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Development Document For Best Available Technology, Pretreatment Technology, And New Source Performance Technology For The Pesticide Chemical Industry

Proposed

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PROPOSED

TECHNICAL DEVELOPMENT DOCUMENT

FOR THE

PESTICIDE CHEMICALS

MANUFACTURING CATEGORY

EFFLUENT LIMITATIONS GUIDELINES,

PRETREATMENT STANDARDS, AND

NEW SOURCE PERFORMANCE STANDARDS

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SECTION 1

INTRODUCTION

1.0 LEGAL AUTHORITY

This regulation is being proposed 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), 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.

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 the national policy of the United States. The Act declares that pollution should be prevented or reduced whenever feasible; pollution that cannot be prevented should be recycled or reused in an environmentally safe manner wherever feasible; pollution that cannot be recycled should be treated; and disposal or release into the environment should be chosen only as a last resort.

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 on April 26, 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. Those existing regulations are not proposed to be changed in today's notice and EPA does not request and will not evaluate public comments on them.

1.2 SCOPE OF TODAY'S PROPOSED RULE

The regulation proposed 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 proposing to expand 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 proposed to be set 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 is today proposing to reserve BCT, BAT, NSPS, PSES, and PSNS effluent limitations for this subcategory.

The proposed 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 ("intermediate") which are not pesticides but which subsequently are converted by further chemical reactions to pesticide active ingredients. The "intermediates" are covered by the Organic Chemicals, Plastics, and Synthetic Fibers (OCPSF) effluent guidelines (40 CFR Parts 414 and 416).

SECTION 2

SUMMARY

2.0 OVERVIEW OF THE INDUSTRY

According to 1986 data collected by EPA during the development of this rule, the pesticide chemicals manufacturing industry includes 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 commerical 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.

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, 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 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 PROPOSED REGULATIONS

2.1.1 Applicability of the Proposed Regulations

The proposed 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, TSS, and pH. The organic PAI regulation also limited total pesticides in wastewaters resulting from the manufacturing of 49 specific organics 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. EPA proposes to expand the coverage of BPT limitations (for BOD_5, COD, TSS, and pH) to include manufacture of 15 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 15 organic PAIs and organo-tin PAIs.

The existing BPT limitations (i.e., those promulgated in 1978) are not proposed to be changed. Additionally, no change is proposed to the existing BPT effluent limitations guidelines for metallo-organic PAIs.

2.1.3 BCT

The Agency proposes in this regulation to set BCT equal to BPT for conventional pollutants under the organic pesticide chemicals manufacturing subcategory. The Agency proposes to reserve 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, COD, and TSS. Options for further removal of TSS and/or BOD, initially considered for evaluation as BCT candidate technologies, included multimedia filtration, carbon adsorption,

Table 2-1

PAIS PROPOSED TODAY FOR INCLUSION UNDER BPT

PAI Code	PAI
025	Cyanazine
058	Ametryn
060	Atrazine
067	Biphenyl
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

membrane filtration, incineration, evaporation, additional biological oxidation (above the level required to meet BPT), and clarification through the use of settling ponds. However, only multimedia filtration was deemed a feasible option for BCT. Multimedia filtration was then evaluated by the BCT cost test. This BCT technology, however, failed the BCT cost test and is therefore not being proposed as BCT for the organic pesticide chemicals manufacturing subcategory. Since no other technologies were identified that would be expected to enhance conventional pollutant removal above that provided by BPT technologies, the Agency is proposing to set 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

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

Limitations for PAIs were derived on a mass basis, using long-term data where available. Where long-term 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

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.

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 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 for 28 priority pollutants are proposed. 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 proposed 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 proposed 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 proposes to reserve BAT for the metallo-organic pesticide chemicals manufacturing subcategory.

Once a pollutant is regulated, it will also be limited 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 proposes new source performance standards (NSPS) for the organic pesticide chemicals manufacturing subcategory on the basis of the best available demonstrated technologies and a 28% achievable flow reduction for certain PAIs. NSPS are proposed for conventional pollutants (BOD, TSS, and pH) and COD on the basis of BPT model treatment technologies and a 28% achievable flow reduction. NSPS regulation of priority pollutants are based on BAT model treatment technologies 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 proposed NSPS limitations for conventional pollutants and

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 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.

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Table 2-3

BAT AND PSES EFFLUENT LIMITATIONS FOR ORGANIC PESTICIDE ACTIVE INGREDIENTS (PAIS)

Organic Pesticide Active Ingredient (PAI)	BAT/PSES effluent limitations	
	Daily Maximum Shall Not Exceed lb./1,000 lb. PAI production	Monthly Average Shall not Exceed lb./1,000 lb. PAI production
2, 4-D[1]	1.19×10^{-4}	3.40×10^{-5}
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	No discharge of process wastewater pollutants	
Acifluorfen	2.32×10^{-2}	8.79×10^{-3}
Alachlor	8.82×10^{-4}	2.68×10^{-4}
Aldicarb[1]	7.23×10^{-4}	3.12×10^{-4}
Ametryn	2.10×10^{-3}	9.14×10^{-4}
Atrazine	2.56×10^{-3}	1.02×10^{-3}
Azinphos Methyl	2.74×10^{-2}	1.41×10^{-2}
Benfluralin[1,2]	3.22×10^{-4}	1.09×10^{-4}
Benomyl[1]	1.91×10^{-1}	5.14×10^{-2}
Biphenyl	No discharge of process wastewater pollutants	
Bolstar	1.69×10^{-2}	8.72×10^{-3}
Bromacil, lithium	No discharge of process wastewater pollutants	
Bromacil	1.24×10^{-1}	4.18×10^{-2}
Bromoxynil	3.95×10^{-3}	1.27×10^{-3}
Bromoxynil octanoate	3.95×10^{-3}	1.27×10^{-3}
Busan 40[3] [Potassium N-hydroxymethyl-N-methyldithiocarbamate]	5.74×10^{-3}	1.87×10^{-3}

Table 2-3

(Continued)

Organic Pesticide Active Ingredient (PAI)	BAT/PSES effluent limitations	
	Daily Maximum Shall Not Exceed lb./1,000 lb. PAI production	Monthly Average Shall not Exceed lb./1,000 lb. PAI production
Busan 85[3] [Potassium dimethyldithiocarbamate]	5.74×10^{-3}	1.87×10^{-3}
Butachlor	3.53×10^{-3}	1.09×10^{-3}
Captafol	No discharge of process wastewater pollutants	
Carbam S[3] [Sodium dimethyldithiocarbamate]	5.74×10^{-3}	1.87×10^{-3}
Carbaryl[1]	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[1]	3.27×10^{-4}	9.96×10^{-5}
Cyanazine	1.63×10^{-3}	8.11×10^{-4}
Dazomet[3]	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[1]	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	
	Daily Maximum Shall Not Exceed lb./1,000 lb. PAI production	Monthly Average Shall not Exceed lb./1,000 lb. PAI production
Endothall, salts and esters	No discharge of process wastewater pollutants	
Endrin	2.20×10^{-2}	5.10×10^{-3}
Ethalfluralin[1,2]	3.22×10^{-4}	1.09×10^{-4}
Ethion	7.37×10^{-4}	2.99×10^{-4}
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}
Glyphosate, salts and esters	No discharge of process wastewater pollutants	
Heptachlor	8.80×10^{-3}	2.90×10^{-3}
Isopropalin[1]	7.06×10^{-3}	2.49×10^{-3}
KN Methyl[3]	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[1]	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}

Table 2-3

(Continued)

Organic Pesticide Active Ingredient (PAI)	BAT/PSES effluent limitations	
	Daily Maximum Shall Not Exceed lb./1,000 lb. PAI production	Monthly Average Shall not Exceed lb./1,000 lb. PAI production
Mevinphos	1.44×10^{-4}	5.10×10^{-5}
Nabam[3]	5.74×10^{-3}	1.87×10^{-3}
Nabonate[3]	5.74×10^{-3}	1.87×10^{-3}
Naled	No discharge of process wastewater pollutants	
Norflurazon	No discharge of process wastewater pollutants	
Organotins[4]	1.72×10^{-2}	7.42×10^{-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	3.21×10^{-3}	1.06×10^{-3}
Permethrin	2.32×10^{-4}	6.06×10^{-5}
Phorate	2.51×10^{-4}	7.53×10^{-4}
Phosmet[5]	No discharge of process wastewater pollutants	
Prometon	2.10×10^{-3}	9.14×10^{-4}
Prometryn	2.10×10^{-3}	9.14×10^{-4}
Pronamide	2.00×10^{-4}	6.90×10^{-5}
Propachlor	5.34×10^{-3}	1.66×10^{-3}
Propanil	1.06×10^{-3}	4.84×10^{-4}
Propazine	2.10×10^{-3}	9.14×10^{-4}
Pyrethrin I	No discharge of process wastewater pollutants	
Pyrethrin II	No discharge of process wastewater pollutants	
Simazine	2.10×10^{-3}	9.14×10^{-4}

Table 2-3

(Continued)

Organic Pesticide Active Ingredient (PAI)	BAT/PSES effluent limitations	
	Daily Maximum Shall Not Exceed lb./1,000 lb. PAI production	Monthly Average Shall not Exceed lb./1,000 lb. PAI production
Stirofos	4.10×10^{-3}	1.35×10^{-3}
TCMTB	2.88×10^{-4}	8.96×10^{-5}
Tebuthiuron	9.78×10^{-2}	3.40×10^{-2}
Terbacil	1.51×10^{-1}	5.12×10^{-2}
Terbufos	4.09×10^{-4}	1.06×10^{-4}
Terbuthylazine	2.10×10^{-3}	9.14×10^{-4}
Terbutryn	2.10×10^{-3}	9.14×10^{-4}
Toxaphene	1.02×10^{-2}	3.71×10^{-3}
Triadimefon	6.52×10^{-2}	3.41×10^{-2}
Trifluralin[1,2]	3.22×10^{-4}	1.09×10^{-4}
Vapam[3] [Sodium methyldithiocarbamate]	5.74×10^{-3}	1.87×10^{-3}
Ziram[3] [Zinc dimethyldithiocarbamate]	5.74×10^{-3}	1.87×10^{-3}

[1] Monitor and comply after in-plant treatment before mixing with other wastewaters.

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

[3] Monitor and report as total dithiocarbamates, as Ziram.

[4] Monitor and report as total tin.

[5] Applies to purification by recrystalization 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

Priority Pollutant	BAT/NSPS effluent limitations[1]	
	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	25	16
Tribromomethane	59	22
Bromodichloromethane	89	40
Dibromochloromethane	211	68
Naphthalene	59	22
Phenol	26	15

Table 2-4

(Continued)

Priority Pollutant	BAT/NSPS effluent limitations[1]	
	Maximum for Any One Day (μg/L)	Maximum for Monthly Average (μg/L)
Tetrachloroethylene	56	22
Total Cyanide	640	220
Total Lead[2]	690	320

[1]All units are micrograms per liter.

[2]Metals limitations apply only to noncomplexed metal-bearing waste streams. Discharges of lead from complexed metal-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

Priority Pollutant	BAT/NSPS effluent limitations[1]	
	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	46	21
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	25	16
Tribromomethane	59	22
Bromodichloromethane	89	40
Dibromochloromethane	211	68
Naphthalene	47	19
Phenol	47	19
Tetrachloroethylene	164	52
Toluene	74	28

Table 2-5

(Continued)

Priority Pollutant	BAT/NSPS effluent limitations[1]	
	Maximum for Any One Day (μg/L)	Maximum for Monthly Average (μg/L)
Total Cyanide	640	220
Total Lead[2]	690	320

[1]All units are micrograms per liter.

[2]Metals limitations apply only to noncomplexed metal-bearing waste streams. Discharges of lead from complexed metal-bearing process wastewater are not subject to these limitations.

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 proposes to reserve NSPS for the metallo-organic pesticide chemicals manufacturing subcategory.

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 proposing PSES for the same PAIs regulated under BAT and for 26 priority pollutants of the 28 regulated under BAT (which the Agency has determined pass through POTWs). The proposed 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.

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 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 2-7

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

Organic Pesticide Active Ingredient	NSPS/PSNS Effluent Limitations	
	Daily Maximum Shall Not Exceed lb./1,000 lb. PAI production	Monthly Average Shall Not Exceed lb./1,000 lb. PAI production
2, 4-D[1]	8.54×10^{-5}	2.45×10^{-5}
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	No discharge of process wastewater pollutants	
Acifluorfen[1]	1.67×10^{-2}	6.33×10^{-3}
Alachlor	6.35×10^{-4}	1.93×10^{-4}
Aldicarb[1]	5.21×10^{-4}	2.25×10^{-4}
Ametryn	1.51×10^{-3}	6.58×10^{-4}
Atrazine	1.85×10^{-3}	7.32×10^{-4}
Azinphos Methyl	1.97×10^{-2}	1.02×10^{-2}
Benfluralin[1,2]	2.32×10^{-4}	7.82×10^{-5}
Benomyl[1]	1.37×10^{-1}	3.70×10^{-2}
Biphenyl	0	0
Bolstar	1.22×10^{-2}	6.27×10^{-3}
Bromacil, lithium	No discharge of process wastewater pollutants	
Bromacil	3.89×10^{-2}	3.01×10^{-2}
Bromoxynil	2.84×10^{-3}	9.14×10^{-4}
Bromoxynil octanoate	2.84×10^{-3}	9.11×10^{-4}
Busan 40[3]	4.14×10^{-3}	1.35×10^{-3}
Busan 85[3]	4.14×10^{-3}	1.35×10^{-3}
Butachlor	2.54×10^{-3}	7.87×10^{-4}
Captafol	No discharge of process wastewater pollutants	

Table 2-7

(Continued)

Organic Pesticide Active Ingredient	NSPS/PSNS Effluent Limitations	
	Daily Maximum Shall Not Exceed lb./1,000 lb. PAI production	Monthly Average Shall Not Exceed lb./1,000 lb. PAI production
Carbam S[3]	4.14×10^{-3}	1.35×10^{-3}
Carbaryl[1]	1.07×10^{-3}	4.76×10^{-4}
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[1]	2.35×10^{-4}	7.17×10^{-5}
Cyanazine	1.18×10^{-3}	5.84×10^{-4}
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[1]	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	1.51×10^{-1}	5.76×10^{-2}
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	1.77×10^{-2}	5.25×10^{-3}
Ethalfluralin[1,2]	2.32×10^{-4}	7.85×10^{-5}
Ethion	5.31×10^{-4}	2.15×10^{-4}

Table 2-7

(Continued)

Organic Pesticide Active Ingredient	NSPS/PSNS Effluent Limitations	
	Daily Maximum Shall Not Exceed lb./1,000 lb. PAI production	Monthly Average Shall Not Exceed lb./1,000 lb. PAI production
Fenarimol	7.31×10^{-2}	2.60×10^{-2}
Fensulfothion	1.06×10^{-2}	5.50×10^{-3}
Fenthion	1.32×10^{-2}	6.79×10^{-3}
Fenvalerate	3.91×10^{-3}	1.50×10^{-3}
Glyphosate, salts and esters	No discharge of process wastewater pollutants	
Heptachlor	5.42×10^{-3}	1.73×10^{-3}
Isopropalin[1]	5.07×10^{-3}	1.82×10^{-3}
KN Methyl[3]	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[1]	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	No discharge of process wastewater pollutants	

Table 2-7

(Continued)

Organic Pesticide Active Ingredient	NSPS/PSNS Effluent Limitations	
	Daily Maximum Shall Not Exceed lb./1,000 lb. PAI production	Monthly Average Shall Not Exceed lb./1,000 lb. PAI production
Organotins[4]	1.25×10^{-2}	5.36×10^{-3}
Parathion Ethyl	5.56×10^{-4}	2.45×10^{-4}
Parathion Methyl	5.56×10^{-4}	2.45×10^{-4}
PCNB	4.16×10^{-4}	1.38×10^{-4}
Pendimethalin	8.81×10^{-3}	2.79×10^{-3}
Pentachlorophenol, salts and esters	No discharge of process wastewater pollutants	
Permethrin	1.68×10^{-4}	4.39×10^{-5}
Phorate	1.81×10^{-4}	5.43×10^{-5}
Phosmet[5]	No discharge of process wastewater pollutants	
Prometon	1.51×10^{-3}	6.58×10^{-4}
Prometryn	1.51×10^{-3}	6.58×10^{-4}
Pronamide	1.28×10^{-4}	4.34×10^{-5}
Propachlor	3.84×10^{-3}	1.19×10^{-3}
Propanil	7.63×10^{-4}	3.48×10^{-4}
Propazine	1.51×10^{-3}	6.58×10^{-4}
Pyrethrin I	No discharge of process wastewater pollutants	
Pyrethrin II	No discharge of process wastewater pollutants	
Simazine	1.51×10^{-3}	6.58×10^{-4}
Stirofos	2.95×10^{-3}	9.72×10^{-4}
TCMTB	2.07×10^{-4}	6.45×10^{-5}
Tebuthiuron	7.04×10^{-2}	2.45×10^{-2}
Terbacil	1.09×10^{-1}	3.69×10^{-2}

Table 2-7

(Continued)

Organic Pesticide Active Ingredient	NSPS/PSNS Effluent Limitations	
	Daily Maximum Shall Not Exceed lb./1,000 lb. PAI production	Monthly Average Shall Not Exceed lb./1,000 lb. PAI production
Terbufos	2.95×10^{-4}	7.62×10^{-5}
Terbuthylazine	1.51×10^{-3}	6.58×10^{-4}
Terbutryn	1.51×10^{-3}	6.58×10^{-4}
Toxaphene	7.35×10^{-3}	2.67×10^{-3}
Triadimefon	4.69×10^{-2}	2.46×10^{-2}
Trifluralin[1,2]	2.32×10^{-4}	7.82×10^{-5}
Vapam[3] [Sodium methyldithiocarbamate]	3.86×10^{-3}	1.39×10^{-3}
Ziram[3] [Zinc dimethyldithiocarbamate]	4.14×10^{-3}	1.35×10^{-3}

[1]Monitor and comply after in-plant treatment before mixing with other wastewaters.

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

[3]Monitor and report as total dithiocarbamates, as Ziram.

[4]Monitor and report as total tin.

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

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 proposes to reserve 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 proposing 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 PSNS in the OCPSF Development Document. 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 proposes to reserve 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	
	Maximum for Any One Day	Maximum for Monthly Average
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	25	16
Tribromomethane	59	22
Bromodichloromethane	89	40
Dibromochloromethane	211	68
Naphthalene	47	19
Phenol	47	19
Tetrachloroethylene	164	52
Toluene	74	28

Table 2-8

(Continued)

Priority Pollutant	PSES/PSNS Effluent Limitations	
	Maximum for Any One Day	Maximum for Monthly Average
Total Cyanide	640	220
Total Lead[2]	690	320

[1]All units are micrograms per liter.

[2]Metals limitations apply only to noncomplexed metal-bearing waste streams. Discharges of lead and zinc from complexed metal-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; and
- Other EPA studies of Pesticides Industry.

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 Study

For the Pesticide Chemicals Manufacturing Category, there are 270 PAIs or classes of PAIs that EPA considered for regulation. The initial basis

for this list 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 270 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 270 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 which PAIs were included in the Pesticide Manufacturing Facility Census of 1986. Table 3-1 lists the PAIs and classes of PAIs considered for regulation.

3.1.3 Development of 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.

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

Figure 3-1

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

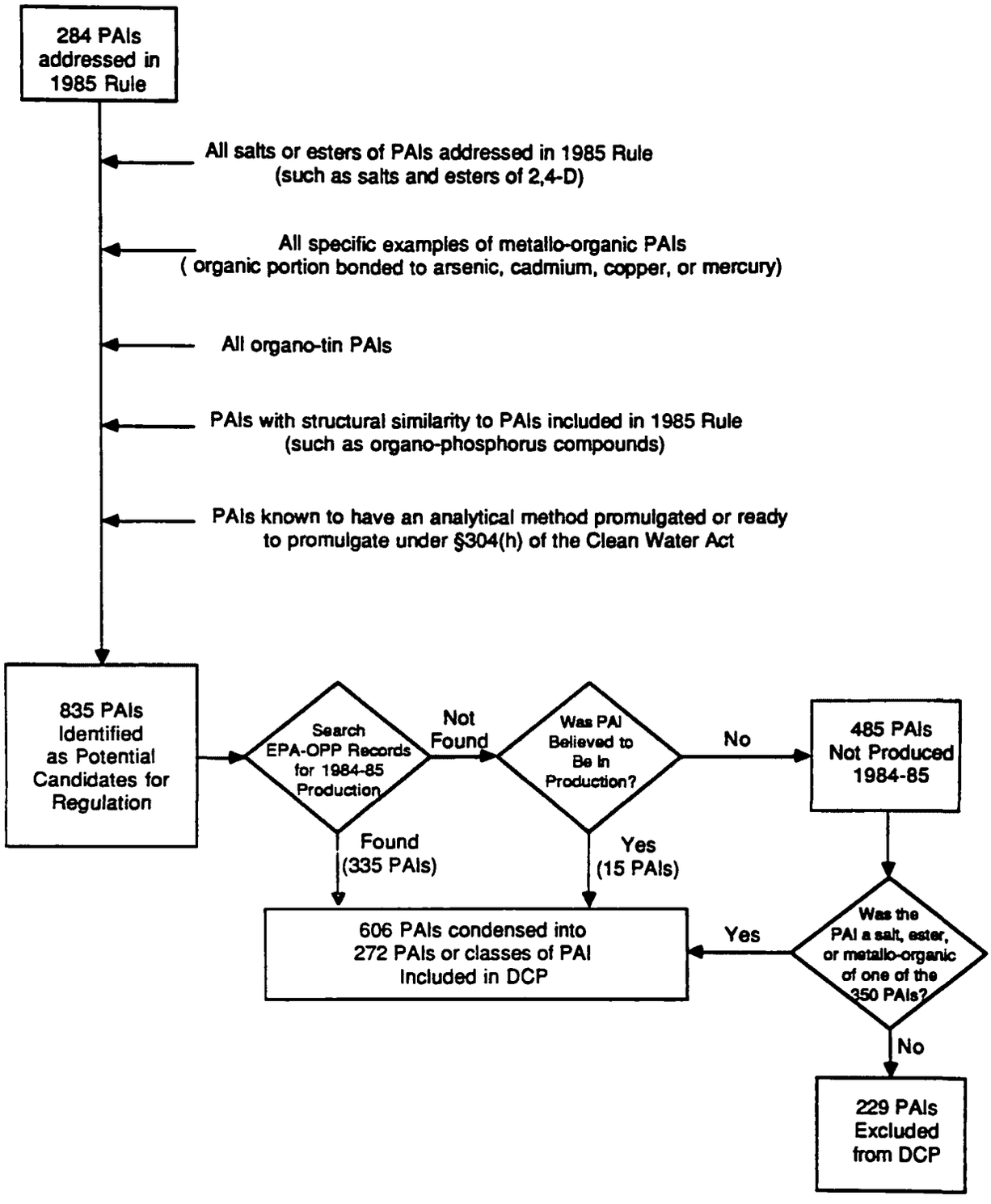


Table 3-1

LIST OF PESTICIDE ACTIVE INGREDIENTS (PAIS)

	PAI Code	Chemical Name	CAS #	Structural Group	Pesticide Type
10501	1	1,1-Bis(chlorophenyl)-2,2,2-trichloroethanol [Dicofol]	00115-32-2	DDT	Insecticide
51501	2	1,2-Dihydro-3,6-pyridazinedione [Maleic Hydrazide]	00123-33-1	Heterocyclic	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	Alkyl halide	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	1,2,4-Pentacylcictriazine	Fungicide
44901	9	2,2'-Methylenebis(3,4,6-trichlorophenol) [Hexachlorophene]	00070-30-4	Bistrichlorophenol	Disinfectant
55004	10	2,2'-Methylenebis(4,6-dichlorophenol) [Tetrachlorophene]	01940-43-8	Aryl halide	Disinfectant
55001	11	2,2'-Methylenebis(4-chlorophenol) [Dichlorophene]	00097-23-4	Aryl halide	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	Trichlorophenylacetic acid	Herbicide
**	14	2,3,6-Trichlorophenylacetic acid, salts and esters	**	Trichlorophenylacetic 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

Table 3-1 (Continued)

LIST OF PESTICIDE ACTIVE INGREDIENTS (PAIS)

	PAI Code	Chemical Name	CAS #	Structural Group	Pesticide Type
30001	16	2,4-Dichlorophenoxyacetic acid [2,4-D]	00094-75-7	Chlorophenoxy acid	Herbicide
**	16	2,4-Dichlorophenoxyacetic acid, salts and esters	**	Chlorophenoxy acid	Herbicide
30801	17	2,4-Dichlorophenoxybutyric acid [2,4-DB]	00094-82-6	Chlorophenoxy acid	Herbicide
**	17	2,4-Dichlorophenoxybutyric acid, salts and esters	**	Chlorophenoxy acid	Herbicide
80811	18	2,4-Dichloro-6-(0-chloroanilino)-s-Triazine [Anilazine]	00101-05-3	s-Triazine	
36001	19	2,4-Dinitro-6-octylphenylcrotonate, 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	Haloaryl	Fungicide
8707	21	2-Bromo-4-hydroxyacetophenone [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	Chlorophenoxy acid	Herbicide
**	27	2-Methyl-4-chlorophenoxyacetic acid, salts and esters	**	Chlorophenoxy acid	Herbicide

Table 3-1 (Continued)

LIST OF PESTICIDE ACTIVE INGREDIENTS (PAIS)

	PAI Code	Chemical Name	CAS #	Structural Group	Pesticide Type
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	Chlorophenoxy acid	Herbicide
**	30	2-(2,4-Dichlorophenoxy)propionic acid, salts and esters	**	Chlorophenoxy acid	Herbicide
31501	31	2-(2-Methyl-4-chlorophenoxy)propionic acid [MCPP]	00093-65-2	Chlorophenoxy acid	Herbicide
**	31	2-(2-Methyl-4-chlorophenoxy)propionic acid, salts and esters	**	Chlorophenoxy 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)benzothiazole [TCMTB]	21564-17-0	Heterocyclic	Fungicide
99001	36	2-((Hydroxymethyl)amino) ethanol [HAE]	34375-28-5	Alcohol	Bacteriostat
67707	37	2-((p-Chlorophenyl)phenylacetyl)-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 [Polyphase antimildew]	55406-53-6		Fungicide

Table 3-1 (Continued)

LIST OF PESTICIDE ACTIVE INGREDIENTS (PAIS)

	PAI Code	Chemical Name	CAS #	Structural Group	Pesticide Type
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	2,4,5-Triaza-3-thio-1-one	Herbicide
19401	46	4-chlorophenoxyacetic acid [CPA]	00122-88-3	Phenoxyacetic acid	Herbicide
**	46	4-chlorophenoxyacetic acid, salts and esters	**	Phenoxyacetic acid	Herbicide
19201	47	4-(2-Methyl-4-chlorophenoxy)butyric acid [MCPB]	00094-81-5	Phenoxyacetic acid	Herbicide
**	47	4-(2-Methyl-4-chlorophenoxy)butyric acid, salts and esters	**	Phenoxyacetic 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	Phosphoramidothioate	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)	**	Cyclopropanecarboxylic 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		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	Aryl	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-dichlorophenoxy)-2-nitrobenzoate]	42576-02-3	Nitrobenzoate	Herbicide
17002	67	Biphenyl	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-hydroxybenzonitrile]	01689-84-5	Benzonitrile	Herbicide

Table 3-1 (Continued)

LIST OF PESTICIDE ACTIVE INGREDIENTS (PAIS)

	PAI Code	Chemical Name	CAS #	Structural Group	Pesticide Type
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
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	Haloaryl	Herbicide
**	78	Chloramben, salts and esters	**	Haloaryl	Herbicide
58201	79	Chlordane [Octachloro-4,7-methanotetrahydroindane]	00057-74-9	Multiring halide	Insecticide
27301	80	Chloroneb [1,4-Dichloro-2,5-dimethoxybenzene]	02675-77-6	Arylchloride	Fungicide
81501	81	Chloropicrin [Trichloronitromethane]	00076-06-2	Alkyl halide	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

Table 3-1 (Continued)

LIST OF PESTICIDE ACTIVE INGREDIENTS (PAIS)

	PAI Code	Chemical Name	CAS #	Structural Group	Pesticide Type
83701	84	Chloro-1-(2,4,5-trichlorophenyl)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
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-cyclopentadiene-1-yl) [Dienochlor]	02227-17-0	Arylchloride	Miticide
57601	94	Demeton [O,O-Diethyl O-(and S-)(2-ethylthio)ethyl) phosphorothioate]	08065-48-3	Phosphorodithioate	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

Table 3-1 (Continued)

LIST OF PESTICIDE ACTIVE INGREDIENTS (PAIS)

	PAI Code	Chemical Name	CAS #	Structural Group	Pesticide Type
29801	98	Dicamba [3,6-Dichloro-o-anisic acid]	01918-00-9	Aryl halide	Herbicide
**	98	Dicamba, salts and esters	**	Aryl halide	Herbicide
29601	99	Dichlone [2,3-Dichloro-1,4-naphthoquinone]	00117-80-6	Aryl halide	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	Benzamide	Insecticide
69122	105	Diisobutylphenoxyethoxyethyl dimethl benzyl Ammonium chloride [Benzethonium chloride]	00121-54-0	R4N	Disinfectant
35001	106	Dimethoate [O,O-Dimethyl [S-((methylcarbamoyl)methyl)phosphorothioate]	00060-51-5	Phosphorodithioate	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
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

Table 3-1 (Continued)

LIST OF PESTICIDE ACTIVE INGREDIENTS (PAIS)

	PAI Code	Chemical Name	CAS #	Structural Group	Pesticide Type
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	Phosphorodithioate	Insecticide
67701	114	Diphacinone [2-(Diphenylacetyl)-1,3-indandione]	00082-66-6	Indandione	Rodenticide
36601	115	Diphenamid [N,N-Dimethyl-2,2-diphenylacetamide]	00957-51-7	Acetamide	Herbicide
38501	116	Diphenylamine	00122-39-4	Arylamine	Insecticide
47201	117	Dipropyl isocinchomeronate [MGK 326]	00113-48-4	Aryl/alkyl 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 [Hexachloroepoxyoctahydro-endo,endo-dimethanonaphthalene]	00072-20-8	Tricyclic	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	Phosphorodithioate	Insecticide
41101	127	Ethoprop [O-Ethyl S,S-dipropyl phosphorodithioate]	13194-48-4	Phosphorodithioate	Insecticide

Table 3-1 (Continued)

LIST OF PESTICIDE ACTIVE INGREDIENTS (PAIS)

	PAI Code	Chemical Name	CAS #	Structural Group	Pesticide Type
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	Aryl halide	Miticide
41405	130	Ethyl diisobutylthiocarbamate [Butylate]	02008-41-5	Carbamate	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	Amide	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	Tricyclic	Insecticide
115601	141	Hexadecyl cyclopropanecarboxylate [Cycloprate]	54460-46-7	C-H-O	
107201	142	Hexazinone [3-Cyclohexyl-6-(dimethylamino)-1-methyl- 1,3,5-triazine-2,4-(1H,3H)-dione]	51235-04-2	s-Triazine	Herbicide

Table 3-1 (Continued)

LIST OF PESTICIDE ACTIVE INGREDIENTS (PAIS)

	PAI Code	Chemical Name	CAS #	Structural Group	Pesticide Type
109401	143	Isofenphos [1-Methylethyl 2-((ethoxy((1-methylethyl)amino) phosphinothioyl)oxy)benzoate]	25311-71-1	Phosphoroamidothioate	Insecticide
100201	144	Isopropalin [2,6-Dinitro-N,N-dipropylcumidine]	33820-53-0	Toluidine	Herbicide
47601	145	Isopropyl N-phenyl carbamate [Propham]	00122-42-9	Carbamate	Insecticide
97401	146	Karbutilate [tert-Butylcarbamic acid ester of 3-(m-hydroxyphenyl)-1,1-dimethylurea]	04849-32-5	Carbamate ester	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
39504	149	Malachite green [Ammonium(4-(p-(dimethylamino)-alpha-phenylbenzylidine)-2,5-cyclohexadien-1-ylidene)-dimethyl chloride]	00569-64-2	R4N	Fungicide, Bacteriostat
57701	150	Malathion [O,O-Dimethyl dithiophosphate of diethyl [mercaptosuccinate]	00121-75-5	Phosphorodithioate	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-(((trifluoromethyl)sulfonyl) amino)phenylacetamide]	53780-34-0	Acetamide	Defoliant
**	153	Mefluidide, salts and esters	**	Acetamide	Defoliant
101201	154	Methamidophos [O,S-Dimethyl phosphoramidothioate]	10265-92-6	Phosphoroamidothioate	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	Phosphorodithion	Insecticide, Miticide
90301	156	Methomyl [S-Methyl N-((methylcarbamoyl)oxy)thioacetimidate]	16752-77-5	Carbamate	Insecticide

Table 3-1 (Continued)

LIST OF PESTICIDE ACTIVE INGREDIENTS (PAIS)

	PAI Code	Chemical Name	CAS #	Structural Group	Pesticide Type
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	Alkyl halide	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	R4N	Disinfectant
68102	163	Methylene bisthiocyanate [Nalco D-2303]	06317-18-6	Thiocyanate	Slimicide
54101	164	Methyl-2,3-quinoxalinedithiol cyclic S,S-dithiocarbamate [Quinmethionate]	02439-01-2	Heterocycle	Fungicide, Miticide
108801	165	Metolachlor [2-Chloro-N-(2-ethyl-6-methylphenyl)-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
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

Table 3-1 (Continued)

LIST OF PESTICIDE ACTIVE INGREDIENTS (PAIS)

	PAI Code	Chemical Name	CAS #	Structural Group	Pesticide Type
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-methanoindan-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	Dithiopyrophosphate	Insecticide
79101	180	O,O,O,O-Tetrapropyl dithiopyrophosphate [Aspon]	03244-90-4	Dithiopyrophosphate	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	Phosphorodithioate	Insecticide
105901	184	O,O-Dimethyl O-(4-nitro-m-tolyl)phosphorothioate [Fenitrothion]	00122-14-5	Phosphorothioate	Insecticide
59201	185	O,O-Dimethyl S-(phthalimidomethyl)phosphorodithioate [Phosmet]	00732-11-6	Phosphorodithioate	Insecticide

Table 3-1 (Continued)

LIST OF PESTICIDE ACTIVE INGREDIENTS (PAIS)

	PAI Code	Chemical Name	CAS #	Structural Group	Pesticide Type
58001	186	O,O-Dimethyl S-((4-oxo-1,2,3-benzotriazin-3(4H)-yl)methyl) phosphorodithioate [Azinphos Methyl]	00086-50-0	Phosphorodithioate	Insecticide
58702	187	O,O-Dimethyl S-((ethylsulfinyl)ethyl)phosphorothioate [Oxydemeton methyl]	00301-12-2	Phosphorodithioate	Insecticide
**	188	Organo-arsenic pesticides (not otherwise listed)	**	Organoarsenic	Coccidiostat
**	189	Organo-cadmium pesticides	**		
**	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-((methylcarbamoyl)oxy)-1-thiooxamidate]	23135-22-0	Carbamate	Insecticide
111601	196	Oxyfluorfen [2-Chloro-1-(3-ethoxy-4-nitrophenoxy)-4-(trifluoromethyl)benzene]	42874-03-3	Miscellaneous	Herbicide
111501	197	O-Ethyl O-(4-(methylthio)phenyl) S-propyl phosphorodithioate [Sulprofos]	35400-43-2	Phosphorodithioate	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	Phosphonodithioate	Insecticide

Table 3-1 (Continued)

LIST OF PESTICIDE ACTIVE INGREDIENTS (PAIS)

	PAI Code	Chemical Name	CAS #	Structural Group	Pesticide Type
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
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-dimethylcyclopropanecarboxylate]	52645-53-1	Cyclopropanecarboxilic 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	Phosphorodithioate	Insecticide
97701	213	Phosalone [O,O-Diethyl S-((6-chloro-2-oxobenzoxazolin-3-yl)methyl) phosphorothioate]	02310-17-0	Phosphorodithioate	Insecticide, Miticide
18201	214	Phosphamidon [2-Chloro-N,N-diethyl-3-hydroxycrotonamide ester of dimethylphosphate]	13171-21-6	Phosphorothioate	Insecticide
5101	215	Picloram [4-Amino-3,5,6-trichloropicolinic acid]	01918-02-1	Pyridine	Herbicide

Table 3-1 (Continued)

LIST OF PESTICIDE ACTIVE INGREDIENTS (PAIS)

	PAI Code	Chemical Name	CAS #	Structural Group	Pesticide Type
**	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	R4N	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
97601	225	Propargite [2-(p-tert-Butylphenoxy)cyclohexyl-2-propynyl sulfite]	02312-35-8	Sulfite	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			Insecticide
69001	230	Pyrethrin I	00121-21-1	Cyclopropanecarboxylic acid	Insecticide

Table 3-1 (Continued)

LIST OF PESTICIDE ACTIVE INGREDIENTS (PAIS)

	PAI Code	Chemical Name	CAS #	Structural Group	Pesticide Type
69002	231	Pyrethrin II	00121-29-9	Cyclopropanecarboxylic acid	Insecticide
69006	232	Pyrethrum (synthetic pyrethrin)	08003-34-7	Cyclopropanecarboxylic acid	Insecticide
97801	233	Resmethrin [(5-Phenylmethyl)-3-furanyl)methyl 2,2-dimethyl-3-(2-methyl-1-propenyl)cyclopropanecarboxylate]	10453-86-8	Cyclopropanecarboxylic 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	Bio extract	Insecticide
74801	236	S,S,S-Tributyl phosphorotrithioate [DEF]	00078-48-8	Phosphorotrithioate	Defoliant
35509	237	Siduron [1-(2-Methylcyclohexyl)-3-phenylurea]	01982-49-6	Urea	Herbicide
82501	238	Silvex [2-(2,4,5-Trichlorophenoxypropionic 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
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	Carbamate	Herbicide
41401	246	S-Ethyl dipropylthiocarbamate [EPTC]	00759-94-4	Carbamate	Herbicide

Table 3-1 (Continued)

LIST OF PESTICIDE ACTIVE INGREDIENTS (PAIS)

	PAI Code	Chemical Name	CAS #	Structural Group	Pesticide Type
**	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	R4N	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
97601	225	Propargite [2-(p-tert-Butylphenoxy)cyclohexyl-2-propynyl sulfite]	02312-35-8	Sulfite	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			Insecticide
69001	230	Pyrethrin I	00121-21-1	Cyclopropanecarboxylic acid	Insecticide

Table 3-1 (Continued)

LIST OF PESTICIDE ACTIVE INGREDIENTS (PAIS)

	PAI Code	Chemical Name	CAS #	Structural Group	Pesticide Type
69002	231	Pyrethrin II	00121-29-9	Cyclopropanecarboxylic acid	Insecticide
69006	232	Pyrethrum (synthetic pyrethrin)	08003-34-7	Cyclopropanecarboxylic acid	Insecticide
97801	233	Resmethrin [(5-Phenylmethyl)-3-furanyl)methyl 2,2-dimethyl-3-(2-methyl-1-propenyl)cyclopropanecarboxylate]	10453-86-8	Cyclopropanecarboxylic 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	Bio extract	Insecticide
74801	236	S,S,S-Tributyl phosphorotrithioate [DEF]	00078-48-8	Phosphorotrithioate	Defoliant
35509	237	Siduron [1-(2-Methylcyclohexyl)-3-phenylurea]	01982-49-6	Urea	Herbicide
82501	238	Silvex [2-(2,4,5-Trichlorophenoxypropionic 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
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	Carbamate	Herbicide
41401	246	S-Ethyl dipropylthiocarbamate [EPTC]	00759-94-4	Carbamate	Herbicide

Table 3-1 (Continued)

LIST OF PESTICIDE ACTIVE INGREDIENTS (PAIS)

	PAI Code	Chemical Name	CAS #	Structural Group	Pesticide Type
41402	247	S-Ethyl hexahydro-1H-azepine-1-carbothioate [Molinate]	02212-67-1	Carbamate	Herbicide
41403	248	S-Propyl butylethylthiocarbamate [Pebulate]	01114-71-2	Carbamate	Herbicide
41404	249	S-Propyl dipropylthiocarbamate [Vernolate]	01929-77-7	Carbamate	Herbicide
35604	250	S-(2-Hydroxypropyl)thiomethanesulfonate [HPTMS]	29803-57-4	Thiosulphonate	Fungicide
9801	251	S-(O,O-Diisopropyl) phosphorodithioate ester of N-(2-mercaptoethyl)benzenesulfonamide [Bensulide]	00741-58-2	Phosphorodithioate	Herbicide
105501	252	Tebuthiuron [N-(5-(1,1-Dimethylethyl)-1,3,4-thiadiazol-2-yl)-N,N'-dimethylurea]	34014-18-1	Heterocyclic	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-methyluracil]	05902-51-2	Uracil	Herbicide
105001	255	Terbufos [S-(((1,1-Dimethylethyl)thio)methyl) O,O-diethyl phosphorodithioate]	13071-79-9	Phosphorodithioate	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-(ethylamino)-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

Table 3-1 (Continued)

LIST OF PESTICIDE ACTIVE INGREDIENTS (PAIS)

	PAI Code	Chemical Name	CAS #	Structural Group	Pesticide Type
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
74901	263	Tributyl phosphorotrithioate [Merphos]	00150-50-5	Phosphorotrithioate	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	s-Esterthiocarbamate	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	Cyclopropanecarboxylic acid	Insecticide
69003	271	(4-Cyclohexene-1,2-dicarboximido)methyl 2,2-dimethyl-3-(2-methylpropenyl)cyclopropanecarboxylate [Tetramethrin]	07696-12-0	Cyclopropanecarboxylic acid	Insecticide
18301	272	Isopropyl N-(3-chlorophenyl) carbamate [Chloropropham]	00101-21-3	Carbamate	Herbicide plant growth regulator

· Deleted because the chemical is covered by OCPSF Effluent Limitations Guidelines and Standards

from those reviewers, EPA determined that the draft questionnaire needed extensive revision to better define and focus the questions and 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 Effluent Limitations and Standards for the Pesticide Manufacturers" for information concerning the development of the economic portion of the questionnaire.)

3.1.3.a Distribution of the Pesticide Manufacturing 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 covers all manufacturing facilities that were operating in 1986.

Under the authority of Section 308 of the Act, EPA distributed the questionnaire entitled "Pesticide Manufacturing Facility Census for 1986" (hereinafter, the "Facility Census") 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 (see Section 3.6 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.

EPA also requested that pesticide manufacturing facilities submit wastewater self-monitoring data. Fifty-five 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 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 process 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 sufficient in establishing effluent limitations.

A summary of the information obtained from the "Facility Census" is presented in this document and also reflects the additional data obtained from follow-up telephone calls and written requests for clarification of the information provided in responses to the questionnaire, as well as wastewater concentration data submitted by facilities along with the Facility Census.

3.1.4 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 today's proposed rule and are described in more detail in Section 3.1.6. 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 the wastewater treatment system was effective in removing PAIs, and 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.

Table 3-2

TREATMENT UNIT OPERATIONS SAMPLED

Treatment Unit Operation	Total Number of Units	Total Number of Units 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 operate more than one treatment unit.

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.

3.1.5 Industry-Supplied 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 this 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.

Pesticide wastewater treatability studies performed by or for the facility were also requested by EPA. These additional data were also considered in the development of effluent limitations guidelines. 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 used to develop limitations for these PAIs when it was demonstrated that the technology was effective at PAI removal.

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. These technologies included hydrolysis, membrane filtration, activated carbon adsorption, chemical oxidation by alkaline chlorination and chemical oxidation by ozone accompanied by irradiation with ultraviolet light. Treatability studies were conducted both on clean water to which PAIs were added ("synthetic wastewaters") and on actual pesticide process wastewaters.

The hydrolysis, membrane filtration, and activated carbon isotherm treatability studies used synthetic wastewaters. General factors included in the 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. Another factor in selecting the PAIs was the hydrolysis rate of each PAI: a too rapid hydrolysis rate could interfere in the chemical analysis of the samples.

The hydrolysis studies used PAIs selected in part based on the existence of hydrolysis data gathered from a literature survey (for comparison with EPA treatability study results), and in part based on the lack of any literature data, so as to fill in those data gaps. All of the PAIs selected were expected to hydrolyze under some conditions.

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

The activated carbon studies used PAIs selected from various structural groups to determine which groups would be most amenable to activated carbon technology. Carbon adsorption isotherms were developed for

29 specific PAIs. Some manufacturers of some PAIs in a few of the PAI structural groups were known to use activated carbon technology to treat their wastewaters; in these cases, the purpose of the carbon isotherm study was to establish benchmarks for determining the potential efficacy of activated carbon technology to other structural groups or to other PAIs in the same structural group. The results of the carbon isotherm tests were evaluated using the Freundlich isotherm equation.

The membrane filtration studies used PAIs selected to span the molecular weight range of the 270 PAIs under consideration for regulation, because the effectiveness of membrane filtration tends to vary according to molecular weight. In the membrane filtration treatability study, a series of bench-scale tests were conducted 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 3 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. These studies helped to fill in gaps where little or 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 the 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.

EPA collected actual process wastewaters to determine adsorption properties of specific PAIs using accelerated column tests. Four PAIs were evaluated as part of these tests which use bench scale results to estimate full-scale carbon system performance, design and cost. Two of the PAIs studied in these tests were also evaluated as part of the carbon isotherm study.

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 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 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 manufacturing wastewaters, and EPA is proposing today to set direct discharge limitations and pretreatment standards for these 28 priority pollutants. For 23 of these 28 priority pollutants, EPA is relying on the OCPSF technical database to propose limitations. Limitations for one priority pollutant, cyanide, are proposed based on long-term data collected from the pesticide industry. The other four priority pollutants being proposed for regulation today were not regulated under OCPSF and there are no treatment performance data for these four specific pollutants. EPA developed proposed limitations for these four priority pollutants by transferring limitations from other structurally similar priority pollutants. This is the same procedure that was used in developing OCPSF limitations (40 CFR Part 414) when performance data was lacking for certain 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 efforts. Fifty-five of the 90 pesticide chemicals manufacturing facilities also manufacture compounds regulated under the OCPSF category. Based on these factors, EPA is proposing that technical data from the OCPSF category and effluent limitations for priority pollutants based on that data be transferred to the pesticide chemicals manufacturing category as supporting data for the proposed limitations for the priority pollutants in this regulation.

EPA is relying on the OCPSF database to set BAT and NSPS limitations for 23 priority pollutants. 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 proposing to transfer PSES and PSNS and data supporting those standards from the OCPSF category for the same 23 priority pollutants. EPA is relying on an analysis originally done to support the OCPSF regulations to determine pass-through for these pollutants. That analysis demonstrates that 21 of the 23 priority pollutants do pass through a

POTW. Therefore, EPA is proposing PSES and PSNS for 21 of those 23 pollutants. EPA's pass-through analysis is discussed in more detail in Section 7.

Only technical data used to develop limitations are being transferred from the OCPSF rulemaking for these 23 pollutants. The economic analysis evaluating whether attainment of these limitations is economically achievable by pesticides manufacturers has been performed independently as part of today's proposed rulemaking.

EPA is also proposing BAT, NSPS, PSES, and PSNS limitations for four brominated priority pollutants that are present in pesticides manufacturers' wastewaters but which are not regulated under the OCPSF guidelines. The proposed limitations were developed based on steam stripping, using the same procedure followed in developing the OCPSF regulations for volatile pollutants where treatment performed data were unavailable.

In the OCPSF regulation, EPA established effluent limitations for 28 priority pollutants based on steam stripping technology, but EPA had performance data for only 15 of those 28 priority pollutants. To develop limitations for the 13 priority pollutants with no performance data, EPA divided the 15 priority pollutants with data into 2 subgroups, a high stripability subgroup and a medium stripability subgroup, based on Henry's Law Constants (a ratio of aqueous solubility, or tendency to stay in solution, to vapor pressure, or tendency to volatize). Based on each pollutant's Henry's

Law Constant, the 13 priority pollutants lacking performance data were assigned to either the high or medium stripability subgroup, and the average data for each subgroup was then transferred for limitations development. (For more details, see 52 FR 42540-41, November 5, 1987.)

This same procedure was followed for each of the four brominated volatile priority pollutants for which limitations are proposed today.

3.2 OVERVIEW OF THE INDUSTRY

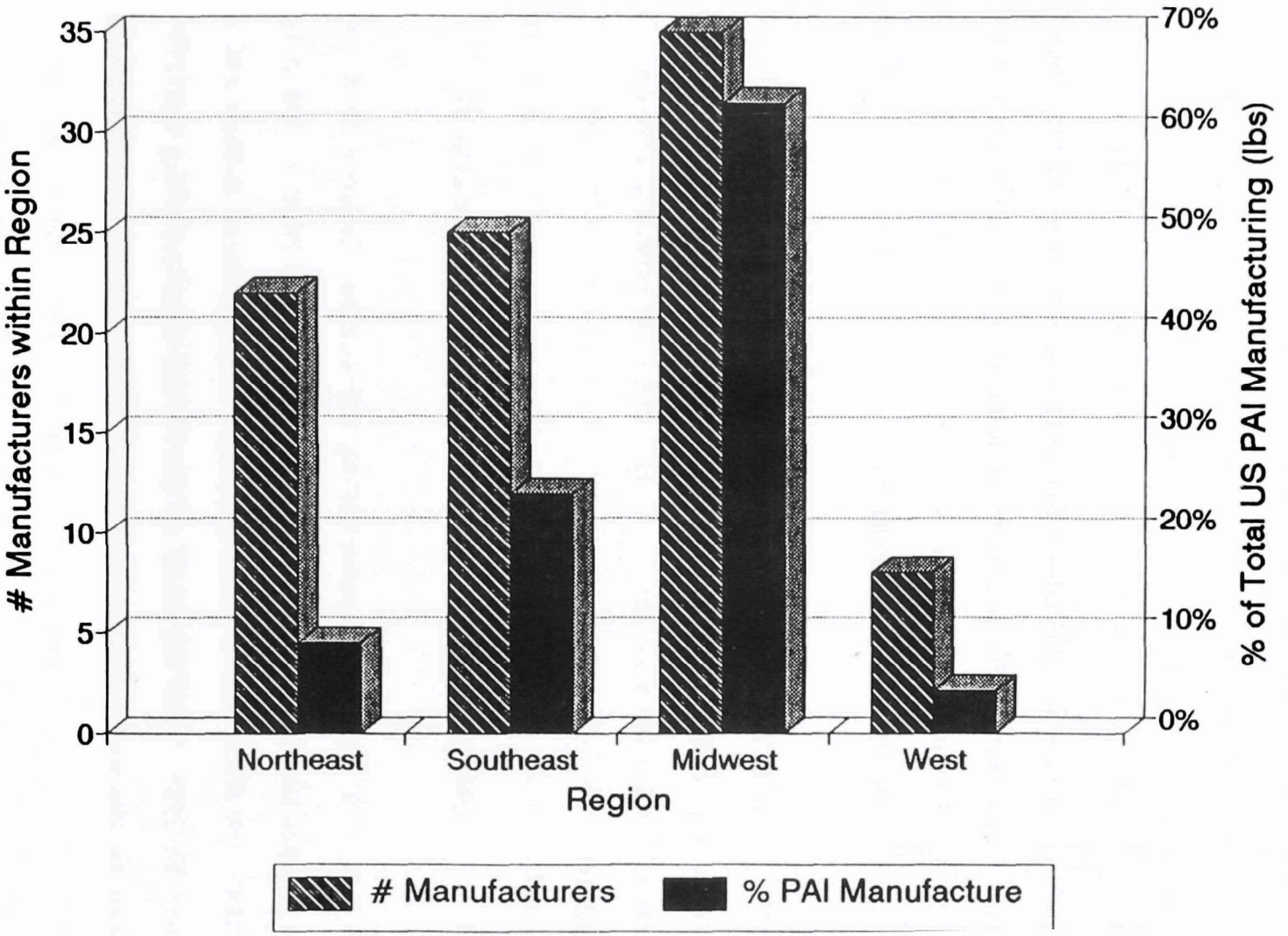
This subsection provides an overview of the Pesticide Chemicals Manufacturing Industry by presenting general information on the geographical locations, SIC code distribution, age, typical markets, and types of facilities.

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. In addition, 8 other products were produced before and after 1986, but not in 1986. The majority of pesticide manufacturing facilities are located in the eastern half of the United States, with a large concentration in the southeast corridor and Gulf Coast states. 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;

Figure 3-2

DISTRIBUTION OF PESTICIDE MANUFACTURING
FACILITIES BY EPA REGION



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. The distribution of OCPSF manufacturing facilities is similar to the distribution of the pesticide chemicals manufacturing industry. Of the 90 pesticide chemicals manufacturers, 55 also manufacture products covered under the OCPSF guidelines.

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.

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
Northeast	311	22	33.1	24.4
Southeast	181	25	19.3	27.8
Midwest	361	35	38.4	38.9
West	87	8	9.2	8.9
TOTAL	**940**	**90**	**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.

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

The majority of facilities which currently manufacture pesticide active ingredients began manufacturing operations in the 1950s and 1960s. The majority of pesticide manufacturing operations also began about this time and pesticide operations start-ups continued into the 1970s. The oldest reported pesticide operation began in 1909, while the most recent operation began in 1987. Thirty-nine facilities reported that pesticide operations began at the same time 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 88 of the 90 pesticide chemicals manufacturing facilities. Approximately 18% of 1986 pesticide active ingredient production was delivered to industry, commerce, or U.S. government

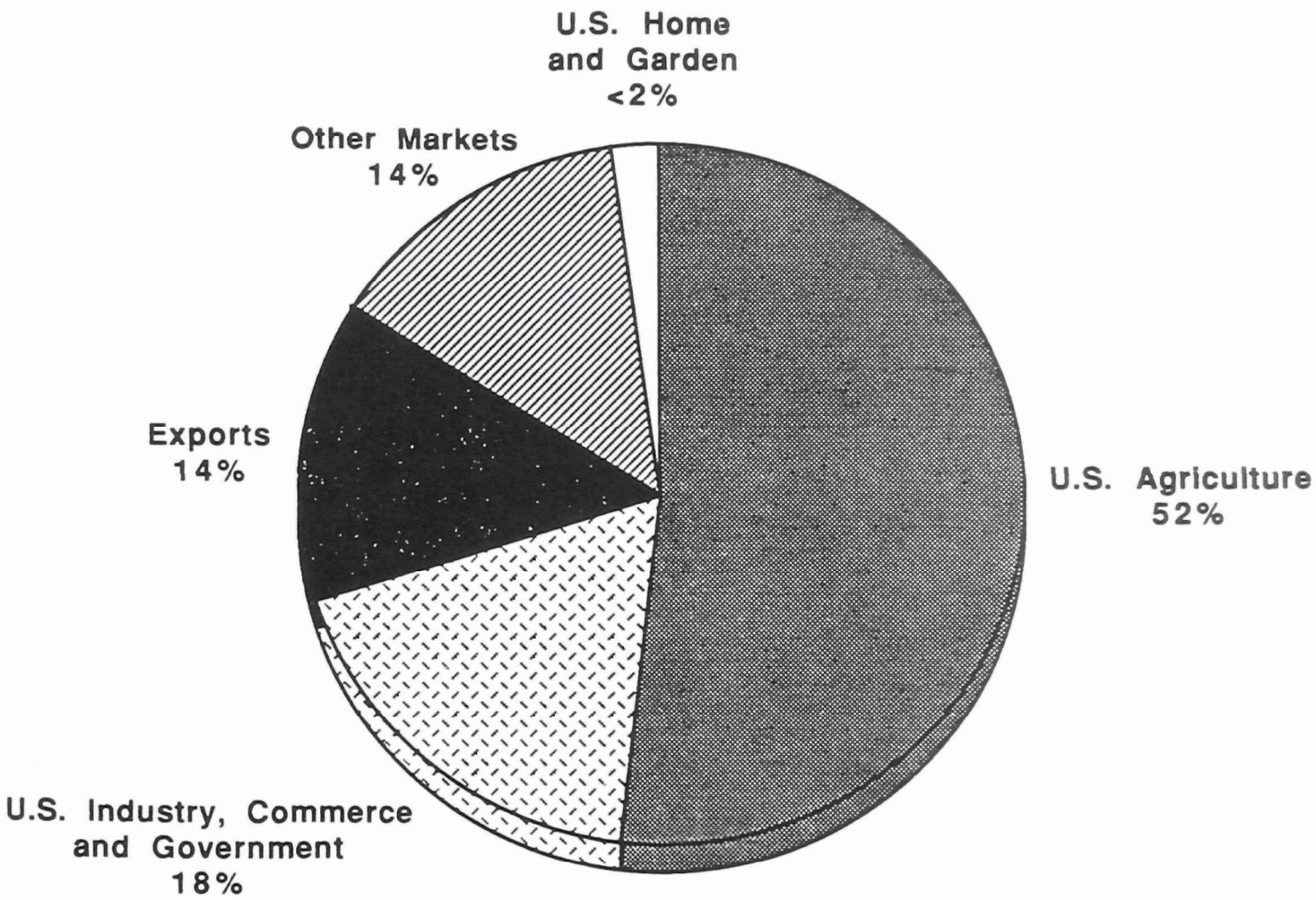
Table 3-4

DISTRIBUTION OF PESTICIDE MANUFACTURING FACILITIES
BY DECADE OF OPERATION

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

Figure 3-3

1986 PESTICIDE MARKET COMPOSITION



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

Of the 90 pesticide manufacturing facilities, 55 generate wastewater discharges which are currently regulated under the OCPSF Point Source Category. Thirty-nine of these facilities co-treat OCPSF wastewater with pesticide manufacturing wastewater.

Over half of the 90 pesticide manufacturing facilities also conduct pesticide formulating and/or packaging (PFP) activities. Nineteen 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 compounds, and conducted PFP operations.

3.3 PESTICIDE PRODUCTION

A wide variety of pesticide active ingredients (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 270 PAIs or classes of PAIs considered for regulation by pesticide type. One type of pesticide, the rodenticides, were not manufactured in 1986.

The 270 PAIs or classes of PAIs may also be grouped into 67 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 manufactured 130 of the 270 PAIs and classes of PAIs and 48 salts and esters of these active ingredients (for a total of 178 active ingredients). These PAIs were manufactured by 224 separate pesticide production processes. In addition, there were eight other PAIs which were manufactured either before or after 1986, but not 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 178 active ingredients was approximately 1.2 billion pounds with 55% of this total accounted for by herbicides. Table 3-5 presents the list of individual PAIs manufactured in 1986 and the 8 PAIs manufactured before or after 1986.

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. 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, 144 of the 178 PAIs produced in 1986 were reported to be manufactured by only one facility in the United States. As shown in Table 3-7, 47 of the 90 manufacturing facilities reported producing only one active ingredient. The remaining facilities produced between 2 and 16 active ingredients each. Each of the 7 largest pesticide active ingredient manufacturing facilities produced more than 45 million pounds of active ingredient in 1986 and together represented almost half (47%) of all 1986 pesticide production for the 178 PAIs.

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-Butoxylethyl 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; Isooctyl (2-ethylhexyl) ester
14	16.29	2,4-D; Isoctyl (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; Trithanolamine salt
18	16.52	2,4-D; Triisopropanolamine salt
19	17.03	2,4-DB; Dimethylamine salt
20	17.06	2,4-DB; 2-Ethylhexyl ester
21	20.00	Dichloran or DCNA
22	21.00	Busan 90
23	22.00	Mevinphos
24	25.00	Cyanazine or Bladex
25	26.00	Propachlor
26	27.05	MCPA; Dimethylamine salt

Table 3-5 (Continued)

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

	AI Code	Common Name
27	27.09	MCPA; Isooctyl ester
28	27.13	MCPA; Sodium salt
29	27.16	MCPA; 2-Ethylhexyl ester
30	28.00	Octhilinone
31	30.02	2,4-DP; Dimethylamine salt
32	30.03	2,4-DP; Isooctyl ester
33	30.05	2,4-DP; 2-Ethylhexyl ester
34	31.01	MCPP; Diethanolamine salt
35	31.02	MCPP; Dimethylamine salt
36	31.03	MCPP; Isooctyl ester
37	32.00	Thiabendazole
38	35.00	TCMTB
39	36.00	HAE
40	39.00	Pronamide
41	41.00	Propanil
42	42.00	Polyphase antimildew or Guardsan 388
43	45.00	Metribuzin
44	49.00	Etridiazole
45	52.00	Acephate or Orthene
46	53.00	Acifluorfen
47	54.00	Alachlor
48	55.00	Aldicarb
49	56.00	Hyamine 3500
50	58.00	Ametryn
51	60.00	Atrazine
52	62.00	Benomyl

Table 3-5 (Continued)

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

	AI Code	Common Name
53	66.00	Bifenox
54	67.00	Biphenyl
55	68.00	Bromacil
56	68.02	Bromacil; Lithium salt
57	69.00	Bromoxynil
58	69.03	Bromoxynil; Octanoic acid ester
59	70.00	Butachlor
60	71.00	Giv-gard
61	73.00	Captafol
62	74.00	Captan
63	75.00	Sevin (Carbaryl)
64	76.00	Carbofuran
65	80.00	Chloroneb
66	81.00	Chloropicrin
67	82.00	Chlorothalonil
68	*84.00	Stirofos
69	86.00	Chlorpyrifos
70	88.00	Bioquin
71	*90.00	Fenvalerate
72	91.00	Cycloheximide
73	98.00	Dicamba
74	103.00	Diazinon
75	*107.00	Methyl Parathion
76	110.00	DCPA
77	112.00	Dinoseb

Table 3-5 (Continued)

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

	AI Code	Common Name
78	113.00	Dioxathion
79	115.00	Diphenamid
80	117.00	MGK 326
81	118.00	Nabonate
82	*119.00	Diuron
83	120.00	Metasol DGH
84	123.00	Endothall
85	123.02	Endothall; Salt
86	123.03	Endothall; Salt
87	123.04	Endothall; Salt
88	*124.00	Endrin
89	125.00	Ethalfluralin
90	126.00	Ethion
91	127.00	Ethoprop
92	129.00	Chlorobenzilate or Acaraben
93	130.00	Butylate
94	132.00	Fenarimol
95	133.00	Fenthion or Baytex
96	135.00	Fluometuron
97	138.00	Glyphosate
98	138.01	Glyphosate; Isopropylamine salt
99	140.00	Heptachlor
100	142.00	Hexazinone
101	144.00	Isopropalin
102	*148.00	Linuron

Table 3-5 (Continued)

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

	AI Code	Common Name
103	150.00	Malathion
104	154.00	Methamidophos
105	156.00	Methomyl
106	157.00	Methoprene
107	158.00	Methoxychlor
108	160.00	Methylbromide or Bromomethane
109	161.01	Monosodium methyl arsenate
110	163.00	Nalco D-2303
111	170.00	Napropamide
112	171.00	Deet
113	172.00	Nabam
114	173.00	Naled
115	175.00	Norflurazon
116	176.00	N-1-Naphthylphthalimide
117	177.00	MGK 264
118	178.00	Benfluralin
119	182.00	Fensulfothion
120	183.00	Disulfoton
121	185.00	Phosmet
122	186.00	Azinphos Methyl
123	190.01	Copper naphthenate
124	190.02	Copper octoate
125	190.03	Copper salt of fatty & resin acids
126	191.01	Phenyl mercuric dodecyl succinate
127	191.02	Phenyl mercuric acetate

Table 3-5 (Continued)

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

	AI Code	Common Name
128	191.03	Phenyl mercuric oxide
129	191.05	Chloromethoxy propyl mercuric acetate
130	192.01	Tributyltin neodecanoate
131	192.02	Tributyltin monopropylene glycol maleat
132	192.03	2-(Methyl-2-phenyolpropyl) distannoxane
133	192.04	Tricyclohexyl tin hydroxide
134	192.05	Tributyltin oxide
135	192.06	Triphenyl tin hydroxide
136	192.07	Tributyl tin fluoride
137	192.08	Tributyl tin benzoate
138	196.00	Oxyfluorfen
139	197.00	Bolstar (Sulprofos)
140	200.00	Fonofos
141	203.00	Parathion
142	204.00	Pendimethalin
143	*205.00	PCNB
144	206.00	Pentachlorophenol (PCP)
145	206.01	Pentachlorophenol; Sodium salt
146	208.00	Permethrin
147	210.00	Phenothiazine
148	211.00	Phenylphenol
149	211.05	Phenylphenol; Sodium salt
150	212.00	Phorate
151	215.00	Picloram
152	215.01	Picloram; Potassium salt

Table 3-5 (Continued)

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

	AI Code	Common Name
153	215.03	Picloram; Triisopropanolamine salt
154	216.00	Piperonyl butoxide
155	218.00	Busan 85 Or Arylane
156	219.00	Busan 40
157	220.00	KN Methyl
158	221.00	Metasol J26
159	223.00	Prometon or Caparol
160	224.00	Prometryn
161	226.00	Propazine or Milogard
162	227.00	Propanoic acid
163	230.00	Pyrethrin I
164	232.00	Pyrethrin II
165	236.00	DEF
166	239.00	Simazine
167	241.00	Carbam-S or Sodam
168	243.00	Vapam
169	245.00	Cycloate or Ro-Neet
170	246.00	EPTC or Eptam
171	247.00	Molinate
172	249.00	Vernolate or Vernam
173	250.00	HPTMS
174	251.00	Bensulide or Betesan
175	252.00	Tebuthiuron
176	253.00	Temephos
177	254.00	Terbacil

Table 3-5 (Continued)

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

	AI Code	Common Name
178	255.00	Terbufos or Counter
179	256.00	Terbuthylazine
180	257.00	Terbutryn
181	259.00	Dazomet
182	*262.00	Toxaphene
183	264.00	Trifluralin or Treflan
184	268.00	Ziram
185	272.00	Chloropropham
186	NA[2]	Diphenyl antimony 2-ethyl hexoate

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

[2]Voluntarily submitted data for PAI not originally on the list considered for regulation.

Table 3-6

NUMBER OF PESTICIDE ACTIVE INGREDIENTS PRODUCED IN 1986
BY NUMBER OF MANUFACTURING FACILITIES

AI Production At:	No. of PAIs
One Facility	144
Two Facilities	25
Three Facilities	7
Four Facilities	1
Five Facilities	1
Total	**178**

Table 3-7

NUMBER OF MANUFACTURING FACILITIES BY NUMBER OF
PESTICIDE ACTIVE INGREDIENTS PRODUCED

No. of PAIs Produced	No. of Facilities
One	47
Two	16
Three	10
Four	7
Five or More	10
Total	**90**

Table 3-8

DISTRIBUTION OF FACILITIES BY QUANTITY OF PAI PRODUCTION

Number of Facilities	Range of PAI Production (lbs)
7	>45,000,000
19	10,000,000-45,000,000
38	1,000,000-9,999,999
18	100,000-999,999
8	0-99,999
90	**~1,150,108,000 (lbs/yr)**

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

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 manufacturing processes used by facilities to produce pesticide active ingredients are highly dependent upon the type of active ingredient(s) 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 224 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. Of the reported 224 manufacturing processes used to produce pesticides in 1986, 46 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.

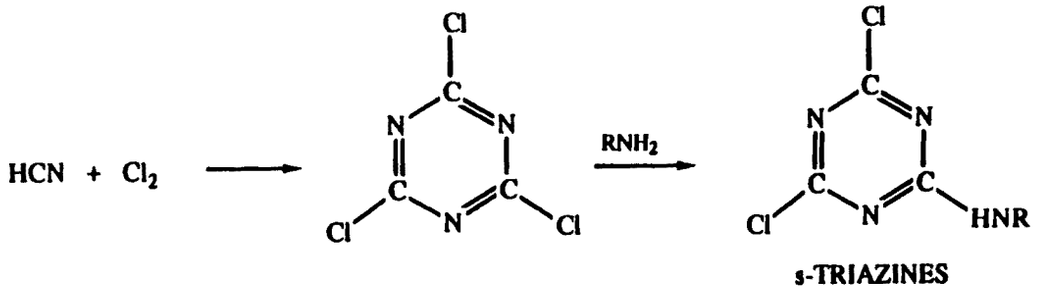
NITROGEN-CONTAINING PESTICIDES

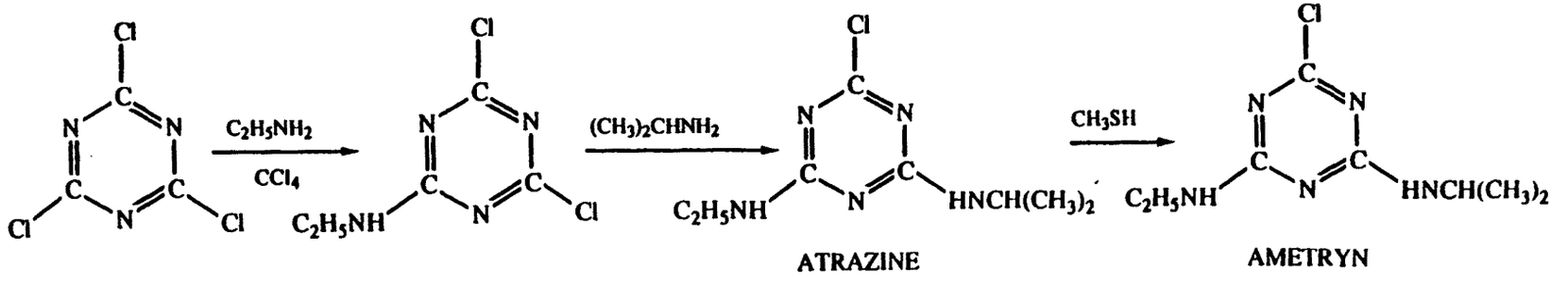
a. s-Triazines

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.

Figure 3-4

REACTION MECHANISMS FOR s-TRIAZINES AND ATRAZINE AND AMETRYN





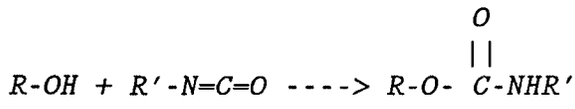
Marshall Sittig, editor, Pesticide Manufacturing and Toxic Materials Control Encyclopedia, Noyes Data Corporation, Park Ridge, NJ, 1980; p. 51, 63.

b. Carbamates

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

Carbonic acid Carbamic acid

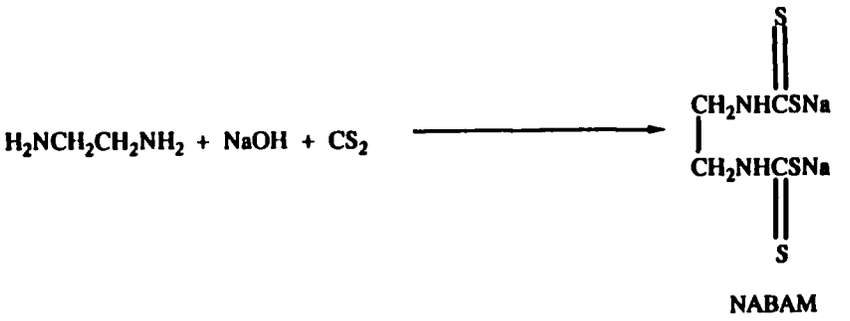
Carbamates are made by the reaction of alkyl or aryl alcohols with isocyanate as shown:



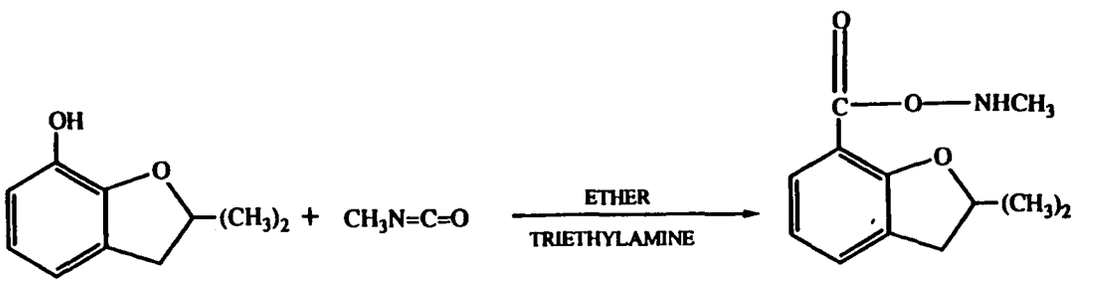
N-Methyl carbamates are produced when methyl isocyanate is used. The aryl N-methylcarbamates are easily formed when phenol and methyl isocyanate are reacted. The pesticide carbofuran can be synthesized by reacting 2,2-dimethyl-2,3-dihydrobenzofuran with methyl isocyanate in the presence of triethylamine 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.

Figure 3-5

REACTION MECHANISMS FOR CARBOFURAN AND NABAM



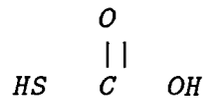
NABAM



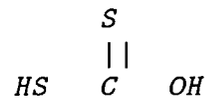
CARBOFURAN

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

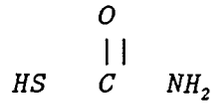
Thiolcarbonic acid and diothiocarbonic acid are the sulfur analogs of carbonic acid which can form thiolcarbamic acid and dithiocarbamic acid upon the addition of an amide:



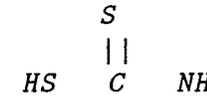
Thiolcarbonic acid



Dithiocarbonic acid

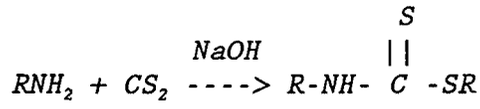


Thiolcarbamic acid



Dithiocarbamic acid

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



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.

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.

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

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.

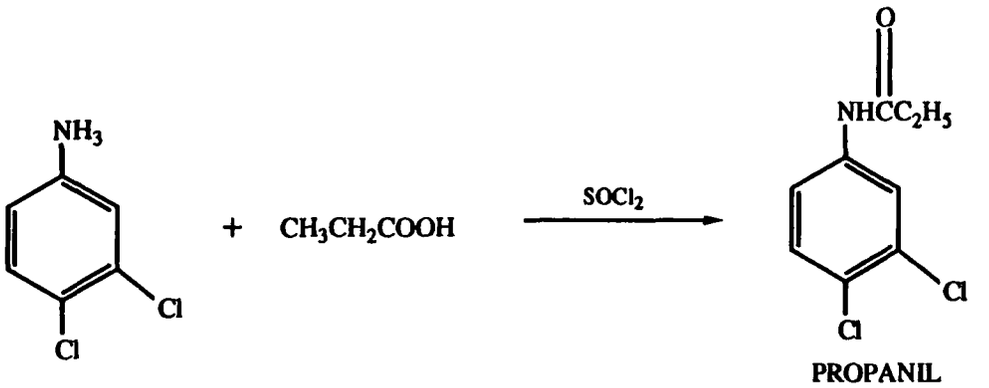
PHENOXYACETIC ACID HERBICIDES

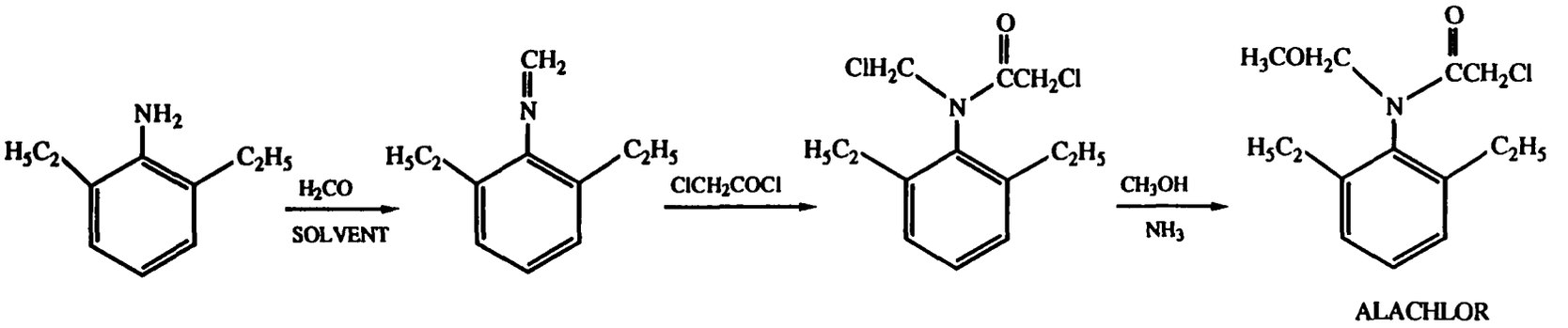
d. 2,4-D

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

Figure 3-6

REACTION MECHANISMS FOR PROPANIL AND ALACHLOR

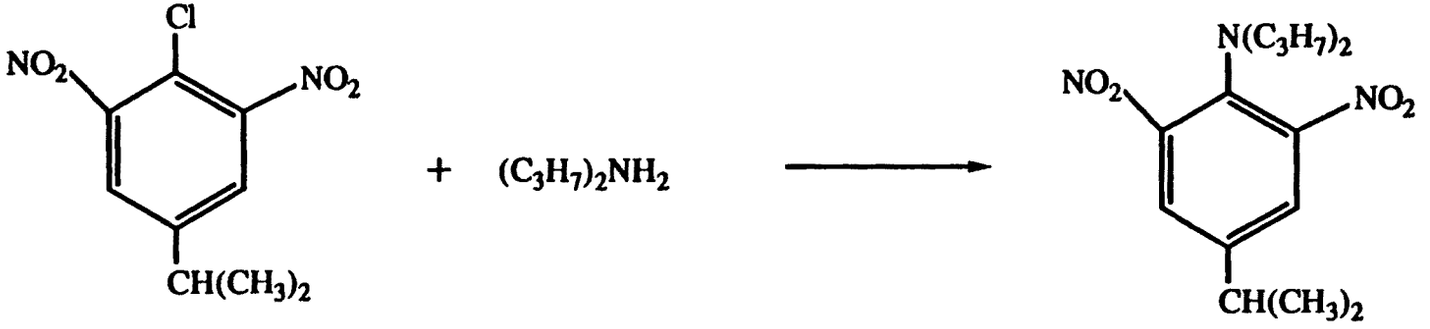




Marshall Sittig, editor, Pesticide Manufacturing and Toxic Materials Control Encyclopedia, Noyes Data Corporation, Park Ridge, NJ, 1980; p. 32, 639.

Figure 3-7

REACTION MECHANISMS FOR ISOPROPALIN



ISOPROPALIN

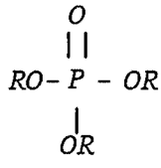
Marshall Sittig, editor, Pesticide Manufacturing and Toxic Materials Control Encyclopedia, Noyes Data Corporation, Park Ridge, NJ, 1980; p. 460.

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:



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

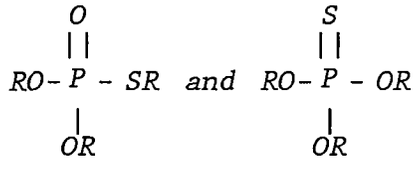
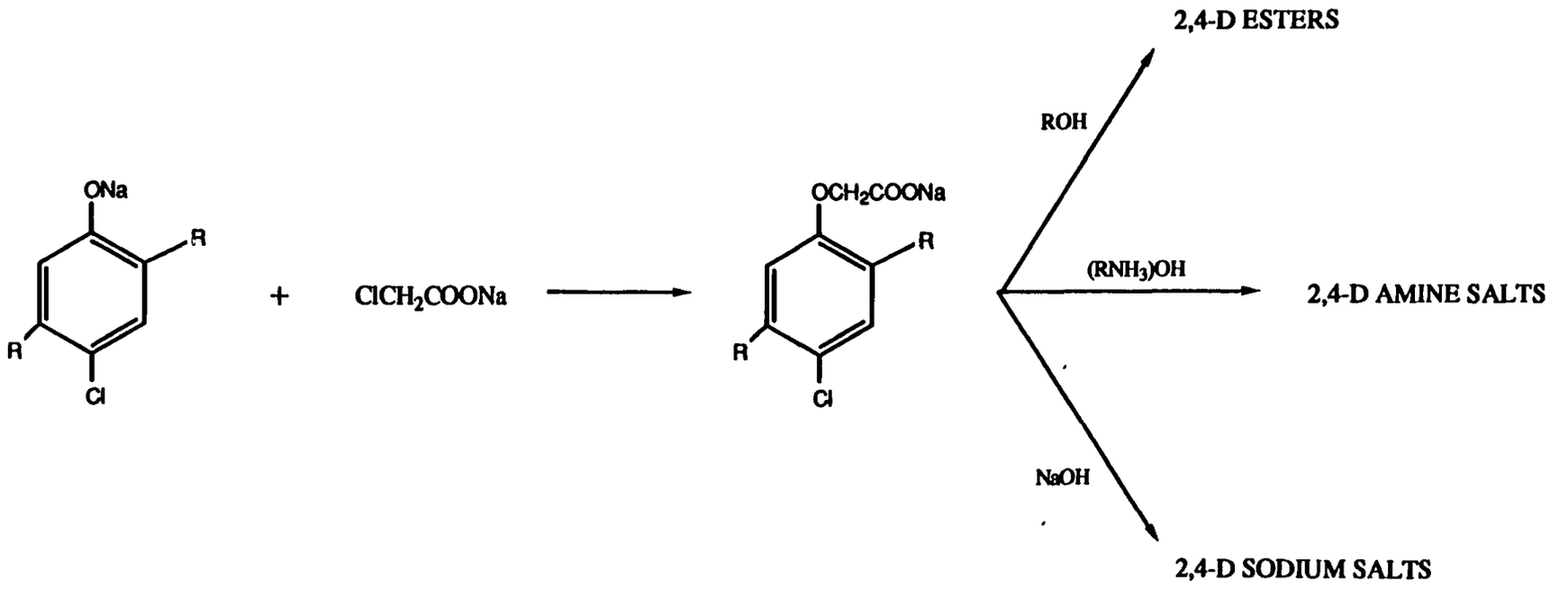


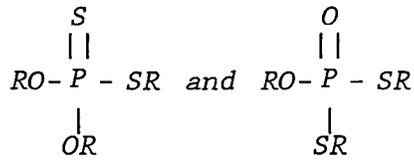
Figure 3-8

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 phosphorodithioates are further sulfur-substituted as follows:



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 phosphororditihioate. 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:

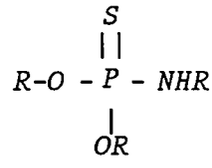
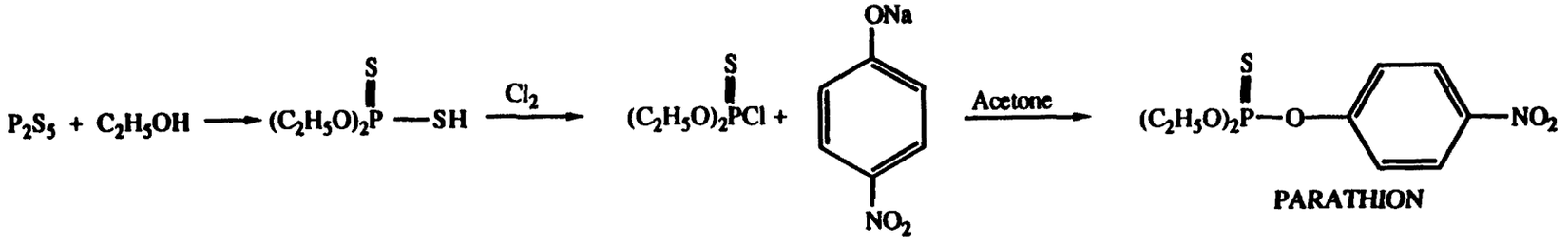
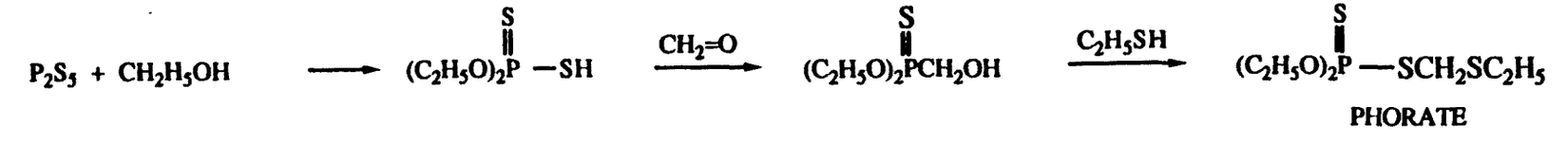


Figure 3-9

REACTION MECHANISMS FOR PARATHION AND PHORATE





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

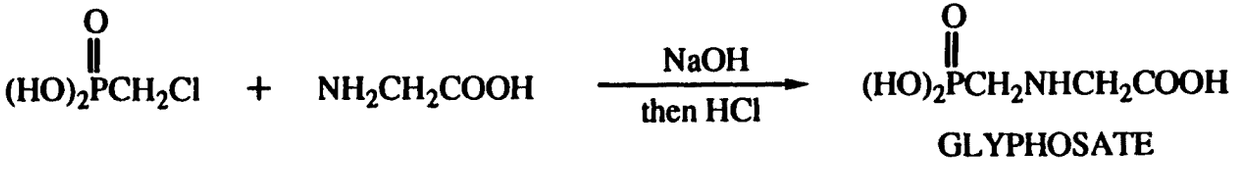
Again, the reaction involves substitution of the acid with the appropriate akyl groups to form the desired product. The reaction for glyphosate is shown in Figure 3-10.

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. An intermediate, as defined in the Pesticide Manufacturing Facility Census for 1986, is any "specific precursor compound formed in the process of 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. These intermediates are associated with 15 pesticide manufacturing processes. As discussed in Section 3.4, the manufacturers of intermediates are not subject to this regulation.

Figure 3-10

REACTION MECHANISM FOR GLYPHOSATE



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

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 by-products at 17 facilities were reported to be produced and sold in 1986. These by-products are associated with 30 pesticide manufacturing processes. The manufacture of by-products are not subject to this regulation.

3.5 CHANGES IN THE INDUSTRY

The Facility Census of 1986 gives 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.

Since 1986, the Agency is aware of 10 facility closings and 1 facility opening. The 1986 Facility Census also identified eight 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 no metallo-organic and 10 organic pesticide manufacturers shutting down facility operations.

One hundred seventy-eight PAIs and salts and esters of PAIs were identified in the 1986 Facility Census as being manufactured that year from 224 production processes. The Agency believes that 16 production processes have been

closed since 1986 resulting in 14 organic chemical and 2 metallo-organic PAIs no longer being produced; however, these 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.

The Agency has also compared the list of PAIs or classes of PAIs not manufactured in 1986 with the OPP database of registered pesticides (FATES Database) in order to identify if any of these PAIs were now being manufactured. Of the 144 PAIs not manufactured in 1986, 97 PAIs were reported as being formulated and packaged in 1986-1988 according to the FATES database. The remaining 47 PAIs were not reported in FATES as being formulated or packaged.

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 1.2, 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 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. Since 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 PROPOSED 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 fit the definition of a metallo-organic pesticide given in the BPT regulation (see Section 455.32), organo-tin pesticides were not included in the metallo-organic pesticide chemicals subcategory (see Section 455.31 (a)) during the 1978 rulemaking because wastewaters from their manufacture have significantly different wastewater characteristics than 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 proposes to regulate the following 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 five existing indirect dischargers in this subcategory.

SECTION 5

WATER USE AND WASTEWATER CHARACTERIZATION

5.0 INTRODUCTION

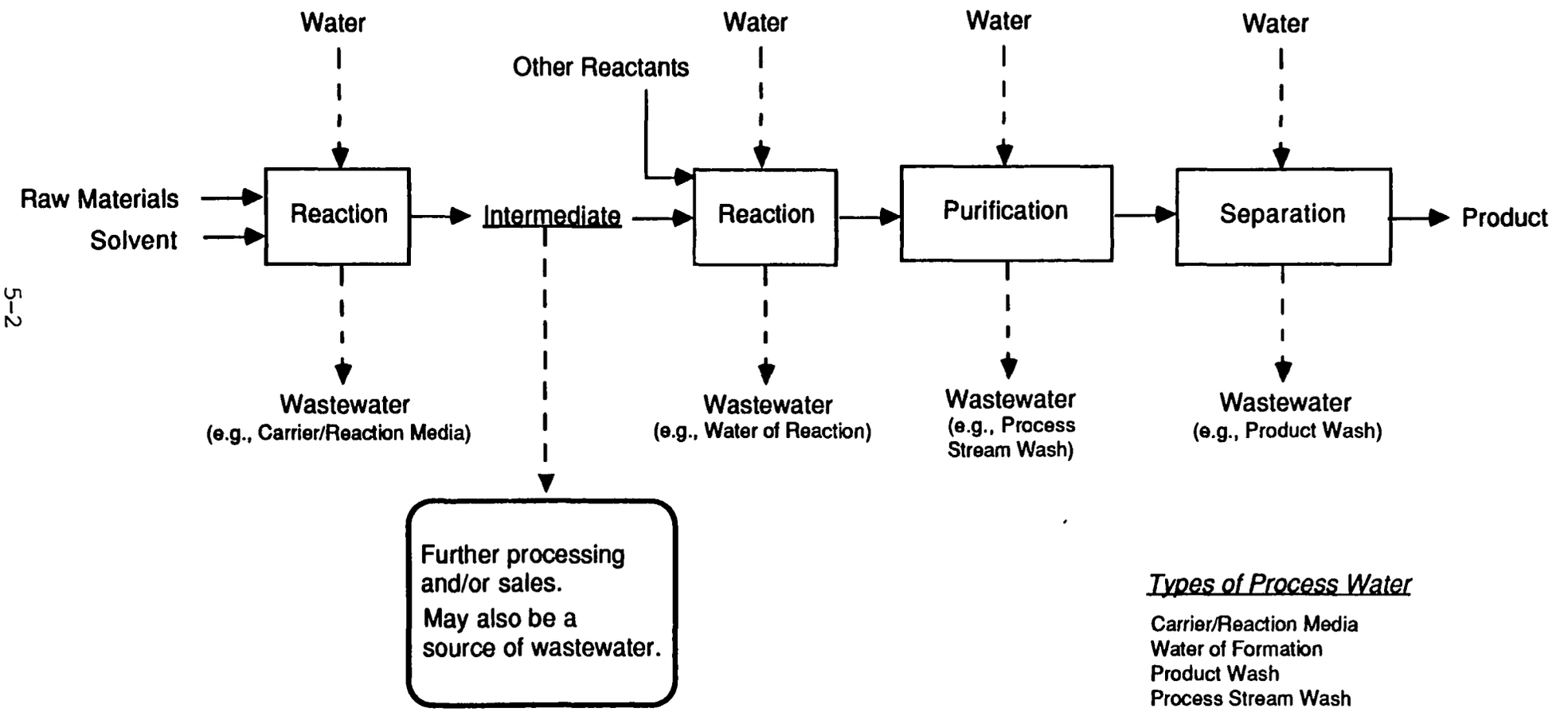
In 1988, under the authority of Section 308 of the Clean Water Act, the Environmental Protection Agency (EPA) distributed questionnaires entitled, "Pesticide Manufacturing Facility Census for 1986," to 247 facilities that EPA had previously identified as possible pesticide active ingredient manufacturers. Responses to the questionnaire by these 247 facilities indicated that 90 facilities manufactured pesticides in 1986. This section presents information on water use at these 90 facilities. This section also presents information on process wastewater characteristics for those pesticide chemicals manufacturing processes that were sampled by EPA and for those pesticide chemicals manufacturing facilities that provided self-monitoring data.

5.1 WATER USE AND SOURCES OF WASTEWATER

As described in Section 3.5, 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

Figure 5-1

EXAMPLE OF PESTICIDE ACTIVE INGREDIENT MANUFACTURING PROCESS



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 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.

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.
- 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 can become process wastewaters when combined with other sources of process wastewaters that are 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."

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 (see Section 3.5.2).
- 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.

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 washes: water used to clean process equipment 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.

- 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 is 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

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]Contaminated stormwater reported as a source of process wastewater is presented here. See Table 5-2 for contaminated stormwater reported as another pesticide wastewater source.

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.

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

- 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 sources, and none monitor the flows (except for stormwater). The number of plants reporting these sources is presented in Table 5-2, along with the average estimated flows reported. As shown in Table 5-2, the flows from 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).

5.1.3 Other Facility Wastewater Co-Treated with Pesticide Wastewater

Often, a facility which manufactures pesticides also manufactures other products. Wastewaters generated from other operations may be co-treated

Table 5-2

WASTEWATER GENERATED FROM OTHER PESTICIDES WASTEWATER SOURCES

Source	# Facilities (out of 90)	Average Wastewater Generated (gal/day)
Showers	67	3,070
Laundry	21	1,210
Safety Equipment	47	3,480
Contaminated Stormwater[1]	47	177,000

[1]Contaminated stormwater reported as another source of pesticide wastewater is presented here. See Table 5-1 for contaminated stormwater reported as a source of process wastewater.

with wastewater associated with pesticide manufacture. 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 270 PAIs and classes of PAIs considered for regulation);
- Organic Chemicals, Plastics, Synthetic Fibers (OCPSF);
- Inorganic Chemicals;
- Pharmaceuticals;
- 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 percent of total flow co-treated for each wastewater source. On the average, when pesticide manufacturing wastewater is co-treated with other wastewaters, the pesticide manufacturing wastewater constitutes 38% of the total wastewater being treated. OCPSF operations contributed the largest percent of wastewater co-treated with pesticide wastewater at 39 manufacturing facilities. Typically, 50% of the total

Table 5-3

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

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

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

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

wastewater volume from treatment systems that co-treat pesticide manufacturing water with OCPSF water is due to OCPSF processes. On the other hand, only 4% of the total wastewater volume from treatment systems that co-treat pesticide manufacturing water with PFP water is due to PFP processes. Other facility wastewater, such as sanitary wastewater, is commingled with pesticide wastewater at 27 manufacturing facilities.

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 (e.g., by incineration, evaporation, or deep-well injection).

5.2.2 Discharge Status of Pesticide Manufacturing Facilities

Thirty-two of the 90 manufacturing facilities are direct dischargers, while 36 are indirect dischargers. One facility discharges wastewater both directly and indirectly; therefore, there are 67 dischargers. Of the remaining 23 facilities, 15 facilities dispose of their wastewater by on- or off-site deep well injection, incineration, or evaporation and 8 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 discharged from pesticide manufacturing processes to waters of the United States was approximately 1.30 billion gallons in 1986, compared to 1.45 billion gallons generated. Eighty-two percent of all process wastewater generated was discharged directly to a receiving stream while 8% was discharged indirectly. Most of the remaining wastewater was disposed of by deep well injection (DWI). Table 5-4 presents the volumes of pesticide process wastewater discharged or disposed in 1986.

Table 5-4

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

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**

[1]"No discharge" facilities dispose of their wastewater through deep well injection (DWI), incineration (on or off-site), or evaporation.

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

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). Over 99% of the wastewater generated and the wastewater discharged in the pesticide manufacturing industry is due to manufacturing of organic pesticide (Subcategory A) products.

5.3 WATER REUSE AND RECYCLE

Recycling or reuse of process wastewater during pesticide production in 1986 was reported by 25 of the 90 manufacturing facilities. Because of the diversity within the industry, it is difficult to summarize the types of recycle operations which are currently available. Table 5-6, therefore, presents general descriptions of current recycling operations.

One group of PAIs in Subcategory A was examined in more detail. This group manufactures PAIs by reaction of phenoxy acids to form either salts or esters. The manufacture of phenoxy esters generates "water of formation", due to the chemistry of the esterification reaction, while the manufacture of phenoxy salts does not generate any process waste streams but requires water to be added to the reactor since the salts are sold in solution. Therefore, use of the water of reaction from the formation of the ester as make-up water for salt formation could eliminate a source of pollution.

Table 5-5

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

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**

[1]"No discharge" facilities dispose of their wastewater through deep well injection (DWI), incineration (on or off-site), or evaporation.

Table 5-6

TYPES OF WASTEWATER RECYCLE OPERATIONS REPORTED

	# Facilities
Recovery of process input or product	14
Reused in pesticide manufacturing process	8
Reused in formulating/packaging process	2
Reused in equipment washwater	2
Reused as cooling water or scrubber water	2
Reused contaminated stormwater in manufacturing process	1
TOTAL	29[1]

[1]The number of facilities exceeds 25 due to multiple recycle operations at some facilities.

Reuse of reaction waters from the esterification processes as feed water for phenoxy salt neutralization and formulation serves the dual purpose of eliminating a contaminated wastewater discharge and recovering the phenoxy acid active ingredient.

The ability of a facility to reuse waters as feed to the neutralization reaction depends on:

1) The ratio of production between the esterification and neutralization process; and

2) The quality of the water recovered from the esterification process.

The production ratio is important because approximately 0.5 pounds of water are normally added to make each pound of product during the manufacture and formulation of phenoxy salts, while approximately 0.08 pounds of reaction water are generated from the esterification of 1 pound of product. Given these ratios, a facility will achieve a perfect water balance if 1 pound of phenoxy salts are produced for every 6.25 pounds of phenoxy ester produced. Therefore, if the quantity of phenoxy salts produced at a facility is more than 16% of the quantity of phenoxy esters produced, there will be insufficient esterification water generated to meet phenoxy salt formulation requirements, and fresh make-up water or reactor vessel washwater must also be used as formulation feedwater. Conversely, if phenoxy salt production is less than 16% of phenoxy ester production, the facility will generate more esterification reaction water than may be used in salt formulations, and water will have to be disposed.

In 1986, of the facilities which manufactured both phenoxy salts and esters, phenoxy salt production was always much higher than 16% of phenoxy ester manufacture, indicating that these facilities should have been able to reuse all esterification water that year. However, three additional factors affect the amounts of esterification water a facility may reuse. First, purity requirements for waters used in the manufacturing of phenoxy salts have an effect on the amount of esterification reaction water which may be reused in this way. Secondly, while the amount of water generated by the esterification reaction may be determined stoichiometrically, the water requirements for phenoxy salt neutralization and formulation will vary based on the specific product registrations being produced. Finally, phenoxy salts and esters are often manufactured in short production runs throughout the year, depending on immediate consumer demand, and a facility may not be able to store these waters until they can be reused.

In general, reaction water from the esterification of a given phenoxy acid active ingredient may only be used in the manufacture of salts of the same active ingredient. The importance of this requirement varies depending on the application and labeling of the phenoxy salt product, and too high a contamination level may affect the final product registration. It is also important that the water used in phenoxy salt formation have a low alcohol content, because alcohol can cause cloudiness within the phenoxy salt formulation product. An effective alcohol/water separation stage at the esterification process is critical to the yield of a high quality water that may be reused in phenoxy salt manufacturing.

All but one of the U.S. facilities which convert phenoxy acids to salts and esters reuse the waters generated by the esterification reaction as make-up water for salt formation. When production schedules do not allow immediate use of esterification process wastewater for salt formation, the esterification process wastewater is typically stored until needed. When demand for the phenoxy acid ester exceeds the demand for the phenoxy acid salt so much that there is not enough storage capacity for the wastewater, the excess wastewater is disposed of. All plants that recycle the esterification process wastewater have had this wastewater incinerated when necessary, although typically this has occurred only once in several years.

5.4 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 and data obtained from EPA sampling at pesticide manufacturing facilities. Results of these data gathering efforts are described in more detail below.

5.4.1 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.

The PAI analyses were often quite detailed and were provided for raw and treated process wastewaters. Monitoring data submitted for 55 PAIs from 27 facilities were of sufficient quality to develop BAT/PSES guidelines based on plant performance.

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

5.4.2 EPA Pesticide Manufacturers Sampling Program

As described above in Section 5.4.1, 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 20 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.).

5.5 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 pesticide wastewaters generated by pesticide chemicals manufacturing facilities. This database was compiled from the two data gathering efforts previously described in Section 5.4. 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.

5.5.1 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. Industry data characterizing final effluent streams show that, on average, plant wastewater treatment systems are removing conventional pollutants to consistently low levels. For almost all (>99%) BOD_5 and TSS results reported for end-of-pipe discharge, the results were below the industry-average concentration-based daily maximum BPT limit for the respective pollutant. The average concentration-based BPT limit was calculated based on the concentration-based BPT limits for each plant in EPA's database. The individual plant concentration-based BPT limits were back calculated from the mass-based BPT limit by factoring in each plant's flow rate and production rate. For pH, most (>88%) of the results reported for end-of-pipe discharge were within the BPT limits of between 6 to 9. Analytical data developed through EPA's sampling program show the same results for the conventional pollutants.

The industry-submitted BOD_5 data characterizing end-of-pipe discharge are summarized in Figure 5-2. The table displays the number of BOD_5 results reported in ranges of 100 mg/L, and compares the results with the industry average daily maximum BPT limit of 582 mg/L. The table shows that the BOD_5 levels in end-of-pipe discharges are typically under 100 mg/L. The industry-submitted TSS data characterizing end-of-pipe discharge are summarized in Figure 5-3, along with the industry average daily maximum BPT

Figure 5-2

INDUSTRY SELF-MONITORING BOD LEVELS IN FINAL EFFLUENT DISCHARGE

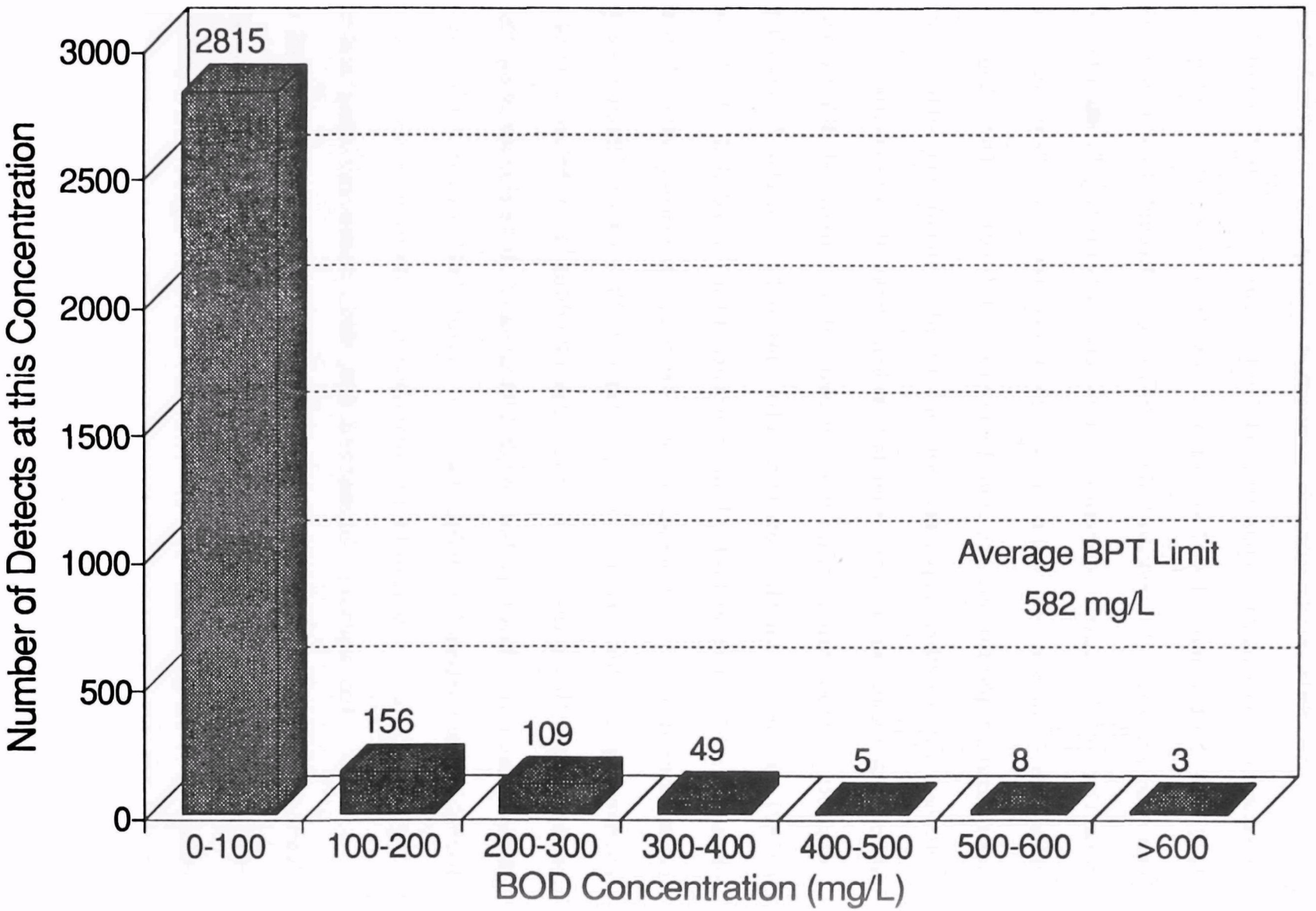
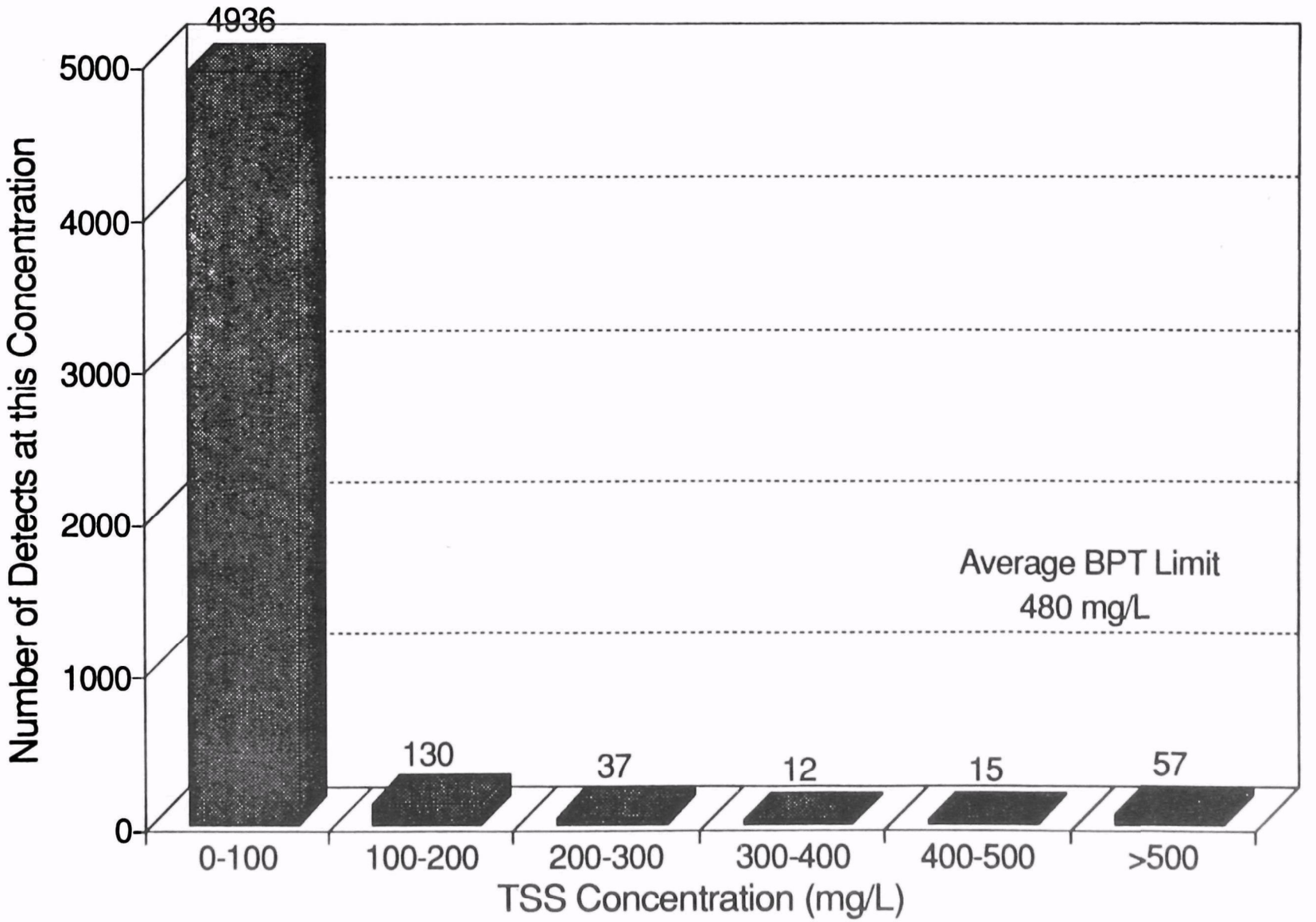


Figure 5-3

INDUSTRY SELF-MONITORING TSS LEVELS IN FINAL EFFLUENT DISCHARGE



limit of 480 mg/L. Similar to BOD_5, the table shows that the TSS levels in end-of-pipe discharges are typically under 100 mg/L. The industry-submitted pH data characterizing end-of-pipe discharge are summarized in Figure 5-4, along with the BPT limit range of between 6 and 9. The figure shows that the majority of the results were within the BPT range.

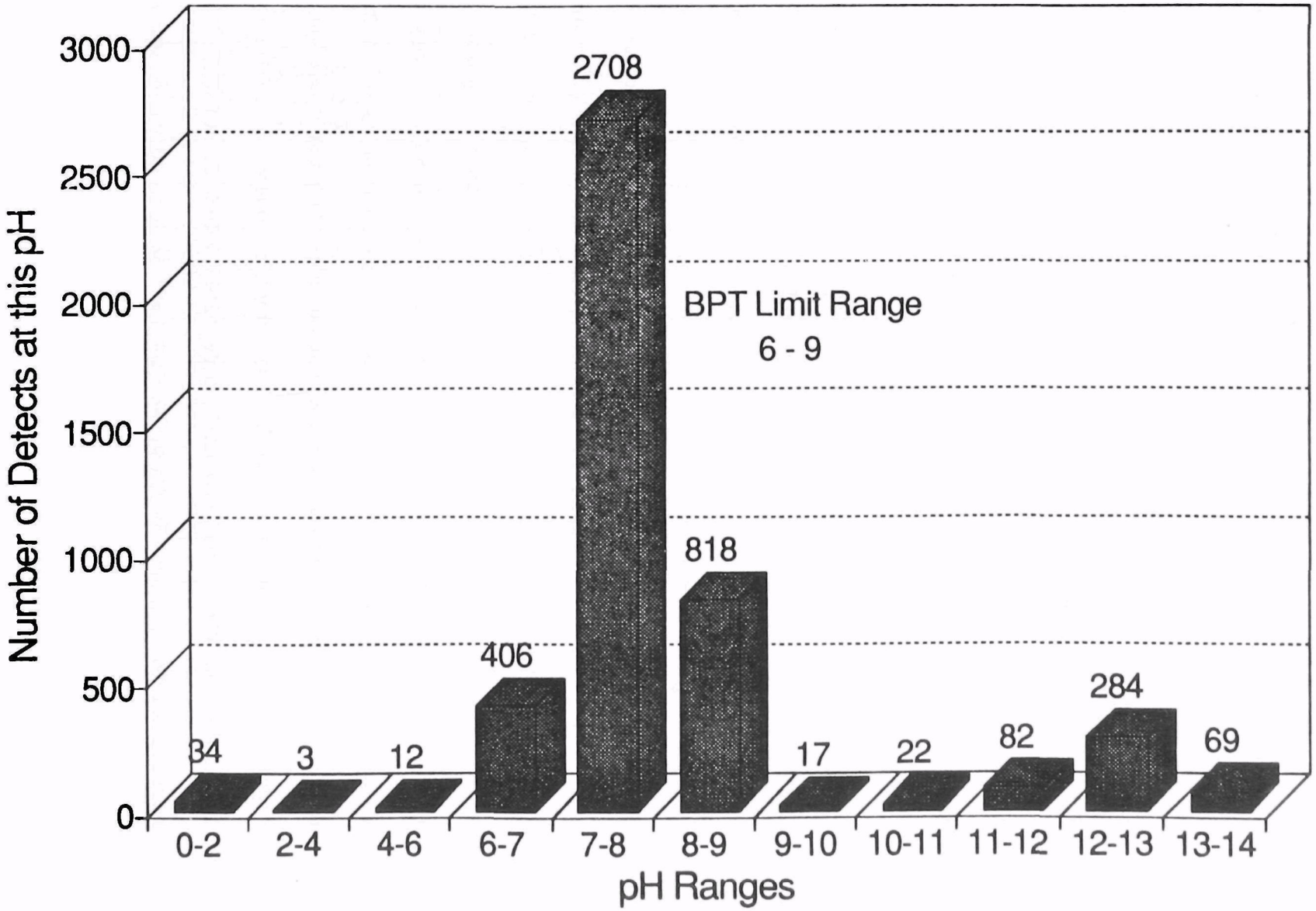
5.5.2 Priority Pollutants

Data characterizing the pesticide manufacturing process wastewater 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 and analysis episodes. In addition, the EPA Toxic Release Inventory System (TRIS) was used to confirm the presence of priority pollutants in pesticide manufacturing 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 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

Figure 5-4

INDUSTRY SELF-MONITORING pH LEVELS IN FINAL EFFLUENT DISCHARGE



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 5-7 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 5-7 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 5-7 also shows whether or not at least one of the facilities submitting data for each

Table 5-7

PRIORITY POLLUTANT DATA-FACILITY SELF MONITORING

			Reported Concentrations (μg/L)		
Pollutant	**Number of Samples Analyzed**	**Number of Reported Detections**	**Minimum**	**Maximum**	**Known or Believed Present**
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

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.

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 20 pesticide manufacturing facilities. As discussed in Section 5.4, in each episode samples were collected for three days at locations throughout the wastewater generation, treatment, and discharge path. A report that there was detection of a priority pollutant in at least two daily samples at the same location would indicate high probability that the priority pollutant was in fact present. Reported detection of a priority pollutant in only one sample would 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.

EPA sampling at the 20 facilities reported detection of 70 priority pollutants in pesticide manufacturing wastewaters. 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 5-8 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 5-8 also shows whether or not at least one of the facilities where each priority pollutant was confirmed present either knew or

Table 5-8

Priority Pollutant Data EPA Sampling
Organic Pesticide Chemicals Manufacturing

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

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.

EPA also collected samples at three metallo-organic pesticide manufacturing (Subcategory B) facilities. During two of the sampling episodes, 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 earlier, 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.

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 should be regulated. 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 5-8 are being regulated as will be discussed in Section 6.

5.5.3 Pesticide Active Ingredient Pollutants

Raw wastewater data for PAIs are available from both industry self-monitoring and EPA sampling. The industry self-monitoring data 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, PAIs detected in commingled wastewaters could be attributed to the pesticide processes since other industrial production at the facility would not generate wastewaters containing PAIs. 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 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. As discussed earlier, EPA sampled at 20 pesticide manufacturing facilities, and these sampling episodes were used to characterize pesticide

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.

5.5.4 Nonconventional Pollutants

Nonconventional pollutants include chemical oxygen demand (COD), total organic carbon (TOC), as well as other organic pollutants not previously mentioned. COD is a measure of organic material in a wastewater that can be oxidized as determined 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 percent 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.

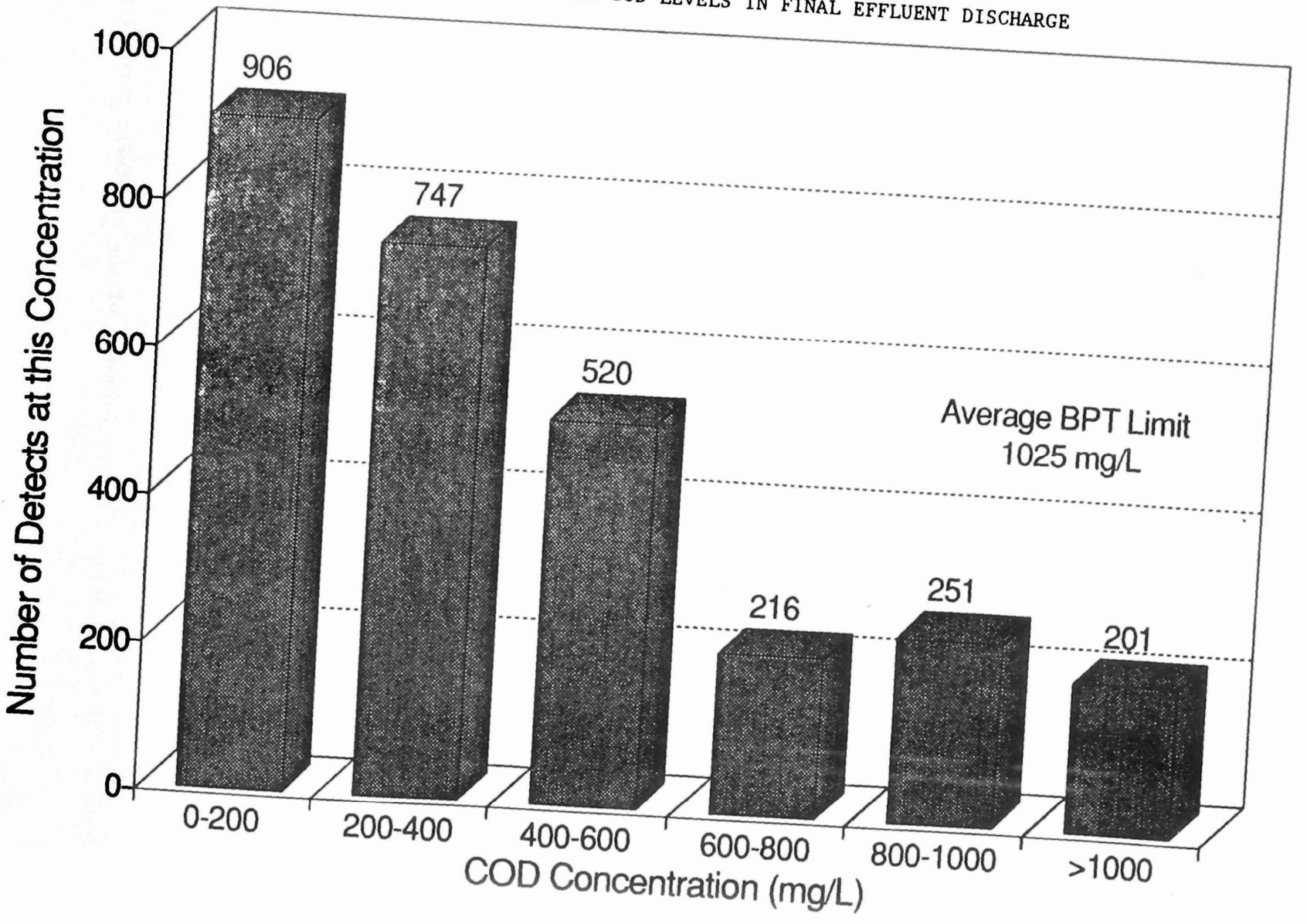
The only non-conventional pollutant currently regulated under BPT (aside from the PAIs) is COD. Self-monitoring data submitted by pesticide manufacturers included substantial amounts of COD analytical results. Similar to the data submitted for the conventional pollutants, the industry data indicate widely-scattered COD levels in in-plant process streams, but consistently low COD levels in end-of-pipe discharge are summarized in Figure 5-5. The figure shows that the majority (>90%) of the COD results for end-of-pipe discharge streams were below the industry average daily maximum BPT limit of 1,025 mg/L (the calculation of industry average concentration-based BPT limits is discussed in Section 5.5.1).

5.6 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 nonconventional pollutants (including the PAIs) are discussed below. The performance of the treatment technologis in-

Figure 5-5

INDUSTRY SELF-MONITORING COD LEVELS IN FINAL EFFLUENT DISCHARGE



place at pesticide manufacturing facilities are 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 nonconventional 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 five 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.

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. EPA estimates that approximately 200,00 pounds of PAI's and 17,000 pounds of priority pollutants per year are discharged directly to surface waters by Subcategory A plants after currently available treatment. In addition, it is estimated that 5.8 million pounds per year of volatile organic priority pollutants are present in PAI wastewaters with considerable potential for volatilization to the atmosphere.

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 110,000 pounds of PAIs and 29,000 pounds of priority pollutants to POTWs.

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 to be proposed for regulation. This section presents the criteria used in the selection process and identifies those pollutants to be regulated under BPT, BAT, PSES, NSPS, and PSNS for the organic pesticides chemicals manufacturing subcategory (Subcategory A). No new limitations and standards are being proposed 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 decision making 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 15 organic PAIs within the group of 25 PAIs and classes of PAIs, and BPT will be amended to include these PAIs. These 15 PAIs are presented below.

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

EPA has also developed analytical methods and collected effluent data to support BPT coverage of organo-tin pesticides.

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 POLLUTANT

There are currently no regulations covering the discharge of 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 current 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 5-10 or 5-11, 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 Table 5-11 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, and total cyanide. The 28 priority pollutants selected for regulation are presented in Table 6-1. The

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

Table 6-1

(Continued)

Pollutant Number	Pollutant
086	Toluene
121	Cyanide
122	Lead

development of limitations for these priority pollutants is discussed in Section 7.

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	α-Endosulfan
4,6-Dinitro-o-cresol	β-Endosulfan
Bis (2-Chloroisopropyl) ether	Endosulfan sulfate
Bis (2-Chloroethoxy) methane	α-BHC
N-Nitrosodimethylamine	β-BHC
N-Nitrosodiphenylamine	γ-BHC
Pentachlorophenol	δ-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 proposed 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.

Hexachlorobutadiene
Hexachlorocyclopentadiene
4-Nitrophenol

- EPA is also not regulating Asbestos 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 proposing to extend the applicability of BPT to cover COD resulting from the manufacture of 15 previously excluded organic PAIs and classes of PAIs and the organo-tin pesticides.

Under Subcategory A, 170 individual PAIs were manufactured in 1986; and 8 PAIs were manufactured from 1985-1989, but were not manufactured in 1986. Therefore, a total of 178 individual PAIs are being considered for potential regulation. Of these, 122 individual PAIs are being selected by the Agency for regulation under either BAT, NSPS, PSES, or PSNS. EPA is not proposing regulations for 56 individual PAIs. Of the 56 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 16 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 and there are no structurally similar PAIs with data which could be transferred. Available toxicity data indicates that these 16 PAIs are less toxic than most of the 122 PAIs for which PAI effluent limitations are proposed.

SECTION 7

TECHNOLOGY SELECTION AND LIMITS DEVELOPMENT

7.0 INTRODUCTION

This section identifies and describes the wastewater control and treatment technologies currently used or available for the reduction and removal of conventional pollutants, PAIs, and priority pollutants discharged in pesticide chemicals manufacturing process wastewater and presents a summary of treatment performance achievable by technology based on industry submissions and treatability tests on these control and treatment technologies. This section also discusses the development of effluent limitations guidelines and standards for PAIs and priority pollutants in Subcategory A of the pesticide chemicals manufacturing industry.

Section 7.1 presents a summary of treatment performance databases available to the Agency on wastewater control. The Agency has compiled three databases; one from industry-submitted data, one from wastewater sampling conducted by EPA, and a third from treatability studies conducted on wastewaters or synthetic wastewaters containing PAIs.

Section 7.2 presents a description of in-plant versus end-of-pipe treatment and an overview of the current and proposed treatment technologies used in the pesticide chemicals manufacturing industry for treatment of conventional pollutants, PAIs, and priority pollutants. This section also

discusses the disposal of solid residues that are generated from wastewater control and treatment technologies.

Section 7.3 presents treatment performance data for technologies considered to be BAT and Section 7.4 presents the methodology used to develop the limitations and standards for the pesticide chemicals manufacturing industry. Section 7.4 also presents those cases where limitations requiring no discharge of process wastewater pollutants have been proposed and discusses options available for compliance with proposed zero discharge standards. Effluent limitations guidelines and standards development for Subcategory B PAIs are discussed in Section 14.

7.1 TREATMENT PERFORMANCE DATABASES

The sources of treatment performance data available for the pesticide chemicals manufacturing industry include: analytical data on PAI treatment submitted with the Pesticide Manufacturing Facility Census for 1986 or collected during EPA short-term sampling and treatability sampling efforts between 1988 and 1991, EPA sponsored bench-scale treatability tests on selected PAIs, and existing treatment performance databases. The treatment performance database for conventional pollutant parameters and COD is from the previous regulation of BPT under the pesticide chemicals manufacturing subcategory. The treatment performance database for priority pollutants is from the previous regulation of the OCPSF point source category. Sections 7.1.1 to 7.1.3 discuss these databases in more detail.

7.1.1 Analytical Data Submitted with the Pesticide Manufacturing Facility Census for 1986 and Associated Data

The U.S. EPA Engineering and Analysis Division (formerly the Industrial Technology Division) of the Office of Water issued the Pesticide Manufacturing Facility Census for 1986. As described in Section 3.1.3, this questionnaire requested engineering and economic data regarding pesticide manufacturing processes, wastewater generation, treatment, and handling procedures from each plant that received the questionnaire. In addition, this questionnaire requested submittal of all wastewater monitoring data collected in 1986, in the form of individual data points. The intent of this request was to obtain a full year of daily monitoring data from each respondent. The questionnaire further requested that the data identify the sample points as shown earlier in the questionnaire process and treatment diagrams, specifically from wastewater streams leaving manufacturing processes and entering and exiting treatment systems.

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. Data were also obtained from a previous (mid to late 1970's) EPA survey of wastewater discharged by pesticide chemical manufacturers. This earlier survey was similar to the 1986 survey because it was also conducted under the authority of Section 308 of the Clean Water Act and requested the same type of information.

EPA sampled pesticide manufacturing process wastewater at various locations throughout the wastewater generation, treatment, and discharge path at 20 facilities to screen the wastewater for the presence of PAIs and priority pollutants and to evaluate control technology performance. Included for consideration with the data submitted with the EPA surveys were selected data obtained from these EPA short-term sampling efforts conducted at pesticide manufacturing facilities between 1988 and 1990.

Of the 90 pesticide manufacturing plants that responded to the 1986 survey, 51 plants submitted long-term wastewater monitoring data. When the data submitted by a plant were found to be insufficient or to require further explanation, a formal request for additional information was made to the plant by EPA. In addition to the data submitted in response to the 1986 survey, the Agency reviewed and considered long-term data from six plants from the earlier EPA survey (containing data from the mid- to late 1970s). The data from this earlier survey do not differ significantly from the data of the 1986 survey in terms of format. Short-term sampling data collected during site visits by EPA to pesticide manufacturing plants between 1988 and 1990 were also reviewed and considered by the Agency.

The industry-submitted long-term data, data from the earlier EPA survey, and the short-term EPA sampling data were entered into an Agency treatment performance database. The long-term data submitted by industry contained mostly PAI data. The Agency evaluated these data extensively in the course of developing limitations as discussed in Section 7.4.

7.1.2 Treatability Test Data

In preparation of this proposed rulemaking effort for the pesticide chemicals manufacturing industry, EPA undertook numerous bench-scale treatability studies using both synthetic pesticide wastewaters, as well as, where practical, actual process wastewaters. These treatability studies investigated activated carbon adsorption, hydrolysis, membrane filtration, and chemical oxidation (using alkaline chlorination and using ozonation enhanced with ultraviolet (UV) light).

Activated Carbon Adsorption

Activated carbon adsorption isotherm tests were performed on 29 selected PAIs chosen from the list of 270 PAIs considered for regulation grouped according to their production volume. The carbon isotherm studies used PAIs selected from various structural groups to determine which groups would be most adaptable to activated carbon technology. Some manufacturers of some PAIs in a few of those groups were known to use activated carbon technology to treat the wastewaters 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. Results were obtained for all 29 PAIs. Twenty-five of the 29 PAIs tested exhibited some adsorption capacity.

Next, Accelerated Column Tests (ACTs) were conducted to generate treatability data for the removal of atrazine, vapam, chlorothalonil, and diazinon by the use of activated carbon. This technique was used to develop effluent concentration breakthrough curves for atrazine, diazinon, and chlorothalonil. For vapam, no calculations were made as the high feed concentration resulted in immediate breakthrough. The atrazine and diazinon wastewater were obtained from plants that operate full-scale carbon treatment systems. The ACT data from both tests were comparable to the full-scale system data with respect to carbon usage and carbon loading. Results of these studies were used in estimating full-scale carbon systems designs and cost.

Hydrolysis

Hydrolysis was evaluated as a wastewater treatment technology through a series of bench-scale tests to determine the hydrolysis rates of selected PAIs in reagent grade water (i.e., not actual wastewater). 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, and in other cases were conducted because of the lack of any literature data to fill in those gaps. All of the PAIs selected were expected to hydrolyze under some

conditions. Thirty-nine PAIs from six structural groups were tested at three different pHs (2, 7, and 12) and two different temperatures (20°C and 60°C). The test results indicated that the hydrolysis rates of the PAIs varied from almost immediate to virtually no reaction in the 24-hour test time for the various PAIs and conditions tested. One phosphorodithioate PAI was tested in a field study at pH 12 and 60°C. The half life ranged from 0.72 hours (at an initial PAI concentration of 5 mg/l) to 1.94 hours (at an initial PAI concentration of 57 mg/l).

Membrane Filtration

Membrane filtration was evaluated as a method of pesticide removal. The membrane filtration studies used PAIs selected to span the molecular weight range of the 270 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 3 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 test results indicated that reverse osmosis was an effective method of pesticide removal. The best results were obtained with the thin-film composite (TFC) membranes. Removals

of 90% or greater were obtained throughout the test, with the majority of PAIs being rejected at 99% or greater.

Alkaline Chlorination

Alkaline chlorination was evaluated as a method of PAI removal using wastewater generated during the manufacture of 6 dithiocarbamate PAIs (Metam, Namet, KN-Methyl, Nabonate, Dimet, and TCMTB). 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. The bench-scale study was conducted at three chlorine dosages at three different contact times. The test results indicate alkaline chlorination was an effective treatment for all PAIs but TCMTB. The chlorine demand for TCMTB was found to be greater than 100,000 mg/l and therefore was not considered a feasible treatment option.

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.

7.1.3 Existing Treatment Performance Databases

The treatment performance databases used in the analysis of treatment of conventional pollutants, COD, and priority pollutants include the pesticide chemicals industry BPT database and the OCPSF database. 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. Found in the docket to this proposed regulation and in the docket to the Tuesday, April 25, 1978 FRN which presents the final BPT regulations for the pesticide chemical manufacturing point source category (also available through the National Technical Information System [NTIS]).

- 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.

7.2 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. The Agency found that the pesticide chemicals manufacturing industry primarily selects in-plant controls 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 wastewater]. 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.

Table 7-1 summarizes the in-plant and end-of-pipe controls for the removal of pollutants from pesticide industry process wastewaters. Table 7-1 also presents the number of plants that reported using each of the listed technologies in the Facility Census for 1986. 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 (these technologies are presented in no particular order):

- 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 below.

Table 7-1

TREATMENT TECHNOLOGIES USED BY THE
PESTICIDE CHEMICALS MANUFACTURING INDUSTRY
AS REPORTED IN THE 1986 FACILITY CENSUS

Treatment Technology	Total Number of Facilities
Biological Treatment	25
Carbon Adsorption	14
Chemical Precipitation/Filtration	7
Chemical Oxidation	11
Coagulation/Flocculation	8
Distillation	1
Evaporation	1
Hydrolysis	6
Incineration	3
Resin Adsorption	2
Solvent Extraction	3
Steam Stripping	4
Ultraviolet Decomposition	2

7.2.1 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,

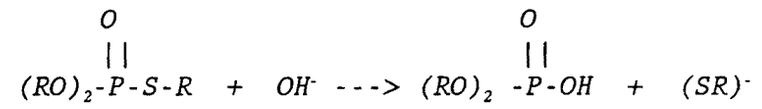
terephthalic acid, and uracil structural groups using carbon to establish this treatment as a basis for control of specific PAIs in these groups. Carbon has also been shown in treatability studies to be an effective polishing control for thiocarbamate PAIs, although insufficient information is currently 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.

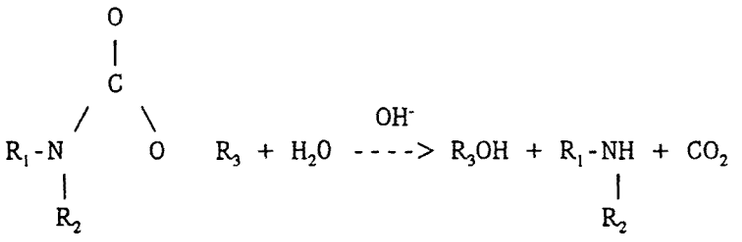
7.2.2 Hydrolysis

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:



Carbamate hydrolysis occurs by the following reaction:



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 is less than one minute.

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.

7.2.3 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.

7.2.4 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 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.

7.2.5 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.

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.

7.2.6 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.

7.2.7 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 (3.94×10^{-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 (3.94×10^{-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.

7.2.8 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.

7.2.9 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.

7.2.10 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.

7.2.11 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).

7.2.12 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.

7.2.13 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 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.

7.2.14 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. (See the final OCPSF rule, 52 FR 42540, for a further description of steam stripping technology).

7.2.15 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).

7.2.16 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.

7.3 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.

7.3.1 Carbon Adsorption

In the pesticide manufacturing industry, activated carbon adsorption is or has been used to treat PAIs in the following structural groups: 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 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 industry treatability studies to be an effective polishing control for thiocarbamate PAIs, although insufficient information currently exists.

Based on long-term concentration data achieved using activated carbon adsorption, the EPA is currently proposing limitations based on activated carbon adsorption technology for individual PAIs in the following structural groups: acetanilides, aryl halides, benzonitrils, bicyclics, phenols, phosphorothioate compounds, 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 loading from their discharge. 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 mean to detection limit (LTM/MDL) ratio varies from 3.19 to 7.35 (i.e., for these compounds, the average concentration following treatment ranged from 3.19 to 7.35 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 pyrethrins.

In addition to the PAI being treated, a number of factors can effect 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 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. Also, besides the competitive effects involved in treating complex matrices with activated carbon, when the effluent concentration approaches the minimum detection limit, the calculated removal efficiencies decrease due to the statistical effects of analyses below the detection limit. However, while the calculated efficiency of removing pesticides from less contaminated streams drops, for those PAIs using carbon as a polishing step very low effluent concentrations were achieved in the carbon effluent, with an average of 8.6 ppb PAI detected. Therefore, the ratio of average concentration to minimum detection limit is comparable to that of systems treating more concentrated process streams.

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.

Through the use of activated carbon adsorption to comply with the proposed BAT and PSES guidelines for organic pesticides chemicals manufacturers, the EPA estimates that an additional 165,000 pounds of active ingredient will be eliminated from plant discharges annually.

7.3.2 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. In reviewing current performances by industry in treating pesticide wastewaters, the EPA has determined that PAI treatment systems incorporating hydrolysis are responsible for removing approximately 93,700 pounds of pesticide from process discharges each year. These systems proved capable of reducing the amount of PAI in wastewater to the extent that the

average long-term mean effluent concentration for facilities using hydrolysis as a PAI treatment technology was 2.69 times the minimum detection limit for the individual PAI. At many of facilities, no PAI was detected at 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. Within those, 51 PAIs had demonstrated half-lives of less than 1 day, 33 had half-lives of less than 1 hour, and 14 had half-lives of 10 minutes. The EPA sponsored treatability studies at more uniformly controlled conditions on those PAIs which were manufactured in 1986 for which hydrolysis appeared to be a potential BAT technology, and hydrolysis did prove highly effective in destroying 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 was 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 currently either discharged or deep-well injected untreated, although this data has generally not contained sufficient detail for determination of achievable concentration at full-scale systems.

The EPA is proposing hydrolysis as a 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 PAI. It is estimated that the utilization of hydrolysis to treat these PAIs would result in the removal of an additional 84,400 pounds of PAI from plant discharges annually.

7.3.3 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, preventing about 8,300 lbs/year of PAI from being discharged.

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. In treatability studies available, dithiocarbamate PAIs do not appear to be uniformly treatable through the use of activated carbon adsorption. Meanwhile, 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 CS_2 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 did find 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. At the same time, EPA is conducting treatability studies on technologies which are not currently used in the pesticide manufacturing industry using ozonation and ultraviolet light (UV) 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, however have not identified the best treatment conditions.

The EPA estimates that the use of alkaline chlorination to destroy dithiocarbamate pesticide active ingredients not currently being treated will result in the elimination of 5,700 pounds of PAI from plant discharges annually.

7.3.4 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 achieve very low discharge concentrations ranging from 3 to 32 ppb PAI in the treated effluent. BAT is being proposed 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.

7.3.5 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 for those facilities expected to comply with BAT/PSES guidelines through the use of existing solvent extraction systems.

EPA estimates that through the use of equalization to enhance existing solvent extraction systems, approximately 100 pounds of PAI discharge

will be eliminated per year, and wide variations in effluent loadings would be eliminated.

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 proposing 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.

7.3.6 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, 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.

7.3.7 Biological Treatment

In the case of one pesticide active ingredient, biological treatment has been demonstrated to achieve PAI removal levels characteristic of BAT performance. This facility currently achieves removals of greater than 98% PAI during biological oxidation, discharging less than 0.5 pounds of PAI

in wastewater per million pounds of PAI manufactured. 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.

7.3.8 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 tri-organotin compounds, this can be achieved through reacting the organotin 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 organotins 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 tri-organotin compounds. Removal efficiencies of up to 99.5% have been achieved on a long-term basis using this technology.

7.3.9 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 virtually 100% destruction of the PAI in wastewater streams. While the PAIs and other pollutants of concern are completely destroyed, an effluent stream is generated from the scrubber on the incinerator overheads. At some facilities, the incinerators do not achieve 100% efficiency, and trace amounts of PAI remain in the scrubber discharge. EPA estimates that approximately 4,000 pounds of PAI are destroyed annually through on-site incineration of PAI manufacturing wastewater.

7.4 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 have been proposed and discusses options available for compliance with proposed zero discharge standards.

EPA identified two regulatory options for consideration to reduce the discharge of PAIs by organic pesticide 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. 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.

EPA is proposing BAT, NSPS, PSES, and PSNS limitations for Subcategory A plants based upon Option 1. As discussed elsewhere in this section, the identified BAT control technologies achieve a high level of pesticide pollutant removal while avoiding cross-media transfer of pollutants. A zero discharge requirement is also proposed for certain PAIs under Option 1 where zero discharge has been demonstrated to be achievable through water reuse or the lack of water use. The Agency proposes to reject the second option, zero discharge of all pesticide manufacturing wastewater pollutants, because of the cross-media implications of the transfer of pollutants as well as the severe economic impacts that would result from implementing this option.

Sections 7.4.1 through 7.4.6 provide a detailed discussion of the steps followed in the determination of effluent limitations guidelines and standards for PAIs. These steps include:

7.4.1 Statistical analysis of long-term self-monitoring data;

7.4.2 Calculation of effluent limitations guidelines under BAT;

7.4.3 Calculation of effluent limitations guidelines under NSPS;

7.4.4 Analysis of POTW pass-through for PAIs; and

7.4.5 Calculation of effluent limitations guidelines under PSES and PSNS.

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 is proposing weekly (four times per month) monitoring to demonstrate compliance. These procedures are discussed in the following section.

7.4.1 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 PAI's 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.

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

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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.

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:

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

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

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

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

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

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:

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

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, $\hat{V}F(1)$.

The daily variability factor multiplied by the long-term mean yields the value used by EPA as the daily maximum limitation. An analogous measure of the maximum limitation for the average (or mean) of four daily concentration measurements can also be defined and estimated from the data. The definition of the four-day variability factor, VF(4), is the 95th

percentile of the distribution of four-day means, divided by the expected value of four-day means.

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:

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

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

and

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

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:

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

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.

7.4.2 Calculation of Effluent Limitations Guidelines 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. Effluent limitations were generated for the PAIs for which there were no performance data by:

- Setting achievable concentrations for each structural group and technology performance based on treatability study results;
- Applying variability factors for each structural group and for each technology; and
- Determining mass discharge allowances based on long-term average flow and annual production levels.

EPA identified 69 PAI structural groups. These groups and the PAIs in them are listed in Table 7-2. The Agency is proposing numerical and zero discharge limits for 93 PAIs and salts and esters of PAIs in 33 of these groups. These PAIs and groups are listed in Table 7-3. Fifteen of these PAIs and salts and esters are receiving zero discharge limitations because there are plants manufacturing these pesticides who are currently achieving zero discharge. The zero discharge technologies in-place at the BAT facilities for these PAIs include dry manufacturing processes, manufacturing processes which do not discharge wastewater, recovery and reuse of wastewater, on-site incineration of wastewater, and distillation of wastewater for reuse. Numerical limitations are being proposed for the remaining 78 PAIs and salts and esters. Of these 78 PAI groups, 62 are associated with plants that have full-scale treatment systems in place.

The Agency based BAT limitations for these 62 PAIs on actual data of PAI concentrations in wastewaters treated by the full-scale BAT treatment

Table 7-2

PAI STRUCTURAL GROUPS

Structural Group	PAI #	PAI Name	Limit Type
2,4-D	14	2,3,6-T, S&E	Reserved Not Mfg in 1986
2,4-D	15	2,4,5-T	Reserved Not Mfg in 1986
2,4-D	15	2,4,5-T, S&E	Reserved Not Mfg in 1986
2,4-D	16	2,4-D, S&E	No Discharge
2,4-D	16	2,4-D	Numerical
2,4-D	17	2,4-DB, S&E	No Discharge
2,4-D	27	MCPA, S&E	No Discharge
2,4-D	30	Dichlorprop, S&E	No Discharge
2,4-D	31	MCPP, S&E	No Discharge
2,4-D	34	Chlorprop, S&E	Reserved Not Mfg in 1986
2,4-D	46	CPA, S&E	Reserved Not Mfg in 1986
2,4-D	47	MCPB, S&E	Reserved Not Mfg in 1986
2,4-D	238	Silvex	Reserved Not Mfg in 1986
Acetamide	115	Diphenamide	Reserved
Acetamide	136	Fluoroacetamide	Reserved Not Mfg in 1986
Acetamide	242	Sodium fluoroacetate	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
Alkyl Acid	227	Propionic acid	Reserved
Alkyl Halide	81	Chloropicrin	Reserved
Alkyl Halide	92	Dalapon	Reserved Not Mfg in 1986
Alkyl Halide	160	Methyl bromide	Reserved (PP Reg)
Aryl	67	Biphenyl	No Discharge

Table 7-2

(Continued)

Structural Group	PAI #	PAI Name	Limit Type
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
Aryl Halide	110	DCPA	Numerical
Aryl Halide	129	Chlorobenzilate	Reserved
Aryl Halide	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
Bicyclic	123	Endothall, S&E	No Discharge
Bicyclic	177	MGK 264	Reserved
Bicyclic	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	Polyphase	Reserved
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

Table 7-2

(Continued)

Structural Group	PAI #	PAI Name	Limit Type
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
Carbamate	170	Napropamide	Reserved
Carbamate	195	Oxamyl	Reserved Not Mfg in 1986
Carbamate	260	Thiophanate methyl	Reserved Not Mfg in 1986
Carbamate	272	Chloropropham	Reserved
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
Chlorophene	11	Dichlorophene	Reserved
Chloropropionanilide	41	Propanil	Numerical
Chloropropionanilide	82	Chlorothalonil	Numerical
Coumarin	43	Coumafuryl	Reserved Not Mfg in 1986
Coumarin	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

Table 7-2

(Continued)

Structural Group	PAI #	PAI Name	Limit Type
Dithiocarbamate	134	Ferbam	Reserved Not Mfg in 1986
Dithiocarbamate	151	Maneb	Reserved Not Mfg in 1986
Dithiocarbamate	152	Manam	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	Reserved
EDB	3	EDB	Reserved
EDB	5	Dichloropropene	Reserved
EDB	97	DBCP	Reserved Not Mfg in 1986
Ester	64	Benzyl benzoate	Reserved Not Mfg in 1986
Ester	117	MGK 326	Reserved
Ester	157	Methoprene	Reserved
Ester	216	Piperonyl butoxide	Reserved
HCp	93	Dienochlor	Reserved Not Mfg in 1986
Heterocyclic	28	Octhilinone	Reserved
Heterocyclic	32	Thiabendazole	Reserved
Heterocyclic	35	TCMTB	Numerical
Heterocyclic	49	Etridiazole	Reserved
Heterocyclic	175	Norflurazon	No Discharge

Table 7-2

(Continued)

Structural Group	PAI #	PAI Name	Limit Type
Heterocyclic	210	Nemazine	Reserved
Heterocyclic	240	Sodium bentazon	Reserved Not Mfg in 1986
Heterocyclic	259	Dazomet	Numerical
Hydrazide	2	Maleic Hydrazide	Reserved Not Mfg in 1986
Iminamide	59	Amitraz	Reserved Not Mfg in 1986
Indandione	114	Diphacinone	Reserved Not Mfg in 1986
Isocyanate	118	Nabonate	Numerical
Lindane	63	BHC	Reserved Not Mfg in 1986
Lindane	147	Lindane	Reserved Not Mfg in 1986
Miscellaneous	21	Busan 90	Reserved
Miscellaneous	29	Pindone	Reserved Not Mfg in 1986
Miscellaneous	37	Chlorophacinone	Reserved Not Mfg in 1986
Miscellaneous	71	Giv-gard	Reserved
Miscellaneous	90	Fenvalerate	Numerical
Miscellaneous	96	Amobam	Reserved Not Mfg in 1986
Miscellaneous	153	Mefluidide	Reserved Not Mfg in 1986
Miscellaneous	164	Quinomethionate	Reserved Not Mfg in 1986
Miscellaneous	196	Oxyfluorfen	Reserved
Miscellaneous	201	Propoxur	Reserved Not Mfg in 1986
Miscellaneous	209	Phenmedipham	Reserved Not Mfg in 1986
Miscellaneous	214	Phosphamidon	Reserved Not Mfg in 1986
Miscellaneous	221	Metasol J26	Reserved
Miscellaneous	225	Propargite	Reserved Not Mfg in 1986
Miscellaneous	228	Previcur N	Reserved Not Mfg in 1986
Miscellaneous	235	Rotenone (Mexide)	Reserved Not Mfg in 1986
Miscellaneous	244	Sulfoxide	Reserved Not Mfg in 1986

Table 7-2

(Continued)

Structural Group	PAI #	PAI Name	Limit Type
Miscellaneous	269	Triallate	Reserved Not Mfg in 1986
Miscellaneous	270	Phenothrin	Reserved Not Mfg in 1986
NR4	7	Dowicil 75	Reserved
NR4	56	Hyamine 3500	Reserved
NR4	105	Benzethonium chloride	Reserved Not Mfg in 1986
NR4	120	Metasol DGH	Reserved
NR4	121	Dodine	Reserved Not Mfg in 1986
NR4	149	Malachite Green	Reserved Not Mfg in 1986
NR4	159	Methyl benzethonium chloride	Reserved Not Mfg in 1986
NR4	162	Hyamine 2389	Reserved Not Mfg in 1986
NR4	217	PBED (Busan 77)	Reserved Not Mfg in 1986
Nitrobenzoate	66	Bifenox	Reserved
Organoantimony	273	Organo-Antimony	Reserved
Organoarsenic	6	Thenarsazine Oxide	Reserved Not Mfg in 1986
Organoarsenic	72	Cacodylic acid	Reserved Not Mfg in 1986
Organoarsenic	161	Monosodium methyl arsenate	Reserved
Organoarsenic	188	Organo-Arsenic	Reserved Not Mfg in 1986
Organocadmium	189	Organo-Cadmium	Reserved Not Mfg in 1986
Organocopper	88	Bioquin (Copper)	Reserved
Organocopper	89	Copper EDTA	Reserved Not Mfg in 1986
Organocopper	190	Organo-Copper	Reserved
Organomercury	191	Organo-Mercury	Reserved
Organotin	192	Organo-Tin	Numerical
Organozinc	266	Zinc MBT	Reserved Not Mfg in 1986
Phenol	44	DNOC	Reserved Not Mfg in 1986

Table 7-2

(Continued)

Structural Group	PAI #	PAI Name	Limit Type
Phenol	112	Dinoseb	Numerical
Phenol	206	PCP; sodium salt	Reserved
Phenol	206	PCP	Reserved
Phenol	211	Phenylphenol	Reserved
Phenol	258	Tetrachlorophenol	Reserved Not Mfg in 1986
Phenylcrotonate	19	Dinocap	Reserved
Phophorothioate	94	Demeton	Reserved Not Mfg in 1986
Phosphate	12	Dichlorvos	Numerical
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
Phosphonate	111	Trichlorofon	Reserved Not Mfg in 1986
Phosphoroamidate	128	Fenamiphos	Reserved Not Mfg in 1986
Phosphoroamidate	138	Glyphosate, S&E	No Discharge
Phosphoroamidate	138	Glyphosate	Reserved
Phosphoroamidate	139	Glyphosine	Reserved
Phosphoroamidothioate	52	Acephate	No Discharge
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

Table 7-2

(Continued)

Structural Group	PAI #	PAI Name	Limit Type
Phosphorodithioate	150	Malathion	Numerical
Phosphorodithioate	155	Methidathion	Reserved Not Mfg in 1986
Phosphorodithioate	183	Disulfoton	Numerical
Phosphorodithioate	185	Phosmet, single crystallized	No Discharge
Phosphorodithioate	185	Phosmet, double crystallized	No Discharge
Phosphorodithioate	185	Phosmet	Reserved
Phosphorodithioate	186	Azinphos Methyl (Guthion)	Numerical
Phosphorodithioate	197	Bolstar	Numerical
Phosphorodithioate	199	Santox (EPN)	Reserved Not Mfg in 1986
Phosphorodithioate	200	Fonofos	Reserved
Phosphorodithioate	212	Phorate	Numerical
Phosphorodithioate	213	Phosalone	Reserved Not Mfg in 1986
Phosphorodithioate	251	Bensulide	Reserved
Phosphorodithioate	255	Terbufos	Numerical
Phosphorothioate	85	Chlorpyrifos methyl	Reserved Not Mfg in 1986
Phosphorothioate	86	Chlorpyrifos	Numerical
Phosphorothioate	103	Diazinon	Numerical
Phosphorothioate	107	Parathion methyl	Numerical
Phosphorothioate	131	Famphur	Reserved Not Mfg in 1986
Phosphorothioate	133	Fenthion	Numerical
Phosphorothioate	179	Sulfotepp	Reserved Not Mfg in 1986
Phosphorothioate	180	Aspon	Reserved Not Mfg in 1986
Phosphorothioate	181	Coumaphos	Reserved Not Mfg in 1986
Phosphorothioate	182	Fensulfothion	Numerical

Table 7-2

(Continued)

Structural Group	PAI #	PAI Name	Limit Type
Phosphorothioate	184	Fenitrothion	Reserved Not Mfg in 1986
Phosphorothioate	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	Fenchlorphos (Ronnel)	Reserved Not Mfg in 1986
Phosphorothioate	253	Temephos	Reserved
Phosphorotrithioate	236	DEF	Numerical
Phosphorotrithioate	263	Merphos	Numerical
Phthalamide	176	Naptalam	Reserved
Phthalimide	73	Captafol	No Discharge
Phthalimide	74	Captan	Reserved
Phthalimide	137	Folpet	Reserved Not Mfg in 1986
Pyrethrin	57	Allethrin	Reserved Not Mfg in 1986
Pyrethrin	208	Permethrin	Numerical
Pyrethrin	229	Pyrethrin coils	Reserved Not Mfg in 1986
Pyrethrin	230	Pyrethrum I	No Discharge
Pyrethrin	231	Pyrethrum II	Reserved Not Mfg in 1986
Pyrethrin	232	Pyrethrins	Reserved Not Mfg in 1986
Pyrethrin	233	Resmethrin	Reserved Not Mfg in 1986
Pyrethrin	271	Tetramethrin	Reserved Not Mfg in 1986
Pyrethrin	275	Pyrethrin I & II	Reserved Not Mfg in 1986
Pyridine	215	Picloram	Reserved
Pyridine	215	Picloram	Reserved
Pyrimidine	132	Fenarimol	Numerical
Quinolin	50	Ethoxyquin	Reserved Not Mfg in 1986

Table 7-2

(Continued)

Structural Group	PAI #	PAI Name	Limit Type
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
Thiocarbamate	141	Cycloprate	Reserved Not Mfg in 1986
Thiocarbamate	245	Cycloate	Reserved
Thiocarbamate	246	EPTC	Reserved
Thiocarbamate	247	Molinate	Reserved
Thiocarbamate	248	Pebulate	Reserved Not Mfg in 1986
Thiocarbamate	249	Vernolate	Reserved
Thiocyanate	65	Lethane 60	Reserved Not Mfg in 1986
Thiocyanate	163	Nalco D-2303	Reserved
Thiosulphonate	250	HPTMS	Reserved
Toluamide	171	Deet	Reserved
Toluidine	125	Ethalfluralin	Numerical
Toluidine	144	Isopropalin	Numerical
Toluidine	178	Benfluralin	Numerical
Toluidine	264	Trifluralin	Numerical
Triazathione	45	Metribuzin	Numerical
Tricyclic	79	Chlordane	Reserved Not Mfg in 1986
Tricyclic	122	Endosulfan	Reserved Not Mfg in 1986
Tricyclic	124	Endrin	Numerical
Tricyclic	140	Heptachlor	Numerical
Uracil	68	Bromacil; lithium salt	No Discharge
Uracil	68	Bromacil	Numerical

Table 7-2

(Continued)

Structural Group	PAI #	PAI Name	Limit Type
Uracil	254	Terbacil	Numerical
Urea	83	Chloroxuron	Reserved Not Mfg in 1986
Urea	104	Diflubenzuron	Reserved Not Mfg in 1986
Urea	119	Diuron	Numerical
Urea	135	Fluometuron	Reserved
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
s-Triazine	8	Triadimefon	Numerical
s-Triazine	18	Anilazine	Reserved Not Mfg in 1986
s-Triazine	25	Cyanazine	Numerical
s-Triazine	33	Belclene 310	Reserved Not Mfg in 1986
s-Triazine	58	Ametryn	Numerical
s-Triazine	60	Atrazine	Numerical
s-Triazine	142	Hexazinone	Reserved
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 7-3

PAIs AND PAI STRUCTURAL GROUPS WITH PAI LIMIT DEVELOPMENT METHODOLOGIES

Structural Group	PAI #	PAI Name	Limit Type	BAT Technology
2,4-D	16	2,4-D	Numerical	CO
2,4-D	16	2,4-D, S&E	No Discharge	DIS/REC/ND
2,4-D	17	2,4-DB, S&E	No Discharge	DIS/REC/ND
2,4-D	27	MCPA, S&E	No Discharge	DIS/REC/ND
2,4-D	30	Dichlorprop, S&E	No Discharge	ND
2,4-D	31	MCPP, S&E	No Discharge	DIS/REC/ND
Acetanilide	26	Propachlor	Numerical	AC
Acetanilide	54	Alachlor	Numerical	AC
Acetanilide	70	Butachlor	Numerical	AC
Aryl	67	Biphenyl	No Discharge	ND
Aryl Halide	80	Chloroneb	Numerical	CO
Aryl Halide	110	DCPA	Numerical	AC, BO
Aryl Halide	205	PCNB	Numerical	AC
Benzeneamine	204	Pendimethalin	Numerical	IN
Benzoic Acid	53	Acifluorfen	Numerical	HD
Benzonitrile	69	Bromoxynil	Numerical	AC
Benzonitrile	69	Bromoxynil octanoate	Numerical	AC
Bicyclic	123	Endothall, S&E	No Discharge	ND
Bicyclic	262	Toxaphene	Numerical	AC
Carbamate	55	Aldicarb	Numerical	HD
Carbamate	62	Benomyl	Numerical	HD
Carbamate	75	Carbaryl	Numerical	HD
Carbamate	76	Carbofuran	Numerical	HD
Carbamate	156	Methomyl	Numerical	HD
Chlorobenzamide	39	Pronamide	Numerical	AC
Chloropropionanilide	41	Propanil	Numerical	BO

Table 7-3

(Continued)

Structural Group	PAI #	PAI Name	Limit Type	BAT Technology
Chloropropionanilide	82	Chlorothalonil	Numerical	BO
DDT	158	Methoxychlor	Numerical	CO
Dithiocarbamate	172	Nabam	Numerical	CO
Dithiocarbamate	218	Busan 85	Numerical	CO
Dithiocarbamate	219	Busan 40	Numerical	CO
Dithiocarbamate	220	KN Methyl	Numerical	CO
Dithiocarbamate	241	Carbam-S	Numerical	CO
Dithiocarbamate	243	Vapam (Metham Sodium)	Numerical	CO
Heterocyclic	35	TCMTB	Numerical	HD
Heterocyclic	175	Norflurazon	No Discharge	DIS/REC
Heterocyclic	259	Dazomet	Numerical	CO
Isocyanate	118	Nabonate	Numerical	CO
Miscellaneous	90	Fenvalerate	Numerical	HD, BO, SE
Organotin	192	Organo-Tin	Numerical	CO, CL
Phenol	112	Dinoseb	Numerical	AC
Phosphate	12	Dichlorvos	Numerical	HD
Phosphate	22	Mevinphos	Numerical	HD
Phosphate	84	Stirofos	Numerical	HD
Phosphate	173	Naled	No Discharge	ND
Phosphoroamidate	138	Glyphosate, S&E	No Discharge	ND
Phosphoroamidothioate	52	Acephate	No Discharge	IN
Phosphoroamidothioate	154	Methamidophos	Numerical	HD, AC
Phosphorodithioate	113	Dioxathion	Numerical	HD, AC
Phosphorodithioate	126	Ethion	Numerical	AC
Phosphorodithioate	150	Malathion	Numerical	HD
Phosphorodithioate	183	Disulfoton	Numerical	HD, BO, AC

Table 7-3

(Continued)

Structural Group	PAI #	PAI Name	Limit Type	BAT Technology
Phosphorodithioate	185	Phosmet, double crystallized	No Discharge	ND
Phosphorodithioate	185	Phosmet, single crystallized	No Discharge	ND
Phosphorodithioate	186	Azinphos Methyl (Guthion)	Numerical	HD, BO, AC
Phosphorodithioate	197	Bolstar	Numerical	HD, BO, AC
Phosphorodithioate	212	Phorate	Numerical	IN
Phosphorodithioate	255	Terbufos	Numerical	IN
Phosphorothioate	86	Chlorpyrifos	Numerical	CO
Phosphorothioate	103	Diazinon	Numerical	AC
Phosphorothioate	107	Parathion methyl	Numerical	HD, BO
Phosphorothioate	133	Fenthion	Numerical	HD, AC
Phosphorothioate	182	Fensulfothion	Numerical	HD, BO, AC
Phosphorothioate	203	Parathion ethyl	Numerical	HD, BO
Phosphorotrithioate	236	DEF	Numerical	HD, BO, AC
Phosphorotrithioate	263	Merphos	Numerical	HD, BO, AC
Phthalimide	73	Captafol	No Discharge	IN
Pyrethrin	208	Permethrin	Numerical	AC, RA
Pyrethrin	230	Pyrethrum I	No Discharge	IN
Pyrimidine	132	Fenarimol	Numerical	IN
Toluidine	125	Ethalfluralin	Numerical	AC
Toluidine	144	Isopropalin	Numerical	IN
Toluidine	178	Benfluralin	Numerical	AC
Toluidine	264	Trifluralin	Numerical	AC
Triazathione	45	Metribuzin	Numerical	HD, AC
Tricyclic	124	Endrin	Numerical	RA
Tricyclic	140	Heptachlor	Numerical	RA
Uracil	68	Bromacil	Numerical	AC

Table 7-3

(Continued)

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

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
SE = Solvent Extraction

systems operated at BAT levels at these plants, when such full-scale data were available. In some cases, pilot-scale data for BAT treatment systems were used when data from the full-scale systems were not available. In other cases, data were available for PAIs manufactured by plants that had full-scale treatment systems in-place, but the treatment systems were not achieving BAT treatment levels in final effluent. At some plants this was due to design factors such as equalization capacity, or due to operational factors such as reagent addition or carbon bed regeneration rate, which resulted in less than optimum treatment system performance. In these cases, EPA based BAT limits on treatability study data demonstrating the achievable optimum performance. At other plants, the BAT treatment was not applied to all the process wastewater streams generated during the manufacture of a particular PAI. In these cases, EPA based BAT limits on the full-scale treatment data extrapolated to cover all process wastewater streams.

BAT treatment system data were not available for 16 of the 78 PAIs. For 15 of these PAIs, short-term treatability study data were used in combination with variability factors transferred from plants operating full scale systems with the same BAT treatment technologies. For the remaining PAI group (pyrethrins), the Agency is proposing zero discharge limitations based on off-site incineration. Given the high toxicity of pyrethrins and the relatively low wastewater flow rates generated during pyrethrin manufacture, off-site incineration is the most economical treatment option.

More specifically, for each of the 62 PAI groups mentioned above, control technologies (including process controls and wastewater treatment systems) are already in place in at least one plant which manufactures the PAI. For 47 of these PAIs, sufficient full-scale data are available, including mass discharge rates and production rates, to develop BAT mass-based limitations. Daily maximum and four-day maximum average discharge limitations were based on achievable effluent concentrations demonstrated by in-place and currently-operating BAT treatment, i.e., the results of plant self-monitoring. The achievable daily maximum and four-day maximum average concentrations were then multiplied by average long-term flow rates to determine the long-term mass discharge of PAI, and then divided by long-term production rates to generate discharge limitations based on the production of the specific PAI. Flow and production data were obtained, in order of preference, from available data either supplied with the self-monitoring data set, from 1986 or 1977 Section 308 census data submissions, or from EPA sampling data or site visit reports.

For six of the PAIs manufactured at plants with BAT-type technology in-place, BAT limitations are based on structurally similar (and analytically indistinguishable) PAIs manufactured at the plants. For example, one facility manufactures two similar phosphorotrithioates, and has monitoring data indicating effective treatment, through hydrolysis, of one of these PAIs. The second phosphorotrithioate cannot be analytically distinguished from the first because it rapidly oxidizes to it. The second PAI would either react via hydrolysis at the same rate as the first or would oxidize to the first and

then hydrolyze. The second PAI can achieve the same BAT limit as the first PAI. In the same way, two toluidine PAIs cannot be analyzed separately and apart from a third toluidine PAI; therefore, the BAT limitations for these two PAIs have been set equal to the BAT limitations for the third toluidine PAI. The same methodology was used to develop BAT limitations for a benzonitrilile PAI, a dithiocarbamate PAI, and a phosphorothioate PAI. These PAIs are not analytically discernable from structurally similar PAIs, and therefore have been regulated based upon the BAT limitations for their matching PAIs.

For nine of the PAIs manufactured at plants with BAT-type technology in-place, the technology is either being used to control only a portion of the process wastewater or is not operating at BAT performance levels. In these cases, BAT limitations were based on the effluent quality which could be achieved through extending and optimizing BAT technology to control all process wastewaters. For those PAIs manufactured at plants employing BAT technology on only a portion of the process wastewater, the achievable daily maximum and four-day maximum average concentrations were multiplied by average long-term flow rates for the entire process wastewater discharge, treated and untreated wastewater, to determine the long-term PAI mass discharge. For those PAIs manufactured at plants employing BAT technology but not operating at BAT performance levels, BAT limitations were based on discharge concentrations demonstrated to be achievable either by plant data or by treatability studies, and on variability factors derived from actual system performance. Daily maximum and four-day maximum average

discharge limitations were then calculated by multiplying by the average long-term flow rates and then dividing by the long-term production rates.

Numerical BAT limitations are being proposed for 15 PAIs, in 8 structural groups, based on treatability study data combined with data transfer of actual system performance data. As discussed earlier in this section, treatability studies were conducted to characterize the efficacy with which activated carbon, hydrolysis, and chemical oxidation could treat certain PAIs. When PAI concentration data were not available for wastewater streams treated by full-scale BAT treatment systems, the Agency based BAT on the transfer of limitations and estimated performance data for structurally similar PAIs. Variability factors for the treatment of these PAIs were based on the performance of BAT treatment systems utilizing the same technology, and when sufficient data were available, on PAIs with similar structures.

EPA is proposing BAT limitations for two uracil PAIs, one chlorobenzamide PAI, one phosphorodithioate PAI, and four s-triazine PAIs based on short-term activated carbon adsorption treatability study data, because there are no available full-scale operating data. A treatability study provided isotherm and continuous column data for the treatment of these PAIs in activated carbon adsorption systems. The treatability study data were used to demonstrate that the PAIs are treatable to achievable BAT concentrations; however, it was necessary to relate this information to actual operating systems to generate achievable daily maximum and four-day average maximum BAT concentrations, as well as the mass-based effluent limitations.

In order to do this, EPA transferred arithmetic factors (as described below) and variability factors from other activated carbon adsorption systems operating at low PAI effluent concentrations.

The arithmetic factor deals with the practicality of analyzing for the PAI at concentrations very close to the detection limit. For all PAIs treated using activated carbon adsorption, an arithmetic factor was developed to reflect the amount that the mean effluent concentration was above the detection limit used to analyze that matrix. It was assumed that each facility utilizes as low a detection limit as is practical to achieve consistent long-term analyses for each PAI in each plant's wastewater matrix. This factor is a ratio of the long-term mean effluent concentration (LTM) to minimum detection limit (MDL), and ranged from 1.03 to 7.35 for the systems considered, with an average ratio of 4.31. This ratio was used in conjunction with the minimum detection limit used by one of the PAI manufacturing plants in their analysis of the PAI in treated wastewater samples to calculate an achievable long-term mean concentration. In no cases did this calculation procedure generate concentrations lower than those achieved in treatability testing.

The statistical variability factors applied to limitations development were those calculated for average BAT activated carbon systems. BAT operating data for 6 full-scale activated carbon systems and one small scale activated carbon system which rely on activated carbon to control pesticides were used to develop daily maximum and four-day maximum average

variability factors. The data sets used to develop these factors were not necessarily generated from systems incorporating the two optimal design parameters recommended above and, therefore, effluent concentrations were higher than would be expected with these optimizations. The average variability factors calculated were 7.15 (daily) and 2.41 (four-day). Achievable daily maximum and four-day average BAT effluent concentrations were then calculated using the arithmetic and variability factors and the treatability study concentrations. These concentrations were converted to mass normalized limitations using the long-term average process discharge flow for each specific PAI, and the average production for each specific PAI manufacturing process which discharges water.

In the case of the four s-triazine PAIs, industry did provide EPA with long-term monitoring data characterizing treated effluent (though not from activated carbon) from the manufacture of two other s-triazine PAIs. EPA therefore used the average long-term monitoring data results as a target for the performance levels achievable for s-triazines manufactured by other facilities. EPA treatability studies on plant wastewater demonstrated that even greater s-triazine removal rates could be achieved through the use of granular activated carbon (GAC) adsorption. Additional treatability study information supporting this conclusion was available from the s-triazine manufacturers themselves. The BAT limitations were therefore based on the removal rates achievable through the use of granular activated carbon. Variability factors were transferred and mass-based BAT limitations were calculated based on the methodology discussed above.

EPA is proposing BAT limitations for a phosphorodithioate PAI based on short-term hydrolysis treatability study data, because there are no available full-scale operating data. This treatability study was conducted on a "synthetic" wastewater stream; that is, deionized water spiked with the PAI. Hydrolysis is used to treat a variety of other phosphorodithioate PAIs, with treatment efficacy quantified through long-term self-monitoring data on these PAIs. Literature data demonstrates that hydrolysis for this PAI takes place faster than hydrolysis of other phosphorodithioates; therefore, EPA concluded that wastewater from the manufacture of this PAI can be treated to equal effluent concentrations.

Similar to the methodology used to evaluate carbon adsorption as BAT technology, daily and four-day variability factors (4.88 and 1.92, respectively) and the LTM/MDL factor (3.40) were transferred from hydrolysis effluent data for other phosphorodithioate PAIs to describe BAT hydrolysis system performance in treating this PAI. These factors were used in conjunction with the minimum detection limit reported by one of the manufacturing plants for their PAI analysis to calculate BAT concentrations for this PAI. These concentrations were then converted to mass normalized limitations using the long-term average process discharge flow and average production for this PAI at this plant.

EPA is proposing BAT limitations for a carbamate PAI based on short-term hydrolysis treatability study data, because there are no available full-scale operating data. As with the phosphorodithioate PAI discussed

above, this treatability study was conducted on a "synthetic" wastewater stream; that is, deionized water spiked with the PAI. Hydrolysis is used to treat a variety of other carbamate PAIs, with treatment efficacy quantified through additional EPA treatability studies on these PAIs. In particular, one plant that manufactures this PAI also manufactures two other carbamate PAIs, and treats the process wastewater with hydrolysis. It was observed that hydrolysis of this carbamate PAI takes place faster than hydrolysis of other carbamates; therefore, EPA concluded that wastewater generated during the manufacture of this PAI can be treated to equal effluent concentrations.

The daily and four-day variability factors (3.57 and 1.59, respectively) and the average LTM/MDL ratio (1.19) were developed based on the treatment data for the hydrolysis of the two carbamate PAIs manufactured with this PAI. These factors were used in conjunction with the minimum detection limit reported by a carbamate manufacturing plant for their PAI analysis to calculate BAT concentrations. These concentrations were then converted to mass normalized limitations using the long-term average process discharge flow and average production for the PAI at this plant.

EPA is proposing BAT limitations for three dithiocarbamates PAIs and one isocyanate PAI based on short-term chemical oxidation treatability study data, because there are no available full-scale operating data. The dithiocarbamates were treated as one group because the analytical method for dithiocarbamates does not distinguish among individual PAIs. The isocyanate PAI is included with the dithiocarbamates because it is manufactured and

treated using technologies common to dithiocarbamate PAIs; in addition, the analytical method cannot distinguish between the isocyanate PAI and the dithiocarbamate PAIs.

Self-monitoring and chemical oxidation treatability study data were available at one plant utilizing chemical oxidation to treat dithiocarbamate PAIs. The plant self-monitoring data was not directly used to set BAT limitations because this plant was treating to meet specific limitations, rather than treating to achieve maximum PAI removal. The facility did report occasional non-detects, and achieved non-detects during EPA sampling. EPA checked these results by conducting a chemical oxidation treatability study on actual plant wastewater samples containing dithiocarbamate PAIs. Results of the treatability study demonstrated that effluent concentrations at or below the method detection limit were achievable for each of these PAIs through chemical oxidation. Variability factors were developed based on the performance of the operating chemical oxidation system at this plant, and these factors were applied to the proposed achievable concentration and used with flow and production data from the same facility to develop mass based limitations.

EPA is proposing BAT limitations for a heterocyclic PAI based on short-term hydrolysis treatability study data, because there are no available full-scale operating data. The treatability study data indicates that hydrolysis of this PAI occurs very rapidly. While there are no data on the hydrolysis of any PAIs with a similar heterocyclic structure to this PAI,

treatability data are available for a number of PAIs with hydrolysis systems performing at BAT levels that have half-lives approximately equal to this PAI. Therefore, variability factors and LTM/MDL ratios were averaged from the list of all hydrolysis-treated PAIs. The average LTM/MDL was 2.44, and the average variability factors were 4.18 (daily maximum) and 1.74 (four-day maximum average). Using this method, achievable daily maximum and four-day maximum average BAT effluent concentrations were calculated. These concentrations were then converted to mass normalized limitations using the long-term average process discharge flow and average production for the heterocyclic PAI at this plant.

A synthetic pyrethrin manufacturing facility currently discharges a low volume of highly concentrated pyrethrin process wastewater to a POTW without treatment. Due to the high concentration of pyrethrin in the plant's discharge water, and the relatively high toxicity of this PAI, treatment prior to disposal is required. Because the flow rate of the waste stream is low, off-site incineration, rather than implementation of on-site treatment, has been determined to be the treatment option with the least cost.

7.4.3 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 reasonableness of costs to implement the best treatment technologies for new plants is considered when setting NSPS limitations. EPA

is proposing NSPS limitations for all the PAIs for which BAT limitations are being proposed. 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 would 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 guidelines for treatment of new PAIs.

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/PSNS PAI guidelines, the Agency investigated trends in reduction of contaminated wastewater discharges by newer manufacturing facilities. To derive the average flow reduction achieved, the Agency compared the 1977 Census industry responses with the 1986 Census responses to determine which PAI processes in operation in 1986 were not in operation during or before 1977. For

Subcategory A, EPA identified 36 processes at 29 plants which appear to have started-up since 1977.

EPA determined the total process wastewater flow to treatment for each product, and then calculated the average flow to treatment per pound of product for both older (pre-1977) and newer (post-1977) plants. EPA did not include flows identified as storm water because the amount of stormwater is not related to production process or production rate. (There will be higher storm water flows in rainy areas of the country than in arid areas.)

"Older" (pre-1977) processes manufactured 737 million pounds of PAIs per year, and generated 1,141 million gallons of total process wastewater, of which 801 million gallons were contact wastewater. This results in production normalized wastewater discharges of 1.55 gallons per pound of PAI for total process wastewater. The corresponding "newer" (post-1977) processes manufacture 94 million pounds of PAIs per year, and generate 104 million gallons of total process wastewater. This results in production normalized wastewater discharges of 1.11 gallons per pound of PAI for total process wastewater.

Between the "Older" and "Newer" plants, there is a difference of 0.44 (1.55-1.11) gallons per pound in total wastewater discharged, representing a 28% reduction in flow.

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. Newer facilities also incorporate a greater degree of segregation between contact streams resulting from pre-PAI formation steps and post-PAI formation steps in the processes. It is clear that selective treatment using PAI destruction/removal technologies of only contaminated wastewater streams can also reduce the flow to and therefore the cost of PAI treatment processes. Source segregation reduces the amount of PAI-contaminated wastewater requiring treatment by a PAI destruction/removal technology. As a result, the size and throughput as well as the corresponding cost of the PAI treatment step are reduced in newer facilities.

There are two factors which affect the projected flow reductions achievable. First, the pesticides produced at the post-1977 plants typically are new PAIs instead of new production of PAIs already being manufactured. As a result, it is generally not possible to directly compare wastewater flow rates from "Old" and "New" plants manufacturing the same PAI. "New" plants, however, would have the capability to better segregate wastewater streams and therefore minimize the flow rate of PAI-contaminated wastewater to PAI treatment. Therefore, EPA believes that flow reduction equal to or greater than 28% is achievable (except as described below for two PAIs), since industry has already demonstrated this reduction in the newer plants. Second, despite dividing the industry into pre- and post-1977 processes, some of the flows documented as pre-1977 values may in fact already reflect some flow

reduction due to process modifications which have reduced or further segregated flow. Because information concerning modifications is not readily available, these changes are not included in this analysis, but it is possible that additional data would document a higher overall flow reduction than 28% from the pre-1977 plants.

The Agency is proposing NSPS effluent limitations for Subcategory A PAIs to be the BAT limitations modified by 28% flow reduction (except as described below). In other words, NSPS for each PAI with a numerical BAT effluent limitation is equal to the BAT limit multiplied by 0.72. The Agency decided not to equate the NSPS limitations with the BAT limitations, because EPA believes that flow reduction has been demonstrated and is achievable. In addition, because flow reduction may decrease the BAT treatment costs, new plants will likely include flow reduction as an integral part of the plant design. The Agency decided not to require zero discharge of process wastewater pollutants as the NSPS limitations because the costs and associated economic impacts of this option are considered to be essentially the same as those for BAT Option 2, since the costs of on-site or off-site incineration (and associated transportation costs) and recycle/reuse would be the same at new and existing plants. The NSPS zero discharge option, like BAT Option 2, therefore would be extremely expensive. The Agency proposes to reject this option because the economic impact of this option would be too severe. The Agency decided not to base NSPS on the addition of membrane filtration technology to BAT treatment plus flow reduction because the removal

levels that this technology can achieve have not been demonstrated at any pesticide chemicals manufacturing plant.

There are two PAIs (carbofuran and DEF) being proposed for regulation (with non-zero limitations) that are being produced at plants or process lines constructed after 1977. Data from these newer plants/processes show that they have achieved flow reductions of at least 28% compared to similar production processes employed at older plants. Therefore, because there is no information demonstrating that further flow reductions are possible, EPA is setting the proposed NSPS limitations for these two PAIs equal to the proposed BAT limitations. In addition, equivalent NSPS limitations are being set for merphos and DEF, because they are analytically indistinguishable PAIs.

The Agency has determined that limitations that are more stringent then BAT limitations required for existing plants can be achieved both technically and economically. These limitations provide for reduction of pollutants discharged into the environment beyond that which is achieved by BAT. In addition, enhanced cross-media pollution control would be realized, due to the reduction in wastewater flow prior to treatment.

7.4.4 Analysis of POTW Pass-Through for PAIs

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 110,000 pounds of PAIs and 29,000 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.

In addition to pass-through, many 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).

7.4.5 Calculation of Effluent Limitations Guidelines Under PSES and PSNS

Based on the results of the pass-through analysis, EPA is proposing 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. EPA is proposing PSES limitations 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. This option is economically achievable and greatly reduces pollutants discharged into the environment, as pollutants not recycled or reused are destroyed by treatment. Option 2 is proposed to be rejected because of the cross-media implications of the transfer of pollutants as well as the severe economic impacts that would result from implementing this option.

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 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. Proposed PSNS for Subcategory A are based on the proposed PSES technologies, modified to reflect the flow reduction capable at certain new facilities. EPA also considered the zero discharge option, but it was rejected due to the resulting severe economic impact.

7.5 EFFLUENT LIMITATIONS DEVELOPMENT FOR PRIORITY POLLUTANTS

This section discusses the development of effluent limitations guidelines and standards for priority pollutants in Subcategory A of the pesticide chemicals manufacturing industry. As discussed in Section 13, EPA is proposing to reserve further regulations for Subcategory B priority pollutants.

EPA is proposing effluent limitations and pretreatment standards for 28 priority pollutants. For 23 of these 28 priority pollutants, EPA is relying on the OCPSF database to set limits that are identical to the limits set for these pollutants in the OCPSF guidelines. For four other priority pollutants which were not regulated under OCPSF and for which there are no treatment performance data, EPA is using limitations set in the OCPSF guidelines for other priority pollutants that are deemed to have similar "strippabilities". This is the same procedure used in the OCPSF rulemaking for developing limitations when performance data was lacking for certain priority pollutants. Limitations for one priority pollutant, cyanide, are

proposed based on actual long-term full-scale data from the pesticide industry.

For 23 priority pollutants, the Agency proposes to transfer BAT limitations form the OCPSF category. As discussed earlier in Section 3, 55 of the 90 pesticide chemicals manufacturing facilities also manufacture compounds regulated under the OCPSF category. Typically, wastewaters from pesticide manufacture are ultimately commingled with OCPSF wastewaters generated at the site and treated in the same end-of-pipe (EOP) 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.

7.5.1 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 pesticides manufacturing. EPA therefore is proposing that the BAT limitations for these 23 pollutants be 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 for BAT under the OCPSF category. EPA is proposing to set BAT effluent limitations for those four pollutants by transferring OCPSF limitations for compounds that have similar strippabilities. BAT limitations for cyanide are being proposed based on treatment data from pesticide manufacturing facilities.

7.5.1.1 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. For the volatiles limited on 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, 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 proposing today to set limitations 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 proposed in today's notice for pesticides 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 proposed for volatile pollutants.

As explained above, the proposed 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 "Subcategory J" limitations) and a different, generally more stringent set of limitations for those plants that do (the OCPSF "Subcategory I" limitations).

In the OCPSF litigation, NRDC claimed that EPA had not sufficiently aired this methodology for comment. Also, on the merits, NRDC claimed that EPA's approach is improper because it allows facilities to meet fewer and less stringent limits on the priority pollutants by choosing not to use end-of-pipe biological treatment to treat their conventionals. The court

remanded this issue to EPA for further notice-and-comment proceedings, and the Agency is in the midst of a new rulemaking to resolve this issue for the OCPSF rule.

On remand, EPA reconsidered this methodology and issued a re-proposal in December, 1991 that adopts the same approach that was originally promulgated (56 FR 63897). The re-proposal discusses NRDC's claims and explains in detail why EPA still believes the original approach is appropriate. To summarize that discussion, the Agency recognized that certain OCPSF facilities, such as chlorosolvent plants, have BOD_5 levels that are too low to allow for effective biological wastewater treatment and do not require end-of-pipe biological treatment to meet their BPT limitations. A biological system cannot operate effectively without a sufficient mass of organic biodegradable material to sustain the microorganisms that consume the biodegradable waste. EPA concluded that these plants should not have their BAT effluent limitations based on the performance of in-plant controls and end-of-pipe biological treatment. Therefore, the OCPSF Subpart J effluent limitations were based solely on the performance of in-plant controls such as steam stripping.

NRDC urged the EPA to establish a raw waste "floor" level below which biological end-of-pipe treatment is not appropriate or to limit the applicability of Subpart J to those categories of OCPSF production that tend to have low raw waste levels. This suggestion appeared logical in theory but EPA concluded that it was not feasible in practice. The Agency explained

that, due to the wide variety and complexity of raw materials and processes used and of products manufactured in the OCPSF industry, it would be nearly impossible to analyze each plant's wastestream to determine a technically defensible BOD_5 floor, or series of floors for different plants with different operating and wastewater characteristics, especially when the literature does not provide a theoretical basis for a BOD_5 cutoff.

EPA also determined that the BOD_5 floor suggested by NRDC was not necessary. Common sense and economic considerations dictate that OCPSF plants will not opt to forego end-of-pipe biological treatment in order to qualify for the Subpart J BAT limitations. Moreover, the Agency found that Subpart J will not result in significantly greater environmental loadings than Subpart I.

In addition, EPA found that NRDC's suggestions could result in undesirable treatment decisions. The Agency's OCPSF regulatory scheme gives the regulated community some degree of management discretion in selecting appropriate combinations of source controls or pollution prevention techniques as well as appropriate in-plant or end-of-pipe wastewater management and treatment techniques. The Agency is concerned that the attempt to establish a BOD_5 floor would result in plants making undesirable treatment decisions that the Agency did not intend; for example, a plant that has already installed or is considering installing in-plant product and by-product recovery may feel compelled to reduce the effectiveness of in-plant control to ensure that sufficient organic matter is available to be able to operate an end-of-pipe

biological treatment system, or to operate such a system in a cost-effective fashion.

The proposed 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 limits, one for plants that use end-of-pipe biological treatment and one for plants that do not. As with the OCPSF industry, some pesticides manufacturers fall into each category. EPA is proposing this approach in order to be consistent with what was promulgated (and now re-proposed) for OCPSF. Moreover, consistency with the OCPSF regulations is necessary in some cases to avoid having two different sets of limits applicable to the same pollutant being discharged by a single combined OCPSF/pesticides plant. EPA expects that any change it may adopt in this approach when the December, 1991 OCPSF re-proposal is made final will also be reflected in the final pesticides manufacturing rule.

EPA notes that there are two priority pollutants (2-chlorophenol and 2,4-dichlorophenol) for which limitations are proposed for plants that use end-of-pipe biological treatment but for which limitations are not proposed 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 proposed 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 Development Document, Section 7).

In this proposal for pesticides 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 limits.

In considering NRDC's suggestions, EPA concluded in the December, 1991 OCPSF re-proposal 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 proposed rule.

7.5.1.2 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. EPA is proposing to set BAT effluent limitations for those four pollutants by transferring OCPSF limitations for compounds that have similar strippabilities.

Of the four brominated organic compounds found in pesticide manufacturing process wastewater, 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 1 or more were detected in 7 of 20 EPA sampling episodes between 1988 and 1990.

Based on comparisons of Henry's Law coefficients for these compounds with other priority pollutants which were regulated under OCPSF, it appears that all may be removed by steam stripping. Two, bromomethane and bromodichloromethane, would be identified as "highly strippable" under the criteria utilized during OCPSF compliance costing, while the others, dichlorobromomethane and tribromomethane, would be identified as "medium strippable."

BAT guidelines are being proposed based on a comparison with compounds having Henry's Law coefficients above and below the brominated compound. These compounds, with their Henry's Law coefficients (as listed in the OCPSF development document, in mg/l in air/mg/l in water), are as follows:

Brominated Compound		Regulated Compound (high)		Regulated Compound (low)	
Bromomethane	8.21	none		1,1-Dichloroethene	7.92
Tribromomethane	0.023	Naphthalene	0.019	Hexachlorobenzene	0.028
Bromodichloromethane	0.10	Chloroform	0.14	Methylene Chloride	0.096
Dibromochloromethane	0.041	1,2-Dichloroethane	0.046	1,1,2-Tetrachloroethane	0.032

EPA decided to base BAT concentration guidelines on the compounds closest to the Henry's Law coefficients of the brominated compound which have the highest limitations under OCPSF. These concentrations are as follows:

Brominated Compound	Regulated Compound	Daily Max	Four-day Max
Bromomethane	1,1-Dichloroethene	25 ppb	16 ppb
Tribromomethane	Naphthalene	59 ppb	22 ppb
Bromodichloromethane	Methylene Chloride	89 ppb	40 ppb
Dibromochloromethane	1,2-Dichloroethane	211 ppb	68 ppb

7.5.1.3 Lead

The OCPSF rule set a concentration-based limitation on lead, to be applied only to the flows discharged from metals-bearing process wastewaters (see 52 FR 42542). 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 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 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) (see discussion at 52 FR 42543).

7.5.1.4 Cyanide

The proposed limitations for total cyanide 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 (# > DL)	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
B Organic Chemical Manufacturing Plant
BO Biological Oxidation
CO Chemical Oxidation

7.5.2 Calculation of Effluent Limitations Guidelines Under NSPS

The Agency is proposing to set NSPS limitations 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.

7.5.3 Calculation of Effluent Limitations Guidelines Under PSES

To evaluate the need for PSES for the priority pollutants, EPA relied on an analysis originally done to support the OCPSF regulations. (See

Section 6 of the OCPSF Technical Development Document.) 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 shows that 21 of these 23 priority pollutants pass through; the only priority pollutants of those 23 for which pass-through is not demonstrated are 2-chlorophenol and 2,4-dichlorophenol.

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.

There are very little data to determine POTW removals for the four brominated priority pollutants: bromomethane, bromoform (tribromomethane), dicromochloromethane, 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 occurs in sewers rather than removal via treatment, and the Agency would expect similar volatilization to 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,

the Agency proposes to determine that pass-through does occur for these four brominated priority pollutants.

Based on the 50-plant study, the average percent removal of cyanide by well-generated POTW's achieving secondary treatment is about 54% whereas, based on full-scale data, the BAT technology removes more than 99 percent. Therefore, pass through does occur for cyanide.

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 and 2,4-dichlorophenol.

7.5.4 Calculation of Effluent Limitations Guidelines Under PSNS

The Agency is proposing PSNS limitations for 26 of the 28 priority pollutants addressed under NSPS. As discussed under PSES, two priority pollutants, 2-chlorophenol and 2,4-dichlorophenol, have not been shown to pass through a POTW and therefore are not being proposed for regulation under PSNS. EPA is proposing concentration-based PSNS limitations equal to the PSES limitations.

7.6 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 today proposing to amend the BPT applicability provision for Subcategory A PAIs to include 15 of these 25 previously excluded PAIs, as well as the organotin pesticides. As discussed in Section 13, no BCT treatment technologies were identified that passed the BCT cost test. As a result, the Agency is proposing to set the BCT limitations for Subcategory A PAIs equal to the BPT limitations.

NSPS effluent limitations and standards would also be set equal to BPT limitations but would reflect a reduction in wastewater flow of 28% in the manner described above for PAIs.

SECTION 8

ENGINEERING COSTS

8.0 INTRODUCTION

This section discusses the costs for treatment technologies for the pesticide chemicals manufacturing industry for compliance with the 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 effluent limitations guidelines are based.

8.1.1 Cost Methodologies

First, the processes of each plant were evaluated to determine raw pollutant discharges. Next, the pollutant discharge levels were compared with the proposed effluent concentration levels for each of two options: the achievable concentration levels in effluent from the treatment technology identified as the best demonstrated and available for Option 1, and no discharge of process wastewater pollutants for Option 2. Finally, the

specific treatment technology or treatment technology sequence upon which the proposed 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.

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, a treatment train (or trains) is designed such that PAIs requiring the same type of treatment (such as activated carbon) are commingled and fed to the same system. This train is then optimized, based on the wastewater flow rate through the system and required PAI removal efficiencies, and costs are calculated for the resulting

Figure 8-1

FLOWCHART USED TO DETERMINE TREATMENT COSTS FOR PAIS

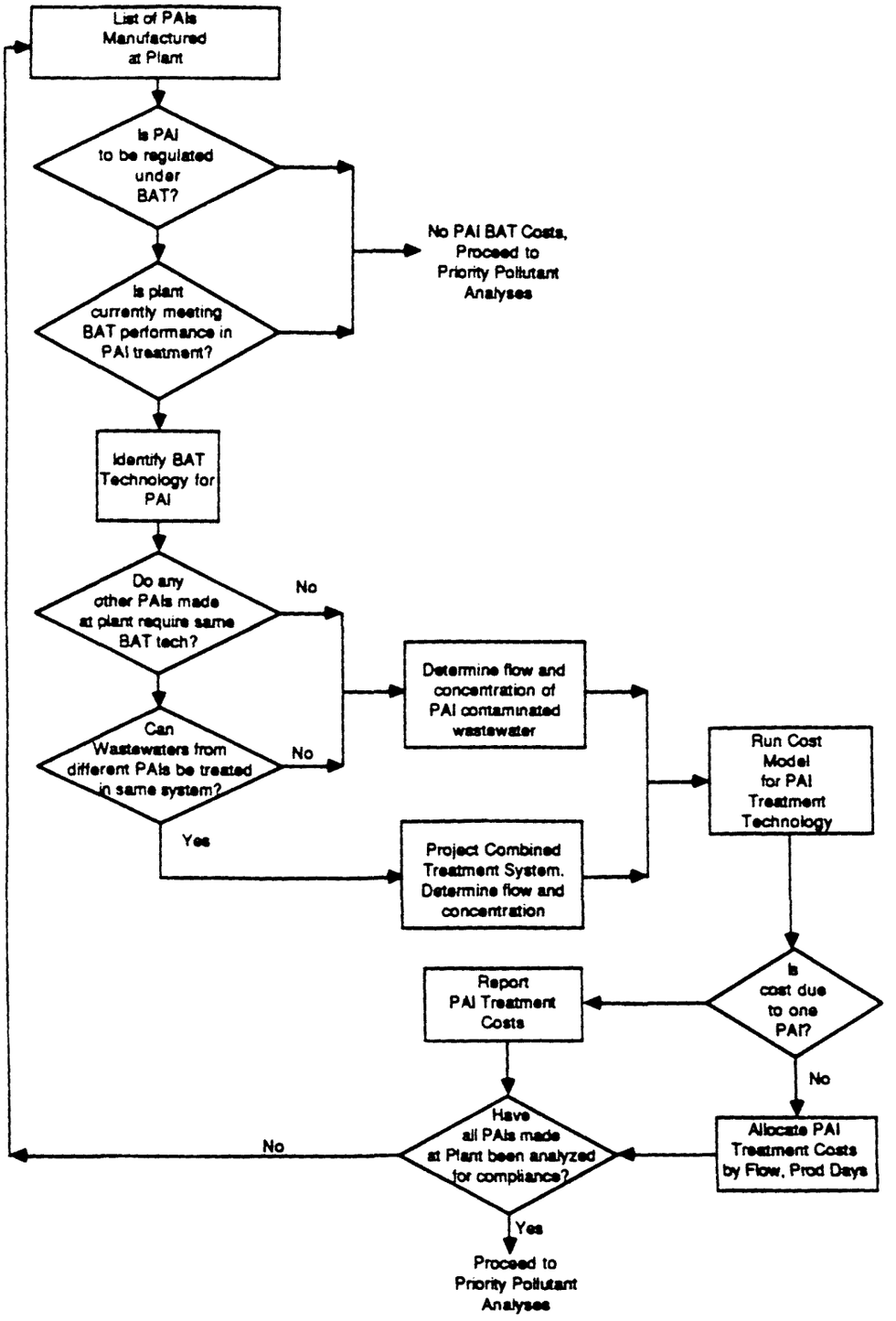
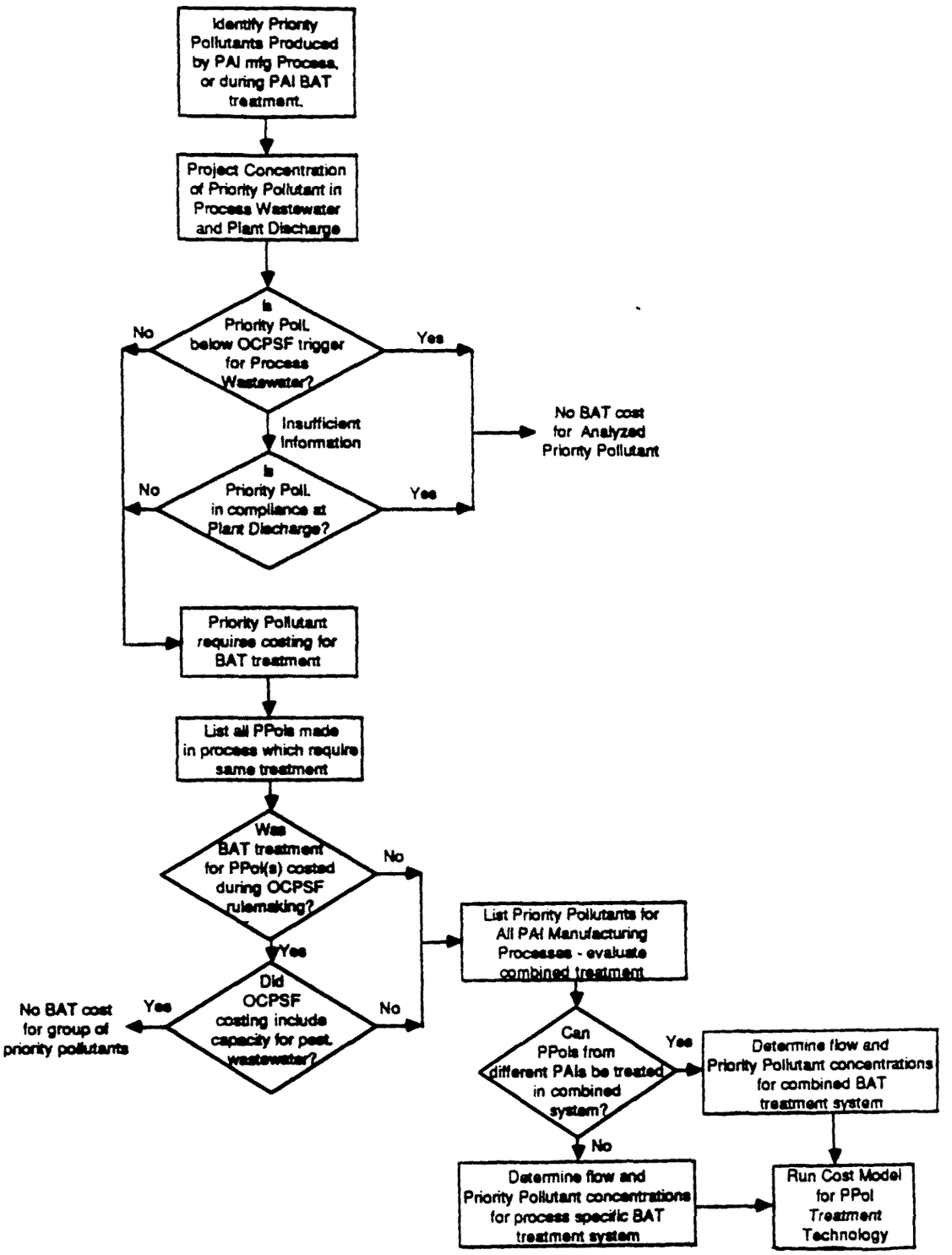


Figure 8-2

FLOWCHART USED TO DETERMINE TREATMENT COSTS FOR PRIORITY POLLUTANTS



design. 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. These monitoring costs will be incurred regardless of whether a plant will require additional treatment. To be conservative, EPA estimated monitoring costs for all plants regardless of whether a plant already conducts monitoring of PAI concentrations.

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. The only difference is that organic chemicals, plastics, and synthetic fibers (OCPSF) limits and treatment technologies, such as steam stripping and distillation, are applied to the priority pollutants (with the exception of cyanide, which has a BAT/PSES limit specific to this rule). 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 and 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 proposed 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 set up 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 either they are 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 model change the base year for costs calculated in the model?

(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 processes. 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.

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

Table 8-1 (Continued)

CAPDET LARGE FACILITY UNIT PROCESSES

27.	Filtration
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)

Table 8-1 (Continued)

CAPDET LARGE FACILITY UNIT PROCESSES

53.	Intermediate pumping
54.	Pure oxygen activated sludge
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

(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.

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
BOD5	MG/L	250
SBOD (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.

(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.

(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

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%

Table 8-4 (Continued)

UNIT COST DATA

26.	Inspection Cost	2.00%
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 waste-water treatment modules.

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.

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 7A 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;
- Filtration;
- Hydrolysis;
- Hydroxide precipitation;
- Resin adsorption; and
- Steam stripping.

This section also discusses how EPA estimated monitoring costs for compliance.

Individual plant treatment costs, for pesticide manufacturing plants that will require additional treatment to meet the BAT/PSES limits specified in Option 1, are listed on Table 8-6. The table lists the treatment costs estimated for each plant, broken down by capital, operating and maintenance, land, and residual waste disposal costs.

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	2,613,673	1,932,135	8,250	303,602
0046	0	40,730	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	3,761,850	2,105,966	1,469	102,200
1287	0	1,920	0	0
1562	0	55,550	0	0
1606	0	1,180	0	0
1624	0	6,540	0	0
1820	0	23,920	0	0
1848	1,628,512	1,662,363	6,480	107,959
1900	0	34,860	0	0
2008	0	15,540	0	0
2080	0	25,880	0	0
2160	218,295	79,825	2,000	0
2302	40,697	248,904	1,280	0
2446	0	35,580	0	0
2507	2,546,993	1,162,428	17,853	633,374

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)
2543	1,026,950	1,176,142	5,400	107,062
2561	23,402	10,189	0	0
2605	0	5,280	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	713,335	222,625	5,970	228,360
3141	254,190	207,090	2,600	0
3169	597,495	89,462	5,970	20,426
3187	0	4,620	0	0
3203	19,583	46,847	17,660	994
3285	0	11,520	0	0
3329	0	6,840	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	0	1,180	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	0	8,500	0	0
4220	925,987	300,262	4,050	6,169
4248	0	12,098	800	0
4284	663,692	154,689	5,188	120,888
4462	2,488,845	3,207,192	15,367	8,410
4505	119,012	18,043	12,787	7,000
4863	0	1,180	0	0
4881	555,136	404,795	2,403	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
5283	0	48,880	0	0
5461	0	27,340	0	0
5504	0	10,620	0	0
5522	0	31,605	0	0

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.

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), 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 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.

Table 8-7

DESIGN PARAMETERS FOR THE BIOLOGICAL TREATMENT COST MODULE

Design Parameter	Units	Default Values
Reaction rate constant	L/mg/hr	0.00135
Fraction BOD synthesized		0.73
Fraction BOD 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
Nonbiodegradable fraction of volatile suspended solids in influent		0.5
Degradable fraction of the mixed liquor volatile suspended solids		0.53
Oxygen transfer ratio		0.9
Oxygen saturation ratio	hp/1,000 gal	0.9
Horsepower	lb BOD/lb MLVSS	
Food/microorganism ratio	lb 02/hp hr	0.5
Standard transfer efficiency		6

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;
- 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.

$$S = \frac{KV}{L}$$

Where $K = \frac{\text{Henry's Law Constant (atm)}}{\text{Tower Operating Pressure (atm)}} = \frac{\text{Henry's Law Constant}}{1.0 \text{ atm}}$

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

Table 8-8

PRIORITY POLLUTANTS DIVIDED INTO GROUPS ACCORDING TO HENRY'S LAW CONSTANT VALUES

High 3×10^{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-^{0}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

Table 8-9

(Continued)

Design Parameter	Units	Medium Strippability	High Strippability
Representative Pollutant		Hexachlorobenzene	Benzene
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
TB = Boiling point of aqueous reflux	°C	100	100
TR = Reflux temperature	°C	9	9
XPRF = Tray construction indicator	unitless	Perforated	Perforated

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 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 (>50,000 gpd), 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 sample and test their wastewater treatment for regulated PAIs and priority pollutants. Testing methods have been developed and promulgated for all PAIs and priority pollutants proposed for regulation. The monitoring costs incurred by facilities depend on the method employed to analyze their effluent wastewaters and the number of times monitoring occurs annually. To estimate monitoring costs, EPA assumed that the proposed analytical methods will be used for each regulated PAI. Costs for analytical methods proposed for individual PAIs do not vary significantly; thus, in cases which the proposal allows several analytical methods to be used, 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, and Method 200.7 is assumed to be used for all metals except cyanide for which Method 335 is to be used. EPA assumed that the permitting authority would require monitoring of regulated PAIs and limited priority pollutants at least once per week of production. EPA also assumed that plants would be required to monitor all priority pollutants at least once per day of

production. Next, 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. The Agency is proposing to amend the applicability of BPT to include these 15 organic PAIs and organo-tin PAIs.

9.1 BPT APPLICABILITY

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

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.

methoprene. EPA has also developed analytical methods and data for organo-tin pesticides, which were not covered in the BPT guidelines.

EPA believes that the 15 organic PAIs listed above and the organo-tin pesticides should be covered by BPT because the NPDES permits for these facilities were based on BPT, and the data and engineering judgement indicate the facilities are capable of achieving the limitations.

EPA is therefore proposing to amend the BPT applicability provision for Subcategory A to include the 15 previously excluded PAIs listed in Section 9.0 and the organo-tin pesticides. Table 9-3 presents these 15 PAIs and the organo-tin PAIs.

EPA is not proposing to make 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.

The effect of this proposed amendment is to set the BPT limitations at the performance level achievable by these facilities under their NPDES permits and to establish a baseline on which to evaluate incremental costs of candidate BCT technologies. Because the facilities are in compliance with NPDES permits that are already based on these BPT

Table 9-3

PAIS PROPOSED TODAY FOR INCLUSION UNDER BPT

PAI Code	PAI
025	Cyanazine
058	Ametryn
060	Atrazine
067	Biphenyl
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, EPA projects that there will be no costs incurred by any of thesefacilities in connection with today's proposed rule. Plants manufacturing three of the PAIs proposed to be included in BPT are currently meeting BPT limitations through no discharge of process wastewater: one plant's process is dry and the two other plant's processes do not discharge any wastewater generated to waters of the United States.

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 proposed 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. EPA is proposing to establish limitations for 28 priority pollutants and 91 PAIs and classes of PAIs (a total of 122 individual PAIs).

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, 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 the Agency is proposing to adopt, EPA estimates that the proposed BAT regulation will result in the incremental removal (beyond that achieved by BPT) of 160,000 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 $14.5 million and annualized costs of $14.8 million (in 1986 dollars). (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 proposed BAT effluent limitations guidelines for organic PAIs are mass-based limitations. No discharge of process wastewater pollutants means, as a practical matter, that the regulated pollutant is not detectable at the final outfall from a facility (i.e., at end-of-pipe). However, because some facilities provide employee showers and laundry facilities, which are not covered by this proposed 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). If treatment to destroy the PAI is so efficient at the plant that the PAI would be reduced to about the detection limit, then dilution with other plant wastewater after this point would render compliance monitoring meaningless. Therefore, in these cases, monitoring for compliance should be done at the exit of the in-plant treatment system prior to dilution. Otherwise, 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 proposed 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 National Pollutant Discharge Elimination System (NPDES) permit issued to direct discharges [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 proposed 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

The proposed 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.

Table 10-1

BAT EFFLUENT LIMITATIONS FOR ORGANIC PESTICIDE ACTIVE INGREDIENTS (PAIS)

Organic Pesticide Active Ingredient (PAI)	BAT effluent limitations	
	Daily Maximum Shall Not Exceed lb./1,000 lb. PAI production	Monthly Average Shall not Exceed lb./1,000 lb. PAI production
2, 4-D[1]	1.19×10^{-4}	3.40×10^{-5}
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	No discharge of process wastewater pollutants	
Acifluorfen	2.32×10^{-2}	8.79×10^{-3}
Alachlor	8.82×10^{-4}	2.68×10^{-4}
Aldicarb[1]	7.23×10^{-4}	3.12×10^{-4}
Ametryn	2.10×10^{-3}	9.14×10^{-4}
Atrazine	2.56×10^{-3}	1.02×10^{-3}
Azinphos Methyl	2.74×10^{-2}	1.41×10^{-2}
Benfluralin[1,2]	3.22×10^{-4}	1.09×10^{-4}
Benomyl[1]	1.91×10^{-1}	5.14×10^{-2}
Biphenyl	No discharge of process wastewater pollutants	
Bolstar	1.69×10^{-2}	8.72×10^{-3}
Bromacil, lithium	No discharge of process wastewater pollutants	
Bromacil	1.24×10^{-1}	4.18×10^{-2}
Bromoxynil	3.95×10^{-3}	1.27×10^{-3}
Bromoxynil octanoate	3.95×10^{-3}	1.27×10^{-3}
Busan 40[3] [Potassium N-hydroxymethyl-N-methyldithiocarbamate]	5.74×10^{-3}	1.87×10^{-3}
Busan 85[3] [Potassium dimethyldithiocarbamate]	5.74×10^{-3}	1.87×10^{-3}

Table 10-1

(Continued)

Organic Pesticide Active Ingredient (PAI)	BAT effluent limitations	
	Daily Maximum Shall Not Exceed lb./1,000 lb. PAI production	Monthly Average Shall not Exceed lb./1,000 lb. PAI production
Butachlor	3.53×10^{-3}	1.09×10^{-3}
Captafol	No discharge of process wastewater pollutants	
Carbam S[3] [Sodium dimethyldithiocarbamate]	5.74×10^{-3}	1.87×10^{-3}
Carbaryl[1]	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[1]	3.27×10^{-4}	9.96×10^{-5}
Cyanazine	1.63×10^{-3}	8.11×10^{-4}
Dazomet[3]	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[1]	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}
Endothall, salts and esters	No discharge of process wastewater pollutants	
Endrin	2.20×10^{-2}	5.10×10^{-3}

Table 10-1

(Continued)

Organic Pesticide Active Ingredient (PAI)	BAT effluent limitations	
	Daily Maximum Shall Not Exceed lb./1,000 lb. PAI production	Monthly Average Shall not Exceed lb./1,000 lb. PAI production
Ethalfluralin[1,2]	3.22×10^{-4}	1.09×10^{-4}
Ethion	7.37×10^{-4}	2.99×10^{-4}
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}
Glyphosate, salts and esters	No discharge of process wastewater pollutants	
Heptachlor	8.80×10^{-3}	2.90×10^{-3}
Isopropalin[1]	7.06×10^{-3}	2.49×10^{-3}
KN Methyl[3]	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[1]	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[3]	5.74×10^{-3}	1.87×10^{-3}
Nabonate[3]	5.74×10^{-3}	1.87×10^{-3}

Table 10-1

(Continued)

Organic Pesticide Active Ingredient (PAI)	BAT effluent limitations	
	Daily Maximum Shall Not Exceed lb./1,000 lb. PAI production	Monthly Average Shall not Exceed lb./1,000 lb. PAI production
Naled	No discharge of process wastewater pollutants	
Norflurazon	No discharge of process wastewater pollutants	
Organotins[4]	1.72×10^{-2}	7.42×10^{-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	3.21×10^{-3}	1.06×10^{-3}
Permethrin	2.32×10^{-4}	6.06×10^{-5}
Phorate	2.51×10^{-4}	7.53×10^{-4}
Phosmet[5]	No discharge of process wastewater pollutants	
Prometon	2.10×10^{-3}	9.14×10^{-4}
Prometryn	2.10×10^{-3}	9.14×10^{-4}
Pronamide	2.00×10^{-4}	6.90×10^{-5}
Propachlor	5.34×10^{-3}	1.66×10^{-3}
Propanil	1.06×10^{-3}	4.84×10^{-4}
Propazine	2.10×10^{-3}	9.14×10^{-4}
Pyrethrin I	No discharge of process wastewater pollutants	
Pyrethrin II	No discharge of process wastewater pollutants	
Simazine	2.10×10^{-3}	9.14×10^{-4}
Stirofos	4.10×10^{-3}	1.35×10^{-3}
TCMTB	2.88×10^{-4}	8.96×10^{-5}
Tebuthiuron	9.78×10^{-2}	3.40×10^{-2}
Terbacil	1.51×10^{-1}	5.12×10^{-2}

Table 10-1

(Continued)

Organic Pesticide Active Ingredient (PAI)	BAT effluent limitations	
	Daily Maximum Shall Not Exceed lb./1,000 lb. PAI production	Monthly Average Shall not Exceed lb./1,000 lb. PAI production
Terbufos	4.09×10^{-4}	1.06×10^{-4}
Terbuthylazine	2.10×10^{-3}	9.14×10^{-4}
Terbutryn	2.10×10^{-3}	9.14×10^{-4}
Toxaphene	1.02×10^{-2}	3.71×10^{-3}
Triadimefon	6.52×10^{-2}	3.41×10^{-2}
Trifluralin[1,2]	3.22×10^{-4}	1.09×10^{-4}
Vapam[3] [Sodium methyldithiocarbamate]	5.74×10^{-3}	1.87×10^{-3}
Ziram[3] [Zinc dimethyldithiocarbamate]	5.74×10^{-3}	1.87×10^{-3}

[1] Monitor and comply after in-plant treatment before mixing with other wastewaters.

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

[3] Monitor and report as total dithiocarbamates, as Ziram.

[4] Monitor and report as total tin.

[5] Applies to purification by recrystalization portion of the process.

Table 10-2

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

Priority Pollutant	BAT effluent limitations[1]	
	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	25	16
Tribromomethane	59	22
Bromodichloromethane	89	40
Dibromochloromethane	211	68
Naphthalene	59	22
Phenol	26	15

Table 10-2

(Continued)

Priority Pollutant	BAT effluent limitations[1]	
	Maximum for Any One Day (µg/L)	Maximum for Monthly Average (µg/L)
Tetrachloroethylene	56	22
Total Cyanide	640	220
Total Lead[2]	690	320

[1]All units are micrograms per liter.

[2]Metals limitations apply only to noncomplexed metal-bearing waste streams. Discharges of lead from complexed metal-bearing process wastewater are not subject to these limitations.

Table 10-3

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

Priority Pollutant	BAT effluent limitations[1]	
	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	46	21
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	25	16
Tribromomethane	59	22
Bromodichloromethane	89	40
Dibromochloromethane	211	68
Naphthalene	47	19
Phenol	47	19
Tetrachloroethylene	164	52
Toluene	74	28

Table 10-3

(Continued)

Priority Pollutant	BAT effluent limitations[1]	
	Maximum for Any One Day (μg/L)	Maximum for Monthly Average (μg/L)
Total Cyanide	640	220
Total Lead[2]	690	320

[1]All units are micrograms per liter.

[2]Metals limitations apply only to noncomplexed metal-bearing waste streams. Discharges of lead from complexed metal-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 proposed for existing plants can be achieved and are justified in some cases; in the remaining cases, NSPS is proposed to be set equal to BAT. BAT limits were modified to reflect the capability for wastewater flow reduction at new facilities. The Agency is

proposing to transfer the organic pesticide chemicals manufacturing subcategory NSPS for 23 priority pollutants from the OCPSF point source category and is developing 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. 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.

11.2 IMPLEMENTATION OF THE NSPS EFFLUENT LIMITATIONS GUIDELINES

11.2.1 National Pollutant Discharge Elimination System (NPDES) Permit Limitations

The proposed NSPS for conventional pollutant parameters, COD, and organic PAIs are mass-based limitations and the proposed 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).

These NSPS, once promulgated, 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 nonprocess 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, the proposed 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 proposed 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.

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

PSNS EFFLUENT LIMITATIONS FOR ORGANIC PESTICIDES ACTIVE INGREDIENTS (PAIS)

Organic Pesticide Active Ingredient	New Source Performance Standards (NSPS)	
	Daily Maximum Shall Not Exceed lb./1,000 lb. PAI production	Monthly Average Shall Not Exceed lb./1,000 lb. PAI production
2, 4-D[1]	8.51×10^{-5}	2.42×10^{-5}
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	No discharge of process wastewater pollutants	
Acifluorfen[1]	1.67×10^{-2}	6.33×10^{-3}
Alachlor	6.35×10^{-4}	1.93×10^{-4}
Aldicarb[1]	5.21×10^{-4}	2.25×10^{-4}
Ametryn	1.52×10^{-3}	6.59×10^{-4}
Atrazine	1.84×10^{-3}	7.33×10^{-4}
Azinphos Methyl	1.97×10^{-2}	1.02×10^{-2}
Benfluralin[1,2]	2.32×10^{-4}	7.82×10^{-5}
Benomyl[1]	1.37×10^{-1}	3.70×10^{-2}
Biphenyl	No discharge of process wastewater pollutants	
Bolstar	1.21×10^{-2}	6.28×10^{-3}
Bromacil, lithium	No discharge of process wastewater pollutants	
Bromacil	8.90×10^{-2}	3.00×10^{-2}
Bromoxynil	2.84×10^{-3}	9.11×10^{-4}
Bromoxynil octanoate	2.84×10^{-3}	9.11×10^{-4}
Busan 40[3]	4.13×10^{-3}	1.35×10^{-3}
Busan 85[3]	4.13×10^{-3}	1.35×10^{-3}
Butachlor	2.54×10^{-3}	7.90×10^{-4}

Table 11-2

(Continued)

Organic Pesticide Active Ingredient	New Source Performance Standards (NSPS)	
	Daily Maximum Shall Not Exceed lb./1,000 lb. PAI production	Monthly Average Shall Not Exceed lb./1,000 lb. PAI production
Captafol	No discharge of process wastewater pollutants	
Carbam S[3]	4.10×10^{-3}	1.37×10^{-3}
Carbaryl[1]	1.18×10^{-3}	5.24×10^{-4}
Carbofuran	1.18×10^{-4}	2.80×10^{-5}
Chloroneb	5.87×10^{-2}	2.38×10^{-2}
Chlorothalonil	1.08×10^{-3}	3.29×10^{-4}
Chlorpyrifos[1]	2.35×10^{-4}	7.19×10^{-5}
Cyanazine	1.18×10^{-3}	5.84×10^{-4}
Dazomet	4.10×10^{-3}	1.37×10^{-3}
DCPA	5.60×10^{-2}	1.90×10^{-2}
DEF [S,S,S-Tributyl phosphorotrithioate]	1.15×10^{-2}	5.58×10^{-3}
Diazinon[1]	2.04×10^{-3}	8.13×10^{-4}
Dichlorprop, salts and esters	No discharge of process wastewater pollutants	
Dichlorvos	6.91×10^{-5}	2.11×10^{-5}
Dinoseb	3.41	1.03
Dioxathion	2.44×10^{-2}	9.31×10^{-3}
Disulfoton	5.27×10^{-3}	2.73×10^{-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[1,2]	2.32×10^{-4}	7.82×10^{-5}

Table 11-2

(Continued)

Organic Pesticide Active Ingredient	New Source Performance Standards (NSPS)	
	Daily Maximum Shall Not Exceed lb./1,000 lb. PAI production	Monthly Average Shall Not Exceed lb./1,000 lb. PAI production
Ethion	5.31×10^{-4}	2.15×10^{-4}
Fenarimol	7.33×10^{-2}	2.62×10^{-2}
Fensulfothion	1.06×10^{-2}	5.50×10^{-3}
Fenthion	1.31×10^{-2}	6.80×10^{-3}
Fenvalerate	3.90×10^{-3}	1.50×10^{-3}
Glyphosate, salts and esters	No discharge of process wastewater pollutants	
Heptachlor	6.31×10^{-3}	2.06×10^{-3}
Isopropalin[1]	5.07×10^{-3}	1.82×10^{-3}
KN Methyl[3]	4.13×10^{-3}	1.35×10^{-3}
Linuron	1.94×10^{-3}	1.40×10^{-3}
Malathion	1.69×10^{-4}	6.88×10^{-4}
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[1]	2.76×10^{-3}	1.27×10^{-3}
Methoxychlor	2.32×10^{-3}	9.45×10^{-4}
Metribuzin	9.79×10^{-3}	5.06×10^{-3}
Mevinphos	1.03×10^{-4}	3.65×10^{-5}
Nabam	4.10×10^{-3}	1.37×10^{-3}
Nabonate	4.13×10^{-3}	1.35×10^{-3}
Naled	No discharge of process wastewater pollutants	
Norflurazon	No discharge of process wastewater pollutants	

Table 11-2

(Continued)

Organic Pesticide Active Ingredient	New Source Performance Standards (NSPS)	
	Daily Maximum Shall Not Exceed lb./1,000 lb. PAI production	Monthly Average Shall Not Exceed lb./1,000 lb. PAI production
Organotins[4]	1.25×10^{-2}	5.35×10^{-3}
Parathion Ethyl	5.55×10^{-4}	2.47×10^{-4}
Parathion Methyl	5.55×10^{-4}	2.47×10^{-4}
PCNB	4.16×10^{-4}	1.38×10^{-4}
Pendimethalin	2.31×10^{-3}	7.64×10^{-4}
Pentachlorophenol, salts and esters	No discharge of process wastewater pollutants	
Permethrin	1.68×10^{-4}	4.38×10^{-5}
Phorate	1.81×10^{-4}	5.42×10^{-5}
Phosmet[5]	No discharge of process wastewater pollutants	
Prometon	1.52×10^{-3}	6.59×10^{-4}
Prometryn	1.52×10^{-3}	6.59×10^{-4}
Pronamide	1.44×10^{-4}	4.97×10^{-5}
Propachlor	3.85×10^{-3}	1.19×10^{-3}
Propanil	7.64×10^{-4}	3.49×10^{-4}
Propazine	1.52×10^{-3}	6.59×10^{-4}
Pyrethrin I	No discharge of process wastewater pollutants	
Pyrethrin II	No discharge of process wastewater pollutants	
Simazine	1.52×10^{-3}	6.59×10^{-4}
Stirofos	2.95×10^{-3}	9.72×10^{-4}
TCMTB	2.07×10^{-4}	6.45×10^{-5}
Tebuthiuron	7.05×10^{-2}	2.45×10^{-2}
Terbacil	1.09×10^{-1}	3.68×10^{-2}
Terbufos	2.95×10^{-4}	7.59×10^{-5}

Table 11-2

(Continued)

Organic Pesticide Active Ingredient	New Source Performance Standards (NSPS)	
	Daily Maximum Shall Not Exceed lb./1,000 lb. PAI production	Monthly Average Shall Not Exceed lb./1,000 lb. PAI production
Terbuthylazine	1.52×10^{-3}	6.59×10^{-4}
Terbutryn	1.52×10^{-3}	6.59×10^{-4}
Toxaphene	7.34×10^{-3}	2.67×10^{-3}
Triadimefon	4.70×10^{-2}	2.46×10^{-2}
Trifluralin[1,2]	2.32×10^{-4}	7.82×10^{-5}
Vapam[3] [Sodium methyldithiocarbamate]	4.13×10^{-3}	1.35×10^{-3}
Ziram[3] [Zinc dimethyldithiocarbamate]	4.13×10^{-3}	1.35×10^{-3}

[1]Monitor and comply after in-plant treatment before mixing with other wastewaters.

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

[3]Monitor and report as total dithiocarbamates, as Ziram.

[4]Monitor and report as total tin.

[5]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	BAT/NSPS effluent limitations[1]	
	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	25	16
Tribromomethane	59	22
Bromodichloromethane	89	40
Dibromochloromethane	211	68
Naphthalene	59	22

Table 11-3

(Continued)

Priority Pollutant	BAT/NSPS effluent limitations[1]	
	Maximum for Any One Day (µg/L)	Maximum for Monthly Average (µg/L)
Phenol	26	15
Tetrachloroethylene	56	22
Total Cyanide	640	220
Total Lead[2]	690	320

[1] All units are micrograms per liter.

[2] Metals limitations apply only to noncomplexed metal-bearing waste streams. Discharges of lead from complexed metal-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[1]	
	Maximum for Any One Day (µg/L)	Maximum for Monthly Average (µg/L)
Benzene	134	57
Carbon Tetrachloride	380	142
Chlorobenzene	380	142
1,2-Dichloroethane	574	180
1,1,1-Trichloroethane	59	22
Chloroform	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
Methylene Chloride	170	36
Methyl Chloride	295	110
Bromomethane	60	22
Tribromomethane	47	19
Bromodichloromethane	170	36
Dibromochloromethane	574	180
Naphthalene	47	19
Phenol	47	19

Table 11-4

(Continued)

Priority Pollutant	BAT effluent limitations[1]	
	Maximum for Any One Day (µg/L)	Maximum for Monthly Average (µg/L)
Tetrachloroethylene	164	52
Toluene	74	28
Total Cyanide	640	220
Total Lead[2]	690	320

[1]All units are micrograms per liter.

[2] Metals limitations apply only to noncomplexed metal-bearing waste streams. Discharges of lead from complexed metal-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 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 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 110,000 pounds of PAIs and 29,000 pounds of priority pollutants to POTWs.

This section summarizes the proposed 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 is proposing to develop PSES and PSNS for 26 of the 28 priority pollutants and for the same 91 PAIs and classes of PAIs proposed under BAT and NSPS. Two priority pollutants, 2-chlorophenol and 2,4-dichlorophenol, do not pass through or interfere with POTW operation, so PSES and PSNS are not being set for these two 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 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.

EPA estimates that the proposed PSES regulation will result in the incremental removal of 105,000 pounds per year of pesticide active ingredients, and 29,000 pounds per year of priority pollutants. EPA estimates that cost for compliance with the proposed PSES are capital costs of $9.1 million and annualized costs of just over $6.4 million (1986 dollars). (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 proposed 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, 12-3, and 12-4.

Table 12-1

PSES FOR ORGANIC PESTICIDE ACTIVE INGREDIENTS (PAIS)

Organic Pesticide Active Ingredient (PAI)	Pretreatment Standards for Existing Sources (PSES)	
	Daily Maximum Shall Not Exceed lb./1,000 lb. PAI production	Monthly Average Shall not Exceed lb./1,000 lb. PAI production
2, 4-D[1]	1.19×10^{-4}	3.40×10^{-5}
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	No discharge of process wastewater pollutants	
Acifluorfen	2.32×10^{-2}	8.79×10^{-3}
Alachlor	8.82×10^{-4}	2.68×10^{-4}
Aldicarb[1]	7.23×10^{-4}	3.12×10^{-4}
Ametryn	2.10×10^{-3}	9.14×10^{-4}
Atrazine	2.56×10^{-3}	1.02×10^{-3}
Azinphos Methyl	2.74×10^{-2}	1.41×10^{-2}
Benfluralin[1,2]	3.22×10^{-4}	1.09×10^{-4}
Benomyl[1]	1.91×10^{-1}	5.14×10^{-2}
Biphenyl	No discharge of process wastewater pollutants	
Bolstar	1.69×10^{-2}	8.72×10^{-3}
Bromacil, lithium	No discharge of process wastewater pollutants	
Bromacil	1.24×10^{-1}	4.18×10^{-2}
Bromoxynil	3.95×10^{-3}	1.27×10^{-3}
Bromoxynil octanoate	3.95×10^{-3}	1.27×10^{-3}
Busan 40[3] [Potassium N-hydroxymethyl-N-methyldithiocarbamate]	5.74×10^{-3}	1.87×10^{-3}

Table 12-1

(Continued)

Organic Pesticide Active Ingredient (PAI)	Pretreatment Standards for Existing Sources (PSES)	
	Daily Maximum Shall Not Exceed lb./1,000 lb. PAI production	Monthly Average Shall not Exceed lb./1,000 lb. PAI production
Busan 85[3] [Potassium dimethyldithiocarbamate]	5.74×10^{-3}	1.87×10^{-3}
Butachlor	3.53×10^{-3}	1.09×10^{-3}
Captafol	No discharge of process wastewater pollutants	
Carbam S[3] [Sodium dimethyldithiocarbamate]	5.74×10^{-3}	1.87×10^{-3}
Carbaryl[1]	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[1]	3.27×10^{-4}	9.96×10^{-5}
Cyanazine	1.63×10^{-3}	8.11×10^{-4}
Dazomet[3]	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[1]	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)	Pretreatment Standards for Existing Sources (PSES)	
	Daily Maximum Shall Not Exceed lb./1,000 lb. PAI production	Monthly Average Shall not Exceed lb./1,000 lb. PAI production
Endothall, salts and esters	No discharge of process wastewater pollutants	
Endrin	2.20×10^{-2}	5.10×10^{-3}
Ethalfluralin[1,2]	3.22×10^{-4}	1.09×10^{-4}
Ethion	7.37×10^{-4}	2.99×10^{-4}
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}
Glyphosate, salts and esters	No discharge of process wastewater pollutants	
Heptachlor	8.80×10^{-3}	2.90×10^{-3}
Isopropalin[1]	7.06×10^{-3}	2.49×10^{-3}
KN Methyl[3]	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[1]	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}

Table 12-1

(Continued)

Organic Pesticide Active Ingredient (PAI)	Pretreatment Standards for Existing Sources (PSES)	
	Daily Maximum Shall Not Exceed lb./1,000 lb. PAI production	Monthly Average Shall not Exceed lb./1,000 lb. PAI production
Mevinphos	1.44×10^{-4}	5.10×10^{-5}
Nabam[3]	5.74×10^{-3}	1.87×10^{-3}
Nabonate[3]	5.74×10^{-3}	1.87×10^{-3}
Naled	No discharge of process wastewater pollutants	
Norflurazon	No discharge of process wastewater pollutants	
Organotins[4]	1.72×10^{-2}	7.42×10^{-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	3.21×10^{-3}	1.06×10^{-3}
Permethrin	2.32×10^{-4}	6.06×10^{-5}
Phorate	2.51×10^{-4}	7.53×10^{-4}
Phosmet[5]	No discharge of process wastewater pollutants	
Prometon	2.10×10^{-3}	9.14×10^{-4}
Prometryn	2.10×10^{-3}	9.14×10^{-4}
Pronamide	2.00×10^{-4}	6.90×10^{-5}
Propachlor	5.34×10^{-3}	1.66×10^{-3}
Propanil	1.06×10^{-3}	4.84×10^{-4}
Propazine	2.10×10^{-3}	9.14×10^{-4}
Pyrethrin I	No discharge of process wastewater pollutants	
Pyrethrin II	No discharge of process wastewater pollutants	
Simazine	2.10×10^{-3}	9.14×10^{-4}

Table 12-1

(Continued)

Organic Pesticide Active Ingredient (PAI)	Pretreatment Standards for Existing Sources (PSES)	
	Daily Maximum Shall Not Exceed lb./1,000 lb. PAI production	Monthly Average Shall not Exceed lb./1,000 lb. PAI production
Stirofos	4.10×10^{-3}	1.35×10^{-3}
TCMTB	2.88×10^{-4}	8.96×10^{-5}
Tebuthiuron	9.78×10^{-2}	3.40×10^{-2}
Terbacil	1.51×10^{-1}	5.12×10^{-2}
Terbufos	4.09×10^{-4}	1.06×10^{-4}
Terbuthylazine	2.10×10^{-3}	9.14×10^{-4}
Terbutryn	2.10×10^{-3}	9.14×10^{-4}
Toxaphene	1.02×10^{-2}	3.71×10^{-3}
Triadimefon	6.52×10^{-2}	3.41×10^{-2}
Trifluralin[1,2]	3.22×10^{-4}	1.09×10^{-4}
Vapam[3] [Sodium methyldithiocarbamate]	5.74×10^{-3}	1.87×10^{-3}
Ziram[3] [Zinc dimethyldithiocarbamate]	5.74×10^{-3}	1.87×10^{-3}

[1]Monitor and comply after in-plant treatment before mixing with other wastewaters.

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

[3]Monitor and report as total dithiocarbamates, as Ziram.

[4]Monitor and report as total tin.

[5]Applies to purification by recrystalization portion of the process.

Table 12-2

PSES FOR PRIORITY POLLUTANTS

Priority Pollutant	Pretreatment Standards for Existing (PSES)[1]	
	Maximum for Any One Day	Maximum for Monthly Average
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	25	16
Tribromomethane	59	22
Bromodichloromethane	89	40
Dibromochloromethane	211	68
Naphthalene	47	19
Phenol	47	19
Tetrachloroethylene	164	52
Toluene	74	28

Table 12-2

(Continued)

Priority Pollutant	Pretreatment Standards for Existing (PSES)[1]	
	Maximum for Any One Day	Maximum for Monthly Average
Total Cyanide	640	220
Total Lead[2]	690	320

[1]All units are micrograms per liter.

[2]Metals limitations apply only to noncomplexed metal-bearing waste streams. Discharges of lead and zinc from complexed metal-bearing process wastewater are not subject to these limitations.

Table 12-3

PSNS FOR ORGANIC PESTICIDES ACTIVE INGREDIENTS (PAIS)

Organic Pesticide Active Ingredient	Pretreatment Standards for New Sources (PSNS)	
	Daily Maximum Shall Not Exceed lb./1,000 lb. PAI production	Monthly Average Shall Not Exceed lb./1,000 lb. PAI production
2, 4-D[1]	8.54×10^{-5}	2.45×10^{-5}
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	No discharge of process wastewater pollutants	
Acifluorfen[1]	1.67×10^{-2}	6.33×10^{-3}
Alachlor	6.35×10^{-4}	1.93×10^{-4}
Aldicarb[1]	5.21×10^{-4}	2.25×10^{-4}
Ametryn	1.51×10^{-3}	6.58×10^{-4}
Atrazine	1.85×10^{-3}	7.32×10^{-4}
Azinphos Methyl	1.97×10^{-2}	1.02×10^{-2}
Benfluralin[1,2]	2.32×10^{-4}	7.82×10^{-5}
Benomyl[1]	1.37×10^{-1}	3.70×10^{-2}
Biphenyl	0	0
Bolstar	1.22×10^{-2}	6.27×10^{-3}
Bromacil, lithium	No discharge of process wastewater pollutants	
Bromacil	8.89×10^{-2}	3.01×10^{-2}
Bromoxynil	2.84×10^{-3}	9.14×10^{-4}
Bromoxynil octanoate	2.84×10^{-3}	9.11×10^{-4}
Busan 40[3]	4.14×10^{-3}	1.35×10^{-3}
Busan 85[3]	4.14×10^{-3}	1.35×10^{-3}
Butachlor	2.54×10^{-3}	7.87×10^{-4}
Captafol	No discharge of process wastewater pollutants	
Carbam S[3]	4.14×10^{-3}	1.35×10^{-3}

Table 12-3

(Continued)

Organic Pesticide Active Ingredient	Pretreatment Standards for New Sources (PSNS)	
	Daily Maximum Shall Not Exceed lb./1,000 lb. PAI production	Monthly Average Shall Not Exceed lb./1,000 lb. PAI production
Carbaryl[1]	1.07×10^{-3}	4.76×10^{-4}
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[1]	2.35×10^{-4}	7.17×10^{-5}
Cyanazine	1.18×10^{-3}	5.84×10^{-4}
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[1]	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	1.51×10^{-1}	5.76×10^{-2}
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	1.77×10^{-2}	5.25×10^{-3}
Ethalfluralin[1,2]	2.32×10^{-4}	7.85×10^{-5}
Ethion	5.31×10^{-4}	2.15×10^{-4}
Fenarimol	7.31×10^{-2}	2.60×10^{-2}
Fensulfothion	1.06×10^{-2}	5.50×10^{-3}

Table 12-3

(Continued)

Organic Pesticide Active Ingredient	Pretreatment Standards for New Sources (PSNS)	
	Daily Maximum Shall Not Exceed lb./1,000 lb. PAI production	Monthly Average Shall Not Exceed lb./1,000 lb. PAI production
Fenthion	1.32×10^{-2}	6.79×10^{-3}
Fenvalerate	3.91×10^{-3}	1.50×10^{-3}
Glyphosate, salts and esters	No discharge of process wastewater pollutants	
Heptachlor	5.42×10^{-3}	1.73×10^{-3}
Isopropalin[1]	5.07×10^{-3}	1.82×10^{-3}
KN Methyl[3]	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[1]	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	No discharge of process wastewater pollutants	
Organotins[4]	1.25×10^{-2}	5.36×10^{-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	Pretreatment Standards for New Sources (PSNS)	
	Daily Maximum Shall Not Exceed lb./1,000 lb. PAI production	Monthly Average Shall Not Exceed lb./1,000 lb. PAI production
PCNB	4.16×10^{-4}	1.38×10^{-4}
Pendimethalin	8.81×10^{-3}	2.79×10^{-3}
Pentachlorophenol, salts and esters	No discharge of process wastewater pollutants	
Permethrin	1.68×10^{-4}	4.39×10^{-5}
Phorate	1.81×10^{-4}	5.43×10^{-5}
Phosmet[5]	No discharge of process wastewater pollutants	
Prometon	1.51×10^{-3}	6.58×10^{-4}
Prometryn	1.51×10^{-3}	6.58×10^{-4}
Pronamide	1.28×10^{-4}	4.34×10^{-5}
Propachlor	3.84×10^{-3}	1.19×10^{-3}
Propanil	7.63×10^{-4}	3.48×10^{-4}
Propazine	1.51×10^{-3}	6.58×10^{-4}
Pyrethrin I	No discharge of process wastewater pollutants	
Pyrethrin II	No discharge of process wastewater pollutants	
Simazine	1.51×10^{-3}	6.58×10^{-4}
Stirofos	2.95×10^{-3}	9.72×10^{-4}
TCMTB	2.07×10^{-4}	6.45×10^{-5}
Tebuthiuron	7.04×10^{-2}	2.45×10^{-2}
Terbacil	1.09×10^{-1}	3.69×10^{-2}
Terbufos	2.95×10^{-4}	7.62×10^{-5}
Terbuthylazine	1.51×10^{-3}	6.58×10^{-4}
Terbutryn	1.51×10^{-3}	6.58×10^{-4}
Toxaphene	7.35×10^{-3}	2.67×10^{-3}

Table 12-3

(Continued)

Organic Pesticide Active Ingredient	Pretreatment Standards for New Sources (PSNS)	
	Daily Maximum Shall Not Exceed lb./1,000 lb. PAI production	Monthly Average Shall Not Exceed lb./1,000 lb. PAI production
Triadimefon	4.69×10^{-2}	2.46×10^{-2}
Trifluralin[1,2]	2.32×10^{-4}	7.82×10^{-5}
Vapam[3] [Sodium methyldithiocarbamate]	3.86×10^{-3}	1.39×10^{-3}
Ziram[3] [Zinc dimethyldithiocarbamate]	4.14×10^{-3}	1.35×10^{-3}

[1]Monitor and comply after in-plant treatment before mixing with other wastewaters.

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

[3]Monitor and report as total dithiocarbamates, as Ziram.

[4]Monitor and report as total tin.

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

Table 12-4

PSNS EFFLUENT LIMITATIONS FOR PRIORITY POLLUTANTS

Priority Pollutant	Pretreatment Standards for New Sources (PSNS)[1]	
	Maximum for Any One Day	Maximum for Monthly Average
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	25	16
Tribromomethane	59	22
Bromodichloromethane	89	40
Dibromochloromethane	211	68
Naphthalene	47	19
Phenol	47	19
Tetrachloroethylene	164	52
Toluene	74	28

Table 12-4

(Continued)

Priority Pollutant	Pretreatment Standards for New Sources (PSNS)[1]	
	Maximum for Any One Day	Maximum for Monthly Average
Total Cyanide	640	220
Total Lead[2]	690	320

[1]All units are micrograms per liter.

[2]Metals limitations apply only to noncomplexed metal-bearing waste streams. Discharges of lead and zinc from complexed metal-bearing process wastewater are not subject to these limitations.

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 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 and TSS concentrations; and
- Effluent BOD 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 and TSS were used to determine the influent BOD and TSS concentrations to the multi-media filter. Since these BOD and TSS data are mass based (i.e. 1.12 lb. BOD/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 and TSS influent concentrations.

To determine the effluent BOD and TSS concentrations for the CAPDET module, BOD 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 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 and TSS removals from the combined sand filter/settling pond system during sampling were 48 percent BOD removal and 53 percent TSS removal.

Using the flows and the influent and effluent BOD 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 and TSS.

Finally, a removal cost ($/lbs. of conventional pollutants removed) was determined by dividing the incremental annual cost by the BOD 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 and TSS removals (lb/yr), and removal costs ($/lb), are presented in Table 13-1.

13.4 CONCLUSIONS

As seen in Table 13-1, the proposed BCT technology, 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 proposing to set 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 & 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 proposing to reserve 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. 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 600,000 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 60 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.)

The Agency considered proposing PSES requiring no discharge of process wastewater pollutants, but determined that the only way the facilities could achieve this standard is by off-site disposal. Off-site disposal was

determined not to be economically achievable because two of the five indirect discharging facilities in this subcategory are 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 already subject to locally imposed pretreatment limits which EPA believes provide adequate protection for the POTW and the environment. Imposing additional controls based on the BAT technologies would result in the additional removal of only three of the 60 pounds of priority pollutants currently being discharged annually by these five facilities. In light of the relatively small amount of pollutants being discharged, EPA proposes not to establish regulations for existing indirect dischargers in this subcategory.

Concerning PSNS, the Agency believes it is unlikely that there will be any new manufacturers of 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. EPA believes that no new producers of metallo-organic pesticides are likely since there have been no new plants and no new metallo-organic PAIs produced in this subcategory for more than 20 years.

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 certain regulations. Pursuant to these provisions, EPA has considered the effect of the BAT regulations on air pollution, solid waste generation, and energy consumption.

The non-water quality environmental impacts associated with this regulation 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 Questionnaire (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.

VOC and HAP are emitted from wastewater beginning at the point where the wastewater first contacts ambient air. Thus, VOC and HAP 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 stream strippers lacking air emission control devices, and any other units where the wastewater is in contact with the air.

The proposed 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 proposed in conjunction with chemical oxidations systems as a combined BAT-level technology to prevent air emissions of chlorinated priority pollutants from the chemical oxidation effluent.

No negative air pollution impacts are expected due to the proposed regulations. Instead, the implementation of steam stripping as an in-plant control technique should decrease air emissions of volatile wastewater pollutants. Based on raw wastewater loading estimates, air emissions of volatile priority pollutants would decrease by about 6 million pounds per year

due to steam stripping when used as an in-plant control technology. Also, steam strippers are proposed in conjunction with chemical oxidation systems to ensure no air emissions of chlorinated priority pollutants from the chemical oxidation effluent. The proposed 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 pesticides manufacturing plants that currently use stripping are using steam strippers and not air strippers.) There are, in fact, activities underway under the Clean Air Act to address emissions of VOCs from industrial wastewater. Specifically, the Agency plans to issue a Control Techniques Guideline (CTG) for Industrial Wastewater (IWW) under Section 110 of the CAA (Title 1 of the 1990 CAAA). The Pesticide Chemicals Industry is one of several industries that would be covered by the IWW CTG. The IWW CTG will provide guidance to the States in recommending reasonably available control technology (RACT) for VOC emissions from industrial wastewater at facilities located in areas failing to attain the National Ambient Air Quality Standards for ozone. The Agency also plans to issue a National Emission Standard for Hazardous Air Pollutants (NESHAP) under Section 112 of the CAA to address air emissions of the HAP listed in Title 3 of the 1990 CAAA. This NESHAP will define maximum achievable control technology (MACT). MACT standards are technology-based standards. The 1990 CAAA set maximum control requirements on which MACT 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 the upcoming pesticide effluent guidelines. Combining compliance with the effluent guidelines and upcoming CAA regulations will be more economical than individual compliance with each rule.

No significant increase in air emissions are expected due to implementation of biological treatment as a BAT since volatile pollutants, if present in significant quantities, would be removed prior to biotreatment by in-plant steam stripping. There is also no significant impact in air emissions expected due to incineration because of the small volume of wastewater (less than 50,000 gallons per year) estimated to be disposed of in this manner.

15.2 SOLID WASTE

Solid waste would be generated due to the following technologies, if implemented to meet proposed regulations: steam stripping, hydroxide precipitation, and biotreatment. 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 is assumed to represent an organic waste and was costed for disposal. 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. While EPA believes that much of this may be amenable to recovery and reuse, EPA was unable to quantify the amount that could be recovered and therefore assumed that all would be incinerated. To provide perspective on the potential incremental increase in solid waste generation due to the proposed rule, EPA reviewed national capacity for organic waste disposal. The national incinerator capacity, including kilns and boilers, is estimated by EPA to be greater than 3 billion pounds per year.

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 thousand pounds per year of precipitated solids would be generated due to the implementation of hydroxide precipitation at one facility. For comparison, EPA estimates from the Toxic Release Inventory (TRI) database that 445 million pounds of toxic chemicals were disposed in landfills in 1989.

Biotreatment is the proposed 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 will be generated due to the proposed regulations. For comparison, EPA estimates that 15,000 POTWs generate almost 8 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

Energy requirements will increase minimally due to pumping needs associated with the proposed technologies. However, the main energy requirement in this regulation is due to steam use by the proposed 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; this amounts to an estimated use of 187,000 barrels per year of fuel oil; the United Stated currently consumes about 19 million barrels per day.

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), (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 proposed effluent limitations used analytical methods employing the latest in analytical technology. EPA is proposing that compliance monitoring of effluent from the manufacture of the 122 PAIs proposed for regulation must employ methods listed in Table 16-1, and will not be permitted to use the methods promulgated at 40 CFR Part 136 (except where the Part 136 method is identical to the proposed 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 Supplement I" (July 1990). EPA is proposing to allow use of these drinking water methods in monitoring pesticide active ingredients in pesticide industry wastewaters.

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
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
17	2,4-DB; 2,4-DB Salts and Esters [2,4-Dichlorophenoxybutyric acid]	00094-82-6	1658/515.1/615
22	Mevinphos	07786-34-7	1657/507/622/525.1
25	Cyanazine	21725-46-2	629
26	Propachlor	01918-16-7	508/608.1/525.1
27	MCPA; MCPA Salts and Esters [2-Methyl-4-chlorophenoxyacetic acid]	00094-74-6	1658/615
30	Dichlorprop; Dichlorprop Salts and Esters [2-(2,4-Dichlorophenoxy) propionic acid]	00120-36-5	1658/515.1/615
31	MCPP; MCPP Salts and Esters [2-(2-Methyl-4-chlorophenoxy) propionic acid]	00093-65-2	1618/615
35	TCMTB [2-(Thiocyanomethylthio) benzothiazole]	21564-17-0	637
39	Pronamide	23950-58-5	525.1
41	Propanil	00709-98-8	632.1
45	Metribuzin	21087-64-9	507/633/525.1/1656
52	Acephate	30560-19-1	1656
53	Acifluorfen	50594-66-6	515.1/1656
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
67	Biphenyl	00092-52-4	1625/642
68	Bromacil; Bromacil Salts and Esters	00314-40-9	507/633/525.1/1656
69	Bromoxynil	01689-84-5	1661/1625
69	Bromoxynil octanoate	01689-99-2	1656
70	Butachlor	23184-66-9	507/645/525.1/1656
73	Captafol	02425-06-1	1618
75	Carbaryl [Sevin]	00063-25-2	531.1/632
76	Carbofuran	01563-66-2	531.1/632
80	Chloroneb	02675-77-6	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	508/608.2/525.1/1656
112	Dinoseb	00088-85-7	1658/515.1/615
113	Dioxathion	00078-34-2	614.1
118	Nabonate [Disodium cyanodithioimidocarbonate]	00138-93-2	630.1
119	Diuron	00330-54-1	632

Table 16-1

(Continued)

EPA Survey Code	Pesticide Name	CAS Number	EPA Analytical Method Number(s)
123	Endothall	00145-73-3	548
124	Endrin	00072-20-8	1656/505/508/608/617/525.1
125	Ethalfluralin	55283-68-6	627*/1656*
126	Ethion	00563-12-2	1657/614/614.1
127	Ethoprop	13194-48-4	1657/507/622
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	547/140A
140	Heptachlor	00076-44-8	1656/505/508/608/617/525.1
144	Isopropalin	33820-53-0	627/1656
148	Linuron	00330-55-2	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	627*/1656*
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	200.7/200.9/IND-01

Table 16-1

(Continued)

EPA Survey Code	Pesticide Name	CAS Number	EPA Analytical Method Number(s)
197	Bolstar	35400-43-2	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
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
230	Pyrethrin I	00121-21-1	508/1660
232	Pyrethrin II	00121-29-9	508/1660
236	DEF [S,S,S-Tributyl phosphorotrithioate]	00078-48-8	1657/1618
239	Simazine	00122-34-9	505/507/619/525.1
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

Table 16-1

(Continued)

EPA Survey Code	Pesticide Name	CAS Number	EPA Analytical Method Number(s)
255	Terbufos	13071-79-9	1657/507/614.1/525.1
256	Terbuthylazine	05915-41-3	619
257	Terbutryn	00886-50-0	507/619/525.1
259	Dazomet	00533-74-4	131/630/630.1/1659
262	Toxaphene	08001-35-2	1656/505/508/608/617
263	Merphos [Tributyl phosphorotrithioate]	00150-50-5	1657/1618/525.1
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.

16.2 PROPOSED 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, FPA 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. EPA is proposing that all of these methods be available for compliance monitoring of effluent from the manufacture of the 122 PAIs

proposed for regulation; for many PAIs, more than one analytical method is being proposed. 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; proposal of alternative methods also allows commenters to provide comparative data which may lead to further improvements in methods or to rejection of some of the proposed methods where data demonstrates that the proposed method is inadequate.

The proposed 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 proposed effluent limitations guidelines and standards. 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 proposing multiple methods is to permit as much flexibility as possible while controlling the quality of the methods approved. In addition to flexibility in method selection, a certain amount of flexibility within each method is permitted. This flexibility was detailed in the preamble to 40 CFR Part 136 wastewater methods [49 FR 43234, October 26, 1984] and allows modification of the method to overcome interference problems. These alternate procedures and techniques may be employed provided that the quality control (QC) criteria within the method are all met.

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 proposes to permit the use of 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 avoids development of a new method by testing 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 proposed for the 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 beings; 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 reproducability 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 (e.g., 49 FR 43234).

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 samples 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 obtained 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 proposed 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 sec. 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 sec. 304(b)(4) of the Act.

BMP Best management practices, as defined by sec. 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 sec. 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 sec. 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 Environmental Quality 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 sec. 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 sec. 306 of the Act.

OCPSF Organic chemicals, plastics, and synthetic fibers manufacturing point source category.

Point Source Category A collection of industrial sources with similar function or product, established by sec. 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 sec. 307(b) of the Act.

PSNS Pretreatment standards for new sources of indirect discharges under sec. 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

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