, however, that all of the pesticide manufacturing plants that currently use stripping are using steam strippers and not air strippers.) Also, there are activities underway under the Clean Air Act to address emissions of VOCs from industrial wastewaters. Specifically, the Agency plans to issue a Control Techniques Guideline (CTG) for Industrial Wastewater (IWW) under Section 110 of the CAA pursuant to Title I of the 1990 Clean Air Act Amendments (CAAA). The pesticide industry is one of several industries that would be covered by this CTG. The CTG will provide guidance to States recommending reasonably available control technology (RACT) for VOC emissions from industrial wastewater at (pesticide manufacturing) facilities located in areas failing to attain the National Ambient Air Quality Standards for ozone.

The Agency also plans to issue a National Emission Standards for Hazardous Air Pollutants (NESHAP) under Section 112 of the CAA to address air emissions of the HAPs listed in Title III of the 1990 CAAA. This list contains 20 of the 28 priority pollutants and 8 of the 120 PAI pollutants with limitations in this rule. The NESHAP will define maximum achievable control technology (MACT). The 1990 CAAA set maximum technology control requirements on which MACT standards can be based for new and existing sources. RACT for the CTG and MACT for the NESHAP will be based on the same control strategy. That control strategy is:

(1) Identify wastewater streams requiring control;

(2) Control the conveyance of the wastewater to the treatment unit (hardpipe, control vents and openings);

(3) Treat the wastewater to remove or destroy the organic compound (e.g. steam stripping);

(4) Control air emissions from the treatment unit; and

(5) Control residuals removed during treatment.

In view of the upcoming air emission guidelines and standards, the Agency encourages facilities to consider integrated multi-media approaches when designing methods of complying with these final pesticide effluent guidelines, such as using steam stripping instead of air stripping. Combining compliance with the effluent guidelines and upcoming CAA regulations will be more economical than individual compliance with each rule.

15.2 SOLID WASTE

Wastewaters from the production of the following PAIs are regulated as RCRA listed hazardous wastes:

K033 -	Wastewater and scrub water from the chlorination of cyclopentadiene in the production of chlordane;
K038 -	Wastewater from the washing and stripping of phorate production;
K098 -	Untreated process wastewater from the production of toxaphene;
K099 -	Untreated wastewater from the production of 2,4-D;
K123 -	Process wastewater (including supernates, filtrates, and washwaters) from the production of ethylenebisdithiocarbamic acid and its salts;
K124 -	Reactor vent scrubber water from the production of ethylenebisdithiocarbamic acid and its salts; and
K131 -	Wastewater from reactor and spent sulfuric acid from the acid dryer from the production of methyl bromide.

The Agency is currently conducting additional hazardous waste listing determinations for waters produced from the manufacture of carbamate, carbamoyl oxime, thiocarbamate, and dithiocarbamate chemicals, which are largely used as pesticides. The Agency expects to propose its hazardous waste listing determination by December 31, 1993, for these carbamate pesticides.

Under Section 3004(n) of RCRA, standards controlling organic emissions from process vents and equipment leaks at facilities which treat, store, or dispose of hazardous wastes (TSDF) have been enacted (55 FR 25454). Additional standards to control air emissions at TSDFs from open tanks, surface impoundments, and landfills were proposed July 22, 1991 (56 FR 33490), and have not yet been promulgated by the Agency. Wastewater treatment units subject to regulation under either Section 402 or 307(b) of the Clean Water Act would be exempt from these regulations under 40 CFR 264.1(g)(6) and 40 CFR 265(c)(10).

Solid waste would be generated due to the following technologies, if implemented to meet these final regulations: steam stripping, hydroxide precipitation, and biological treatment. The solid wastes generated due to the implementation of the technologies discussed above were costed for disposal by off-site incineration. These costs were included in the economic evaluation of the proposed technologies.

The overhead stream from steam stripping will generally contain organic waste. In some cases, due to the large volume of the overhead stream, the Agency costed two steam strippers in series, with the second steam stripper treating the overheads stream from the first stripper. In these cases, the only organic waste that would need disposal is the overheads from the second steam stripper. EPA estimates that about 12 million pounds per year of organic waste would be generated due to steam stripping at 16 facilities.

Hydroxide precipitation technology utilizes calcium hydroxide or a similar chemical reagent to treat metal-containing wastewaters. The precipitated solids represent a solid waste. It is estimated that 31,000 pounds per year of precipitated solids would be generated due to the implementation of hydroxide precipitation at one facility.

Biotreatment is the model technology for controlling PAI wastewater discharges at two facilities. Biosludge is continuously generated during biotreatment, and part of the sludge must be discharged from the treatment system to ensure proper operation. It is estimated that 48,000 pounds per year of biosludge would be generated due to these final regulations. For comparison, EPA estimates that all POTW's combined generate more than 7.7 million tons of sludge annually, while compliance with OCPSF BAT effluent guidelines is projected to increase solid waste generation by over 22,000 tons annually.

15.3 ENERGY REQUIREMENTS

EPA estimates that the attainment of BAT, NSPS, PSES, and PSNS will increase energy consumption by a small increment over present industry use. The main energy requirement in the final rule is to generate steam used by steam strippers. Steam provides the heat energy necessary to separate volatile pollutants from wastewater streams treated by this technology. It is estimated that about 800 million pounds per year of steam would be required by steam strippers operating at 16 facilities. This would require approximately 187,000 barrels of oil annually; the United States currently consumes about 19 million barrels per day. Energy requirements will also increase minimally due to pumping needs associated with the proposed technologies.

SECTION 16

ANALYTICAL METHODS

16.0 REGULATORY BACKGROUND AND REQUIREMENTS

16.1 CLEAN WATER ACT (CWA)

Under the Clean Water Act, EPA promulgates guidelines establishing test procedures for the analysis of pollutants (see 304(h), 33 U.S.C. Section 1314(h)). The Administrator has made these procedures applicable to monitoring and reporting of National Pollutant Discharge Elimination System (NPDES) permits and to implementation of pretreatment standards.

Under the Clean Water Act, the Agency regulates three broad categories of pollutants: conventional pollutants, toxic pollutants, and non-conventional pollutants.

The pollutants designated as conventional pollutants under Section 304(a)(4) of the CWA are: (1) Biological Oxygen Demand (BOD_5), (2) Total Suspended Solids (TSS), (3) Fecal Coliforms, (4) pH, and (5) Oil and Grease. The list of these pollutants has been promulgated at 40 CFR Part 401.16.

The pollutants designated as toxic pollutants under Section 307(a)(1) of the CWA are the list of 65 compounds and classes of compounds promulgated at 40 CFR 401.15, and expanded to the list of 126 "Priority Pollutants" presented at 40 CFR Part 423, Appendix A.

The pollutants designated as non-conventional pollutants under the CWA are those pollutants not identified as either conventional pollutants or toxic pollutants.

Pesticides industry wastewaters contain conventional pollutants and many of the toxic pollutants, and most active ingredients are non-conventional pollutants.

Analytical methods for conventional pollutants, toxic pollutants, and some non-conventional pollutants have been promulgated under Section 304(h) of the CWA at 40 CFR Part 136. In addition to the methods developed by EPA and promulgated at 40 CFR Part 136, certain methods developed by other Agencies and by associations such as the American Public Health Association which publishes "Standard Methods for the Examination of Water and Wastewater" have been incorporated by reference into 40 CFR Part 136.

Many of the currently approved promulgated methods for PAIs do not include the most recent advances in technology, particularly the clean-up procedures necessary to eliminate interferences and improve reliability, nor do they account for the latest and most sensitive detection devices, which permit accurate detection of PAI pollutants at very low concentrations. This latest technology is used by many companies to monitor wastewaters, and was used by EPA in its sampling of pesticide manufacturing industry wastewaters. All of the PAI pollutant data EPA is relying on for the final effluent limitations used analytical methods employing the latest in analytical technology. EPA is today requiring that compliance monitoring of PAIs in effluent from the manufacture of the 120 PAIs with limitations in this rule must employ methods listed in Table 16-1, and will not be permitted to use the methods promulgated at 40CFR Part 136 (except where the Part 136 method is identical to the method in Part 455).

16.1.1 Safe Drinking Water Act (SDWA)

The SDWA authorizes the Agency to set primary drinking water regulations for public water suppliers. Public water suppliers are required to perform routine monitoring to demonstrate compliance with these regulations. To support this monitoring, EPA has provided a set of test procedures for measurement of pollutants in drinking water. These procedures have been promulgated at 40 CFR Part 136.

Publications containing methods for the determination of many pesticide active ingredients are EPA/600/4-88/039 "Methods for Determination of Organic Compounds in Drinking Water" (December 1988), and EPA/600/4-90/020 "Methods for Determination of Organic Compounds in Drinking Water - SupplementI" (July 1990). EPA is including many of these drinking water methods for monitoring pesticide active ingredients in pesticide industry wastewaters.

16.2 PROMULGATED METHODS

16.2.1 Methods for PAI Pollutants

EPA has not previously promulgated methods for most of the PAI pollutants in the proposed rule. In 1985, as part of the promulgation of effluent limitations guidelines and standards for the Pesticide Industry, EPA promulgated methods for 61 PAIs (50 FR 40672, October 4, 1985). These methods were contained in a methods compendium titled "Methods for Nonconventional Pesticides Chemicals Analysis - Municipal and Industrial Wastewater," EPA 440/1-83/079-C. This document is presently out of print and unavailable except in photocopy form. The methods were also published in their entirety in the October 4, 1985, Federal Register. The promulgated methods were withdrawn as a part of the withdrawal of the 1985 proposed rule to allow for further testing and possible revision.

Since 1986, EPA has conducted additional methods development for PAI pollutants to incorporate the most recent advances in technology, particularly the clean-up procedures necessary to eliminate interferences and improve reliability, and to account for the latest and most sensitive detection devices, which permit accurate detection of PAI pollutants at very low concentrations. In addition, EPA requested and received new analytical methods from pesticide manufacturing facilities which monitor their wastewater.

Table 16-1

TEST METHODS FOR PESTICIDE ACTIVE INGREDIENTS

EPA Survey Code	Pesticide Name	CAS Number	EPA Analytical Method Number(s)
8	Triadimefon	43121-43-3	507/633/525.1/1656
12	Dichlorvos	00062-73-7	1657/507/622/525.1
16	2,4-D; 2,4-D Salts and Esters [2,4-Dichlorophenoxyacetic acid]	00094-75-7	1658/515.1/615/ 515.2/555
17	2,4-DB; 2,4-DB Salts and Esters [2,4-Dichlorophenoxybutyric acid]	00094-82-6	1658/515.1/615/ 515.2/555
22	Mevinphos	07786-34-7	1657/507/622/525.1
25	Cyanazine	21725-46-2	629/507
26	Propachlor	01918-16-7	1656/508/608.1/525.1
27	MCPA; MCPA Salts and Esters [2-Methyl-4-chlorophenoxyacetic acid]	00094-74-6	1658/615/555
30	Dichlorprop; Dichlorprop Salts and Esters [2-(2,4-Dichlorophenoxy) propionic acid]	00120-36-5	1658/515.1/615/ 515.2/555
31	MCPP; MCPP Salts and Esters [2-(2-Methyl-4-chlorophenoxy) propionic acid]	00093-65-2	1658/615/555
35	TCMTB [2-(Thiocyanomethylthio) benzothiazole]	21564-17-0	637
39	Pronamide	23950-58-5	525.1/507/633.1
41	Propanil	00709-98-8	632.1/1656
45	Metribuzin	21087-64-9	507/633/525.1/1656
52	Acephate	30560-19-1	1656/1657
53	Acifluorfen	50594-66-6	515.1/515.2/555
54	Alachlor	15972-60-8	505/507/645/525.1/ 1656

Table 16-1

(Continued)

EPA Survey Code	Pesticide Name	CAS Number	EPA Analytical Method Number(s)
55	Aldicarb	00116-06-3	531.1
58	Ametryn	00834-12-8	507/619/525.1
60	Atrazine	01912-24-9	505/507/619/525.1/1656
62	Benomyl	17804-35-2	631
68	Bromacil; Bromacil Salts and Esters	00314-40-9	507/633/525.1/1656
69	Bromoxynil	01689-84-5	1625/1661
69	Bromoxynil octanoate	01689-99-2	1656
70	Butachlor	23184-66-9	507/645/525.1/1656
73	Captafol	02425-06-1	1656
75	Carbaryl [Sevin]	00063-25-2	531.1/632/553
76	Carbofuran	01563-66-2	531.1/632
80	Chloroneb	02675-77-6	1656/508/608.1/525.1
82	Chlorothalonil	01897-45-6	508/608.2/525.1/1656
84	Stirofos	00961-11-5	1657/507/622/525.1
86	Chlorpyrifos	02921-88-2	1657/508/622
90	Fenvalerate	51630-58-1	1660
103	Diazinon	00333-41-5	1657/507/614/622/525.1
107	Parathion methyl	00298-00-0	1657/614/622
110	DCPA [Dimethyl 2,3,5,6-tetrachloroterephthalate]	01861-32-1	508/608.2/525.1/515.1/515.2/1656
112	Dinoseb	00088-85-7	1658/515.1/615/515.2/555
113	Dioxathion	00078-34-2	1657/614.1

Table 16-1

(Continued)

EPA Survey Code	Pesticide Name	CAS Number	EPA Analytical Method Number(s)
118	Nabonate [Disodium cyanodithioimidocarbonate]	00138-93-2	630.1
119	Diuron	00330-54-1	632/553
123	Endothall	00145-73-3	548/548.1
124	Endrin	00072-20-8	1656/505/508/608/617/525.1
125	Ethalfluralin	55283-68-6	1656*/627*
126	Ethion	00563-12-2	1657/614/614.1
127	Ethoprop	13194-48-4	1657/507/622/525.1
132	Fenarimol	60168-88-9	507/633.1/525.1/1656
133	Fenthion	00055-38-9	1657/622
138	Glyphosate [N-(Phosphonomethyl) glycine]	01071-83-6	547
140	Heptachlor	00076-44-8	1656/505/508/608/617/525.1
144	Isopropalin	33820-53-0	1656/627
148	Linuron	00330-55-2	553/632
150	Malathion	00121-75-5	1657/614
154	Methamidophos	10265-92-6	1657
156	Methomyl	16752-77-5	531.1/632
158	Methoxychlor	00072-43-5	1656/505/508/608.2/617/525.1
172	Nabam	00142-59-6	630/630.1
173	Naled	00300-76-5	1657/622
175	Norflurazon	27314-13-2	507/645/525.1/1656
178	Benfluralin	01861-40-1	1656*/627*

Table 16-1

(Continued)

EPA Survey Code	Pesticide Name	CAS Number	EPA Analytical Method Number(s)
182	Fensulfothion	00115-90-2	1657/622
183	Disulfoton	00298-04-4	1657/507/614/622/ 525.1
185	Phosmet	00732-11-6	1657/622.1
186	Azinphos Methyl	00086-50-0	1657/614/622
192	Organo-tin pesticides	12379-54-3	Ind-01/200.7/200.9
197	Bolstar	35400-43-2	1657/622
203	Parathion	00056-38-2	1657/614
204	Pendimethalin	40487-42-1	1656
205	Pentachloronitrobenzene	00082-68-8	1656/608.1/617
206	Pentachlorophenol	00087-86-5	625/1625/515.2/555/ 515.1/ 525.1
208	Permethrin	52645-53-1	608.2/508/525.1/ 1656/1660
212	Phorate	00298-02-2	1657/622
218	Busan 85 [Potassium dimethyldithiocarbamate]	00128-03-0	630/630.1
219	Busan 40 [Potassium N-hydroxymethyl-N-methyldithiocarbamate]	51026-28-9	630/630.1
220	KN Methyl [Potassium N-methyldithiocarbamate]	00137-41-7	630/630.1
223	Prometon	01610-18-0	507/619/525.1
224	Prometryn	07287-19-6	507/619/525.1
226	Propazine	00139-40-2	507/619/525.1/1656
230	Pyrethrin I	00121-21-1	1660
232	Pyrethrin II	00121-29-9	1660

Table 16-1

(Continued)

EPA Survey Code	Pesticide Name	CAS Number	EPA Analytical Method Number(s)
236	DEF [S,S,S-Tributyl phosphorotrithioate]	00078-48-8	1657
239	Simazine	00122-34-9	505/507/619/525.1/ 1656
241	Carbam-S [Sodium dimethyldithiocarbanate]	00128-04-1	630/630.1
243	Vapam [Sodium methyldithiocarbamate]	00137-42-8	630/630.1
252	Tebuthiuron	34014-18-1	507/525.1
254	Terbacil	05902-51-2	507/633/525.1/1656
255	Terbufos	13071-79-9	1657/507/614.1/525.1
256	Terbuthylazine	05915-41-3	619/1656
257	Terbutryn	00886-50-0	507/619/525.1
259	Dazomet	00533-74-4	630/630.1/1659
262	Toxaphene	08001-35-2	1656/505/508/608/ 617/525.1
263	Merphos [Tributyl phosphorotrithioate]	00150-50-5	1657/507/525.1/622
264	Trifluralin	01582-09-8	1656/508/617/627/ 525.1
268	Ziram [Zinc dimethyldithiocarbamate]	00137-30-4	630/630.1

*Monitor and report as total Trifluralin.

A number of commenters stated that their plants have analytical methods that differ from the methods listed in Table 161 to some degree. Several of those commenters have submitted their methods as part of their comments. EPA has evaluated those methods and has determined that the differences are within the range allowed by the Table 16-1 methods, providing that the quality control criteria in the promulgated methods are met. Several commenters also noted that their methods have been submitted to the permitting authority for their plants and the methods have met the requirements and have been accepted by the permitting authority. The concern expressed was that the promulgation of these methods would require the discharger to resubmit the methods for reevaluation, at possibly considerable expense. Where the methods were submitted with the comments or as supplemental information and comment, EPA has evaluated those methods and has sent letters to the commenter with EPA's evluation of that method. In all cases, EPA believes that the commenters' method is equivalent to the promulgated method. The commenter may use that letter as demonstration to the permitting authority that the commenter's analytical method is equivalent to the promulgated method and therefore may be used by the commenter for compliance monitoring.

Revisions to Analytical Methods--

EPA listed the method numbers of the analytical methods required for monitoring the pesticide active ingredients (PAIs) in Table 7 of the proposed rule (57 FR 12601). The methods referenced by number in Table 7 had either been promulgated at 40 CFR Part 136 or copies were obtainable from the EPA Sample Control Center or the National Technical Information Service (NTIS) at the addresses given in the proposal (57 FR 12590), and a copy of the obtainable methods was included in the docket for the proposed rule.

EPA has revised and promulgated Table 7 of the proposed rule as Table 7 in the final rule. The revisions are the result of changes in method numbers, corrections to method numbers, comments received, and revision and development of additional methods by EPA.

At the time of proposal, EPA was in the process of separating Method 1618 into Methods 1656, 1657, and 1658 for the organo-chlorine pesticides and PCBs, organo-phosphate pesticides, and phenoxy-acid herbicides, respectively. Table 7 of the proposed rule did not contain these individual method numbers. However, the correct method numbers were listed in the Development document for the proposed rule and the index of the methods compendium titled "Methods for the Determination of Nonconventional Pesticides in Municipal and Industrial Wastewater" (EPA 821/R-92-002, April 1992) ("Compendium"), available from the EPA Sample Control Center and included in the docket. The active ingredients affected by the change from Method 1618 to Method 1656 are propachlor, captafol, chloroneb, endrin, heptachlor, methoxychlor, pentachloronitrobenzene, toxaphene, and trifluralin. The active ingredients affected by the change from Method 1618 to Method 1657 are dichlorvos, mevinphos, stirofos, chlorpyrifos, diazinon, parathion methyl, dioxathion, ethion, ethoprop, fenthion, malathion, methamidophos, naled, fensulfothion, disulfoton, phosmet, azinphos methyl, bolstar, parathion, phorate, DEF, terbufos, and merphos. The active ingredients affected by the change from Method 1618 to Method 1658 are 2,4-D and its salts and esters, dichlorprop and its salts and esters, MCPP and its salts and esters, and dinoseb.

Some of the method numbers listed in the Compendium for certain PAIs were inadvertently omitted from Table 7 of the proposal. The correct method numbers are listed in Table 7 of the final rule. The active ingredients for which Method 1656 was added are triadimefon, propanil, metribuzin, alachlor, atrazine, bromacil and its salts and esters, butachlor, chlorothalonil, DCPA, ethalfluralin, fenarimol, isopropalin, norflurazon, benfluralin, propazine, simazine, terbacil, and terbuthylazine. The active ingredients for which the respective methods were added are: Method 515.1 for DCPA and pentachlorophenol; Method 633.1 for pronamide; Method 1657 for acephate; Method 515.2 for pentachlorophenol; and Methods 507 and 622 for merphos. EPA has dropped outdated industry methods that were not to be included in Table 7 of the proposed rule and were not included in the methods Compendium. Industry Method 140A for gyphosate was dropped in favor of EPA Method 547 and industry Method 131 for dazomet was dropped in favor of EPA Method 1659. Also EPA has dropped inapplicable methods for AIs for which they were inadvertently listed in Table 7 of the proposed rule. EPA dropped Method 1656 for DEF and merphos, for which Method 1657 should have been listed and for which it is now listed in this final rule. EPA deleted the listing of Method 508 for pyrethrin I and pyrethrin II because Method 508 does not cover these compounds. EPA also dropped Method 1656 for bromoxynil in favor of Method 1661, and for fenvalerate in favor of Method 1660.

EPA has expanded the list of methods required for monitoring many of the PAIs, and has included the identification numbers of these methods in Table 7. In the proposal, EPA stated that the objective in allowing multiple methods was to permit as much flexibility as possible while controlling the quality of the methods approved (57 FR 12590). The additional methods included in this final rule are EPA Methods 515.2 and 555 for determination of the phenoxy-acid herbicides, Method 548.1 for determination of endothall, and Method 553 for the determination of carbaryl, diuron, and linuron. Method 515.2 was developed with pollution prevention objectives (to reduce solvent use) in mind, and uses solid phase extraction (SPE) disks for extraction of the herbicides from water. Method 548.1 is an extensive revision of Method 548 and EPA recommends that users of Method 548 change to Method 548.1 because of the simplicity and greater reliability of Method 548.1. Method 555 is a new method for phenoxy-acid herbicides that uses high performance liquid chromatography with a diode array detector. Method 553 is a new method employing SPE and liquid chromatography followed by particle-beam/mass spectrometry. These improved and new methods are being included in this final rule as additional methods that may be used and as allowable variants of the methods proposed. The active ingredients affected by the addition of Method 515.2 are 2,4-D and its salts and esters, 2,4-DB and its salts and esters, dichlorprop and its salts and esters, acifluorfen, DCPA, dinoseb, and pentachlorophenol. The active ingredients affected by the addition of Method 555 are 2,4-D and its salts and esters, 2,4-DB and its salts and esters, MCPA and its salts and esters, MCPP and its salts and esters, dichlorprop and its salts and esters, acifluorfen, dinoseb, and pentachlorophenol.

EPA listed Method 525.1 as an allowable method for many PAIs in Table 7 of the proposed rule, and as the only method for Pronamide. Method 525.1 was included in the set of methods obtainable from NTIS and included in the docket. However, many of the PAIs for which Method 525.1 was listed in Table 7 of the proposal are not listed within Method 525.1 itself. The reason that these PAIs were not listed within Method 525.1 was that EPA's Environmental Monitoring Systems Laboratory in Cincinnati, Ohio (EMSL-Ci) had not revised Method 525.1 to include the PAIs, although EMSL-Ci had produced performance data demonstrating analysis of these PAIs using Method 525.1. EPA has included Method 525.1 in the revised Compendium and has printed the performance data supplied by EMSL-Ci at the end of the Method because Method 525.1 is the only gas chromatography/mass spectrometry (GC/MS) method available for many of the PAIs, because EPA wants to allow continued use of Method 525.1 for the PAIs for which it was proposed, and because Method 525.1 was the only method proposed for measurement of pronamide. Method 525.1 was also added for the determination of ethoprop, pentachlorophenol and toxaphene.

EPA has also approved Method 507 for pronamide, as indicated in Table 7 of the final rule, because the only major difference between Methods 525.1, which was proposed and is approved for pronamide, and Method 507, which was not proposed, is that Method 525.1 uses a mass spectrometer detector whereas Method 507 uses a nitrogen-phosphorus detector (NPD). EPA has also approved Method 507 for cyanazine, based on data submitted by industry. These data show that cyanazine, a triazine herbicide closely related to the other triazine herbicides listed in Method 507, can be analyzed using GC/NPD. Method 515 was changed to Method 615 for MCPA and its salts and esters as a result of a typographical error. Fenvalerate, pyrethrin I, and pyrethrin II were added to Method 1660 based on new test data.

Corrections and Additions to Methods Compendium--

EPA has revised the Compendium that was included in the docket and discussed in the proposed rule . Typographical errors were corrected and a technical correction was made to EPA Method 1660 reducing by a factor of 10 the Method Detection Limits (MDLs), estimated MDLs, minimum levels, and concentrations for certain quality control acceptance criteria, for the pyrethrin/pyrethroid active ingredients covered by Method 1660. The factor of 10 technical correction was the result of improper calculations in the original version of Method 1660. This final rule is not affected by the corrections because the effluent limits for the pyrethrin/pyrethroid active ingredients covered by this rule are above the higher minimum levels and MDLs published in the original version of the Compendium.

To provide a single set of documents for the methods required for monitoring the regulated PAIs that are not promulgated at 40 CFR Part 136, EPA has expanded the Compendium to include the proposed Method 525.1, newly developed Methods 515.2, 553 and 555, the revised Method and 548.1, and the other methods that EPA listed as obtainable from NTIS in the proposed rule (57 FR 12590) that are applicable to the regulated PAIs. The revised (two volume) Compendium is also available from the U.S. EPA Office of Water. EPA has retained Method 642 in the Compendium because the decision not to regulate biphenyl came too late to remove Method 642 from the Compendium. Compliance monitoring of the priority pollutants, as in the proposal, is required to be conducted using methods contained in 40 CFR 136.

EPA is today promulgating all of these methods so they will be available for compliance monitoring of PAIs in effluent from the manufacture of the 120 regulated PAIs; for many PAIs, more than one analytical method is being promulgated. The availability of more than one method for a specific PAI allows flexibility to the analyst to select the analytical method that provides the most accurate results.

The analytical methods promulgated today are listed in Table 16-1. This list references method numbers contained in the documents identified below. Both of the documents containing the methods are available in the docket for this rulemaking. The documents may also be obtained as follows:

Document Title and Number	**Source**
"Methods for the Determination of Nonconventional Pesticides in Municipal and Industrial Wastewater" Volume I EPA-821-R-93-010-A Revision 1	EPA Sample Control Center 300 N. Lee Street Alexandria, VA 22314
"Methods for the Determination Nonconventional Pesticides in Municipal and Industrial Wastewater" Volume II EPA-821-R-93-010-B	EPA Sample Control Center 300 N. Lee Street Alexandria, VA 22314

These documents include methods for the 120 PAIs regulated today as well as other PAIs. A number of PAIs which are not manufactured in the United States are incorporated into products that are formulated in the United States. The Agency is continuing its evaluation of these methods, and developing new methods, for potential use in monitoring discharges from PFPR plants. EPA intends to propose effluent guidelines for the PFPR industry in January, 1994.

EPA is approving these analytical methods so that all pesticide methods for water and wastewater developed by EPA to date will be available for use by industry and by laboratories that test for these pesticides, and in anticipation of EPA's future rulemaking for Pesticides Formulators and Packagers. However, the fact that EPA is approving the use of a published method for measuring a specific PAI does not mean that EPA definitely will regulate (or not regulate) that PAI in a future rulemaking.

The promulgated analytical methods will be used by pesticide manufacturers, by regulatory agencies including POTWs, by commercial testing laboratories, and by others, to determine compliance with the final effluent limitations guidelines and standards. The methods for monitoring the PAIs included in the final rule are listed in Table 7 of the final rule. There is at least one method for each PAI, at least two methods for most PAIs, and three methods for many PAIs. EPA's intent in promulgating multiple methods is to permit as much flexibility as possible while controlling the quality of the methods approved.

Method Flexibility--

EPA will continue to allow flexibility in the selection of methods and flexibility within methods, as stated in the proposed rule (57 FR 12590), and within the methods themselves, consistent with the flexibility allowed in the 40 CFR Part 136, Appendix A methods (49 FR 43234). To further support this flexibility, EPA has produced a document titled "Guidance on Evaluation, Resolution, and Documentation of Analytical Problems Associated with Compliance Monitoring" (EPA 821-B-93-001, February 1993) (the "Monitoring Guidance"). This document gives details of the flexibility allowed in resolving analytical problems and the documentation required under the NPDES regulations when a method is altered. This document is also available from the EPA Sample Control Center, 300 N. Lee Street, Alexandria, VA 22314.

16.2.2 Methods for Metals

EPA's Environmental Monitoring Systems Laboratory in Cincinnati, Ohio (EMSL-Ci) has recently developed a set of methods titled "Methods for the Determination of Metals in Environmental Samples" (EPA 600/4-91/010). This methods set includes techniques such as inductively coupled plasma/atomic emission spectrometry (Method 200.7) and stabilized temperature graphite furnace atomic absorption spectrometry (Method 200.9) to measure metals at low levels. EPA is promulgating Methods 200.7, 200.9, and industry method IND-01 for the measurement of organo-tin compounds in pesticides industry wastewaters.

16.2.3 Development of Methods

Since the previous methods set was published, the trend of pesticides and herbicides produced and applied in the U.S. has continued from chlorinated compounds to phosphorus-containing compounds and other molecules found to be less persistent in the environment. This change has necessitated the development of analytical methods to measure these compounds in wastewater discharges and in other environmental samples. EPA has therefore developed additional methods as a part of its data gathering efforts for the proposed rule.

Where possible, EPA tests existing methods to determine if an active ingredient can be measured by these existing methods. If these tests are successful, EPA revises the method to incorporate the new analyte. In addition, EPA has attempted to consolidate multiple methods for the same analyte by selecting a given method or writing a revised or new method and including as many analytes as possible in this method. For example, EPA has used wide-bore, fused silica capillary columns in recently developed gas chromatography (GC) methods for pesticide active ingredients to increase resolving power so that more analytes can be measured simultaneously and so that these analytes can be measured at lower levels. Drinking water methods 507, 508, 515.1, and wastewater methods 1656, 1657, and 1658 represent GC methods that encompass a large number of analytes.

On the other hand, it is frequently not possible to include an analyte or group of analytes in an existing method because the nature of the molecule(s) does not lend itself to the techniques in the method. In these instances, an entirely separate method must be developed. In the methods promulgated in this final rule, Method 1659 for Dazomet, Method 1660 for the Pyrethrins and Pyrethroids, and Method 1661 for Bromoxynil represent examples of methods that were developed. The method for Dazomet employs a base hydrolysis to convert Dazomet to methyl isothiocyanate (MITC) and gas chromatography with a fused silica capillary column and nitrogen/phosphorous detector for selective detection of MITC. The method for the Pyrethrins and Pyrethroids employs acetonitrile extraction of a salt-saturated wastewater sample and high-performance liquid chromatography (HPLC) for selective detection of these analytes. The method for Bromoxynil employs direct aqueous injection HPLC.

16.2.4 Procedures for Development and Modification of Methods

In many instances, EPA has combined method development with data gathering to support the effluent limitations and guidelines in the proposed rule. In this process, commercial analytical laboratories compete to apply an existing method, modify an existing method, or develop a new method under "Special Analytical Services" contracts. EPA then works closely with the laboratory selected to assure that all quality assurance program requirements will be met. The laboratory outlines the exact tests to be undertaken to modify the method (if required) or to develop a new procedure. EPA approves the approach before samples are collected.

Samples are collected at the facility that manufactures the given active ingredient or group of pesticides. Frequently, multiple pesticides requiring different procedures are required. In this instance, more than one laboratory may be involved in the determination of multiple pesticides. Samples collected are of in-process wastewater, untreated effluent, treated effluent, and other streams. The samples are preserved and shipped to the laboratory.

After receipt at the laboratory, analysts attempt to measure the active ingredient in each waste stream type using the method specified by EPA or with the modification approved by EPA. If the attempt is successful, routine analysis of the samples begins; if unsuccessful, EPA works closely with its scientific consultants and the laboratory to try other approaches.

Frequently, the industry is consulted as to how to solve an analytical problem because industry scientists are often most familiar with the measurement of a given active ingredient in their particular wastewater. When an approach is successful, the laboratory documents the approach and performs an initial precision and recovery study to demonstrate the accuracy and reproducibility of the method. The requirement for an initial precision and recovery study forms one of the cornerstones of the wastewater methods, and is described in detail in the preamble to the proposal and promulgation of these methods.

After completing the initial precision and recovery study, the laboratory begins analysis of wastewater samples using the procedure specified by EPA or with the modification as approved by EPA. In addition to analyzing the samples directly, a sample of each wastewater type is spiked (fortified) with the active ingredient of interest. This spiked sample is then analyzed to determine the recovery of the analyte from the actual sample, and assures that the active ingredient can be measured accurately in each type of wastewater sample.

After all samples are analyzed, the laboratory prepares a report containing a "Narrative" of exactly what modifications were required in order to apply a method or modification to a given sample. The report also contains result summaries, run chronologies (showing that analyses were performed in the correct order on a calibrated instrument), and includes raw data so that EPA can reconstruct the results as a part of the audit process. The report is then submitted to EPA by the laboratory.

EPA has its audit team review the report and obtains from the laboratory any missing or incomplete results. EPA also audits the data submitted for adherence to method specifications and consistency with data collected from other laboratories. Deficiencies are corrected by the laboratory and the data are included in the package for guideline development.

16.2.5 Method Writing and Modification

After data are collected and reviewed by EPA, methods are written or modified to include the active ingredient. For example, the active ingredient Methamidophos is highly soluble in water but not soluble in organic solvents. The procedure suggested by industry for extraction of Methamidophos used a combination of saturating the water with salt and a powerful solvent combination for the extraction. The laboratory applied this technique and found that Methamidophos could be recovered at 95 percent. Further, the laboratory found that pre-extraction of the sample with an organic solvent could be used to remove nearly all potential interferents from the sample, so that the aggressive extraction would result in only Methamidophos and similar highly water-soluble molecules in the final extract. EPA then modified Method 1657 to incorporate the pre-extraction and aggressive extraction procedure for highly water-soluble analytes.

16.3 INVESTIGATION OF OTHER ANALYTICAL TECHNIQUES

In addition to methods developed for the final rule, EPA is investigating other methods and other analytical techniques to aid in the determination of non-conventional pesticides and other analytes of concern. EPA is interested in simplifying methods where possible and in reducing the potential pollution threat caused by the volumes of solvents used in some methods. An example of a simplification technique is the use of an immunoassay specific to a given analyte (such as a pesticide) or analyte group (such as the phenoxyacid herbicides) to allow EPA to screen rapidly for these analytes in discharges and in other environmental samples. EPA is also investigating the use of "solid phase extraction" (liquid-solid extraction) as a means of reducing the amount of solvent used in conventional extraction procedures. Solid phase extraction (SPE) has been successfully applied to drinking water matrices, but initial tests with wastewaters containing high dissolved solids yielded low recoveries of the analytes of concern. More recent materials have yielded recoveries more consistent with conventional extraction techniques. EPA will continue to investigate these and other analytical techniques with the objective of producing lower cost, more rapid, and potentially less environmentally damaging analytical methods.

SECTION 17

GLOSSARY

Act - The Clean Water Act

Agency - U.S. Environmental Protection Agency.

BAT - The best available technology economically achievable, applicable to effluent limitations to be achieved by July 1, 1984, for industrial discharges to surface waters, as defined by Section 304(b)(2)(B) of the Act.

BCT - The best conventional pollutant control technology, applicable to discharges of conventional pollutants from existing industrial points sources, as defined by Section 304(b)(4) of the Act.

BMP - Best management practices, as defined by Section 304(e) of the Act.

BPT - The best practicable control technology currently available, applicable to effluent limitations to be achieved by July 1, 1977, for industrial discharges to surface waters, as defined by Section 304(b)(1) of the Act.

Clean Water Act - The Federal Water Pollution Control Act Amendments of 1972 (33 U.S.C. 1251 et seq.), as amended by the Clean Water Act of 1977 (Pub. L. 95-217), and the Water Quality Act of 1987 (Pub.L. 100-4).

Conventional Pollutants - Constituents of wastewater as determined by Section 304(a)(4) of the Act, including, but not limited to, pollutants classified as biochemical oxygen demand, suspended solids, oil and grease, fecal coliform, and pH.

Direct Discharger - An industrial discharger that introduces wastewater to a receiving body of water with or without treatment by the discharger.

Effluent Limitation - A maximum amount, per unit of time, production or other unit, of each specific constituent of the effluent that is subject to limitation from an existing point source. Allowed pollutant discharge may be expressed as a mass loading in pound per 1,000 pound PAI produced or as a concentration in milligrams per liter.

End-of-Pipe Treatment (EOP) - Refers to those processes that treat a plant waste stream for pollutant removal prior to discharge. EOP technologies covered are classified as primary (physical separation processes), secondary (biological processes), and tertiary (treatment following secondary) processes. Different combinations of these treatment technologies may be used depending on the nature of the pollutants to be removed and the degree of removal required.

Indirect Discharger - An industrial discharger that introduces wastewater into a publicly-owned treatment works.

In-Plant Control or Treatment Technologies - Controls or measures applied within the manufacturing process to reduce or eliminate pollutant and hydraulic loadings of raw wastewater. Typical in-plant control measures include process modification, instrumentation, recovery of raw materials, solvents, products or by-products, and water recycle.

Nonconventional Pollutants - Parameters selected for use in developing effluent limitation guidelines and new source performance standards which have not been previously designated as either conventional pollutants or priority pollutants.

Non-Water Quality Environmental Impact - Deleterious aspects of control and treatment technologies applicable to point source category wastes, including, but not limited to air pollution, noise, radiation, sludge and solid waste generation, and energy used.

NPDES - National Pollutant Discharge Elimination System, a Federal program requiring industry and municipalities to obtain permits to discharge pollutants to the nation's waters, under Section 402 of the Act.

NSPS - New source performance standards, applicable to industrial facilities whose construction is begun after the publication of the proposed regulations, as defined by Section 306 of the Act.

OCPSF - Organic chemicals, plastics, and synthetic fibers manufacturing point source category. (40 CFR Part 414).

PAI - Pesticide Active Ingredient.

Point Source Category - A collection of industrial sources with similar function or product, established by Section 306(b)(1)(A) of the Federal Water Pollution Control Act, as amended for the purpose of establishing Federal standards for the disposal of wastewater.

POTW - Publicly-owned treatment works. Facilities that collect, treat, or otherwise dispose of wastewaters, owned and operated by a village, town, county, authority or other public agency.

Pretreatment Standard - Industrial wastewater effluent quality required for discharge to a publicly-owned treatment works.

Priority Pollutants - The toxic pollutants listed in 40 CFR Part 423, Appendix A.

PSES - Pretreatment Standards for existing sources of indirect discharges, under Section 307(b) of the Act.

PSNS - Pretreatment standards for new sources of indirect discharges under Section 307(b) and (c) of the Act.

SIC - Standard Industrial Classification, a numerical categorization scheme used by the U.S. Department of Commerce to denote segments of industry.

Technical Development Document - Development Document for Proposed Effluent Limitations Guidelines and Standards for the Pesticides Chemicals Manufacturing Point Source Category.

SECTION 18

REFERENCES

1. Aly, O. M., and M. A. El-Dib, "Studies on the Persistence of Some Carbamate Insecticides in the Aquatic Environment - I - Hydrolysis of Sevin, Baygon, Pyrolan, and Dimethilan in Waters", Water Research, 5(12):1191-1205, 1971.

2. American Paper Institute v. EPA, 660 F. 2d 954 (4th Cir. 1980).

3. BASF Wyandotte Corp. v. Costle, 614 F. 2d 21 (1st Cir. 1980).

4. BASF Wyandotte Corp. v. Costle, 596 F. 2d 637 (1st Cir. 1979), cert. denied.

5. Biello, L. J., et al., "Final Report of Laboratory Study of Pesticides Wastewater Treatability", Environmental Science and Health, B12(2):129-146, 1977.

6. Brown, N. P. H., and B. T. Graysen, "Base-Catalyzed Hydrolysis of (E) - and (Z) - Mevinphos", Pesticide Science, 14(6):547-549, 1983.

7. Budavari, Susan, editor, The Merck Index: An Encyclopedia of Chemicals, Drugs and Biologicals - Eleventh Addition, Merck & Co, Rahway, NJ, 1989.

8. The Bureau of National Affairs, Pesticides: State and Federal Regulation, Bureau of National Affairs, Rockville, MD, 1987.

9. Callahan, M. A., et al., Water-Related Environmental Fate of 129 Priority Pollutants, Volume I: Introduction and Technical Background, Metals and Inorganics, Pesticides and PCBs, EPA-44/4-79-029a, United States Environmental Protection Agency, Washington DC, 1979.

10. Chau, Alfred S. Y., and B. K. Afghan, Analysis of Pesticides in Water, Volumes I, II, and III, CRC Press, Boca Raton, FL, 1982.

11. Chemical Specialities Manufacturers Association, et. al., v. EPA, (86-8024).

12. Cowart, R. P., F. L. Bonner, and E. A. Epps, Jr., "Rate of Hydrolysis of Seven Organophosphate Pesticides", Bulletin of Environmental Contamination and Toxicology, 6(3):231-234, 1971.

13. Crittenden, J. C., J. K. Berrigan, and D. W. Hand, "Design of Rapid Small-Scale Adsorption Tests for a Constant Diffusivity", Journal WPCF, Volume 58, Number 4, April 1986.

REFEREENCES

(Continued)

14. Dennis, W. H., Jr., Methods of Chemical Degradation of Pesticides and Herbicides - A Review, USAMEERU No. 73-04, United States Army Medical Envionmental Engineering Research Unit, Edgewood Arsenal, Maryland, 1972.

15. Dobbs, Richard A., and Jesse M. Cohen, "Carbon Adsorption Isotherms for Toxic Organics", EPA Report Number EPA-60/8-80-023, April 1980.

16. "Domestic Sewage Study", DSS - Report to Congress on the Discharge of Hazardous Waste to Publicly Owned Treatment Works, EPA/530-SW-86-004, February 1986.

17. Drevenkar, V., et al., "The Fate of Pesticides in Aquatic Environment II - Hydrolysis of Dichlorvos in a Model System and in River Water" (translation of "Archivza Higijenu Rada"), Toksikolgigu 27(4) 297-305, 1976.

18. El-Dib, M. A., and O. A. Aly, "Persistance of Some Phenylamide Pesticides in the Aquatic Environment - I - Hydrolysis", Water Research, 10(12):1047-1050, 1976.

19. Eli Lilly v. Costle, 444 U.S. 1096, 1980.

20. "EPA Method 632", Federal Register, Volume 50, No. 193, October 4, 1985.

21. Eto, M., Organophosphorus Pesticides: Organic and Biological Chemistry, CRC Press, Cleveland, OH, 1974.

22. Faust, S. D., and H. M. Gomaa, "Chemical Hydrolysis of Some Organic Phosphorus and Carbamate Pesticides in Aquatic Environments", Environmental Letters, 3(3):171-201, 1972.

23. Fest, C., and K. J. Schmidt, The Chemistry of Organophosphorus Pesticides, Springer-Verlag, New York, 1973.

24. Freed, V. H., C. T. Chiou, D. W. Schmedding, "Degradation of Selected Organophosphate Pesticides in Water and Soil", Journal of Agricultural Food Chemicals, 27(4):706-708, 1979.

25. Gardner, David A., and Gregory L. Huibregtse, Radian Corporation, and Thomas J. Holdsworth, Glenn M. Shaul, Kenneth M. Dostal, Water and Hazardous Wastes Treatment Research Division, Risk Reduction Engineering Laboratory, Accelerated Column Testing of Pesticide Manufacturing Wastewaters, EPA Contract No. 68-03-3371, December 1990.

REFEREENCES

(Continued)

26. Gardner, D. A., Radian Corporation, and G. M. Shaul and K. A. Dostal, Water and Hazardous Wastes Treatment Research Division, Risk Reduction Engineering Laboratory, Activated Carbon Isotherms for Pesticides, EPA Contract No. 68-03-3371, September 1989.

27. Gomaa, H. M., I. H. Suffet, and S. D. Faust, "Kinetics of Hydrolysis of Diazinon and Diozoxan", Residual Review, 29:171-190, 1969.

28. Hand, D. W., J. C. Crittenden, and W. E. Thacker, "Simplified Models for Design of Fixed-Bed Adsorption Systems", Journal of the American Society of Civil Engineers, Environmental Engineering Division, 110(2):440-456, April 1985.

29. Hineline, D. W., J. C. Crittenden, and D. W. Hand, "Use of Rapid Small-Scale Column Tests to Predict Full-Scale Adsorption Capacity and Performance", Proceedings of the AWWA Annual Meeting, Kansas City, MO, June 1987.

30. Hinton, J. F., Hydrolytic and Photochemical Degradation of Organophosphorus Pesticides, Publication No. 63, University of Arkansas, Fayetteville, AK, 1978.

31. Houghton, Mary J., The Clean Waters Act Amendments of 1987, The Bureau of National Affairs, Washington DC, 1987.

32. Kuhr, R. J., and H. W. Dorough, Carbamate Insecticides: Chemistry, Biochemistry and Toxicology, CRC Press, Cleveland, OH, 1976.

33. Lande, S. S., Identification and Description of Chemical Deactivation/Detoxification Methods for the Safe Disposal of Selected Pesticides SW-165C, United States Environmental Protection Agency, Washington DC, 1978.

34. Lemley, A. T., et al., "Investigation of Degradation Rates of Carbamate Pesticides - Exploring a New Detoxification Method", ASC Symposium Series, 259 (Treatment and Disposal of Pesticide Wastes): 245-259, 1984.

35. Macalady, D. L., and N. L. Wolfe, "New Perspectives on the Hydrolytic Degradation of the Organophosphorothioate Insecticide Chlorpyrifos", Journal of Agricultural Food Chemicals, 31(6):1139-1147, 1983.

36. Mahoney, William D., Means Site Work Cost Data 1989, R. S. Means Company, Inc., Kingston, MA, 1988.

REFEREENCES

(Continued)

37. Marchenko, P. V., A. V. Grechki and E. V. Kravets, "Application of the Hydrolysis of Organophosphorus Pesticides in the Purification of Effluents", Soviet Journal of Water Chemistry and Technology, 3(5):62-65, 1981.

38. Marco, Gino J., Robert M. Hollingsworth, and Jack R. Plummer, editors, Regulation of Agrochemicals: A Driving Force in Their Evolution, American Chemical Society, Washington DC, 1991.

39. Melnikov, N. N., "Decomposition of Organophosphorus Pesticides", (translation of "Khimiya v Seskom Khosyaistve"), Pesticides and the Environment, 12(3):49-57, 1975.

40. "Methods for Chemical Analysis for Water and Wastes", EPA-600/4-79/020, EMSL, 1983.

41. NRDC, et. al., v. Reilly, Civ. No. 89-2980.

42. Pereira, Percival E., Dodge Construction Cost Information System 1986, McGraw-Hill Information Systems, Princeton, NJ, 1985.

43. Perry, Robert H., and Don Green, Perry's Chemical Engineer's Handbook, McGraw-Hill Book Company, New York, 1984.

44. Radian Corporation, Alkaline Chlorination and Alkaline Hydrolysis Treatability Study of Pesticide Manufacturing Wastewaters, EPA Contract No. 68-C8-0008, July 1991.

45. Radian Corporation, Draft Pesticide Manufacturers Database Report, EPA Contract No. 68-C8-0008, March 1990.

46. Radian Corporation, Hydrolysis Treatability Study Final Report, EPA Contract No. 68-C8-0008, July 1991.

47. Radian Corporation, Membrane Filtration Treatability Study Final Report, EPA Contract No. 68-C8-0008, April 1990.

48. Sieber, J. N., M. P. Catahan, and C. R. Barril, "Loss of Carbofuran from Rice Paddy Water: Chemical and Physical Factors", Journal of Environmental Science and Health, B13(2):131-148, 1978.

49. Sine, Charlotte, editorial director, Farm Chemicals Handbook '90, Meister Publishing Company, Willoughby, OH, 1990.

50. Sittig, Marshall, editor, Pesticide Manufacturing and Toxic Materials Control Encyclopedia, Noyes Data Corporation, Park Ridge, NJ, 1980.

51. Sontheimer, H., J. C. Crittenden, and R. S. Summers, <u>Activated Carbon for Water Treatment</u>, 2nd Edition, DVGW Forschurgsstelle, Karlsruhu, West Germany, Distributed by AWWA Research Foundation, Denver, CO, 1988.

52. Speth, T. F., and R. S. Miltner, "Adsorption Capacity of GAC for Synthetic Organics", <u>AWWA Research Foundation</u>, 82(2):72-75, February 1990.

53. "Standard Methods for the Examination of Water and Wastewater", 15th Edition, American Public Health Association, Washington DC, 1981.

54. Summers, R. S., and J. C. Crittenden, <u>The Use of Mini-Columns for the Prediction of Full-Scale GAC Behavior Design and Use of Granular Activated Carbon: Practical Aspects</u>, AWWA Research Foundation, Denver, CO, 1989.

55. Tchobanoglous, George, and Edward D. Schoeder, <u>Water Quality</u>, Addison-Wesley Publishing Company, Reading, MA, 1985.

56. United States Congress, <u>The Clean Water Act of 1972 and 1977</u>, Public Law 95-217.

57. United States Congress, <u>The Clean Water Act as Amended by the Water Quality Act of 1987</u>, Public Law 1004.

58. United States Congress, <u>The Pollution Prevention Act of 1990</u>, Public Law 101-508.

59. United States Environmental Protection Agency, <u>Development Document for Effluent Limitations Guidelines and Standards for the Organic Chemicals, Plastics, and Synthetic Fibers - Point Source Category, Volumes I and II</u>, United States Environmental Protection Agency 440/1-87/009, Washington DC, 1987.

60. United States Environmental Protection Agency, <u>Development Document for Effluent Limitations Guidelines and Standards for the Pesticide (Final) Point Source Category</u>, United States Environmental Protection Agency, Washington DC 1985.

61. United States Environmental Protection Agency, Effluent Guidelines Division, <u>EPA Method 630</u>, Washington DC, January 1983.

62. United States Environmental Protection Agency, <u>EPA Method 637</u>, Effluent Guidelines Division, Washington DC, October 1985.

REFEREENCES

(Continued)

63. United States Environmental Protection Agency, Effluent Guidelines Division, EPA Method 1613A, Washington DC, March 1989.

64. United States Environmental Protection Agency, Office of Water Regulations and Standards, EPA Method 1916, Sample Control Center, Alexandria, VA.

65. United States Environmental Protection Agency, Effluent Guidelines Division, EPA Method 1624/1625, Washington DC, July 1988.

66. United States Environmental Protection Agency, Office of Drinking Water Health Advisories, Drinking Water Health Advisory: Pesticides, Lewis Publishers, Chelsea, MI, 1989.

67. United States Environmental Protection Agency, "Best Conventional Polluntant Control Technology; Effluent Limitations Guidelines - Final Rule", 40 CFR Parts 405, 406, 407, 408, 409, 411, 412, 418, 422, 424, 426, and 432, Federal Register, FRL 2941-9, Volume 51, No. 131, July 9, 1988.

68. United States Environmental Protection Agency, "Effluent Guidelines and Standards for the Pesticide Chemicals Category - Regulatory Program", Federal Register, Volume 55, No. 209, October 29, 1990.

69. United States Environmental Protection Agency, "General Pretreatment Regulations for Existing and New Sources - Final Rule" 40 CFR Part 403, Federal Register, OW-FRL 3006-4, Volume 52, No. 9, January 14, 1987.

70. United States Environmental Protection Agency, FIFRA and TSCA Enforcement System (FATES) Database, National Library of Medicine.

71. United States Environmental Protection Agency, "Guidelines Establishing Test Procedures for the Analysis of Pollutants Under the Clean Water Act; Final Rule and Interim Final Rule and Proposed Rule", 40 CFR Part 136, Federal Register, FRL 2636-6, Volume 49, No. 209, October 26, 1984.

72. United States Environmental Protection Agency, "Notice of Plan to Review and Promulgate Effluent Guideline Regulations", Federal Register, FRL 3626-3, Volume 55, No. 1, January 2, 1990.

73. United States Environmental Protection Agency, "Organic Chemicals, Plastics, and Synthetic Fibers Category Effluent Limitations Guidelines, Pretreatment Standards, and New Source Performance Standards - Proposed Regulation", 40 CFR Parts 414 and 416, Federal Register, Volume 48, No. 55, March 21, 1983.

REFEREENCES

(Continued)

74. United States Environmental Protection Agency, "Organic Chemicals, Plastics, and Synthetic Fibers Category Effluent Limitations Guidelines, Pretreatment Standards; and Standards of Performance for New Sources - Notice of Availability and Request for Comments", 40 CFR Parts 414 and 416, Federal Register, OW-FRL-2863-6, Volume 50, No. 187, July 17, 1985.

75. United States Environmental Protection Agency, "Organic Chemicals, Plastics, and Synthetic Fibers Category Effluent Limitations Guidelines, Pretreatment Standards, and New Source Performance Standards - Extension of Comment Period, Correction Notice, and Notice of Availability", 40 CFR Parts 414 and 416, Federal Register, FRL-2911-4, Volume 50, No. 198, October 11, 1985.

76. United States Environmental Protection Agency, "Organic Chemicals, Plastics, and Synthetic Fibers Category Effluent Limitations Guidelines and Standards, and New Source Performance Standards - Amendments to 40 CFR Parts 414 and 416", 40 CFR Parts 414 and 416, Federal Register, FRL 3230-5, Volume 52, No. 214, November 5, 1987.

77. United States Environmental Protection Agency, "Organic Chemicals, Plastics, and Synthetic Fibers Category Effluent Limitations Guidelines, Pretreatment Standards, and New Source Performance Standards - Final Rule - Technical Amendments and Revocation of Regulations", 40 CFR Part 414, Federal Register, FRL 3577-9, Volume 54, No. 124, June 29, 1989.

78. United States Environmental Protection Agency, "Organic Chemicals, Plastics, and Synthetic Fibers Category Effluent Limitations Guidelines, Pretreatment Standards, and New Source Performance Standards - Final Rule", 40 CFR Part 414, Federal Register, FRL 3726-6, Volume 55, No. 126, June 29, 1990.

79. United States Environmental Protection Agency, "Organic Chemicals, Plastics, and Synthetic Fibers Category Effluent Limitations Guidelines, Pretreatment Standards, and New Source Performance Standards - Proposed Rule", 40 CFR Part 414, Federal Register, FRL 3809-4, Volume 55, No. 202, October 18, 1990.

80. United States Environmental Protection Agency, "Pesticide Chemicals Category Effluent Limitations Guidelines, Pretreatment Standards, and New Source Performance Standards - Proposed Regulation", 40 CFR Part 455, Federal Register, WH-FRL-2220-1, Volume 47, No. 230, November 30, 1982.

81. United States Environmental Protection Agency, "Pesticide Chemicals Category Effluent Limitations Guidelines, Pretreatment

Standards, and New Source Performance Standards - Final Regulation", 40 CFR Part 455, Federal Register, OW-FRL-2877-6, Volume 50, No. 193, October 4, 1985.

82. United States Environmental Protection Agency, "Pesticide Chemicals Category Effluent Limitations Guidelines, Pretreatment Standards, and New Source Performance Standards - Final Rule - Withdrawal", 40 CFR Part 455, Federal Register, OW-FRL-3128-1, Volume 51, No. 240, December 15, 1986.

83. United States Environmental Protection Agency, "Pesticide Chemicals Manufacturing Point Source Category, Part 455 Subchapter N - Effluent Limitations and Guidelines - Interim Final Rulemaking", Federal Register, FRL 637-5, Volume 41, No. 211, November 1, 1976.

84. United States Environmental Protection Agency, "Pesticide Chemicals Manufacturing Point Source Category Part 455, Subchapter N - Effluent Guidelines and Standards - Final Rule", Federal Register, FRL 887-6, Volume 43, No. 80, April 25, 1978.

85. United States Environmental Protection Agency, "Pesticide Chemicals Manufacturing Point Source Category, Part 455 - Amendments to Final Rule", Federal Register, FRL 973-7, Volume 43, No. 190, September 29, 1978.

86. United States Environmental Protection Agency, Pesticide Fact Handbook, Noyes Data Corporation, Park Ridge, NJ, 1988.

87. United States Environmental Protection Agency, Pesticide Manufacturing Facility Census for 1986, June 1988.

88. United States Environmental Protection Agency, Process Design Manual for the Stripping of Organics, EPA-600/2-84-139.

89. United States Environmental Protection Agency, Proposed Effluent Guidelines - Rulemaking for the Pesticide Chemicals Category, Office of Water and Waste Management, Washington DC, Winter 1983.

90. United States Environmental Protection Agency, Toxic Release Inventory System (TRIS) Database.

91. Viesman, Warren, Jr., and Mark J. Hammer, Water Supply and Pollution Control, Harper and Row Publishers, New York, 1985.

92. Weber, W. J., Jr., Physicochemical Processes., John Wiley and Sons, New York, 1972.

REFEREENCES

(Continued)

93. Weigman, Diana L., editor, Pesticides in the Next Decade: The Challenges Ahead - Proceedings of the Third National Research Conference on Pesticides, November 8-9, 1990, Virginia Water Resources Research Center, Virginia Polytechnic Institute and State University, Blacksburg, VA, 1990.

94. Worthing, C. R., editor, The Pesticide Manual, The Lavenham Press Limited, Lavenham, Suffolk, Great Britian, 1987.