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Final

Development Document for Effluent Limitations Guidelines and Standards for the

Organic Chemicals, Plastics and Synthetic Fibers

Point Source Category

Volume I

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

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ABSTRACT

This document describes the technical development of the U.S. Environmental Protection Agency's promulgated effluent limitations guidelines and standards that control the discharge of pollutants into navigable waters and publicly owned treatment works (POTWs) by existing and new sources in the organic chemicals, plastics, and synthetic fibers point source category. The regulation establishes effluent limitations guidelines attainable by the application of the "best practicable control technology currently available" (BPT) and the "best available technology economically achievable" (BAT), Pretreatment standards applicable to existing and new discharges to POTWs (PSES and PSNS, respectively), and new source performance standards (NSPS) attainable by the application of the "best available demonstrated control technology." The regulation was promulgated under the authority of Sections 301, 304, 306, 307, 308, 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). It was also promulgated in response to the Settlement Agreement in Natural Resources Defense Council, Inc. v. Trian, 8 ERC 2120 (D.D.C. 1976), modified, 12 ERC 1833 (D.D.C.).

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SECTION I

INTRODUCTION

This document describes the technical development of the U.S. Environmental Protection Agency's (EPA's) promulgated effluent limitations guidelines and standards that limit the discharge of pollutants into navigable waters and publicly owned treatment works (POTWs) by existing and new sources in the organic chemicals, plastics, and synthetic fibers (OCPSF) point source category. The regulation establishes effluent limitations guidelines attainable by the application of the "best practicable control technology currently available" (BPT) and the "best available technology economically achievable" (BAT), pretreatment standards applicable to existing and new discharges to POTWs (PSES and PSNS, respectively), and new source performance standards (NSPS) attainable by the application of the "best available demonstrated technology."

A. LEGAL AUTHORITY

This regulation was promulgated under the authority of Sections 301, 304, 306, 307, 308, 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) also referred to as "the Act" or "CWA." It was also promulgated in response to the Settlement Agreement in Natural Resources Defense Council, Inc. v. Train, 8 ERC 2120 (D.D.C. 1976), modified, 12 ERC 1833 (D.D.C. 1979), modified by Orders dated October 26, 1982; August 2, 1983; January 6, 1984; July 5, 1984; January 7, 1985; April 24, 1986; and January 8, 1987.

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 was required to issue effluent limitations guidelines, pretreatment standards, and NSPS for industrial dischargers.

In addition to these regulations for designated industrial categories, EPA was required to promulgate effluent limitations guidelines and standards applicable to all discharges of toxic pollutants. The Act included a timetable for issuing these standards. However, EPA was unable to meet many of the deadlines and, as a result, in 1976, it was sued by several environmental groups. In settling this lawsuit, EPA and the plaintiffs executed a "Settlement Agreement" that was approved by the Court. This agreement required EPA to develop a program and adhere to a schedule for controlling 65 "priority" toxic pollutants and classes of pollutants. In carrying out this program, EPA was required to promulgate BAT effluent limitations guidelines, pretreatment standards, and NSPS for a variety of major industries, including the OCPSF industry.

Many of the basic elements of the Settlement Agreement were incorporated into the Clean Water Act of 1977. Like the Agreement, the Act stressed control of toxic pollutants, including the 65 priority toxic pollutants and classes of pollutants.

Under the Act, the EPA is required to establish several different kinds of effluent limitations guidelines and standards. These are summarized briefly below.

1. Best Practicable Control Technology Currently Available (BPT)

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 familiar (e.g., conventional) pollutants, such as BOD_5, TSS, and pH.

In establishing BPT effluent limitations guidelines, EPA considers the total cost in relation to the effluent reduction benefits, age of equipment and facilities involved, processes employed, process changes required, engineering aspects of the control technologies, and nonwater quality environmental impacts (including energy requirements). The Agency balances the category-wide or subcategory-wide cost of applying the technology against the effluent reduction benefits.

2. Best Available Technology Economically Achievable (BAT)

BAT effluent limitations guidelines, in general, represent the best existing performance in the category or subcategory. The Act establishes BAT as the principal national means of controlling the direct discharge of toxic and nonconventional pollutants to navigable waters.

In establishing BAT, the Agency considers the age of equipment and facilities involved, processes employed, engineering aspects of the control technologies, process changes, cost of achieving such effluent reduction, and nonwater quality environmental impacts.

3. Best Conventional Pollutant Control Technology (BCT)

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. The Administrator designated oil and grease a 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 the BCT effluent limitations guidelines be assessed in light of a two part "cost-reasonableness" test [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 costs to 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 limitations are "reasonable" under both tests before establishing them as BCT. In no case may BCT be less stringent than BPT.

EPA has promulgated a methodology for establishing BCT effluent limitations guidelines (51 FR 24974, July 8, 1986).

4. New Source Performance Standards (NSPS)

NSPS are based on the performance of the best available demonstrated 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 best available demonstrated control technology for all pollutants (i.e., toxic, conventional, and nonconventional).

5. 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 POTWs. The Clean Water Act requires pretreatment standards for pollutants that pass through POTWs or interfere with either the POTW's treatment process or chosen sludge disposal method. 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 PSES and PSNS, EPA generally determines that there is pass through of pollutants, and thus a need for categorical standards if the nationwide average percentage of pollutants 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 serve as the framework for categorical pretreatment standards, are found at 40 CFR Part 403. (Those regulations contain a definition of pass through that addresses localized rather that national instances of pass through and does not use the percent removal comparison test described above (52 FR 1586, January 14, 1987).)

6. Pretreatment Standards for New Sources (PSNS)

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

B. HISTORY OF OCPSF RULEMAKING EFFORTS

EPA originally promulgated effluent limitations guidelines and standards for the organic chemicals manufacturing industry in two phases. Phase I, covering 40 product/processes (a product that is manufactured by the use of a particular process -- some products may be produced by any of several processes), was promulgated on April 25, 1974 (39 FR 14676). Phase II, covering 27 additional product/processes, was promulgated on January 5, 1976 (41 FR 902). The Agency also promulgated effluent limitations guidelines and standards for the plastics and synthetic fibers industry in two phases. Phase I, covering 13 product/processes, was promulgated on April 5, 1974 (39 FR 12502). Phase II, covering eight additional product/processes, was promulgated on January 23, 1975 (40 FR 3716).

These regulations were challenged, and on February 10, 1976, the Court in Union Carbide v. Train, 541 F.2d 1171 (4th Cir. 1976), remanded the Phase I organic chemicals regulation. EPA also withdrew the Phase II organic chemicals regulation on April 1, 1976 (41 FR 13936). However, pursuant to an agreement with the industry petitioners, the regulations for butadiene manufacture were left in place. The Court also remanded the Phase I plastics and synthetic fibers regulations in FMC Corp. v. Train, 539 F.2d 973 (4th Cir. 1976) and in response EPA withdrew both the Phase I and II plastics and synthetic fibers regulations on August 4, 1976 (41 FR 32587) except for the pH limitations, which had not been addressed in the lawsuit. Consequently, only the regulations covering butadiene manufacture for the organic chemicals industry and the pH regulations for the plastics and synthetic fibers industry have been in effect to date. These regulations were superseded by the regulations described in this report.

In the absence of promulgated, effective effluent limitations guidelines and standards, OCPSF direct dischargers have been issued National Pollutant Discharge Elimination System (NPDES) permits on a case-by-case basis using best professional judgment (BPJ), as provided in Section 402(a)(1) of the CWA.

Subsequent to the withdrawal/suspension of the national regulations cited above, studies and data-gathering were initiated in order to provide a basis for issuing effluent limitations guidelines and standards for this industry. These efforts provided a basis for the March 21, 1983 proposal (48 FR 11828); the July 17, 1985 (50 FR 29071), October 11, 1985 (50 FR 41528), and December 8, 1986 (51 FR 44082) post-proposal notices of availability of information; and the final regulation.

This report presents a summary of the data collected by the Agency since 1976, the data submitted by the OCPSF industry in response to the Federal Register notices cited above, and the analyses used to support the promulgated regulations. Section II presents a summary of the findings and conclusions developed in this document as well as the promulgated regulations. Sections III through VIII present the technical data and the supporting analyses used as the basis for the promulgated regulations, and Sections IX through XIII include the rationale and derivation of the national effluent limitations and standards. Detailed data displays and analyses are included in the appendices.

SECTION II

SUMMARY AND CONCLUSIONS

A. OVERVIEW OF THE INDUSTRY

The organic chemicals, plastics, and synthetic fibers (OCPSF) industry is large and diverse, and many plants in the industry are highly complex. The industry includes approximately 750 facilities whose principal or primary production activities are covered under the OCPSF regulations. There are approximately 250 other plants that are secondary producers of OCPSF products (i.e., OCPSF production is ancillary to their primary production activities). Thus, the total number of plants to be regulated totally or in part by the OCPSF industry regulation is approximately 1,000. Secondary OCPSF plants may be part of the other chemical producing industries such as the petroleum refining, inorganic chemicals, pharmaceuticals, and pesticides industries as well as the chemical formulation industries such as the adhesives and sealants, paint and ink, and the plastics molding and forming industries. Although over 25,000 different organic chemicals, plastics, and synthetic fibers are manufactured, less than half of these products are produced in excess of 1,000 pounds per year.

Some plants produce chemicals in large volumes while others produce only small volumes of "specialty" chemicals. Large volume production tends to utilize continuous processes. Continuous processes are generally more efficient than batch processes in minimizing water use and optimizing the consumption of raw materials.

Different products are made by varying the raw materials, the chemical reaction conditions, and the chemical engineering unit processes. The products being manufactured at a single large chemical plant can vary on a weekly or even daily basis. Thus, a single plant may simultaneously produce many different products using a variety of continuous and batch operations, and the product mix may change on a weekly or daily basis.

A total of 940 facilities (based on 1982 production) are included in the technical and economic studies used as a basis for this regulation. Approximately 76 percent of these facilities are primary OCPSF manufacturers (over 50 percent of their total plant production involves OCPSF products), and approximately 24 percent of the facilities are secondary OCPSF manufacturers that produce mainly other types of products. An estimated 32 percent of the plants are direct dischargers; about 42 percent discharge indirectly to publicly owned treatment works (POTWS); and the remaining facilities (26 percent) are either zero or alternative dischargers, or their discharge status is unknown. The estimated average daily process wastewater discharge per plant is 1.31 millions of gallons per day (MGD) for direct dischargers and 0.25 MGD for indirect dischargers. The non-discharging plants use dry processes, reuse their wastewater, or dispose of their wastewater by deep well injection, incineration, contract hauling, or by means of evaporation and percolation ponds.

As a result of the wide variety and complexity of raw materials and processes used and of products manufactured in the OCPSF industry, an exceptionally wide variety of pollutants are found in the wastewaters of this industry. This includes conventional pollutants (pH, BOD_5, TSS, and oil and grease); an unusually wide variety of toxic priority pollutants (both metals and organic compounds); and a large number of nonconventional pollutants. Many of the toxic and nonconventional pollutants are organic compounds produced by the industry for sale. Others are created by the industry as by-products of their production operations. This study focused on the conventional pollutants and on the 126 priority pollutants.

To control the wide variety of pollutants discharged by the OCPSF industry, OCPSF plants use a broad range of in-plant controls, process modifications, and end-of-pipe treatment techniques. Most plants have implemented programs that combine elements of both in-plant control and end-of-pipe wastewater treatment. The configuration of controls and technologies differs from plant to plant, corresponding to the differing mixes of products manufactured by different facilities. In general, direct dischargers treat their wastes more extensively than indirect dischargers.

The predominant end-of-pipe control technology for direct dischargers in the OCPSF industry is biological treatment. The chief forms of biological treatment are activated sludge and aerated lagoons. Other systems, such as extended aeration and trickling filters, are also used, but less extensively. All of these systems reduce biochemical oxygen demand (BOD_5) and total suspended solids (TSS) loadings, and in many instances, incidentally remove toxic and nonconventional pollutants. Biological systems biodegrade some of the organic pollutants, remove bio-refractory organics and metals by sorption into the sludge, and strip some volatile organic compounds (VOCs) into the air. Well-designed biological treatment systems generally incorporate secondary clarification unit operations to ensure adequate control of solids.

Other end-of-pipe treatment technologies used in the OCPSF industry include neutralization, equalization, polishing ponds, filtration, and carbon adsorption. While most direct dischargers use these physical/chemical technologies in conjunction with end-of-pipe biological treatment, at least 71 direct dischargers use only physical/chemical treatment.

In-plant control measures employed at OCPSF plants include water reduction and reuse techniques, chemical substitution, and process changes. Techniques to reduce water use include the elimination of water use where practicable, and the reuse and recycling of certain streams, such as reactor and floor washwater, surface runoff, scrubber effluent, and vacuum seal discharges. Chemical substitution is utilized to replace process chemicals possessing highly toxic or refractory properties with others that are less toxic or more amenable to treatment. Process changes include various measures that reduce water use, waste discharges, and/or waste loadings while improving process efficiency. Replacement of barometric condensers with surface condensers, replacement of steam jet ejectors with vacuum pumps, recovery of product or by-product by steam stripping, distillation, solvent extraction or recycle, oil-water separation, and carbon adsorption, and the addition of spill control systems are examples of process changes that have been successfully employed in the OCPSF industry to reduce pollutant loadings while improving process efficiencies.

Another type of control widely used in the OCPSF industry is physical/chemical in-plant control. This treatment technology is generally used selectively on certain process wastewaters to recover products or process solvents, to reduce loadings that may impair the operation of the biological system, or to remove certain pollutants that are not treated sufficiently by the biological system. In-plant technologies widely used in the OCPSF industry include sedimentation/clarification, coagulation, flocculation, equalization, neutralization, oil-water separation, steam stripping, distillation, and dissolved air flotation.

Some OCPSF plants also use physical/chemical treatment after biological treatment. Such treatment is usually intended to reduce solids loadings that are discharged from biological treatment systems. The most common post-biological treatment unit operations are polishing ponds and multimedia filtration. These unit operations are sometimes used in lieu of secondary clarification or to improve upon substandard biological treatment systems. A few plants also use activated carbon after biological treatment as a final "polishing" step.

At approximately 9 percent of the direct discharging plants surveyed, either no treatment is provided or no treatment beyond equalization and/or neutralization is provided. At another 19 percent, only physical/chemical treatment is provided. The remaining 72 percent utilize biological treatment. Approximately 41 percent of biologically treated effluents are further treated by polishing ponds, filtration, or other forms of physical/chemical control.

At approximately 39 percent of the indirect discharging plants surveyed, either no treatment is provided or no treatment beyond equalization and/or neutralization is provided. At another 47 percent, some physical/chemical treatment is provided. The remaining 14 percent utilize biological treatment. Approximately 22 percent of biologically treated effluents are further treated by polishing ponds, filtration, or other forms of physical/chemical control.

Economic data provided in response to questionnaires completed pursuant to Section 308 of the CWA indicate that OCPSF production in 1982 totaled 185 billion pounds and that the quantity shipped was 151 billion pounds. The corresponding value of shipments equaled $59 billion, while employment in the industry totaled 187,000 in 1982. In that same, year a total of 455 firms operated the 940 facilities referenced above.

B. CONCLUSIONS

1. Applicability of the Promulgated Regulation

The OCPSF regulation applies to process wastewater discharges from existing and new organic chemicals, plastics, and synthetic fibers (OCPSF) manufacturing facilities. OCPSF process wastewater discharges are defined as discharges from all establishments or portions of establishments that manufacture products or product groups listed in the applicability sections of the promulgated regulation (see Appendix III-A of this report), and are included within the following U.S. Department of Commerce, Bureau of the Census, Standard Industrial Classification (SIC) major groups:

- SIC 2865 - Cyclic Crudes and Intermediates, Dyes, and Organic Pigments
- SIC 2869 - Industrial Organic Chemicals, not Elsewhere Classified
- SIC 2821 - Plastic Materials, Synthetic Resins, and Nonvulcanizable Elastomers
- SIC 2823 - Cellulosic Man-Made Fibers
- SIC 2824 - Synthetic Organic Fibers, Except Cellulosic.

The regulations apply to plastics molding and forming processes only when plastic resin manufacturers mold or form (e.g., extrude and pelletize) crude intermediate plastic material for shipment off-site. This regulation also applies to the extrusion of fibers. Plastic molding and forming processes other than those described above are regulated by the plastics molding and forming effluent guidelines and standards found in 40 CFR Part 463.

The regulations also apply to wastewater discharges from OCPSF research and development, pilot plant, technical service, and laboratory bench-scale operations if such operations are conducted in conjunction with and related to existing OCPSF manufacturing activities at the plant site.

The regulations do not apply to discharges resulting from the manufacture of OCPSF products if the products are included in the following SIC subgroups, and have in the past been reported by the establishment under these subgroups and not under the OCPSF SIC groups listed above:

- SIC 2843085 - Bulk Surface Active Agents
- SIC 28914 - Synthetic Resin and Rubber Adhesives
- Chemicals and Chemical Preparations, not Elsewhere Classified
  - SIC 2899568 - sizes, all types
  - SIC 2899597 - other industrial chemical specialties, including fluxes, plastic wood preparations, and embalming fluids
- SIC 2911058 - Aromatic Hydrocarbons Manufactured from Purchased Refinery Products
- SIC 2911632 - Aliphatic Hydrocarbons Manufactured from Purchased Refinery Products.

The regulations are not applicable to any discharges for which a different set of previously promulgated effluent limitations guidelines and standards in 40 CFR Parts 405 through 699 apply, unless the facility reports OCPSF production under SIC codes 2865, 2869, or 2821, and the facility's OCPSF wastewater is treated in a separate treatment system or discharged separately to a POTW. They also do not apply to any process wastewater discharges from the manufacture of organic chemical compounds solely by extraction from plant and animal raw materials or by fermentation processes.

2. BPT

The technology basis for the promulgated effluent limitations for each BPT subcategory consists of biological treatment, which usually involves either activated sludge or aerated lagoons, followed by clarification (and preceded by appropriate process controls and in-plant treatment to ensure that the biological system may be operated optimally). Many of the direct discharge facilities have installed this level of treatment.

The Agency designated seven subcategory classifications for the OCPSF category to be used for establishing BPT limitations. These subcategory classifications are 1) rayon fibers (viscose process only); 2) other fibers (SIC 2823, except rayon, and 2824); 3) thermoplastics (SIC 28213); 4 thermosets (SIC 28214); 5) commodity organic chemicals (SIC 2865 and 2869); 6) bulk organic chemicals (SIC 2865 and 2869); and 7) specialty organic chemicals (SIC 2865 and 2869). The specific products and product groups within each subcategory are listed in Appendix III-A.

While some plants may have production that falls entirely within one of the seven subcategory classifications, most plants have production that is divided among two or more subcategories. In applying the subcategory limitations set forth in the regulation, the permit writer will use what is essentially a building-block approach that takes into consideration applicable subcategory characteristics based upon the proportion of production quantities within each subcategory at the plant. Production characteristics are reflected explicitly in the plant's limitations through the use of this approach.

The long-term median effluent BOD_5 concentrations were calculated for each subcategory through the use of a mathematical equation that estimates effluent BOD_5 as a function of the proportion of the production of each subcategory at each facility. The coefficients of this equation were estimated from reported plant data using standard statistical regression methods. Plants were selected for developing BPT BOD_5 limitations only if they achieved at least 95 percent removal for BOD_5 or a long-term average effluent BOD_5 concentration at or below 40 mg/l. The long-term median effluent TSS concentrations were calculated for each subcategory through the use of a mathematical equation that estimates effluent TSS as a function of effluent BOD_5. The coefficients of this equation were also estimated from reported plant data using standard statistical regression methods. Plants were selected for developing BPT TSS limitations if they passed the BOD_5 edit and also achieved a long-term average effluent TSS concentration at or below 100 mg/l. This statistical analysis is described in detail in Sections IV and VII.

"Maximum for monthly average" and "maximum for any one day" effluent limitations were determined by multiplying long-term median effluent concentrations by appropriate variability factors that were calculated through statistical analysis of long-term BOD_5 and TSS daily data. This statistical analysis is described in detail in Section VII.

The BPT subcategory BOD_5 and TSS effluent limitations are presented in Table II-1; pH, also a regulated parameter, must remain within the range of 6.0 to 9.0 at all times. EPA has determined that the BPT effluent limitations shall apply to all direct discharge point sources.

3. BCT

The Agency did not promulgate BCT effluent limitations as part of this regulation. BCT is reserved until a future BCT analysis is completed.

4. BAT

The Agency promulgated BAT limitations for two subcategories. These subcategories are largely determined by conventional pollutant raw waste characteristics. The end-of-pipe biological treatment subcategory (BAT Subcategory One) includes plants that have or will install biological treatment to comply with BPT limits. The non-end-of-pipe biological treatment subcategory (BAT Subcategory Two) includes plants that either generate such low levels of BOD_5 that they do not need to utilize biological treatment, or that choose to use physical/chemical treatment to comply with the BPT limitations. The Agency has concluded that, within each subcategory, all plants can treat priority pollutants to the levels established for that subcategory.

Different limits are being established for these two subcategories. Biological treatment is an integral part of the model BAT treatment technology for the end-of-pipe biological treatment subcategory; it achieves incremental removals of some priority pollutants beyond the removals achieved by in-plant treatment without end-of-pipe biological treatment. In addition, the Agency is establishing two different limitations for zinc. One is based on data collected from rayon manufacturers and acrylic fibers manufacturers using the zinc chloride/solvent process. This limitation applies only to those plants

TABLE II-1.
BPT EFFLUENT LIMITATIONS AND NSPS BY SUBCATEGORY (mg/l)

	Effluent Limitations[1]			
	Maximum for Monthly Average		Maximum for Any One Day	
Subcategory[2]	BOD_5	TSS	BOD_5	TSS
Rayon Fibers	24	40	64	130
Other Fibers	18	36	48	115
Thermoplastic Resins	24	40	64	130
Thermosetting Resins	61	67	163	216
Commodity Organic Chemicals	30	46	80	149
Bulk Organic Chemicals	34	49	92	159
Specialty Organic Chemicals	45	57	120	183

[1] pH, also a regulated parameter, shall remain within the range of 6.0 to 9.0 at all times.

[2] Product and product group listings for each subcategory are contained in Appendix III-A.

that use the viscose process to manufacture rayon and the zinc chloride/solvent process to manufacture acrylic fibers. The other zinc limitation is based on the performance of chemical precipitation technology used in the metal finishing point source category, and applies to all plants other than those described above.

The concentration-based BAT effluent limitations hinge on the performance of the end-of-pipe treatment component (biological treatment for the end-of-pipe biological treatment subcategory and physical/chemical treatment for the non-end-of-pipe biological treatment subcategory) plus in-plant control technologies that remove priority pollutants prior to discharge to the end-of-pipe treatment system.

The in-plant technologies include steam stripping to remove selected volatile and semivolatile priority pollutants, such as toluene, benzene, carbon tetrachloride, and the dichlorobenzenes; activated carbon for selected base/neutral priority pollutants, such as 4-nitrophenol and 4,6-dinitro-o-cresol; hydroxide precipitation for metals; alkaline chlorination for cyanide; and in-plant biological treatment for selected acid and base/neutral priority pollutants, such as phenol, the phthalate esters, and the polynuclear aromatics.

The limits are based on priority pollutant data from both OCPSF and other industry plants with well-designed and well-operated BAT model treatment technologies in place. The organic priority pollutant limits are derived from selected data within the Agency's verification study, cooperative EPA/CMA study, the 12-Plant Study, and the industry-supplied data base. Except as noted above, the cyanide and metal priority pollutant limits are derived from the metal finishing industry data base. The organic priority pollutant limits apply at the end-of-pipe process wastewater discharge point. There are no in-plant limitations established for volatile organic priority pollutants. However, the cyanide and metal limitations apply only to the process wastewater flow from cyanide-bearing and metal-bearing waste streams. Compliance for cyanide and metals could be monitored in the plant or, after accounting for dilution by noncyanide- and nonmetal-bearing process wastewater and nonprocess wastewater, at the outfall.

Derivation of the limitations is detailed in Section VII. "Maximum for Monthly Average" and "Maximum for Any One Day" limitations have been calculated for each regulated pollutant. Effluent limitations have been established for 63 pollutants for the end-of-pipe biological treatment subcategory and 59 pollutants for the non-end-of-pipe biological treatment subcategory; these limitations are listed in Tables II-2 and II-3, respectively.

In the final rule, EPA has decided that each discharger in a subcategory will be subject to the effluent limitations for all pollutants regulated for that subcategory. Once a pollutant is regulated in the OCPSF regulation, it must also be limited in the NPDES permit issued to direct dischargers (see Sections 301 and 304 of the Act; see also 40 CFR Part 122.44(a)). EPA recognizes that guidance on appropriate monitoring requirements for OCPSF plants would be useful, particularly to assure that monitoring will not be needlessly required for pollutants that are not likely to be discharged at a plant. EPA intends to publish guidance on OCPSF monitoring in the near future. This guidance will address the issues of compliance monitoring in general, of initially determining which pollutants should be subject only to infrequent monitoring based on a conclusion that they are unlikely to be discharged, and of determining the appropriate flow upon which to derive mass-based permit requirements.

EPA has determined that this technology basis is the best available technology economically achievable for all plants except for a subset of small facilities. For plants whose annual OCPSF production is less than or equal to 5 million pounds, EPA has concluded that the BAT effluent limitations are not economically achievable. For these plants, EPA has set BAT equal to BPT.

5. NSPS

EPA promulgated new source performance standards (NSPS) on the basis of the best available demonstrated technology. NSPS are established for conventional pollutants (BOD_5, TSS, and pH) on the basis of BPT model treatment technology. Priority pollutant limits are based on BAT model treatment technology.

TABLE II-2.
BAT EFFLUENT LIMITATIONS AND NSPS FOR THE
END-OF-PIPE BIOLOGICAL TREATMENT SUBCATEGORY

Pollutant Number	Pollutant Name	BAT Effluent Limitations and NSPS[1] Maximum for Any One Day	Maximum for Monthly Average
1	Acenaphthene	59	22
3	Acrylonitrile	242	96
4	Benzene	136	37
6	Carbon Tetrachloride	38	18
7	Chlorobenzene	28	15
8	1,2,4-Trichlorobenzene	140	68
9	Hexachlorobenzene	28	15
10	1,2-Dichloroethane	211	68
11	1,1,1-Trichloroethane	54	21
12	Hexachloroethane	54	21
13	1-1-Dichloroethane	59	22
14	1,1,2-Trichloroethane	54	21
16	Chloroethane	268	104
23	Chloroform	46	21
24	2-Chlorophenol	98	31
25	1,2-Dichlorobenzene	163	77
26	1,3-Dichlorobenzene	44	31
27	1,4-Dichlorobenzene	28	15
29	1,1-Dichloroethylene	25	16
30	1,2-Trans-dichloroethylene	54	21
31	2,4-Dichlorophenol	112	39
32	1,2-Dichloropropane	230	153
33	1,3-Dichloropropene	44	29
34	2,4-Dimethylphenol	36	18
35	2,4-Dinitrotoluene	285	113
36	2,6-Dinitrotoluene	641	255
38	Ethylbenzene	108	32
39	Fluoranthene	68	25
42	Bis(2-Chloroisopropyl)ether	757	301
44	Methylene Chloride	89	40
45	Methyl Chloride	190	86
52	Hexachlorobutadiene	49	20
55	Naphthalene	59	22
56	Nitrobenzene	68	27
57	2-Nitrophenol	69	41
58	4-Nitrophenol	124	72
59	2,4-Dinitrophenol	123	71
60	4,6-Dinitro-o-cresol	277	78
65	Phenol	26	15
66	Bis(2-ethylhexyl)phthalate	279	103
68	Di-n-butyl phthalate	57	27
70	Diethyl phthalate	203	81

TABLE II-2.
BAT EFFLUENT LIMITATIONS AND NSPS FOR THE
END-OF-PIPE BIOLOGICAL TREATMENT SUBCATEGORY (Continued)

Pollutant Number	Pollutant Name	BAT Effluent Limitations and NSPS[1] Maximum for Any One Day	Maximum for Monthly Average
71	Dimethyl phthalate	47	19
72	Benzo(a)anthracene	59	22
73	Benzo(a)pyrene	61	23
74	3,4-Benzofluoranthene	61	23
75	Benzo(k)fluoranthene	59	22
76	Chrysene	59	22
77	Acenaphthylene	59	22
78	Anthracene	59	22
80	Fluorene	59	22
81	Phenanthrene	59	22
84	Pyrene	67	25
85	Tetrachloroethylene	56	22
86	Toluene	80	26
87	Trichloroethylene	54	21
88	Vinyl Chloride	268	104
119	Total Chromium[2]	2,770	1,110
120	Total Copper[2]	3,380	1,450
121	Total Cyanide[3]	1,200	420
122	Total Lead[2]	690	320
124	Total Nickel[2]	3,980	1,690
128	Total Zinc[2,4]	2,610	1,050

[1]All units are micrograms per liter.

[2]Metals limitations apply only to noncomplexed metal-bearing waste streams, including those listed in Table X-4. Discharges of chromium, copper, lead, nickel, and zinc from "complexed metal-bearing process wastewater," listed in Table X-5, are not subject to these limitations.

[3]Cyanide limitations apply only to cyanide-bearing waste streams, including those listed in Table X-3.

[4]Total zinc limitations and standards for rayon fiber manufacture by the viscose process and acrylic fiber manufacture by the zinc chloride/solvent process are 6,796 μg/l and 3,325 μg/l for Maximum for Any One Day and Maximum for Monthly Average, respectively.

TABLE II-3.
BAT EFFLUENT LIMITATIONS AND NSPS FOR THE
NON-END-OF-PIPE BIOLOGICAL TREATMENT SUBCATEGORY

Pollutant Number	Pollutant Name	BAT Effluent Limitations and NSPS[1] Maximum for Any One Day	Maximum for Monthly Average
1	Acenaphthene	47	19
3	Acrylonitrile	232	94
4	Benzene	134	57
6	Carbon Tetrachloride	380	142
7	Chlorobenzene	380	142
8	1,2,4-Trichlorobenzene	794	196
9	Hexachlorobenzene	794	196
10	1,2-Dichloroethane	574	180
11	1,1,1-Trichloroethane	59	22
12	Hexachloroethane	794	196
13	1-1-Dichloroethane	59	22
14	1,1,2-Trichloroethane	127	32
16	Chloroethane	295	110
23	Chloroform	325	111
25	1,2-Dichlorobenzene	794	196
26	1,3-Dichlorobenzene	380	142
27	1,4-Dichlorobenzene	380	142
29	1,1-Dichloroethylene	60	22
30	1,2-Trans-dichloroethylene	66	25
32	1,2-Dichloropropane	794	196
33	1,3-Dichloropropene	794	196
34	2,4-Dimethylphenol	47	19
38	Ethylbenzene	380	142
39	Fluoranthene	54	22
42	Bis(2-Chloroisopropyl)ether	794	196
44	Methylene Chloride	170	36
45	Methyl Chloride	295	110
52	Hexachlorobutadiene	380	142
55	Naphthalene	47	19
56	Nitrobenzene	6,402	2,237
57	2-Nitrophenol	231	65
58	4-Nitrophenol	576	162
59	2,4-Dinitrophenol	4,291	1,207
60	4,6-Dinitro-o-cresol	277	78
65	Phenol	47	19
66	Bis(2-ethylhexyl)phthalate	258	95
68	Di-n-butyl phthalate	43	20
70	Diethyl phthalate	113	46

TABLE II-3.
BAT EFFLUENT LIMITATIONS AND NSPS FOR THE
NON-END-OF-PIPE BIOLOGICAL TREATMENT SUBCATEGORY (Continued)

Pollutant Number	Pollutant Name	BAT Effluent Limitations and NSPS[1] Maximum for Any One Day	Maximum for Monthly Average
71	Dimethyl phthalate	47	19
72	Benzo(a)anthracene	47	19
73	Benzo(a)pyrene	48	20
74	3,4-Benzofluoranthene	48	20
75	Benzo(k)fluoranthene	47	19
76	Chrysene	47	19
77	Acenaphthylene	47	19
78	Anthracene	47	19
80	Fluorene	47	19
81	Phenanthrene	47	19
84	Pyrene	48	20
85	Tetrachloroethylene	164	52
86	Toluene	74	28
87	Trichloroethylene	69	26
88	Vinyl Chloride	172	97
119	Total Chromium[2]	2,770	1,110
120	Total Copper[2]	3,380	1,450
121	Total Cyanide[3]	1,200	420
122	Total Lead[2]	690	320
124	Total Nickel[2]	3,980	1,690
128	Total Zinc[2,4]	2,610	1,050

[1]All units are micrograms per liter.

[2]Metals limitations apply only to noncomplexed metal-bearing waste streams, including those listed in Table X-4. Discharges of chromium, copper, lead, nickel, and zinc from "complexed metal-bearing process wastewater," listed in Table X-5, are not subject to these limitations.

[3]Cyanide limitations apply only to cyanide-bearing waste streams, including those listed in Table X-3.

[4]Total zinc limitations and standards for rayon fiber manufacture by the viscose process and acrylic fiber manufacture by the zinc chloride/solvent process are 6,796 μg/l and 3,325 μg/l for Maximum for Any One Day and Maximum for Monthly Average, respectively.

The Agency issued conventional pollutant new source standards for the same seven subcategories for which BPT limits were established. These standards are equivalent to the limits established for BPT shown in Table II-1. Priority pollutant new source standards are applied to new sources according to the same subcategorization scheme applicable under BAT. The set of 63 standards listed in Table II-2 for the end-of-pipe biological treatment subcategory will apply to new sources that use biological treatment in order to comply with BOD_5 and TSS limitations. The standards in the subcategory for sources that do not use end-of-pipe biological treatment apply to new sources that will either generate such low levels of BOD_5 that they do not need to use end-of-pipe biological treatment, or that choose to use physical/chemical treatment to comply with the BOD_5 standard. These facilities will have to meet the 59 priority pollutant standards listed in Table II-3, which are based on the application of in-plant control technologies with or without end-of-pipe physical/chemical treatment.

EPA has determined that NSPS will not cause a barrier to entry for new source OCPSF plants.

6. PSES

Pretreatment standards for existing sources applicable to indirect dischargers are generally analogous to BAT limitations applicable to direct dischargers. The Agency promulgated PSES for 47 priority pollutants which were determined to pass through POTWs. The standards apply to all existing indirect discharging OCPSF 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 is presented in Section VI.

Indirect dischargers generate wastewater with the same pollutant characteristics as the direct discharge plants; therefore, the same technologies that were discussed for BAT are appropriate for application at PSES. The Agency established PSES for all indirect dischargers on the same technology basis as the BAT non-end-of-pipe biological treatment subcategory.

Therefore, the pretreatment standards for existing sources, shown in Table II-4, are equivalent to the BAT limitations for the non-end-of-pipe biological treatment subcategory for the pollutants deemed to pass through.

EPA is not including end-of-pipe biological treatment in the final PSES model technology in part, because, as a matter of treatment theory, biological pretreatment may be largely redundant to the biological treatment provided by the POTW.

Although EPA has rejected the option of adding end-of-pipe biological treatment, EPA sometimes uses biological treatment as part of its model technology for the in-plant treatment of certain semivolatile pollutants such as phenol, the phthalate esters, and the polynuclear aromatics. Specifically, for such pollutants, EPA has in some cases used in-plant biological treatment systems as an alternative to in-plant activated carbon adsorption for these organic pollutants. Thus, EPA actually has used biological treatment as part of PSES model treatment technology where appropriate.

7. <u>PSNS</u>

Like PSES and BAT, PSNS is generally analogous to NSPS. However, as for PSES, EPA is not establishing PSNS limits for conventional pollutants or including end-of-pipe biological treatment in its PSNS model treatment technology, for the same reasons discussed above with respect to PSES. The Agency promulgated PSNS on the same technology basis as PSES, and issued standards for the 47 priority pollutants in Table II-4 that have been determined to pass through or otherwise interfere with the operation of POTWs. The Agency has determined that PSNS will not cause a barrier to entry for new source OCPSF plants.

TABLE II-4.
PRETREATMENT STANDARDS FOR EXISTING AND NEW SOURCES (PSES AND PSNS)

Pollutant Number	Pollutant Name	Pretreatment Standards[1] Maximum for Any One Day	Maximum for Monthly Average
1	Acenaphthene	47	19
4	Benzene	134	57
6	Carbon Tetrachloride	380	142
7	Chlorobenzene	380	142
8	1,2,4-Trichlorobenzene	794	196
9	Hexachlorobenzene	794	196
10	1,2-Dichloroethane	574	180
11	1,1,1-Trichloroethane	59	22
12	Hexachloroethane	794	196
13	1-1-Dichloroethane	59	22
14	1,1,2-Trichloroethane	127	32
16	Chloroethane	295	110
23	Chloroform	325	111
25	1,2-Dichlorobenzene	794	196
26	1,3-Dichlorobenzene	380	142
27	1,4-Dichlorobenzene	380	142
29	1,1-Dichloroethylene	60	22
30	1,2-Trans-dichloroethylene	66	25
32	1,2-Dichloropropane	794	196
33	1,3-Dichloropropene	794	196
34	2,4-Dimethylphenol	47	19
38	Ethylbenzene	380	142
39	Fluoranthene	54	22
44	Methylene Chloride	170	36
45	Methyl Chloride	295	110
52	Hexachlorobutadiene	380	142
55	Naphthalene	47	19
56	Nitrobenzene	6,402	2,237
57	2-Nitrophenol	231	65
58	4-Nitrophenol	576	162
60	4,6-Dinitro-o-cresol	277	78
65	Phenol	47	19
66	Bis(2-ethylhexyl)phthalate	258	95
68	Di-n-butyl phthalate	43	20
70	Diethyl phthalate	113	46
71	Dimethyl phthalate	47	19
78	Anthracene	47	19
80	Fluorene	47	19
81	Phenanthrene	47	19
84	Pyrene	48	20
85	Tetrachloroethylene	164	52
86	Toluene	74	28
87	Trichloroethylene	69	26

TABLE II-4.
PRETREATMENT STANDARDS FOR EXISTING AND NEW SOURCES (PSES AND PSNS)
(Continued)

Pollutant Number	Pollutant Name	Pretreatment Standards[1] Maximum for Any One Day	Maximum for Monthly Average
88	Vinyl Chloride	172	97
121	Total Cyanide[2]	1,200	420
122	Total Lead[3]	690	320
128	Total Zinc[3,4]	2,610	1,050

[1]All units are micrograms per liter.

[2]Cyanide limitations apply only to cyanide-bearing waste streams, including those listed in Table X-3.

[3]Metals limitations apply only to noncomplexed metal-bearing waste streams, including those listed in Table X-4. Discharges of lead and zinc from "complexed metal-bearing process wastewater," listed in Table X-5, are not subject to these limitations.

[4]Total zinc limitations and standards for rayon fiber manufacture by the viscose process and acrylic fiber manufacture by the zinc chloride/solvent process are 6,796 μg/l and 3,325 μg/l for Maximum for Any One Day and Maximum for Monthly Average, respectively.

SECTION III

INDUSTRY DESCRIPTION

A. INTRODUCTION

The organic chemicals industry began modestly in the middle of the 19th century. The production of coke, used both as a fuel and reductant in blast furnaces for steel production, generated coal tar as a by-product. These tars were initially regarded as wastes. However, with the synthesis of the first coal tar dye by Perkin in 1856, chemists and engineers began to recover the waste tar and use it to manufacture additional products.

The organic chemicals industry began with the isolation and commercial production of aromatic hydrocarbons (e.g., benzene and toluene and phenolics from coal tar). As more organic compounds possessing valuable properties were identified, commercial production methods for these compounds became desirable. The early products of the chemical industry were dyes, explosives, and pharmaceuticals.

The economic incentive to recover and use by-products was a driving force behind the growing synthetic chemicals industry. For example, the manufacture of chlorinated aromatics was prompted by: 1) the availability of large quantities of chlorine formed as a by-product from caustic soda production (already a commodity chemical), 2) the availability of benzene derived from coal tar, and 3) the discovery that compounds could serve as intermediates for the production of other valuable derivatives, such as phenol and picric acid. Specialty products such as surfactants, pesticides, and aerosol propellants were developed later to satisfy particular commercial needs.

The plastics and synthetic fibers industry began later as an outgrowth of the organic chemicals industry. The first commercial polymers, rayon and bakelite, were produced in the early 1900's from feedstocks manufactured by the organic chemicals industry. In the last several decades, the development of a variety of plastic and synthetic fiber products and the diversity of markets and applications of these products have made the plastic and synthetic fibers industry the largest (measured by volume) consumer of organic chemicals.

Chemicals derived from coal were the principal feedstocks of the early industry, although ethanol, derived from fermentation, was the source of some aliphatic compounds. Changing the source of industry feedstocks to less expensive petroleum derivatives lowered prices and opened new markets for organic chemicals, plastics, and synthetic fibers during the 1920's and 1930's. By World War II, the modern organic chemicals and plastics and synthetic fiber industries based on petro-chemicals were firmly established in the United States.

Today, the organic chemicals, plastics and synthetic fibers (OCPSF) industry includes production facilities of two distinct types: those whose primary function is chemical synthesis, and those that recover organic chemicals as by-products from unrelated manufacturing operations such as coke plants (steel production) and pulp mills (paper production). The majority of the plants in this industry are plants that process chemical precursors (raw materials) into a wide variety of products for virtually every industrial and consumer market.

Approximately 90 percent (by weight) of the precursors, the primary feedstocks for all of the industry's thousands of products, are derived from petroleum and natural gas. The remaining 10 percent is supplied by plants that recover organic chemicals from coal tar condensates generated by coke production.

There are numerous ways to describe the OCPSF industry; however, traditional profiles such as number of product lines or volume of product sales mask the industry's complexity and diversity. The industry is even more difficult to describe in terms that make distinctions among plants according to wastewater characteristics. Subsequent parts of this section discuss the OCPSF industry from several different perspectives, including product line, product sales, geographic distribution, facility size, facility age, and wastewater treatment and disposal methods as practiced by the industry. OCPSF wastewater treatment practices are summarized in Section II and described in detail in Section VII of this document. The subcategorization of plants within the OCPSF industry by process chemistry, raw and treated wastewater characteristics, and other plant-specific factors, is discussed in Section IV.

B. DEFINITION OF THE INDUSTRY

A single definition of the OCPSF industry is difficult to derive because of the complexity and diversity of the products and the manufacturing processes used in the industry. However, some traditional profiles can provide general descriptions of the industry, and these are discussed briefly in the following subsections:

- Standard Industrial Classification (SIC) system
- Scope of the final regulation
- Raw materials and product processes
- Geographic location
- Age of plant
- Size of plant
- Mode of discharge.

1. Standard Industrial Classification System

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. For this reason, the product descriptions in SIC codes are arbitrary, often technically ambiguous, and in some cases inaccurately representative of the products that are purported to be classified. SIC codes also list archaic products that are no longer relevant to the OCPSF industry. In some industries the SIC Code(s) match the activities covered by the issuance of effluent guidelines and standards regulations. For the OCPSF industry, product descriptions under the following SIC codes are nominal at best:

2865 Cyclic (Coal Tar) Crudes, and Cyclic Intermediates, Dyes, and Organic Pigments (Lakes and Toners)

2869 Industrial Organic Chemicals, Not Elsewhere Classified

2821 Plastics Materials, Synthetic Resins, and Nonvulcanizable Elastomers

2823 Cellulosic Man-Made Fibers

2824 Synthetic Organic Fibers, Except Cellulosic.

In addition, as a result of 1976 litigation and agreement, the organic chemicals manufacturing, and the plastics and synthetic materials manufacturing industries (since combined into the industry category addressed by this development document) was defined to include all facilities manufacturing products that could be construed to fall within these specific SIC codes. The U.S. Environmental Protection Agency (EPA) considered two of these SIC codes: SIC 2865, cyclic (coal tar) crudes, and cyclic intermediates, dyes, and organic pigments (lakes and toners); and SIC 2869, industrial organic chemicals, not elsewhere classified, to be applicable to the organic chemicals manufacturing industry.

The products that the SIC Manual includes in the industrial organic chemical industry (SIC 286) are natural products such as gum and wood chemicals (SIC 2861), aromatic and other organic chemicals from the processing of coal tar and petroleum (SIC 2865), and aliphatic or acyclic organic chemicals (SIC 2869).

These chemicals are the raw materials for deriving products such as plastics, rubbers, fibers, protective coatings, and detergents, but have few direct consumer uses. Gum and wood chemicals (SIC 2861) are regulated under a separate consent decree industrial category, gum and wood chemicals manufacturing (40 CFR 454).

The plastics and synthetic materials manufacturing category as defined by the 1976 agreement, comprises SIC 282, plastic materials and synthetic resins, synthetic rubber, and synthetic and other manmade fibers, except glass. SIC 282 includes the following SIC codes:

2821 Plastics Materials, Synthetic Resins, and Nonvulcanizable Elastomers

2822 Synthetic Rubber (Vulcanizable Elastomers)

2823 Cellulosic Man-Made Fibers

2824 Synthetic Organic Fibers, Except Cellulosic.

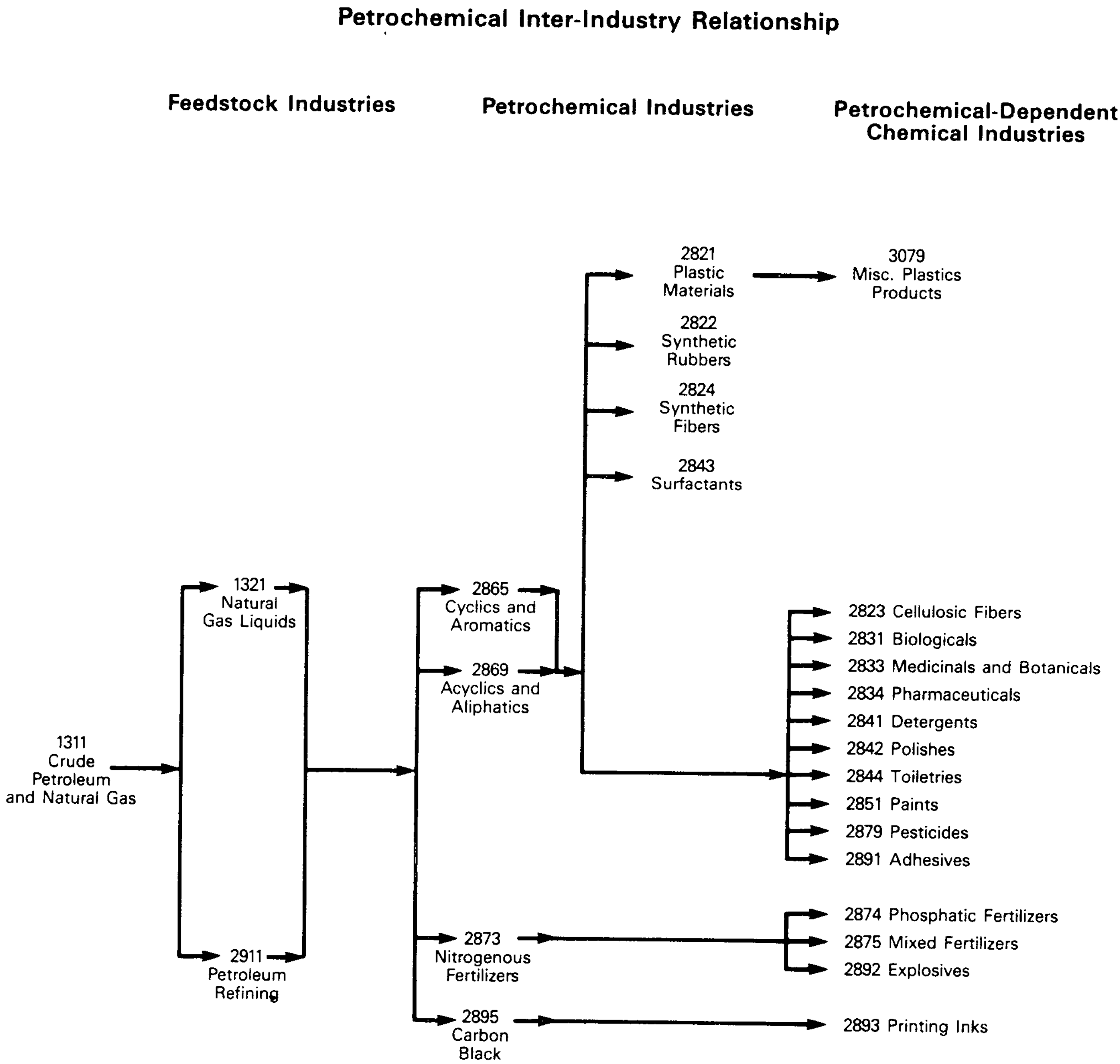
Of these codes, SIC 2822 is covered specifically in the 1976 agreement by another industrial category, rubber manufacturing (40 CFR 428). Similarly, miscellaneous plastic products (SIC 3079), which is related to the plastics industry, is covered by the specific industrial category, plastics molding and forming (40 CFR 463). EPA considers a plant that merely processes a polymeric material for any end use other than as a fiber to be in SIC 3079. In contrast, if the plant manufactures that polymeric material from monomeric raw materials, then that portion of its production is in SIC 2821.

The relationship of all the industries listed in the SIC Manual as being related to production of organic chemicals, plastics, or synthetic fibers is shown in Figure III-1.

a. Additional SIC Codes Could Be Considered as Part of the OCPSF Industry

A review of SIC product code data supplied by OCPSF industry facilities in the 1983 Section 308 Questionnaire identified 11 SIC product categories that are classified under SIC codes different from those in the Settlement Agreement discussed above that could be considered as part of the OCPSF industry because they include the manufacture of OCPSF products or utilize OCPSF process chemistry. These additional SIC code product categories are also shown in Figure III-1 and listed below.

SIC Code	Description
2891400	Synthetic Resin (and Rubber) Adhesives
2891423	Phenolics and Modified Phenolics Adhesives
2891433	Urea and Modified Urea Adhesives
2891453	Acrylic Adhesives



Source: U.S. Department of Commerce, 1981. " 1981 U.S. Industrial Outlook." Bureau of Industrial Economics, Washington, D.C.

Figure III-1.
Relationships Among the SIC Codes Related to the Production of Organic Chemicals, Plastics, and Synthetic Fibers

2843085	Bulk Surface Active Agents
2899568	Sizes, All Types
2899597	Other Industrial Chemical Specialties, Including Fluxes, Plastic Wood Preparations and Embalming Chemicals
2899598	Other Industrial Chemical Specialties, Including Fluxes and Plastic Wood Preparations
2911058	Aromatics, Made from Purchased Refinery Products
2911632	Liquified Refinery Gases (Including Other Aliphatics), Made from Purchased Refinery Products
3079000	Miscellaneous Plastics Products (Including Only Cellophane Manufacture From the Viscose Process)

b. Primary, Secondary, and Tertiary SIC Codes

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 SIC code system is commonly employed for collection and organization of data (e.g., gross production, sales, number of employees, and geographic location) for U.S. industries. An establishment is an economic unit that produces goods or services (e.g., a chemical plant, a mine, a factory, or a store). The establishment is a single physical location and is typically engaged in a single or dominant type of economic activity for which an industry code is applicable.

Where a single physical location encompasses two or more distinct and separate economic activities for which different industrial classification codes seem applicable (e.g., a steel plant that produces organic chemicals as a result of its coking operations), such activities are treated as separate establishments under separate SIC codes, provided that: 1) no one industry description in the SIC includes such combined activities; 2) the employment in each such economic activity is significant; 3) such activities are not ordinarily associated with one another at common physical locations; and

4) reports can be prepared on the number of employees, their wages and salaries, and other establishment type data. A single plant may include more than one establishment and more than one SIC code.

A plant is assigned a primary SIC code corresponding to its primary activity, which is the activity producing its primary product or group of products. The primary product is the product having the highest total annual shipment value. The secondary products of a plant are all products other than the primary products. Frequently in the chemical industry a plant may produce large amounts of a low-cost chemical, but be assigned another SIC code because of lower-volume production of a high-priced specialty chemical. Many plants are also assigned secondary, tertiary, or lower order SIC codes corresponding to plant activities beyond their primary activities. The inclusion of plants with a secondary or lower order SIC code produces a list of plants manufacturing a given class of industrial products, but also includes plants that produce only minor (or in some cases insignificant) amounts of those products. While the latter plants are part of an industry economically, their inclusion may distort the description of the industry's wastewater production and treatment, unless the wastewaters can be segregated by SIC codes.

c. Products of Various SIC Categories

Important classes of chemicals of the organic chemicals industry within SIC 2865 include: 1) derivatives of benzene, toluene, naphthalene, anthracene, pyridine, carbazole, and other cyclic chemical products; 2) synthetic organic dyes; 3) synthetic organic pigments; and 4) cyclic (coal tar) crudes, such as light oils and light oil products; coal tar acids; and products of medium and heavy oil such as creosote oil, naphthalene, anthracene and their high homologues, and tar.

Important classes of chemicals of the organic chemicals industry within SIC 2869 include: 1) non-cyclic organic chemicals such as acetic, chloroacetic, adipic, formic, oxalic acids and their metallic salts, chloral, formaldehyde, and methylamine; 2) solvents such as amyl, butyl, and ethyl alcohols; methanol; amyl, butyl, and ethyl acetates; ethyl ether, ethylene glycol ether, and diethylene glycol ether; acetone, carbon disulfide, and chlorinated solvents such as carbon tetrachloride, tetrachloroethene, and trichloroethene; 3) polyhydric alcohols such as ethylene glycol, sorbitol, pentaerythritol, and synthetic glycerin; 4) synthetic perfume and flavoring materials such as coumarin, methyl salicylate, saccharin, citral, citronellal, synthetic geraniol, ionone, terpineol, and synthetic vanillin; 5) rubber processing chemicals such as accelerators and antioxidants, both cyclic and acyclic; 6) plasticizers, both cyclic and acyclic, such as esters of phosphoric acid, phthalic anhydride, adipic acid, lauric acid, oleic acid, sebacic acid, and stearic acid; 7) synthetic tanning agents such as sulfonic acid condensates; and 8) esters, amines, etc. of polyhydric alcohols and fatty and other acids. Tables III-1 and III-2 list specific products of SIC 2865 and SIC 2869, respectively.

Important products produced by the plastics and synthetic fibers industry within SIC 2821 include: cellulose acetate, phenolic, and other tar acid resins; urea and melamine resins; vinyl acetate resins; polyethylene resins; polypropylene resins; rosin modified resins; coumarone-indene resins; petroleum resins; polyamide resins, silicones, polyisobutylenes, polyesters, polycarbonate resins, acetal resins, fluorohydrocarbon resins. Table III-3 lists important products of SIC 2821.

Important cellulosic man-made fibers (SIC 2823) include: cellulose acetate, cellulose triacetate and rayon, triacetate fibers. Important non-cellulosic synthetic organic fibers (SIC 2824) include: acrylic, modacrylic, fluorocarbon, nylon, olefin, polyester, and polyvinyl. Tables III-4 and III-5 list specific products of SIC 2823 and SIC 2824, respectively.

Certain products of SIC groups other than 2865, 2969, 2821, 2823, and 2824 are identical to OCPSF industry products. Benzene, toluene, and mixed xylenes manufactured from purchased refinery products in SIC 29110582 (in contrast to benzene, toluene, and mixed xylenes manufactured in refineries--SIC 29110558) are manufactured with the same reaction chemistry and unit operations as OCPSF products (see Table III-6). Similar considerations apply to aliphatic hydrocarbons manufactured from purchased refinery products--SIC 29116324 (see Table III-7).

TABLE III-1.
SIC 2865: CYCLIC (COAL TAR), CRUDES, AND CYCLIC INTERMEDIATES, DYES, AND ORGANIC PIGMENTS (LAKES AND TONERS)

Acid dyes, synthetic
Acids, coal tar: derived from coal tar distillation
Alkylated diphenylamines, mixed
Alkylated phenol, mixed
Aminoanthraquinone
Aminoazobenzene
Aminoazotoluene
Aminophenol
Aniline
Aniline oil
Anthracene
Anthraquinone dyes
Azine dyes
Azo dyes
Azobenzene
Azoic dyes
Benzaldehyde
Benzene hexachloride (BHC)
Benzene, product of coal tar distillation
Benzoic acid
Benzol, product of coal tar distillation
Biological stains
Chemical indicators
Chlorobenzene
Chloronaphthalene
Chlorophenol
Chlorotoluene
Coal tar crudes, derived from coal tar distillation
Coal tar distillates
Coal tar intermediates
Color lakes and toners
Color pigments, organic: except animal black and bone black
Colors, dry: lakes, toners, or full strength organic colors
Colors, extended (color lakes)
Cosmetic dyes, synthetic
Creosote oil, product of coal tar distillation
Cresols, product of coal tar distillation
Cresylic acid, product of coal tar distillation
Cyclic crudes, coal tar: product of coal tar distillation
Hydroquinone
Isocyanates
Lake red C toners
Leather dyes and stains, synthetic
Lithol rubine lakes and toners
Maleic anhydride
Methyl violet toners
Naphtha, solvent: product of coal tar distillation
Naphthalene chips and flakes
Naphthalene, product of coal tar distillation
Naphthol, alpha and beta
Nitro dyes
Nitroaniline
Nitrobenzene
Nitrophenol
Nitroso dyes
Oil, aniline
Oils: light, medium, and heavy--product of coal tar distillation
Organic pigments (lakes and toners)
Orthodichlorobenzene
Paint pigments, organic
Peacock blue lake
Pentachlorophenol
Persian orange lake
Phenol
Phloxine toners
Phosphomolybdic acid lakes and toners
Phosphotungstic acid lakes and toners
Phthalic anhydride
Phthalocyanine toners
Pigment scarlet lake
Pitch, product of coal tar distillation
Pulp colors, organic
Quinoline dyes
Resorcinol
Scarlet 2 R lake
Stains for leather
Stilbene dyes
Styrene
Styrene monomer
Tar, product of coal tar distillation
Toluene, product of coal tar distillation

TABLE III-1.
SIC 2865: CYCLIC (COAL TAR), CRUDES, AND CYCLIC INTERMEDIATES, DYES, AND ORGANIC PIGMENTS (LAKES AND TONERS)
(Continued)

Cyclic intermediates	Toluidines
Cyclohexane	Toluol, product of coal tar distillation
Diphenylamine	Vat dyes, synthetic
Drug dyes, synthetic	Xylene, product of coal tar distillation
Dye (cyclic) intermediates	Xylol, product of coal tar distillation
Dyes, food: synthetic	
Dyes, synthetic organic	
Eosine toners	
Ethylbenzene	

Source: OMB 1972. Standard Industrial Classification Manual 1972. Statistical Policy Division, Washington, D.C.

TABLE III-2.
SIC 2869: INDUSTRIAL ORGANIC CHEMICALS, NOT ELSEWHERE CLASSIFIED

Accelerators, rubber processing: cyclic and acyclic
Acetaldehyde
Acetates, except natural acetate of lime
Acetic acid, synthetic
Acetic anhydride
Acetin
Acetone, synthetic
Acid esters, amines, etc.
Acids, organic
Acrolein
Acrylonitrile
Adipic acid
Adipic acid esters
Adiponitrile
Alcohol, aromatic
Alcohol, fatty: powdered
Alcohol, methyl: synthetic (methanol)
Alcohols, industrial: denatured (nonbeverage)
Algin products
Amyl acetate and alcohol
Antioxidants, rubber processing: cyclic and acyclic
Bromochloromethane
Butadiene, from alcohol
Butyl acetate, alcohol, and proprionate
Butyl ester solution of 2, 4-D
Calcium oxalate
Camphor, synthetic
Carbon bisulfide (disulfide)
Carbon tetrachloride
Casing fluids, for curing fruits, spices, tobacco, etc.
Cellulose acetate, unplasticized
Chemical warfare gases
Chloral
Chlorinated solvents
Chloroacetic acid and metallic salts
Chloroform
Chloropicrin
Citral
Citrates
Citric acid
Citronellal
Coumarin
Cream of tartar
Cyclopropane
DDT, technical
Decahydronaphthalene
Dichlorodifluoromethane
Diethylcyclohexane (mixed isomers)
Diethylene glycol ether
Dimethyl divinyl acetylene (di-isopropenyl acetylene)
Dimethylhydrazine, unsymmetrical
Embalming fluids
Enzymes
Esters of phosphoric, adipic, lauric, oleic, sebacic, and stearic acids
Esters of phthalic anhydride
Ethanol, industrial
Ether
Ethyl acetate, synthetic
Ethyl alcohol, industrial (non-beverage)
Ethyl butyrate
Ethyl cellulose, unplasticized
Ethyl chloride
Ethyl ether
Ethyl formate
Ethyl nitrite
Ethyl perhydrophenanthrene
Ethylene
Ethylene glycol
Ethylene glycol ether
Ethylene glycol, inhibited
Ethylene oxide
Fatty acid esters, amines, etc.
Ferric ammonium oxalate
Flavors and flavoring materials, synthetic
Fluorinated hydrocarbon gases
Formaldehyde (formalin)
Formic acid and metallic salts
Freon
Fuel propellants, solid: organic
Fuels, high energy: organic
Geraniol, synthetic
Glycerin, except from fats (synthetic)
Grain alcohol, industrial (non-beverage)

TABLE III-2.
SIC 2869: INDUSTRIAL ORGANIC CHEMICALS, NOT ELSEWHERE CLASSIFIED (Continued)

Hexamethylenediamine
Hexamethylenetetramine
High purity grade chemicals, organic: refined from technical grades
Hydraulic fluids, synthetic base
Hydrazine
Industrial organic cycle compounds
Ionone
Isopropyl alcohol
Ketone, methyl ethyl
Ketone, methyl isobutyl
Laboratory chemicals, organic
Lauric acid esters
Lime citrate
Malononitrile, technical grade
Metallic salts of acyclic organic chemicals
Metallic stearate
Methanol, synthetic (methyl alcohol)
Methyl chloride
Methyl perhydrofluorine
Methyl salicylate
Methylamine
Methylene chloride
Monochlorodifluoromethane
Monomethylparaminophenol sulfate
Monosodium glutamate
Mustard gas
Napthalene sulfonic acid condensates
Naphthenic acid soaps
Normal hexyl decalin
Nuclear fuels, organic
Oleic acid esters
Organic acid esters
Organic chemicals, acyclic
Oxalates
Oxalic acid and metallic salts
Pentaerythritol
Perchloroethylene
Perfume materials, synthetic
Phosgene
Phthalates
Plasticizers, organic: cyclic and acyclic
Polyhydric alcohol esters, amines, etc.
Polyhydric alcohols
Potassiium bitartrate
Propellants for missiles, solid: organic
Propylene
Propylene glycol
Quinuclidinol ester of benzylic acid
Reagent grade chemicals, organic: refined from technical grades
Rocket engine fuel, organic
Rubber processing chemicals, organic: accelerators and antioxidants
Saccharin
Sebacic acid
Silicones
Soaps, naphthenic acid
Sodium acetate
Sodium alginate
Sodium benzoate
Sodium glutamate
Sodium pentachlorophenate
Sodium sulfoxalate formaldehyde
Solvents, organic
Sorbitol
Stearic acid salts
Sulfonated naphthalene
Tackifiers, organic
Tannic acid
Tanning agents, synthetic organic
Tartaric acid and metallic salts
Tartrates
Tear gas
Terpineol
Tert-butylated bis (p-phenoxyphenyl) ether fluid
Tetrachloroethylene
Tetraethyl lead
Thioglycolic acid, for permanent wave lotions
Trichloroethylene
Trichloroethylene stabilized, degreasing
Trichlorophenoxyacetic acid
Trichlorotrifluoroethane tetrachlorodi fluoroethane isopropyl alcohol
Tricresyl phosphate

TABLE III-2.
SIC 2869: INDUSTRIAL ORGANIC CHEMICALS, NOT ELSEWHERE CLASSIFIED (Continued)

Tridecyl alcohol
Trimethyltrithiophosphite (rocket propellants)
Triphenyl phosphate
Vanillin, synthetic
Vinyl acetate

Source: OMB 1972. Standard Industrial Classification Manual 1972. Statistical Policy Division, Washington, D.C.

TABLE III-3.
SIC 2821: PLASTIC MATERIALS, SYNTHETIC RESINS, AND NONVULCANIZABLE ELASTOMERS

Acetal resins	Nylon resins
Acetate, cellulose (plastics)	Petroleum polymer resins
Acrylic resins	Phenol-furfural resins
Acrylonitrile-butadiene-styrene resins	Phenolic resins
Alcohol resins, polyvinyl	Phenoxy resins
Alkyd resins	Phthalic alkyd resins
Allyl resins	Phthalic anhydride resins
Butadiene copolymers, containing less than 50% butadiene	Polyacrylonitrile resins
Carbohydrate plastics	Polyamide resins
Casein plastics	Polycarbonate resins
Cellulose nitrate resins	Polyesters
Cellulose propionate (plastics)	Polyethylene resins
Coal tar resins	Polyhexamethylenediamine adipamide resins
Condensation plastics	Polyisobutylenes
Coumarone-indene resins	Polymerization plastics, except fibers
Cresol-furfural resins	Polypropylene resins
Cresol resins	Polystyrene resins
Dicyandiamine resins	Polyurethane resins
Diisocyanate resins	Polyvinyl chloride resins
Elastomers, nonvulcanizable (plastics)	Polyvinyl halide resins
Epichlorohydrin bisphenol	Polyvinyl resins
Epichlorohydrin diphenol	Protein plastics
Epoxy resins	Pyroxylin
Ester gum	Resins, phenolic
Ethyl cellulose plastics	Resins, synthetic: coal tar and non-coal tar
Ethylene-vinyl acetate resins	Rosin modified resins
Fluorohydrocarbon resins	Silicone fluid solution (fluid for sonar transducers)
Ion exchange resins	Silicone resins
Ionomer resins	Soybean plastics
Isobutylene polymers	Styrene resins
Lignin plastics	Styrene-acrylonitrile resins
Melamine resins	Tar acid resins
Methyl acrylate resins	Urea resins
Methyl cellulose plastics	Vinyl resins
Methyl methacrylate resins	
Molding compounds, plastics	
Nitrocellulose plastics (pyroxylin)	

Source: OMB 1972. Standard Industrial Classification Manual 1972. Statistical Policy Division, Washington, D.C.

TABLE III-4.
SIC 2823: CELLULOSIC MAN-MADE FIBERS

Acetate fibers	Rayon primary products: fibers, straw, strips, and yarn
Cellulose acetate monofilament, yarn, staple, or tow	Rayon yarn, made in chemical plants (primary products)
Cellulose fibers, man-made	Regenerated cellulose fibers
Cigarette tow, cellulosic fiber	Triacetate fibers
Cuprammonium fibers	Viscose fibers, bands, strips, and yarn
Fibers, cellulose man-made	Yarn, cellulosic: made in chemical plants (primary products)
Fibers, rayon	
Horsehair, artifical: rayon	
Nitrocellulose fibers	

Source: OMB, 1972. Standard Industrial Classification Manual 1972. Statistical Policy Division, Washington, D.C.

TABLE III-5
SIC 2824: SYNTHETIC ORGANIC FIBERS, EXCEPT CELLULOSIC

Acrylic fibers	Polyester fibers
Acrylonitrile fibers	Polyvinyl ester fibers
Anidex fibers	Polyvinylidene chloride fibers
Casein fibers	Protein fibers
Elastomeric fibers	Saran fibers
Fibers, man-made: except cellulosic	Soybean fibers (man-made textile materials)
Fluorocarbon fibers	Vinyl fibers
Horsehair, artificial: nylon	Vinylidene chloride fibers
Linear esters fibers	Yarn, organic man-made fiber except cellulosic
Modacrylic fibers	Zein fibers
Nylon fibers and bristles	
Olefin fibers	
Organic fibers, synthetic: except cellulosic	

Source: OMB 1972. Standard Industrial Classification Manual 1972. Statistical Policy Division, Washington, D.C.

TABLE III-6.
OCPSF CHEMICAL PRODUCTS ALSO LISTED AS SIC 29110582 PRODUCTS

Benzene
Cresylic acid
Cyclopentane
Naphthalene
Naphthenic Acid
Toluene
Xylenes, Mixed
C9 Aromatics

Source: 1982 Census of Manufacturers and Census of Mineral Industries. Numerical List of Manufactured and Mineral Products. U.S. Department of Commerce, Bureau of the Census, 1982.

TABLE III-7.
OCPSF CHEMICAL PRODUCTS ALSO LISTED AS SIC 29116324 PRODUCTS

C2 Hydrocarbons
Acetylene
Ethane
Ethylene
C3 Hydrocarbons
Propane
Propylene
C4 Hydrocarbons
Butadiene and butylene fractions
1,3-Butadiene, grade for rubber
n-Butane
Butanes, mixed
1-Butene
2-Butene
1-Butane and 2-butene, mixed
Hydrocarbons, C4, fraction
Hydrocarbons, C4, mixtures
Isobutane (2-Methylpropane)
Isobutylene (2-Methylpropene)
C4 Hydrocarbons, all other
amylenes
Dibutanized aromatic concentrate
C5 Hydrocarbon, mixtures
Isopentane (2-Methylbutane)
Isoprene (2-Methyl-1,3-butadiene)
n-Pentane
1-Pentene
Pentenes, mixed
Piperylene (1,3-Pentadiene)
C5 Hydrocarbons, all other
C6 Hydrocarbons
Diisopropane
Hexane
Hexanes, mixed
Hydrocarbons, C5-C6, mixtures
Hydrocarbons, C5-C7, mixtures
Isohexane
Methylcyclopentadiene
Neohexane (2,2-Dimethylbutane)
C6 Hydrocarbons, C6, all other
n-Heptane
Heptenes, mixed
Isoheptanes
C7 Hydrocarbons
C8 Hydrocarbons
Diisobutylene (Diisobutene)
n-Octane
Octenes, mixed
2,2,4-Trimethylpentane (Isooctane)
C8 Hydrocarbons, all other
C9 and above Hydrocarbons
Dodecene
Eicosane
Nonene (Tripropylene)
Alpha olefins
Alpha olefins, C6-C10
Alpha olefins, C11 and higher
n-Paraffins
n-Paraffins, C6-C9
n-Paraffins, C9-C15
n-Paraffins, C10-C14
n-Paraffins, C10-C16
n-Paraffins, C12-C18
n-Paraffins, C15-C17
n-Paraffins, other
Hydrocarbons, C5-C9, mixtures
Polybutene
Hydrocarbon derivatives
n-Butyl mercaptan (1-Butanethiol)
sec-Butyl mercaptan (2-Butanethiol)
tert-Butyl mercaptan (2-Methyl-2-propanethiol)
Di-tert-butyl disulfide
Diethyl sulfide (Ethyl sulfide)
Dimethyl sulfide
Ethyl mercaptan (Ethanethiol)
Ethylthioethanol
n-Hexyl mercaptan (1-Hexanethiol)
Isopropyl mercaptan (2-Propanethiol)
Methyl ethyl sulfide
Methyl mercaptan (Methanethiol)
tert-Octyl mercaptan (2,4,4-Trimethyl-2-pentanethiol)
Octyl mercaptans
Thiophane (Tetrahydrothiophene)
Hydrocarbon derivatives: all other hydrocarbon derivatives
Hydrocarbons, C9 and above, all other, including mixtures

Source: 1982 Census of Manufacturers and Census of Mineral Industries. Numerical List of Manufactured and Mineral Products. U.S. Department of Commerce, Bureau of the Census, 1982.

2. Scope of the Final Regulation

The promulgated regulation establishes effluent limitations guidelines and standards for existing and new organic chemicals, plastics, and synthetic fibers manufacturing facilities (BPT, BAT, NSPS, PSES, and PSNS). The final regulations apply to process wastewater discharges from these facilities.

For the purposes of this regulation, OCPSF process wastewater discharges are defined as discharges from all establishments or portions of establishments that manufacture the products or product groups listed in the applicability sections of the regulation and also in Appendix III-A of this document, and are included within the following U.S. Department of Commerce Bureau of the Census SIC major groups:

- SIC 2865 - Cyclic Crudes and Intermediates, Dyes, and Organic Pigments
- SIC 2869 - Industrial Organic Chemicals, Not Elsewhere Classified
- SIC 2821 - Plastic Materials, Synthetic Resins, and Nonvulcanizable Elastomers
- SIC 2823 - Cellulosic Man-Made Fibers
- SIC 2824 - Synthetic Organic Fibers, Except Cellulosic.

The OCPSF regulation does not apply to process wastewater discharges from the manufacture of organic chemical compounds solely by extraction from plant and animal raw materials or by fermentation processes. Thus, ethanol derived from natural sources (SIC 28095112) is not considered to be an OCPSF industry product; however, ethanol produced synthetically (hydration of ethene) is an OCPSF industry product.

The OCPSF regulation covers all OCPSF products or processes whether or not they are located at facilities where the OCPSF covered operations are a minor portion of and ancillary to the primary production activities or a major portion of the activities.

The OCPSF regulation does not apply to discharges from OCPSF product/process operations that are covered by the provisions of other categorical industry effluent limitations guidelines and standards if the wastewater is treated in combination with the non-OCPSF industrial category regulated wastewater. (Some products or product groups are manufactured by different processes and some processes with slight operating condition variations give different products; EPA uses the term "product/process" to define all different variations within this category of the same basic process to manufacture different products as well as to manufacture the same product using different processes.) However, the OCPSF regulation applies to the product/processes covered by this regulation if the facility reports OCPSF products under SIC codes 2865, 2869, or 2821, and its OCPSF wastewaters are treated in a separate treatment system at the facility or discharged separately to a publicly owned treatment works (POTW).

For example, some vertically integrated petroleum refineries and pharmaceutical manufacturers discharge wastewaters from the production of synthetic organic chemical products that are specifically regulated under the petrochemical and integrated subcategories of the petroleum refining point source category (40 CFR Part 419, Subparts C and E) or the chemical synthesis products subcategory of the pharmaceuticals manufacturing point source category (40 CFR Part 439, Subpart C). Thus, the principles discussed in the preceding paragraph apply as follows: the process wastewater discharges by petroleum refineries and pharmaceutical manufacturers from production of organic chemical products specifically covered by 40 CFR Part 419 Subparts C and E and Part 439 Subpart C, respectively, that are treated in combination with other petroleum refinery or pharmaceutical manufacturing wastewater, respectively, are not subject to regulation no matter what SIC they use to report their products. However, if the wastewaters from their OCPSF production is separately discharged to a POTW or treated in a separate treatment system, and they report their products (from these processes) under SIC codes 2865, 2869, or 2821, then these manufacturing operations are subject to regulation under the OCPSF regulation, regardless of whether the OCPSF products are covered by 40 CFR Part 419, Subparts C and E and Part 439, Subpart C.

The promulgated OCPSF category regulation applies to plastics molding and forming processes when plastic resin manufacturers mold or form (e.g., extrude and pelletize) crude intermediate plastic material for shipment off-site.

This regulation also applies to the extrusion of fibers. Plastics molding and forming processes other than those described above are regulated by the plastics molding and forming effluent guidelines and standards (40 CFR Part 463).

Public comments requested guidance relating to the coverage of OCPSF research and development facilities. Stand-alone OCPSF research and development, pilot-plant, technical service, and laboratory bench-scale operations are not covered by the OCPSF regulation. However, wastewater from such operations conducted in conjunction with and related to existing OCPSF manufacturing operations at OCPSF facilities is covered by the OCPSF regulation because these operations would most likely generate wastewater with characteristics similar to the commercial manufacturing facility. Research and development, pilot-plant, technical service, and laboratory operations that are unrelated to existing OCPSF plant operations, even though conducted on-site, are not covered by the OCPSF regulation because they may generate wastewater with characteristics dissimilar to that from the commercial OCPSF manufacturing facility.

Finally, as described in the following paragraphs, this regulation does not cover certain production that has historically been reported to the Bureau of Census under a non-OCPSF SIC subgroup heading, even if such production could be reported under one of the five SIC code groups covered by the final regulation.

The Settlement Agreement required the Agency to establish regulations for the organic chemicals manufacturing SIC codes 2864 and 2869 and for the plastics and synthetic materials manufacturing SIC Code 282. SIC 282 includes the three codes covered by this regulation, 2821, 2823, and 2824, as well as SIC 2822, synthetic rubber (vulcanizable elastomers), which is covered specifically in the Settlement Agreement by another industrial category, rubber manufacturing (40 CFR 428). The Agency therefore directed its data collection efforts to those facilities that report manufacturing activities under SIC codes 2821, 2823, 2824, 2865, and 2869. Based on an assessment of this information and the integrated nature of the synthetic OCPSF industry, the Agency also defined the applicability of the OCPSF regulation by listing the specific products and product groups that provide the technical basis for the regulation (see Appendix III-A).

Since many of these products may be reported under more than one SIC code even though they are often manufactured with the same reaction chemistry or unit operations, the Agency proposed to extend the applicability of the OCPSF regulation (50 FR 29068; July 17, 1985 or 51 FR 44082; December 8, 1986) to include OCPSF production reported under the following SIC subgroups:

- SIC 2911058 - aromatic hydrocarbons manufactured from purchased refinery products
- SIC 2911632 - aliphatic hydrocarbons manufactured from purchased refinery products
- SIC 28914 - synthetic resin and rubber adhesives (including only those synthetic resins listed under both SIC 28914 and SIC 2821 that are polymerized for use or sale by adhesive manufacturers)
- Chemicals and chemical preparations, not elsewhere classified:
    - SIC 2899568 - sizes, all types
    - SIC 2899597 - other industrial chemical specialties, including fluxes, plastic wood preparations, and embalming fluids
- SIC 2843085 - bulk surface active agents
- SIC 3079 - miscellaneous plastics products (including only cellophane manufacture from the viscose process).

However, for the reasons discussed below, the Agency has decided not to extend the applicability of the OCPSF regulation to discharges from establishments that manufacture OCPSF products and have, in the past, reported such production under these non-OCPSF SIC subgroups.

As noted earlier, the SIC codes are classifications of commercial and industrial establishments by type of activity in which they are engaged. The predominant purpose of the SIC code is to classify the manufacturing industries for the collection of economic data. The product descriptions in SIC codes are often technically ambiguous and also list products that are no longer produced in commercial quantities. For this reason, the Agency proposed to define the applicability of the OCPSF regulation in terms of both SIC codes and specific products and product groups (50 FR 29073, July 17, 1985). Many chemical products may appear under more than one SIC code depending on the manufacturing raw material sources, use in the next stage of the manufacturing process, or type of sale or end use. For example, phenolic, urea, and acrylic resin manufacture may be reported under SIC 28914, synthetic resin adhesives, as well as under SIC 2821, plastics materials and resins. Benzene, toluene, and xylene manufacture may be reported under SIC 2911, petroleum refining, or under SIC 2911058, aromatics, made from purchased refinery products, as well as SIC 2865, cyclic crudes and intermediates. Likewise, alkylbenzene sulfonic acids and salts manufacture may be reported under SIC 2843085, bulk surface active agents, which include all amphoteric, anionic, cationic, and nonionic bulk surface active agents excluding surface active agents produced or purchased and sold as active incredients in formulated products, as well as SIC 286, industrial organic chemicals.

Many commenters stated that the Agency's OCPSF technical and economic studies do not contain sufficient information to extend coverage to all facilities reporting OCPSF manufacturing under all of the above SIC subgroups. The Agency agrees in part with these commenters. The OCPSF technical, cost, and economic impact data-gathering efforts focused only on those primary and secondary manufacturers that report OCPSF manufacturing activities under SIC codes 2821, 2823, 2824, 2865, and 2869. Specific efforts were not directed toward gathering technical and financial data from facilities that report OCPSF manufacturing under SIC subgroups 2911058, 2911632, 28914, 2843085, 2899568, 2899597, and 3079. As a result, EPA lacks cost and economic information from a significant number of plants that report OCPSF manufacturing activities to the Bureau of the Census under these latter SIC subgroups. Consequently, the applicability section of the final regulation (§414.11) clarifies that the OCPSF regulation does not apply to a plant's OCPSF production that has been reported by the plant in the past under SIC groups 2911058, 2911632, 28914, 2843085, 2899568, 2899597, and 3079.

Approximately 140 of the 940 OCPSF plants that provide the technical basis for the final regulation reported parts of their OCPSF production under SIC codes 2911058, 2911632, 28914, 2843085, 2899568, and 2899597, as well as SIC codes 2821, 2823, 2824, 2865, and 2869. As a result of the definition of applicability, a smaller portion of plant production than was reported as OCPSF production for these plants is covered by the final regulation.

The Agency does note, however, that the OCPSF manufacturing processes are essentially identical regardless of how manufacturing facilities may report OCPSF production to the Bureau of the Census. Therefore, the OCPSF technical data base and effluent limitations and standards provide permit issuing authorities with technical guidance for establishing "Best Professional Judgment" (BPJ) permits for OCPSF production activities to which this regulation does not apply.

Some of the non-OCPSF SIC subgroups were the subject of prior EPA decisions not to establish national regulations for priority pollutants under the terms of Paragraph 8 of the Settlement Agreement. Such action was taken for adhesive and sealant manufacturing (SIC 2891), as well as plastics molding and forming (SIC 3079), paint and ink formulation and printing (which industries were within SIC 2851, 2893, 2711, 2721, 2731 and 10 other SIC 27 groups) and soap and detergent manufacturing (SIC 2841). However, it should be noted that in specific instances where a plant in these categories has OCPSF production activities, toxic pollutants may be present in the discharge in amounts that warrant BPJ regulatory control. Moreover, the adhesives and sealants, plastics molding and forming, and paint and ink formulation and printing Paragraph 8 exclusions do not include process wastewater from the secondary manufacture of synthetic resins. Similarly, the soaps and detergents Paragraph 8 exclusion does not include process wastewater from the manufacture of surface active agents (SIC 2843). In these cases, and even in cases where priority pollutants from OCPSF production covered by other categorical standards (e.g., petroleum refining and pharmaceuticals) have been excluded from those regulations under the terms of Paragraph 8 of the Settlement Agreement, BPJ priority pollutant regulation for individual plants having OCPSF production may be appropriate.

3. Raw Materials and Product Processes

a. Raw Materials

Synthetic organic chemicals are derivatives of naturally occurring materials (petroleum, natural gas, and coal) that have undergone at least one chemical reaction. Given the large number of potential starting materials and chemical reactions available to the industry, many thousands of organic chemicals are produced by a potentially large number of basic processes having many variations. Similar considerations also apply to the plastics and synthetic fibers industry, although both the number of starting materials and processes are more limited. Both organic chemicals and plastics are commercially produced from six major raw material classifications: methane, ethane, propene, butanes/butenes, and higher aliphatic and aromatic compounds. This list can be expanded to eight by further defining the aromatic compounds to include benzene, toluene, and xylene. These raw materials are derived from natural gas and petroleum, although a small portion of the aromatic compounds is derived from coal.

Using these eight basic raw materials (feedstocks) derived from the petroleum refining industry, process technologies used by the OCPSF industry lead to the formation of a wide variety of products and intermediates, many of which are produced from more than one basic raw material either as a primary reaction product or as a co-product. Furthermore, the reaction product of one process is frequently used as the raw material for a subsequent process. The primary products of the organic chemicals industry, for example, are the raw materials of the plastics and synthetic fibers industry. Furthermore, the reaction products of one process at a plant are frequently the reactants for other processes at the same plant, leading to the categorization of a chemical as a product in one process and a reactant in another. This ambiguity continues until the manufacture of the ultimate end product, normally at the fabrication or consumer stage. Many products/intermediates can be made from more than one raw material. Frequently, there are alternate processes by which a product can be made from the same basic raw material.

A second characteristic of the OCPSF industry that adds to the complexity of the industry is the high degree of integration in manufacturing units. Most plants in this industry use several of the eight basic raw materials derived from petroleum or natural gas to produce a single product.

In addition, many plants do not use the eight basic raw materials, but rather use products produced at other plants as their raw materials. Relatively few manufacturing facilities are single product/process plants unless the final product is near the fabrication or consumer product stage. Any attempt to define or subcategorize the industry on the basis of the 8 raw materials would require the establishment of over 256 definitions or subcategories. Schematic diagrams illustrating some of these relationships are shown in Section V of this document (see Figures V-1 to V-16).

b. Process Chemistry

Chemical and plastics manufacturing plants share an important characteristic: chemical processes never convert 100 percent of the feedstocks to the desired products, since the chemical reactions/processes never proceed to total completion.

Moreover, because there is generally a variety of reaction pathways available to reactants, undesirable by-products are often generated. This produces a mixture of unreacted raw materials, products, and by-products that must be separated and recovered by operations that generate residues with little or no commercial value. These losses appear in process wastewater, in air emissions, or directly as chemical wastes. The specific chemicals that appear as losses are determined by the feedstock and the process chemistry imposed upon it. The different combinations of products and production processes distinguish the wastewater characteristics of one plant from those of another.

Manufacture of a chemical product necessarily consists of three steps: 1) combination of reactants under suitable conditions to yield the desired product; 2) separation of the product from the reaction matrix (e.g., by-products, co-products, reaction solvents); and 3) final purification and/or disposal of the wastewaters. Pollutants arise from the first step as a result of alternate reaction pathways; separation of reactants and products from a reaction mixture is imperfect and both raw materials and products are typically found in process wastewaters.

Although there is strong economic incentive to recover both raw materials and products, there is little incentive to recover the myriad of by-products formed as the result of alternate reaction pathways. An extremely wide variety of compounds can form within a given process. Typically, chemical species do not react via a single reaction pathway; depending on the nature of the reactive intermediate, there is a variety of pathways that lead to a series of reaction products. Often, and certainly the case for reactions of industrial significance, one pathway may be greatly favored over all others, but never to total exclusion. The direction of reactions in a process sequence is controlled through careful adjustment and maintenance of conditions in the reaction vessel. The physical condition of species present (liquid, solid, or gaseous phase), conditions of temperature and pressure, the presence of solvents and catalysts, and the configuration of process equipment dictate the kinetic pathway by which a particular reaction will proceed.

Therefore, despite the differences between individual chemical production plants, all transform one chemical to another by chemical reactions and physical processes. Although each transformation represents at least one chemical reaction, production of most of the industry's products can be described by one or more of the 41 major generalized chemical reactions/processes listed in Table III-8. Subjecting the basic feedstocks to sequences of these 41 generic processes produces most commercial organic chemicals and plastics.

Pollutant formation is dependent upon both the raw material and process chemistry, and broad generalizations regarding raw wastewater loads based solely on process chemistry are difficult at best. Additionally, OCPSF manufacturing processes typically employ unique combinations of the major generic processes shown in Table III-8 to produce organic chemicals, plastics, and synthetic fibers that tend to blur any distinctions possible.

c. Product/Processes

Each chemical product may be made by one or more combinations of raw feedstock and generic process sequences. Specification of the sequence of product synthesis by identification of the product and the generic process by which it is produced is called a "product/process." There are, however, thousands of product/processes within the OCPSF industries. Data gathered on the nature and quantity of pollutants associated with the manufacture of specific products within the organic chemicals and plastic/synthetic fibers

TABLE III-8.
MAJOR GENERALIZED CHEMICAL REACTIONS AND PROCESSES
OF THE ORGANIC CHEMICALS, PLASTICS, AND SYNTHETIC FIBERS INDUSTRY

Acid cleavage	Fiber production
Alkoxylation	Halogenation
Alkylation	Hydration
Amination	Hydroacetylation
Ammonolysis	Hydrodealkylation
Ammoxidation	Hydrogenation
Carbonylation	Hydrohalogenation
Chlorohydrination	Hydrolysis
Condensation	Isomerization
Cracking	Neutralization
Crystallization/Distillation	Nitration
Cyanation/Hydrocyanation	Oxidation
Dehydration	Oxyhalogenation
Dehydrogenation	Oxymation
Dehydrohalogenation	Peroxidation
Distillation	Phosgenation
Electrohydrodimerization	Polymerization
Epoxidation	Pyrolysis
Esterification	Sulfonation
Etherification	
Extractive distillation	
Extraction	

industries have been indexed for 176 product/processes. These data are discussed in Section V of this document.

Organic chemical plants vary greatly as to the number of products manufactured and processes employed, and may be either vertically or horizontally integrated. One representative plant, which is both vertically and horizontally integrated, may produce a total of 45 high-volume products with an additional 300 lower-volume products. In contrast, a specialty chemicals plant may produce a total of 1,000 different products with 70 to 100 of these being produced on any given day.

On the other hand, specialty chemicals may involve several chemical reactions and require a more detailed description. For example, preparation of toluene diisocyanate involves three synthesis steps -- nitration, hydrogenation, and phosgenation. This example, in fact, is relatively simple; manufacture of other specialty chemicals is more complex. Thus, as individual chemicals become further removed from the feedstock of the industry, more processes are required to produce them.

In contrast to organic chemicals, plastics and synthetic fibers are polymeric products. Their manufacture directly utilizes only a small subset of either the chemicals manufactured or processes used within the OCPSF industry. Such products are manufactured by polymerization processes in which organic chemicals (monomers) react to form macromolecules or polymers, composed of thousands of monomer units. Reaction conditions are designed to drive the polymerization as far to completion as practical and to recover unreacted monomer.

Unless a solvent is used in the polymerization, by-products of polymeric product manufacturers are usually restricted to the monomer(s) or to oliomers (a polymer consisting of only a few monomer units). Because the mild reaction conditions generate few by-products, there is economic incentive to recover the monomer(s) and oliomers for recycle; the principal yield loss is typically scrap polymer. Thus, smaller amounts of fewer organic chemical co-products (pollutants) are generated by the production of polymeric plastics and synthetic fibers than are generated by the manufacture of the monomers and other organic chemicals.

For the purposes of characterizing the OCPSF industry in this section, the manufacturing facilities are assigned to one of the following three groups based on SIC codes reported in the 1983 Section 308 Questionnaire.

Plant Group	Associated SIC Codes Reported
Organics Plants	2865, 2869
Plastics Plants	2821, 2823, 2824
Organics and Plastics Plants (Mixed)	One or more from each of the two groups above

d. Industry Structure by Product/Process

A portion of the branched product structure of the OCPSF industry is illustrated in Figures V-1 to V-16 of Section V, which include key OCPSF products and organic priority pollutants. The total product line of the industry is considerably more complex, but Figures V-1 to V-16 illustrate the ability of the organic chemicals industry to produce a product by different synthesis routes. For each of the products that are produced in excess of 1,000 pounds per year (approximately 1,500 to 2,500 products), there is an average of two synthetic routes. The more than 20,000 compounds that are produced in smaller quantities by the industry tend to be more complex molecules that can be synthesized by multiple routes. Because many products are often produced by more than one manufacturer, using the same or different synthetic routes, few plants have exactly the same product/process combinations as other plants.

An important characteristic of the OCPSF industry is the degree of vertical integration among manufacturing units at individual plants. Since a majority of the basic raw materials is derived from petroleum or natural gas, many of the commodity organic chemical manufacturing plants are either part of or contiguous to petroleum refineries; most of these plants have the flexibility to produce a wide variety of products.

Relatively few organic chemical manufacturing facilities are single product/process plants, unless the final product is near the fabrication or consumer product stage.

Additionally, many process units are integrated in such a way that production levels of related products can be varied as desired over wide ranges. There can be a wide variation in the size (production capacity) of the manufacturing complex, as well as diversity of product/processes. In addition to variations based on the design capacity and design product mix, economic and market conditions of both the products and raw materials can greatly influence the production rate and the processes that are employed even on a relatively short-term basis.

4. Geographic Distribution

Plant distribution by state is presented in Table III-9. Most organic chemical plants are located in coastal regions or on waterways near either sources of raw materials (especially petrochemicals) or transportation centers. Plastics and synthetic fibers plants are generally located near organic chemicals plants to minimize costs of monomer feedstock transportation. However, a significant number of plastics plants are situated near product markets (i.e., large population centers) to minimize costs of transporting the products to market.

5. Plant Age

The ages of plants within the OCPSF industry are difficult to define, since the plants are generally made up of more than one process unit, each designed to produce different products. As the industry introduces new products and product demand grows, process units are added to a plant. It is not clear which process should be chosen to define plant age. Typically, the oldest process in current operation is used to define plant age. Information concerning plant age was requested in the 1983 "308" Questionnaire.

Respondents were asked to report the year plant operation began and the year the oldest OCPSF process line still operating went into operation. Table III-10 presents the plant distribution of the age of the oldest OCPSF process line still operating. Table III-10 indicates that a few plants are currently operating processes that are over 100 years old. However, over two-thirds of the plants began operating the oldest process within the past 35 years. In addition, the startup of new plants has been declining since the early 1970's.

TABLE III-9.
PLANT DISTRIBUTION BY STATE

State*	Organics Plants	Plastics Plants	Organics and Plastics Plants	Total
AL	14	4	5	23
AR	4	2	2	8
CA	19	40	4	63
CO	2	1	-	3
CT	6	8	2	16
DE	5	2	2	9
FL	2	6	3	11
GA	7	9	2	18
IA	2	4	-	6
IL	16	24	15	55
IN	7	3	2	12
KS	3	-	1	4
KY	7	9	5	21
LA	27	12	8	47
MA	4	13	3	20
MD	4	5	1	10
MI	9	8	4	21
MN	1	1	1	3
MO	8	6	1	15
MS	4	5	3	12
MT	-	-	1	1
NC	13	18	10	41
NE	1	-	-	1
NH	2	2	-	4
NJ	70	23	16	109
NY	23	15	5	43
OH	27	30	12	69
OK	-	2	-	2
OR	1	5	4	10
PA	22	13	8	43
PR	-	1	1	2
RI	4	2	3	9
SC	17	12	8	37
TN	8	6	4	18
TX	57	20	29	106
UT	2	-	-	2
VA	7	15	2	24
WA	3	4	1	8
WI	4	5	3	12
WV	13	3	6	22
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Total	425	338	177	940

*Only states that contain at least one facility are listed.

Source: EPA CWA Section 308 Survey, October 1983.

TABLE III-10.
DISTRIBUTION OF PLANTS BY AGE OF OLDEST
OCPSF PROCESS STILL OPERATING AS OF 1984

Plant Age	Organics Plants	Plastics Plants	Organics and Plastics Plants	Total
1-5	24	14	2	40
6-10	37	29	2	68
11-15	40	41	20	101
16-20	55	54	17	126
21-25	44	46	19	109
26-30	50	41	28	119
31-35	42	24	20	86
36-40	24	17	21	62
41-50	30	23	16	69
51-60	23	19	8	50
61-70	28	16	10	54
71-80	16	4	5	25
81-90	3	5	4	12
91-100	3	1	3	7
101-120	5	1	-	6
>120	-	-	1*	1*
Data not Available	1	3	1	5
Total	425	338	177	940

*Note: The one plant whose age is >120 is 137 years old.

Source: EPA CWA Section 308 Survey, 1983.

This major decline in startup of combined organics and plastics plants in the past 10 years may indicate a trend toward construction of plants that produce fewer products or many specialty products geared toward specific markets, since the combined plants tend to be the larger, multi-product, vertically integrated plants.

6. Plant Size

Although plant size may be defined in many ways, including number of employees, number of product/processes, plant capacity, production volume, and sales volume, none of these factors alone is sufficient to define plant size; each is discussed in this subsection.

a. Number of Employees

Perhaps the most obvious definition of plant size would be the number of workers employed. However, continuous process plants producing high-volume commodity chemicals typically employ fewer workers per unit of production than do plants producing specialty (relatively low-volume) chemicals. Table III-11 presents the plant distribution by the average number of employees engaged in OCPSF operations during 1982. These data were obtained from the 1983 Section 308 Questionnaire.

b. Number of Product/Processes

Plant size may also be expressed in terms of the number of product/processes that are operated at a plant. Analysis of the number of product/processes for 546 primary producers in the edited 1983 Section 308 Questionnaire data base is presented in Table III-12. The table generally includes only direct and indirect discharge facilities whose total plant production is greater than 50 percent OCPSF products. Detailed product/process information was not collected from zero discharge or secondary OCPSF manufacturing facilities.

The data presented in Table III-12 may understate the number of distinct product/processes because plants were requested to group certain products that were listed in the questionnaire instructions or that individually constituted less than 1 percent of the total plant production. For example, many dye

TABLE III-11.
PLANT DISTRIBUTION BY NUMBER OF EMPLOYEES

Number of Employees	Organics Plants	Plastics Plants	Organics and Plastics Plants	Total
1-105	70	73	I9	162
11-20	55	58	16	129
21-30	41	32	11	94
31-40	39	26	10	75
41-50	34	23	4	61
51-100	64	45	21	130
101-200	53	27	14	94
201-500	36	23	30	89
501-1000	7	9	19	35
1001-2000	5	9	17	31
2001-5000	-	7	8	15
>5000	-	-	*1	*1
Data not Available	11	6	7	24
Total	425	338	177	940

*Note: The only plasnt with >5,000 employees hasd 11,262 employees.

Source: EPA CWA Section 308 Survey, 1983.

TABLE III-12.
PLANT DISTRIBUTION BY NUMBER OF PRODUCT/PROCESSES AND PRODUCT GROUPS FOR PRIMARY PRODUCERS THAT ARE ALSO DIRECT AND/OR INDIRECT DISCHARGERS*

Number of Product/Processes	Organics Plants	Plastics Plants	Organics and Plastics Plants	Total
1	41	72		113
2	23	30	5	58
3	30	27	15	72
4	24	17	16	57
5	15	8	13	36
6	34	10	11	55
7	18	6	13	37
8	11	2	-	13
9	6	2	3	11
10	16	-	5	21
11-12	12	1	13	26
13-15	9	-	6	15
16-20	4	-	7	11
21-30	7	-	12	19
31-40	-	-	1	1
41-50	-	-	1 (50)	1
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Total	250	175	121	546

*Table consists of plants that completed Part B of the 1983 Section 308 Questionnaire.

plants reported individual dye products, while others reported types of dyes such as Azo- or Vat-dyes as one product. A review of Table III-12 shows that: plastics plants tend to have fewer product/processes with 88 percent reporting 5 or fewer; organics plants have a wider range of number of product/processes with 87 percent reporting 10 or fewer; and that plants manufacturing both organics and plastics, although fewer in number, tend to have more product/ processes with 88 percent reporting 20 or fewer.

c. Plant Capacity and Production Volume

For the purposes of this report, plant size cannot be sufficiently defined based on design capacity due to the often broad differences between a plant's design capacity or rate and its average production rate per year. Plants continuously producing high-volume chemicals (generally employing relatively few workers), may be physically smaller than plants producing lower-volume specialty chemicals by batch processes. Table III-13 presents the distribution of plant OCPSF production and total production for the year 1982 with plants sorted by their primary SIC code. The rates given are total (all products) production for the plant, not just the product SIC group under which they are listed. All data are from the 1983 Section 308 Questionnaire. Additional production information is available in the Economic Impact Analysis Report. Even though the table includes 38 plants that have been determined to be non-scope facilities, the general trends reflected in the table should apply to the final list of 940 scope facilities.

d. Plant Sales Volume

Sales volume alone is not necessarily an accurate indicator of plant size. High-volume commodity chemicals are typically less expensive than specialty chemicals. However, sales volume or production volume in terms of dollars is very useful in describing plant size in economic terms. This definition of size has been used in the economic analysis for this OCPSF rule. Table III-14 presents the distribution of plants by OCPSF total 1982 sales value with plants sorted by their major SIC code. These 1983 Section 308 Questionnaire data are presented in the same format as production volumes above. Additional sales data are available in the Economic Impact Analysis Report. Like Table III-13, Table III-14 includes 38 facilities that have been determined to be non-scope facilities.

TABLE III-13.
DISTRIBUTION OF 1982 PLANT PRODUCTION QUANTITY BY OCPSF SIC GROUP

	No SIC No. of Plants	2821 No. of Plants	2823 No. of Plants	2824 No. of Plants	2865 No. of Plants	2869 No. of Plants	All No. of Plants	All Percent
OCPSF Production (Million lbs.)								
No data	39	3	-	2	-	3	47	4.8
0-.2	-	10	-	-	6	29	45	4.6
.2-1	-	22	-	1	17	22	62	6.3
1-2	-	18	-	-	5	19	42	4.3
2-10	-	67	1	6	25	75	174	17.8
10-20	-	60	-	2	10	37	109	11.1
20-100	-	120	1	12	14	109	256	26.2
100 Plus	-	83	4	18	34	104	243	24.8
All	39	383	6	41	111	398	978[1]	100.0
Total Production (Million lbs.)								
No data	12	3	-	2	-	3	20	2.0
0-.2	2	6	-	-	3	22	33	3.4
.2-1	2	12	-	1	14	12	41	4.2
1-2	1	12	-	-	7	11	31	3.2
2-10	12	40	1	6	23	65	147	15.0
10-20	5	50	-	2	11	33	101	10.3
20-100	3	151	1	11	14	107	287	29.3
100 Plus	2	109	4	19	39	145	318	32.5
All	39	383	6	41	111	398	978[1]	100.0

[1]Includes 38 plants that have been determined to be non-scope facilities.

Source: OCPSF Economic Impact Analysis.

TABLE III-14.
DISTRIBUTION OF 1982 PLANT SALES VALUE BY OCPSF SIC GROUP

	No SIC No. of Plants	2821 No. of Plants	2823 No. of Plants	2824 No. of Plants	2865 No. of Plants	2869 No. of Plants	All No. of Plants	All Percent
OCPSF Production (Million $)								
No data	39	11	-	2	-	8	60	6.1
0-1	-	34	-	-	5	39	78	8.0
1-5	-	76	-	2	23	56	157	16.1
5-10	-	61	1	3	11	47	123	12.6
10-50	-	128	1	8	45	132	314	32.1
50-100	-	33	-	5	10	43	91	9.3
100-500	-	38	4	20	17	57	136	13.9
500 Plus	-	2	-	1	-	16	19	1.9
All	39	383	6	41	111	398	978[1]	100.0
Total Sales Value (Million $)								
No data	13	5	-	2	-	6	26.	2.6
0-1	2	15	-	-	5	26	48	4.9
1-5	9	32	-	1	15	45	102	10.4
5-10	3	56	1	3	13	33	109	11.1
10-50	9	157	1	9	47	143	366	37.4
50-100	2	58	-	5	13	46	124	12.7
100-500	1	50	4	20	18	82	175	17.9
500 Plus	-	10	-	1	-	17	28	2.9
All	39	383	6	41	111	398	978[1]	100.0

[1]Includes 38 plants that have been determined to be non-scope facilities.

Source: OCPSF Economic Impact Analysis.

7. Mode of Discharge

There are three basic discharge modes utilized by the industry: direct, indirect, and zero or alternative disposal/discharge. Direct dischargers are plants that produce a contaminated process wastewater, treated or untreated, that is discharged directly into a surface water. Plants that produce only noncontact cooling water and/or sanitary sewage effluents (non-process wastewater) are not considered to be direct dischargers of OCPSF process wastewater for purposes of this report. Indirect dischargers are plants that route their OCPSF process wastewater effluents to POTWs. Zero or alternative disposal/ dischargers are plants that discharge no OCPSF process wastewater to surface streams or to POTWs. For the purposes of this report, these include plants that generate no process wastewaters, plants that recycle all contaminated waters, and plants that use some kind of alternative disposal technology (e.g., deep well injection, incineration, contractor removal, etc).

The discharge of process wastewaters into the system of an adjoining manufacturing facility or to a treatment system not owned by a government entity is not considered indirect discharge, but is termed off-site treatment and is considered an alternative disposal method. Table III-15 shows the plant distribution based on mode of discharge. The table also shows the distribution between primary producers (i.e., plants whose OCPSF production exceeds 50 percent of the plant total) and secondary producers.

Fifteen plants discharge treated and/or untreated wastewater both directly and indirectly. In general, these plants discharge high-strength or "difficult to treat" wastewater to POTWs and direct discharge more easily treated low-strength wastewater.

C. DATA BASE DESCRIPTION

1. 1983 Section 308 Questionnaire Data Base

In the preamble to the March 21, 1983 proposed regulation, the Agency recognized the need to gather additional data to ensure that the final regulation is based upon information that represents the entire industry and to assess wastewater treatment installed since 1977. Therefore, the Agency

TABLE III-15.
MODE OF DISCHARGE

	Direct	Indirect	Direct and Indirect	Zero	Unknown	Total
Primary Producers						
Organics Plants	96	146	5	3	-	250
Plastics Plants	72	96	2	5	-	175
Organics & Plastics Plants	70	45	5	1	-	121
Total Primary Producers	238	287	12	9	-	546
Secondary Producers and/or Zero Dischargers						
Organics Plants	30	48	1	92	4	175
Plastics Plants	13	41	1	104	4	163
Organics & Plastics Plants	8	17	1	29	1	56
Total Secondary Producers/Zero Dischargers	51	106	3	225	9	393
Total All Plants	289	393	15	234	9	940

Source: EPA CWA Section 308 Survey, 1983.

conducted an extensive data-gathering program to improve the coverage of all types of OCPSF manufacturers. A comprehensive Clean Water Act Section 308 Questionnaire was developed and distributed in 1983. The mailing list was compiled from the following references that identify manufacturers of OCPSF products:

- Economic Information Service
- SRI Directory of Chemical Manufacturers
- Dun and Bradstreet Middle Market Directory
- Moody's Industrial Manual
- Standard and Poor's Index
- Thomas Register
- Red Book of Plastics Manufacturers
- 1976 and 1977 308 Questionnaire Data Bases
- Plastics Manufacturers Telephone Survey of 301 Plants.

In October 1983, the Agency sent a General Questionnaire to 2,840 facilities and corporate headquarters to obtain information regarding individual plant characteristics, wastewater treatment efficiency, and the statutory factors expected to vary from plant to plant. The General Questionnnaire consisted of three parts: Part I (General Profile), Part II (Detailed Production Information), and Part III (Wastewater Treatment Technology, Disposal Techniques, and Analytical Data Summaries).

Some plants that received the Section 308 Questionnaire had OCPSF operations that were a minor portion of their principal production activities and related wastewater streams. The data collected from these facilities allow the Agency to characterize properly the impacts of ancillary (secondary) OCPSF production. Generally, if a plant's 1982 OCPSF production was less than 50 percent of the total facility production (secondary manufacturer), then only Part I of the questionnaire was completed.

Part I identified the plant, determined whether the plant conducted activities relevant to the survey, and solicited general data (plant age, ownership, operating status, permit numbers, etc.). General OCPSF and non-OCPSF production and flow information was collected for all plant manufacturing activities. This part also requested economic information, including data on shipments and sales by product groups, as well as data on plant employment and capital expenditures.

Part I determined whether a respondent needed to complete Parts II and III (i.e., whether the plant is a primary or secondary producer of OCPSF products, whether the plant discharges wastewater, and for secondary producers, whether the plant segregates OCPSF process wastewaters). For those plants returning only the General Profile, Part I identified the amounts of process wastewater generated, in-place wastewater treatment technologies, wastewater characteristics, and disposal techniques.

Part II requested detailed 1980 production information for 249 specific OCPSF products, 99 specific OCPSF product groups, and OCPSF products that constituted more than 1 percent of total plant production. Less detailed information was requested for the facility's remaining OCPSF and non-OCPSF production. Part II also requested information on the use or known presence of the priority pollutants for each OCPSF product/process or product group. Part III requested detailed information on plant wastewater sources and flows, technology installed, treatment system performance, and disposal techniques.

Responses to economic and sales items in Part I pertained to calendar year 1982, which were readily available, since the plants were required to submit detailed 1982 information to the Bureau of the Census. This reduced the paperwork burden for responding plants.

The remainder of the Section 308 Questionnaire, however, requested data for 1980, a more representative production year. The Agency believed that treatment performance in 1982 would be unrepresentative of treatment during more typical production periods. This is because decreased production normally results in decreased wastewater generation. With lower volumes of wastewater being treated, plants in the industry might be achieving levels of effluent quality that they could not attain during periods of higher production. The year 1980 was selected in consultation with industry as representative of operations during more normal production periods, but recent enough to identify most new treatment installed by the industry since 1977. The industry representatives did not assert that significant new treatment had been installed since 1980.

The Section 308 Questionnaires were designed to be encoded into a computer data base directly from the questionnaires. To ensure that the questionnaires were filled out completely and correctly a copy of each questionnaire was reviewed by engineers. Due to the diversity and complexity of the OCPSF industry, a number of problems were encountered in reviewing the questionnaires. Some of the problems encountered included incorrect units of measure, incomplete responses, misinterpretation of data requested, conflicting data for different questions, pooling of data for separate questions, and unusual circumstances at the plant.

Solutions to these problem included recalculation of the data, followup contacts for clarification, or in some cases rejection of the data. Some of these problems may be explained in part by the fact that some companies simply did not keep records of the information that was requested by the questionnaire, and consequently could not respond fully on all items of interest.

The data were encoded onto computer tapes from the corrected copies of the questionnaires. Each questionnaire was double entered by separate individuals to help eliminate keypunch errors. The data were then sorted into separate computer files for each question.

The data in each question-file were then verified by various means. Verification methods included but were not limited to: visual inspection of the file printout, checks for missing data, checks for conflicting data, and checks for unusually high or low values. In addition, many of the engineering analyses required a more detailed review of the data, plus the execution of the analyses often exposed faulty data through erroneous results or the inability of a program to run. Wherever suspect data were identified, they were referred to the review engineers who then took appropriate action to resolve the problem. The economic study assessments also determined that some plants that responded as a scope facility should be considered non-scope. A separate data file called the Master Analysis File has been created from the 308 Questionnaire data. This data file contains only data that are useful in the engineering analyses and are used for that purpose.

The Section 308 Questionnaires were mailed in October 1983. In February 1984, Section 308 followup letters were sent to 914 nonrespondents. A total of 940 questionnaire responses provide the basis for the final technical and economic studies. A total of 1,574 responses were from facilities that were determined to be outside of the scope of the final regulations (e.g., sales offices, warehouses, chemical formulators, non-scope production, etc.); 166 were returned by the Post Office; and 160 did not respond. A followup telephone survey of 52 randomly selected nonrespondents concluded that over 90 percent of the nonrespondents were not manufacturers of OCPSF products.

In addition, a Supplemental Questionnaire was sent to 84 facilities known to have installed selected wastewater treatment unit operations. Detailed design and cost information was requested for four major treatment components commonly used to treat OCPSF wastewaters (i.e., biological treatment, steam stripping, solvent extraction, and granular activated carbon) and summary design and cost information for other wastewater and sludge treatment components. The questionnaires also collected available treatment system performance data for in-plant wastewater control or treatment unit operations, influent to the main wastewater treatment system, intermediate waste stream sampling locations, and final effluent from the main wastewater treatment system. Unlike the General Questionnaire, it asked for individual daily data rather than summary data. After a followup effort 64 plants responded with useful data and information.

2. Daily Data Base Development

One of the major purposes of this study is the development of long-term daily pollutant data. These data are required to derive variability factors that characterize wastewater treatment performance and provide the basis for derivation of proposed effluent limitations guidelines and standards. Hundreds of thousands of data points have been collected, analyzed, and entered into the computer.

The first effort at gathering daily data involved the BPT and BAT mailings in 1976 and 1977. These questionnaires asked each plant for backup information to support the long-term pollutant values reported. Many plants submitted influent and effluent daily observations convering the time period of interest in the BPT questionnaire (January 1, 1976 to September 30, 1976). Additionally, there were other conventional and nonconventional pollutant daily data in the files from the period of verification sampling. Some plants also submitted additional data with their public comments for the 1983 proposed requlations. Additional data were collected through the supplemental 1983 Section 308 Supplemental Questionnaires.

3. BAT Data Base

The BAT Data Base contains long- and short-term priority pollutant data used in the development of effluent limits. The data base consists primarily of end-of-pipe wastewater treatment system influent and effluent data, but also includes other types of samples. These other samples include individual process streams, intermediate samples within the end-of-pipe system, and influent and effluent samples of individual treatment units, especially those under consideration as BAT technology.

Data sources include both EPA sampling programs and data supplied by OCPSF plants. In all cases, the analytical data have been considered acceptable for limitations development only if the QA/QC procedures were documented and in the case of organic pollutants the analyses were confirmed by GC/MS or known to be present based on process chemistry. The major sources of data are listed below:

- EPA Screening Sampling Program (1977 to 1979)
- EPA Verification Sampling Program (1978 to 1980)
- EPA/CMA Five-Plant Study (1980 to 1981)
- EPA 12-Plant Sampling Program (1983 to 1984)
- Plant Submissions Accompanying Comments to the March 1983 Proposed Regulations
- Plant Submissions Accompanying Comments to the July and October 1985 and December 1986 Notices of New Information
- Supplemental Sections to the 1983 Section 308 Questionnaire.

The data base designations used throughout this report are listed in Table III-16. The four EPA sampling programs are discussed in greater detail in Sections V and VII of this report.

TABLE III-16.
DATA BASE DESIGNATION

Data Base File Name	Description
308 Data Base	Data base containing all data extracted from 1983 Section 308 Questionnaires
Master Analysis File (MAF)	Contains data excerpted from the 1983 Section 308 Data Base (includes conventional pollutant parameter long-term average data)
Daily Data Base	Contains long-term conventional pollutant effluent daily data from 69 plants
BAT Data Base	Contains long- and short-term treatment system influent and effluent daily data for priority pollutants
Master Process File (MPF)	Contains priority pollutant raw wastewater characterization data for 176 OCPSF product/processes

SECTION IV

SUBCATEGORIZATION

A. INTRODUCTION

Sections 304(b)(1)(B) and 304(b)(4)(B) of the Clean Water Act (CWA) require the U.S. Environmental Protection Agency (EPA) to assess certain factors in establishing effluent limitations guidelines based on the best practicable control technology (BPT) and best available technology economically achievable (BAT). These factors include the age of equipment and facilities involved; the manufacturing process employed; the engineering aspects of the application of recommended control technologies, including process changes and in-plant controls; nonwater quality environmental impacts, including energy requirements; and such other factors as deemed appropriate by the Administrator.

To accommodate these factors, it may be necessary to divide a major industry into a number of subcategories of plants sharing some common characteristics. This allows the establishment of uniform national effluent limitations guidelines and standards, while at the same time accounting for the particular characteristics of different groups of facilities.

The factors considered for technical significance in the subcategorization of the Organic Chemicals and Plastics and Synthetics Fibers (OCPSF) point source categories include:

- Manufacturing product/processes
- Raw materials
- Wastewater characteristics
- Facility size
- Geographical location
- Age of facility and equipment
- Treatability
- Nonwater quality environmental impacts
- Energy requirements.

The impacts of these factors have been evaluated to determine if subcategorization is necessary or feasible. These evaluations, which are discussed in detail in the following sections, result in the following final subcategories:

- o BPT: Rayon, other fibers, thermoplastic resins, thermosetting resins, commodity organics, bulk organics, and specialty organics
- o BAT: Subcategory One (end-of-pipe biological treatment) and Subcategory Two (non-end-of-pipe biological treatment).

B. BACKGROUND

In the March 21, 1983, Federal Register, EPA proposed a subcategorization approach for regulation of the OCPSF industry. A Notice of Availability (NOA) appeared in the July 17, 1985, Federal Register, which addressed a number of concerns raised by industry relating to the March 1983 proposal. Another NOA appeared in the December 8, 1986, Federal Register, which presented an alternative subcategorization approach. This section discusses the subcategorization methodologies for the proposal and the two NOAs and presents the concerns and issues raised during the public comment periods for each.

1. March 21, 1983 Proposal

The March 21, 1983, proposal established four subcategories (Plastics Only, Oxidation, Type I, and Other Discharges) for BPT effluent limitations, which were based on generic chemical reactions such as oxidation, peroxidation, acid cleavage, and esterfication and whether a plant produced plastics or organics. This approach was found to be too cumbersome to implement because the process information necessary to place a plant in a subcategory was not readily available. Also, a major problem raised by both industry and regulatory agencies in public comments on the proposal was that a plant could shift from one subcategory to another simply by changing a single product/ process.

The March 21, 1983, proposal also established two subcategories (Plastics Only and Not Plastics Only) for BAT effluent limitations. The rationale for this two-subcategory approach was that plants in the Plastics Only subcategory tended to have fewer toxic pollutants present and less significant levels than the remaining discharges, all of which result from the manufacture of at least some organic chemicals which were contained in the Not Plastics Only subcategory. The Agency also announced its intention to establish a separate BAT subcategory with different zinc limitations for those plants manufacturing rayon and utilizing the viscose process.

After reviewing public comments and evaluating its proposed subcategorization methodology, the Agency decided to revise its approach and developed another subcategorization approach, which was published for public comment in the July 17, 1985, Federal Register NOA. This revised methodology is discussed in the following section.

2. July 17, 1985, Federal Register NOA

The July 17, 1985, Federal Register NOA sought to correct some of the difficulties described above by categorizing plants according to the products accounting for most of their production. Under this subcategorization strategy, every plant was to be put into a single categoric grouping. The subcategories in this approach were as follows:

1. Thermoplastics Only (SIC 28213)
2. Thermosets (SIC 28214 plus Organics)
3. Rayon (Viscose)
4. Other Fibers (SIC 2824 and 2823 plus Organics)
5. Thermoplastics and Organics (SIC 28213 and 2865 or 2869)
6. Commodity Organics
7. Bulk Organics
8. Specialty Organics.

These eight subcategories were defined as follows:

- Subcategories 1 and 3 were defined as facilities that produced at least 95 percent thermoplastics and rayon, respectively.
- Subcategories 2 and 4 were for facilities whose production was at least 95 percent of the subcategory heading or facilities whose combination of organic chemicals and the subcategory heading represented at least 95 percent of the plant production.

- Subcategory 5 represented plants with a production that was at least 95 percent thermoplastic and organic products with neither product group representing 95 percent production. This group was interpreted to be vertically integrated plants producing organics, which were then used primarily for the production of thermoplastics.

- Subcategories 6 through 8 identified the relatively pure organics plants that had a production that was at least 95 percent organics. Organics production was further subdivided according to volume.

  - Commodity: Those chemicals produced nationally in amounts greater than or equal to 1 billion pounds per year.

  - Bulk: Those chemicals produced nationally in amounts less than 1 billion but more than 40 million pounds per year.

  - Specialty: Those chemicals produced nationally in amounts less than or equal to 40 million pounds per year.

Plants were assigned to these categories based on their mix of production; plants having at least 75 percent commodity or specialty were assigned to these respective subcategories. Remaining plants were assigned to the bulk subcategory. Thus, a plant might be assigned to the bulk subcategory, but it could also manufacture both commodity and specialty chemicals.

The July 17, 1985, Federal Register NOA also announced the Agency's intentions to establish a single set of BAT effluent limitations that would be applicable to all OCPSF facilities rather than the two subcategory approach presented in the March 21, 1983, proposal. The rationale for this "one BAT subcategory" approach was that the available data for BAT show that plants in differing BPT subcategories can achieve similar low toxic pollutant effluent concentrations by installing the best available treatment components. The Agency also again announced its intention to establish a separate BAT subcategory with different zinc limitations for those plants manufacturing rayon and utilizing the viscose process.

While the subcategories developed for the July 17, 1985, Federal Register NOA were more useful than those established for the March 21, 1983, proposal, the revised subcategorization approach was still criticized by OCPSF trade associations and companies for the reasons summarized below.

a. Multiple Subcategory Plants

A significant number of the plants cannot be classified according to the July 17, 1985, Federal Register NOA subcategorization approach for the following reasons:

- No single subcategory accounts for the majority of the production at a number of plants.
- No allowance was made in the thermoplastics and organics subcategory for variations in the types of organic products produced. From analysis of the data, plants with high specialty volume can be expected to have higher BOD_5 effluent concentrations when compared to plants with high commodity production.
- Plants could change their subcategory classifications by making small changes in the proportion of products produced.

b. Low Flow/High Flow Plants

In the March 21, 1983, Proposal, the Agency incorporated a low flow/high flow cutoff in one of its proposed subcategories, because flow was found to be a statistically significant subcategorization factor. This adjustment was not made in the July 17, 1985, Federal Register NOA because flow was not found to be a statistically significant factor for the revised subcategorization approach. However, the Agency received numerous public comments requesting that consideration be given to plants that conserve water and are low water users.

All the above considerations led the Agency to modify the July 17, 1985, subcategorization approach to accommodate these issues while trying to preserve a workable subcategorization and guideline structure.

3. December 8, 1986, Federal Register

The Agency again revised its subcategorization methodology and presented it in the December 8, 1986, Federal Register NOA. Initially, a regulatory approach that would have created plant specific long-term averages based on a flow proportioning of individual product subcategory long-term averages was attempted. This would have eliminated a number of difficulties associated with multiple subcategory plants and was consistent with current permit writing "building block" practices.

Production/flow information had been requested from industry in the 1983 308 Questionnaire Survey in anticipation of implementing such an approach. Unfortunately, much of the production/flow information (when supplied) was either estimated or grouped with other product/process flows and was considered too inaccurate or nebulous for subcategorization purposes. However, since relatively accurate production volume information by product/process or product groups was available, a regulatory approach that proportions the various subcategory long-term averages for each plant based on the reported proportion of production by product group was developed. This revised subcategorization approach incorporated essentially the same product-based subcategories as presented in the July 17, 1985, Federal Register NOA:

1. Thermoplastics (SIC 28213)
2. Thermosets (SIC 28214)
3. Rayon (Viscose Process)
4. Other Fibers (SIC 2823 and 2824)
5. Commodity Organics (SIC 2865 and 2869)
6. Bulk Organics (SIC 2865 and 2869)
7. Specialty Organics (SIC 2865 and 2869).

While the prior subcategorization approaches incorporated subcategories that included both a major production group and other secondary production, these seven subcategories represented only single production groups, while plants that have production that falls into more than one production group were handled by a regression model that emulates the production proportioning used by permit writers. This regression model was as follows:

$$\ln(BOD_i) = a + \sum_{j=1}^{7} w_{ij} \cdot T_j + B \cdot [\ln(flow_i)] + D \cdot I5_i + e_i$$

where $\ln(BOD_i)$, w_{ij}, $\ln(flow_i)$, and $I5_i$ are plant-specific data available in the data base (for plant i), and the parameters a, T_j, and D are values estimated from the data base using standard statistical regression methods. Definitions of the terms in this regression equation (and also used in subsequent equations) are as follows:

$\ln(BOD_i)$ = natural logarithm (ln) of the 1980 annual arithmetic average BOD_5 effluent in mg/l, which has been adjusted for dilution with uncontaminated miscellaneous wastewaters (as described in Section VII), for plant i.

$\ln(flow_i)$ = ln(total flow (MGD)), corrected for non-process waste streams) for plant i, with associated coefficient B.

$I5_i$ = indicator variable for plant i

= 1, if plant i meets 95 percent BOD_5 removal or at most 50 mg/l BOD_5 effluent editing criteria (95/50), for plants with biological treatment and polishing ponds,

= 0, otherwise

w_{ij} = proportion of OCPSF 1980 production from plant i from subcategory j

e_i = statistical error term associated with plant i

The seven subcategories, represented by the subscript j, are as follows:

j=1: Thermoplastics

j=2: Thermosets

j=3: Rayon

j=4: Other Fibers

j=5: Commodity Organics

j=6: Bulk Organics

j=7: Specialty Organics.

The coefficients T_j and D are related to the intercept of this equation (denoted by "a"). The T_j coefficients are subcategorical deviations from the overall intercept "a." The restriction $\sum_{j=1}^{7} T_j=0$ is placed on the regression equation, as discussed in Appendix IV-A, to allow for estimation of these values by standard multiple regression methods. The coefficient D represents the difference between the intercept of this equation (based on all full-response, direct discharge OCPSF plants that have at least biological treatment in place and have provided BOD_5 effluent, subcategorical production, and flow data) and the intercept based on the subset of these plants that have biological treatment and polishing ponds and meet the 95/50 editing criteria used by EPA at the time of the 1986 NOA.

In addition to its production proportioning approach, the Agency also included a flow adjustment factor in its regression model in an attempt to respond to public comments criticizing its elimination in the July 17, 1985, subcategorization approach. When included in the regression model and tested statistically, the flow adjustment coefficient, B, was found to be statistically significant in explaining plant-to-plant variation of reported average BOD_5 effluent.

A regression model relating effluent TSS to effluent BOD_5 was also developed to calculate estimated TSS effluent long-term averages for individual plants, as follows:

$$\ln(TSS_i) = a + b \cdot [\ln(BOD_i)] + e_i$$

where:

$\ln(TSS_i)$ = ln(1980 annual arithmetic average TSS effluent in mg/l, which has been adjusted for dilution with uncontaminated miscellaneous wastewaters, as described in Section VII), for plant i

e_i = statistical error term associated with plant i.

The data base used to determine these long-term averages included all full-response, direct discharge OCPSF plants with biological treatment and polishing ponds that met the 95/50 editing criteria for BOD_5 described previously and that had TSS effluent concentrations of at most 100 mg/l. The variables $\ln(BOD_i)$ [defined previously] and $\ln(TSS_i)$ are plant-specific data available in this data base, and the intercept and slope parameters a and b, respectively, are values estimated from the data base using standard statistical regression methods.

The December 8, 1986, Federal Register NOA retained the "one BAT subcategory" approach along with the separate subcategory and different zinc limitations for rayon manufacturers utilizing the viscose process.

While the revised subcategorization approach was yet another improvement on previous subcategorizations, a number of major issues were raised during the public comment period for the December 8, 1986, Federal Register NOA, which are detailed below.

a. Flow Adjustment Factor

Many comments were received which stated that the flow adjustment factor was not the equitable flow correction that the Agency intended, since it utilized total wastewater flow in its adjustment that would penalize high-production facilities with high flows and plants with certain product/processes that typically utilize and discharge large volumes of wastewater (e.g., rayon and fibers plants). Commenters suggested that the flow adjustment factor be changed to account for production volume at each facility; i.e., use a gallon of wastewater/pound production adjustment factor.

A related issue raised by commenters also concerned the flow adjustment factor: a flow adjustment coefficient based on the use of all OCPSF plants with biological treatment, regardless of effluent BOD_5, causes a small group of plants exhibiting high effluent BOD_5 and low wastewater flow to disproportionately influence the estimated long-term averages for other plants, based on the regression model. The commenters stated that if approximately 16 plants with effluent BOD_5 values greater than 200 mg/l were removed from the regression, the flow adjustment coefficient, B, was no longer significant.

b. Total Production

Commenters stated that a total production factor should be included in the regression model even though production was evaluated in the December 8, 1986, subcategorization approach and was found not to be significant.

C. FINAL ADOPTED BPT AND BAT SUBCATEGORIZATION METHODOLOGY AND RATIONALE

Based on an assessment of the comments on the subcategorization methodology presented in the December 8, 1986, Federal Register NOA, the Agency revised its regression model and the methodology for using the model to establish effluent BOD_5 long-term averages. The final revised regression model is as follows:

$$\ln(BOD_i) = a + \sum_{j=1}^{7} w_{ij} \cdot T_j + B \cdot I4_i + C \cdot Ib_i + e_i$$

where:

$I4_i$ = performance indicator variable for plant i

= 1, if plant i meets the 95 percent BOD_5 removal or at most 40 mg/l BOD_5 effluent editing criteria (the final BOD_5 performance editing criteria)

= 0, otherwise

Ib_i = treatment indicator variable for plant i

= 1, if plant i has only biological treatment

= 0, if plant i has treatment in addition to biological treatment

e_i = statistical error term associated with plant i.

The other terms have been defined previously.

The values for a, T_j, B and C are regression coefficients that are estimated from the 157 full-response, direct discharge OCPSF plants that have at least biological treatment in place and provided BOD_5 effluent and subcategorical production data.

Procedures used to estimate the model coefficients and the estimates are presented in Appendix IV-A, Exhibit 1. The data base employed to obtain the estimates is presented in Appendix IV-A, Exhibit 8.

This regression model differs from the model presented in the December 8, 1986, Federal Register NOA in several major respects:

- BPT Treatment System: The revised regression model is designed to estimate BOD_5 effluent long-term averages for biological treatment only (the selected BPT regulatory option) rather than for biological treatment and polishing ponds (see Section IX for rationale of options selection).
- BOD_5 Performance Edit: The indicator variable $I5_i$ in the December 8, 1986 subcategorization specified at least 95 percent BOD_5 removal or at most 50 mg/l BOD_5 in the treated wastewater (95/50), while the revised regression model has indicator variable $I4_i$, which specifies 95/40 (see Section VII for discussion on change of performance editing rules).

- Performance and Treatment System Shifts: The regression model presented in the December 8, 1986 Federal Register NOA included a single parameter to account for differences in the logarithm of BOD_5 due to treatment systems other than biological treatment and polishing ponds and less than adequate performance (defined as 95/50). The revised regression model includes separate parameters to account for differences: one parameter to distinguish between BPT treatment systems (now biological only) and other treatment systems; and another parameter to account for performance (now defined as 95/40). Discussion of these changes in parameters is included in this section.

- Adjustment for OCPSF flow: The model published in the December 8, 1986, subcategorization included an OCPSF flow adjustment, but the current model includes no such adjustment for flow. Discussion of this change is included in this section.

- Individual Plant Versus Subcategory Long-Term Averages: While the subcategorization methodology published in the December 8, 1986, NOA yielded individual plant-specific long-term averages, the revised subcategorization methodology yields pure subcategory BOD_5 and TSS effluent long-term averages that will be applied by the NPDES permit writers.

The procedures used to calculate the pure subcategory long-term averages are presented in Appendix IV-A. (See Section VII for discussion of rationale for choosing between pure subcategory and individual plant-specific long-term averages.)

The Agency retained the same methodology presented in the December 8, 1986, Federal Register NOA for calculating TSS effluent long-term averages. A discussion of the relationship of TSS to BOD_5 effluent concentrations is presented in Section VII, along with a discussion of the final TSS performance criterion. The regression model for estimating TSS effluent long-term averages is as follows:

$$\ln(TSS_i) = a + b\cdot[\ln(BOD_i)] + e_i$$

The coefficients a and b are estimated from the 61 OCPSF plants that have only biological treatment in place, meet the 95/40 editing criteria for BOD_5 described previously, and have TSS effluent concentrations of at most 100 mg/l.

Estimates of the TSS-model coefficients are given in Appendix IV-A, Exhibit 2. The data base employed to generate the estimates is presented in Appendix IV-A, Exhibit 8.

The following sections discuss the rationale behind some of the changes made to the subcategorization methodology.

1. Performance and Treatment System Shifts

One change in the form of the BOD_5 long-term average model is a revision of the indicator functions. The regression model published in the December 8, 1986, Federal Register NOA had a single shift indicator. This indicator was the sole explanatory variable to account for adjusted differences in average treatment performance between biological plants having polishing ponds and satisfying the proposed 95/50 performance criterion and all other plants.

If this kind of single indicator function was applied to the revised BPT treatment and performance standards of biological only and 95/40, then this single shift indicator would account for adjusted differences between biological only, 95/40 plants and all other plants. The set of all other facilities can be divided into three distinct subsets: plants with treatment other than biological only which satisfy the performance criterion; plants with treatment other than biological only which do not satisfy the performance criterion; and plants with only biological treatment which do not satisfy the performance criterion. Clearly, plants with more than biological treatment are expected to perform at least as well as biological-only facilities, and biological-only plants that fail to satisfy the 95/40 edit will perform below the BPT "average of the best" performance. A single shift indicator alone, similar to that included in the regression model published in the December 8, 1986, NOA, cannot separately account for the adjusted differences due to treatment and performance between the biological-only, 95/40 plants and all other plants. In an effort to reformulate the revised BOD_5 long-term average model to better reflect the separate effects of the treatment and performance characteristics of the data base, EPA redefined the single indicator shift in the form of two indicator variables for the model: one indicator accounts for adjusted differences between biological only treatment and treatment other than biological only, and the other indicator accounts for adjusted differences between plants meeting the 95/40 performance criteria and those that do not.

2. Flow and Total Production Adjustment Factors

The regression model published in the December 8, 1986, Federal Register NOA contained a flow adjustment term in the form of the natural logarithm of the plant OCPSF flow in MGD. EPA included this term in an effort to account for plants that practice water conservation. The regression coefficient for that term was negative, which resulted in a decreasing BOD_5 long-term average concentration for increasing flow. Although this result is reasonable and may account for water conservation, it could impose unreasonably low limitations on plants with a high proportion of fibers production that already achieve low effluent BOD_5 levels (i.e., 12 mg/l). Industry commenters claimed that flow rate alone cannot distinguish between plants that practice water conservation and those plants that use excessive amounts of water. Certain product/processes (e.g., rayon manufacture) must use large amounts of water in relation to other plants and are then unjustly penalized with lower limits. Furthermore, commenters stated the inclusion of the flow adjustment term does not reflect total production, which should be incorporated into the subcategorical regression model. According to the commenters, increased production should result in larger flows and higher BOD_5 concentrations, which is contrary to the results obtained from the regression model EPA published in the December 8, 1986, NOA. An examination of these issues is summarized below.

EPA reexamined the inclusion of the flow adjustment factor. Based on that examination, EPA agrees that flow rate alone does not indicate whether a plant practices water conservation. Moreover, the 1986 published model, in EPA's assessment, did result in excessively low BOD_5 long-term average concentrations for some plants with large flows.

Commenters further argued that the statistical significance of the flow adjustment factor for the regression model presented in the December 8, 1986, NOA was due entirely to a small number of plants with small flows and large BOD_5 effluents. EPA's examination of the data base revealed that facilities with relatively high BOD_5 and low flows are mostly facilities that have biological treatment but failed the 95/40 performance criteria. To formalize this analysis, EPA considered models in the context of the data base used for determining BOD_5 effluent long-term averages to explore the effects of these plants on flow adjustments. In particular, the model

$$\ln(BOD_i) = a + \sum_{j=1}^{7} w_{ij} \cdot T_j + F \cdot [\ln(flow_i)] + e_i$$

was examined separately for the following four subsets of the data base:

(1) Biological only and 95/40

(2) Biological only and not 95/40

(3) Not biological only and 95/40

(4) Not biological only and not 95/40

These four mutually exclusive subsets partition completely the 153 full-response, direct discharger OCPSF plants that have at least biological treatment in place and provided BOD_5 effluent, flow, and subcategorical production data. The computer analysis for these regression models and plots of ln(BOD_5 effluent) versus ln(flow) are presented in Appendix IV-A, Exhibit 3. Note that the set of plants in (1) above has information regarding all subcategories. Rayon plants are not present in the set of plants in subsets (2), (3), and (4), however, and the term corresponding to rayon has been excluded from the model for these sets of plants. Also, fibers plants are not present in the set of plants in subset (4), and the term corresponding to fibers has also been excluded from the model when examining the set of plants in (4). These models were examined for the significance of the coefficient F, corresponding to the natural logarithm of flow.

Based on this analysis, the Agency agrees with the commenters that the significance of the flow adjustment term in the December model is largely influenced by the poorly performing plants (plants that do not meet the 95/40 BPT performance edit) with only biological treatment. Because this pattern is exhibited only by a subset of plants that are not well-designed and operated, the Agency concludes that this pattern should not be reflected in the estimation of long-term BOD_5 averages as a construct of the model. Therefore, EPA has deleted the flow adjustment factor from the model.

EPA has also examined the inclusion of a production adjustment factor using the following model:

$$\ln(BOD_i) = a + \sum_{j=1}^{7} w_{ij} \cdot T_j + G \cdot [\ln(prod_i)] + e_i$$

where:

$\ln(prod_i)$ = ln (OCPSF 1980 total production) from plant i, in millions of pounds per year, with associated coefficient G.

As described in the analysis of flow, this model was examined separately for the four subsets of the 157 full-response, direct discharge OCPSF plants that have at least biological treatment in place and provided BOD_5 effluent and subcategorical production data. The computer analysis for these regression models and plots of ln(BOD) are presented in Appendix IV-A, Exhibit 4. These models were examined for the coefficient of G, corresponding to the natural logarithm of production. The same pattern emerges with this factor as was present when the natural logarithm of flow was examined; namely, the significance of this term is largely due to the poorly performing plants with biological only treatment (plants that do not meet the 95/40 BPT performance edit). Consequently, EPA has decided not to add a production adjustment factor to the model.

Commenters have asserted that increased production should result in higher BOD_5 effluent concentrations. As seen by the regressions involving total production, the data do not support a positive association between BOD_5 effluent concentration and total production (higher BOD_5 effluent concentrations associated with higher production levels), after adjustment for proportion of production in a subcategory.

EPA has also considered the effect of flow per unit of production, using the following model, applied separately to the 4 subsets of 153 full-response, direct discharge OCPSF plants that have at least biological treatment in place and provided BOD_5 effluent, flow, and subcategorical production data (4 of the 157 full-response plants did not report flow):

$$\ln(BOD_i) = a + \sum_{j=1}^{7} w_{ij} \cdot T_j + H \cdot [\ln(365 * flow_i / prod_i)] + e_i$$

where:

$flow_i/prod_i$ = annual total flow (MGD), corrected for non-process waste streams, for plant i, divided by OCPSF 1980 production (in millions of pounds per year), for plant i.

The units for $\ln(365 * flow_i/prod_i)$ are gallons/pound--the significance of the coefficient H, associated with this quantity, was examined. Results similar to those found for flow and production were observed, in the sense that this flow per unit production variable is only marginally significant for plants with biological only treatment that do not meet the 95/40 BPT performance edit (see Appendix IV-A, Exhibit 5). The Agency concluded that a flow per unit production adjustment factor was not appropriate for the same reasons described for flow and production; that is, the model should not reflect a pattern exhibited only by a subset of plants that are not well-designed and operated.

D. FINAL ADOPTED BAT SUBCATEGORIZATION APPROACH

Based on comments received during public comment periods for the proposal and the NOAs, the Agency noted that a certain subset of OCPSF plants existed that either generate such low raw waste BOD_5 levels that they do not require end-of-pipe biological treatment or choose to use physical/chemical treatment alone to comply with BPT effluent limitations. The Agency has decided to establish two BAT subcategories that are largely determined by raw waste BOD_5 characteristics, as follows:

- Subcategory One - all plants that have or will install biological treatment to comply with BAT effluent limitations.

- Subcategory Two - all plants which, based on raw waste characteristics, will not utilize biological treatment to comply with BPT effluent limitations.

In addition, the Agency is also establishing a different BAT effluent limitation for zinc, including manufacturers of rayon by the viscose process and plants manufacturing acrylic fibers utilizing the zinc chloride/solvent process.

BAT effluent limitations for Subcategory One will be based on the performance of biological treatment and in-plant controls. Biological treatment is an integral part of this subcategory's model BAT treatment technology; it achieves incremental removals of some toxic pollutants beyond the removals achieved by in-plant treatment without end-of-pipe biological treatment. BAT effluent limitations for Subcategory Two will be based on the performance of only in-plant treatment technologies such as steam stripping, activated carbon, chemical precipitation, cyanide destruction, and in-plant biological treatment of selected waste streams. The Agency has concluded that, within each subcategory, all plants can treat priority pollutants to the levels established. (The Agency determined that further BPT subcategorization for plants without end-of-pipe biological treatment is unnecessary. As described in the Section VII assessment of nonbiological end-of-pipe treatment systems, the Agency concluded that plants that do not need biological treatment to comply with the BPT BOD_5 limitations can meet the TSS limitations with physical/chemical controls alone. As also shown, some plants achieve sufficient control of BOD_5 through the use of only physical/chemical treatment unit operations.)

The Agency also received comments (supported by submitted data) during public comment periods stating that plants manufacturing acrylic fibers by the zinc chloride/solvent process produced raw waste and treated effuent levels of zinc similar to those levels produced by rayon manufacturers utilizing the viscose process. After examining these data, the Agency agreed with the commenters that it was appropriate to include these plants along with rayon manufacturers. Based on this decision, the Agency is establishing two different limitations for the pollutant zinc. One is based on data collected from rayon manufacturers and acrylic fibers manufacturers using the zinc chloride/solvent process. This limitation applies only to those plants that use the viscose process to manufacture rayon and the zinc chloride/solvent process to manufacture acrylic fibers. The other zinc limitation is based on the performance of chemical precipitation technology used in the metal finishing point source category, and applies to all plants other than described above.

E. SUBCATEGORIZATION FACTORS

1. Introduction

All nine factors listed in the beginning of this section were examined for technical significance in the development of the proposed subcategorization scheme. However, in general, the proposed subcategorization reflected primarily differences in waste characteristics, since many of the other eight factors, while considered, could not be examined in appropriate technical and statistical depth due to the intricacies of the plants in this industry. Therefore, variations in waste characteristics were utilized to evaluate the impact of the other eight factors on subcategorization. For example, the ideal data base for evaluating the need for subcategorization and the development of individual subcategories would include raw wastewater and final effluent pollutant data for facilities which segregate and treat each process raw waste stream separately. In this manner, each factor could be evaluated independently. However, the available information consists of historical data collected by individual companies, primarily for the purpose of monitoring the performance of end-of-pipe wastewater treatment technology and compliance with NPDES permit limitations. The OCPSF industry is primarily composed of multi-product/process, integrated facilities. Wastewaters generated from each product/process are typically collected in combined plant sewer systems and treated in one main treatment facility.

Therefore, each plant's overall raw wastewater characteristics are affected by all of the production processes occurring at the site at one time. The effects of each production operation on the raw wastewater characteristics cannot be isolated accurately from all of the other site-specific factors. Therefore, a combination of both technical and statistical methodologies had to be used to evaluate the significance of each of the subcategorization factors. The methodologies and analyses necessarily are limited to indicating trends rather than yielding definitive quantitative significance of the factors considered.

In the methodology that was employed, the results of the technical analysis were compared to the results of the statistical efforts to determine the usefulness of each factor as a basis for subcategorization. The combined technical/statistical evaluations of the nine factors are presented below.

2. Manufacturing Product/Processes

Comments have been received that state that the choice of the final seven subcategories based on production is arbitrary, since the Agency did not perform a statistical analysis to group plants in optimal subcategories. Product groups are based on both the marketing structure of the industry and technical factors affecting the generation of contaminants.

By choosing subcategories based on SIC codes, the marketing characteristics by which the industry is organized are emphasized; facilities can be easily classified since the SIC codes are readily available to the plant. Furthermore, from a technical point of view, based on engineering judgment and analysis of the data supplied by the industry, most of these subcategories represent different waste streams.

The purpose of subcategorization is the division of the OCPSF industry into smaller groups that account for the particular common characteristics of different facilities. The OCPSF industry (as defined by EPA) is recognized to comprise several product groups:

- Organic Chemicals (SIC 2865/2869)
- Plastic Materials and Synthetic Resins (SIC 2821)
- Cellulosic Manmade Fibers (SIC 2823)
- Synthetic Organic Fibers (SIC 2824).

Vertical integration of plants within these industries is common, however, blurring distinctions between organic chemical plants and plastics/synthetic fibers plants. As a practical matter, the OCPSF industry is divided among three types of plants:

- Plants manufacturing only organic chemicals (SIC 2865/2869)
- Plants manufacturing only plastics and synthetic materials (SIC 2821/ 2823/2824)
- Integrated plants manufacturing both organic chemicals and plastics/ synthetic materials (SIC 2865/2869/2821/2823/2824).

Each type of plant is unique not only in terms of product type (e.g., plastics) but also in terms of process chemistry and engineering. Using raw materials provided by organic chemical plants, plastic plants employ only a small subset of the chemistry practiced by the OCPSF industry to produce a limited number of products (approximately 200). Additionally, product recovery from process wastewaters in plastic plants generally is possible, thus lowering raw waste BOD_5 concentrations. Plants producing organic chemicals, on the other hand, utilize a much larger set of process chemistry and engineering to produce approximately 25,000 products; process wastewaters from these plants are in general not as amenable to product recovery and are generally higher in raw waste BOD_5 concentration and priority pollutant loadings.

Further divisions are possible within these broad groupings. Plastic materials and synthetic resins manufacturers can be subdivided into thermoplastic materials (SIC 28213) producers and thermosetting resin (SIC 28214) producers. Rayon manufacturers and synthetic organic fiber manufacturers are also both unique. Again, process chemistry and engineering are broadly consistent within these groupings in terms of BOD_5.

The organic chemicals industry produces many more products that does the plastics/synthetic fibers industry and is correspondingly more complex. While it is indeed possible to separate this industry into product groups, the number of such product groups is large. Moreover, with few exceptions, plants produce organic chemicals from several product groups and thus limit the utility of such an approach.

An alternative to a product-based approach is an approach based on the type of manufacturing conducted at a plant. Large plants producing primarily commodity chemicals (the basic chemicals of the industry, e.g., ethylene, propylene, benzene) comprise the first group of plants. A second tier of plants includes plants that produce high-volume intermediates (bulk chemicals). Plants within this tier typically utilize the products of the commodity chemical plants (first tier plants) to produce more structurally complex chemicals. Bulk chemical plants are generally smaller than those in the first group, but still may produce several hundred million pounds of chemicals per year (e.g., aniline, methylene dianiline, toluene diisocyanate). The third group includes those plants that are devoted primarily to manufacture of specialty chemicals -- chemicals intended for a particular end use (e.g., dyes and pigments). Generally, specialty chemicals are more complex structurally than either commodity or bulk chemicals.

Chemicals within the three groups -- commodity, bulk, and specialty -- are defined on the basis of national production. Commodity chemicals are those chemicals produced nationally in amounts greater than or equal to 1 billion pounds per year. Bulk chemicals are defined to be those chemicals produced nationally in amounts less than 1 billion but more than 40 million pounds per year. Specialty chemicals are those chemicals produced nationally in amounts less than or equal to 40 million pounds per year. Using these definitions, there are 35 commodity chemicals, 229 bulk chemicals or bulk chemical groups, and more than 786 specialty chemicals or specialty chemical groups.

In general, the rate of biodegradation decreases with increasing molecular complexity. Because commodity chemical plants produce the least complex chemicals, a general trend of lower BOD_5 effluent concentrations for commodity chemical plants to higher BOD_5 effluent concentrations for specialty chemical plants is observed.

With regard to subcategorization for BAT, the Agency considered whether the industry should be subcategorized by evaluating the same subcategorization approach developed for BPT, which is based primarily on manufacturing product/processes. The available data for BAT show that plants in differing BPT subcategories can achieve similar low toxic pollutant effluent concentrations by installing the best available treatment components. Since all plants within the two BAT technology-based subcategories can achieve compliance with the same BAT effluent limitations through some combination of demonstrated technology, the predominant issue relates to the cost of the required treatment technology. EPA has analyzed these costs and their associated impacts and has determined them to be reasonable. Therefore, the Agency believes that BAT subcategorization based on manufacturing product/processes is not necessary for effective, equitable regulation.

3. Raw Materials

Synthetic organic chemicals can be defined as derivative products of naturally occurring materials (e.g., petroleum, natural gas, and coal) that have undergone at least one chemical reaction, such as oxidation, hydrogenation, halogenation, or alkylation. This definition, when applied to the larger number of potential starting materials and the host of chemical reactions that can be applied, leads to the possibility of many thousands of organic chemical compounds being produced by a potentially large number of basic processes having many variations. There are more than 25,000 commercial organic chemical products derived principally from petrochemical sources. These are produced from five major raw material classifications: methane, ethylene, propylene, C_4 hydrocarbons and higher aliphatics, and aromatics. This major raw materials list can be expanded by further defining the aromatics to include benzene, toluene, and xylene. These raw materials are derived from natural gas and petroleum, although a small portion of the aromatics are derived from coal.

Currently, approximately 90 percent (by weight) of the organic chemicals used in the world are derived from petroleum or natural gas. Other sources of raw materials are coal and some naturally occurring renewable material of which fats, oils, and carbohydrates are the most important.

Regardless of the relatively limited number of basic raw materials utilized by the organic chemicals industry, process technologies lead to the formation of a wide variety of products and intermediates, many of which can be produced from more than one basic raw material either as a primary reaction product or as a byproduct. Furthermore, primary reaction products are frequently processed to other chemicals that categorize the primary product from one process as the raw material for a subsequent process.

Delineation between raw materials and products is nebulous at best, since the product from one manufacturer can be the raw material for another manufacturer. This lack of distinction is more pronounced as the process approaches the ultimate end product, which is normally the fabrication or consumer stage. Also, many products/intermediates can be made from more than one raw material. Frequently, there are alternate processes by which a product can be made from the same basic raw material.

Another characteristic of the OCPSF industry that makes subcategorization by raw material difficult is the high degree of integration in manufacturing units. Since the majority of basic raw materials derive from petroleum and natural gas, many of the organic chemical manufacturing plants are either incorporated into or contiguous to petroleum refineries, and may formulate a product at almost any point in a process from any or all of the basic raw materials. Normally, relatively few organic chemical manufacturing facilities are single product/process plants unless the final product is near the fabrication or consumer product stage.

Because of the integrated complexity of the largest (by weight) single segment of the organics industry (petrochemicals), it may be concluded that BPT and BAT subcategorization by raw materials is not feasible for the following reasons:

- The organic chemicals industry is made up primarily of chemical complexes of various sizes and complexity.
- Very little, if any, of the total production is represented by single raw material plants.
- The raw materials used by a plant can be varied widely over short time spans.
- The toxic, conventional, and nonconventional wastewater pollutant parameter data gathered for this study were not collected and are not available on a raw material orientation basis, but rather represent the mixed end-of-pipe plant wastewaters.

4. Facility Size

Although sales volume, number of employees, area of a plant site, plant capacity, and production rate might logically be considered to define facility size, none of these factors alone describes facility size in a satisfactory manner. Recognizing these limitations, the Agency has chosen total OCPSF production to define facility size.

The regression model approach allows the Agency to easily test for BPT subcategorization factors such as facility size as measured by total OCPSF production. EPA has analyzed total OCPSF production, as discussed previously in this section, to determine its appropriateness as a subcategorization factor, and determined that the significance of production is due largely to plants with only biological treatment that do not meet the 95/40 BPT performance edit. Consequently, an adjustment factor for production is not incorporated into the model.

In terms of a BAT subcategorization factor, although facility sizes (as measured by total OCPSF production) of the waste streams with the OCPSF industry vary widely, ranging from less than 10,000 pounds/day to more than 5 million pounds/day, this definition fails to embody fundamental characteristics such as continuous or batch manufacturing processes. While equivalent production rates may be accomplished by either production method, the characteristics of these waste streams in terms of toxic pollutants may vary substantially because of different yield losses inherent in each process. Therefore, the Agency has determined that no adequate method exists for defining facility size and that there is no technical basis for the use of facility size as a BAT subcategorization factor.

5. Geographical Location

Companies in the OCPSF industry usually locate their plants based on a number of factors. These include:

- Sources of raw materials
- Proximity of markets for products
- Availability of an adequate water supply

- Cheap sources of energy
- Proximity to proper modes of transportation
- Reasonably priced labor markets

In addition, a particular product/process may be located in an existing facility based on availability of certain types of equipment or land for expansion.

Companies also locate their facilities based on the type of production involved. For example, specialty producers may be located closer to their major markets, whereas bulk producers may be centrally located to service a wide variety of markets. Also, a company that has committed itself to zero discharge as its method of wastewater disposal has the ability to locate anywhere, while direct dischargers must locate near receiving waters, and indirect dischargers must locate in a city or town that has an adequate POTW capacity to treat OCPSF wastewaters.

Because of the complexity and inter-relationships of the factors affecting plant locations outlined above, no clear basis for either BPT or BAT subcategorization according to plant location could be found. Therefore, location is not a basis for BPT and BAT subcategorization of the OCPSF industry.

Since biological treatment installed to meet BPT effluent limitations is an important part of both BPT and BAT subcategorization approaches, the Agency decided to perform an analysis to confirm that temperature (as defined by the heating-degree day variable to measure winter/summer effects), instead of location, is not a subcategorization factor. The Agency used a regression model approach similiar to the analysis for facility size. Analysis on the following regression model was performed to test for the significance of this factor:

$$\ln(BOD_i) = a + \sum_{j=1}^{7} w_{ij} \cdot T_j + J \cdot (\text{degree days}_i) + e_i$$

where:

degree days_i = the number of degrees that the mean daily outdoor temperature is below 65°F for a given day, accumulated over the number of days in the year that the mean temperature is below 65°F, at plant i (with associated coefficient J).

This analysis was performed separately for the four subsets described previously which partition the 157 full-response, direct discharge OCPSF plants that have at least biological treatment in place and provided BOD_5 effluent and subcategorical production data. The computer analysis for these regression models is presented in Appendix IV-A, Exhibit 6. In none of these four subsets was temperature significant, and consequently a temperature factor is determined to be inappropriate.

6. Age of Facility and Equipment

The age of an OCPSF plant is difficult to define accurately. This is because production facilities are continually modified to meet production goals and to accommodate new product lines. Therefore, actual process equipment is generally modern (i.e., 0-15 years old). However, major building structures and plant sewers are not generally upgraded unless the plant expands significantly. Older plants may use open sewers and drainage ditches to collect process wastewater. In addition, cooling waters, steam condensates, wash waters, and tank drainage waters are sometimes collected in these drains due to their convenience and lack of other collection alternatives. These ditches may run inside the process buildings as well as between manufacturing centers. Therefore, older facilities are likely to exhibit higher wastewater discharge flow rates than newer facilities. In addition, since the higher flows may result from the inclusion of relatively clean noncontact cooling waters and steam condensates as well as infiltration/inflow, raw wastewater concentrations may be lower due to dilution effects. Furthermore, recycle techniques and wastewater segregation efforts normally cannot be accomplished with existing piping systems, and would require the installation of new collection lines as well as the isolation of the existing collection ditches. However, due to water conservation measures as well as ground contamination control, many older plants are upgrading their collection systems. In addition, the energy crisis of recent years has caused many plants to upgrade their steam and cooling systems to make them more efficient. Based on the factors mentioned above, the Agency has determined its only accurate age measurement to be the age of the oldest process at each OCPSF facility. Analysis on the following regression model was performed to test for the significance of age:

$$\ln(BOD_i) = a + \sum_{j=1}^{7} w_{ij} \cdot T_j + K \cdot (age_i) + e_i$$

where:

age_i = the age of the oldest process at plant i (with associated coefficient K).

This analysis was performed separately for the four subsets described previously that partition the 157 full-response, direct discharge OCPSF plants that have at least biological treatment in place and provided BOD_5 effluent and subcategorical production data. The computer analysis for these regression models is presented in Appendix IV-A, Exhibit 7. Results of this analysis are similar to results seen for production, flow, and flow per unit of production; that is, the only group of plants that exhibit a relationship between age and effluent BOD_5 concentration is the subset of poorly performing biological-only plants (plants that do not meet the 95/40 BPT editing criteria). Consequently, the Agency has determined that an age factor is not appropriate.

The extent to which process wastewaters are contaminated with toxic pollutants depends mainly upon the degree of contact that process water has with reactants/products, the effectiveness of the separation train, and the physical-chemical properties of those priority pollutants formed in the reaction. Raw wastewater quality is determined by the specific process design and chemistry. For example, water formed during a reaction, used to quench a reaction mixture, or used to wash reaction products will contain greater amounts of pollutants than does water that does not come into direct contact with reactants or products. The effectiveness of a separation train is determined by the process design and the physical-chemical properties of those pollutants present. While improvements are continually made in the design and construction of process equipment, the basic design of such equipment may be quite old. Process equipment does, however, deteriorate during use and requires maintenance to ensure optimal performance. When process losses can no longer be effectively controlled by maintenance, process equipment is replaced. The maintenance schedule and useful life associated with each piece of equipment are in part determined by equipment age and process conditions. Equipment age, however, does not directly affect either pollutant concentrations in influent or effluent wastewaters and is therefore inappropriate as a basis for BAT subcategorization.

7. Wastewater Characteristics and Treatability

a. BPT Subcategorization

The treatability of OCPSF wastewaters is discussed in detail in Section VII. The treatability of a given wastewater is affected by the presence of inhibitory materials (toxics), availability of alternative disposal methods, and pollutant concentrations in, and variability of, the raw wastewater concentrations. However, all of these factors can be controlled by sound waste management, treatment technology design, and operating practices. Examples of these are:

- The presence of toxic materials in the wastewater can be controlled by in-plant treatment methods. Technologies such as steam stripping, metals precipitation, activated carbon, and reverse osmosis can eliminate the presence of materials in a plant's wastewater that may inhibit or upset biological treatment systems.

- Although some plants utilize deep well injection for disposal of highly toxic wastes to avoid treatment system upsets, other alternative disposal techniques such as contract hauling and incineration are available to facilities that cannot utilize deep well disposal. In addition, stricter groundwater regulations may eliminate the option of deep well disposal for some plants and make it uneconomical for others, forcing facilities to look more closely at these other options.

- Raw waste concentration variability can easily be controlled by the use of equalization basins. In some plants, "at-process" storage and equalization is used to meter specific process wastewaters, on a controlled basis, into the plant's wastewater treatment system.

- Raw waste concentrations can be reduced with roughing biological filters or with the use of two-stage biological treatment systems. These techniques are discussed in detail in Section VII.

OCPSF wastewaters can be treated by either physical-chemical or biological methods, depending on the pollutant to be removed. Also, depending on the specific composition of the wastewater, any pollutant may be removed to a greater or lesser degree by technology not designed for removal of this pollutant. For example, a physical-chemical treatment system designed to remove suspended solids will also remove a portion of the BOD_5 of a wastewater if the solids removed are organic and biodegradable. It is common in the OCPSF industry to use a combination of technologies adapted to the individual wastewater stream to achieve desired results. These concepts are discussed in detail in Section VII. In general, the percent removals of BOD_5 and TSS are consistent across the seven final subcategories. It is also possible for plants in these subcategories to achieve high percent removals (greater than 95%) for both BOD_5 and TSS (data supporting these removals are presented and discussed in Section VII). Also, OCPSF plants producing the same products and generating similiar raw waste BOD_5 concentrations are, in general, equally distributed above and below the pure subcategory long-term averages for BOD_5 effluent as determined by the BPT regression equation. Figures IV-1 through IV-7 present the distribution of plants within each pure subcategory (defined as full-response direct discharge plants that have at least 80 percent of their total OCPSF production in one of the seven final subcategories) by effluent BOD_5 and the product(s) each plant produces. Also included with each plant's BOD_5 effluent is its associated raw waste BOD_5 concentration (when available); in addition, if a plant produces more than one product within a subcategory, its effluent and raw waste BOD_5 values are repeated and noted on each figure, as multiple effluent and influent, respectively.

In reviewing these figures, it should be noted that for most of the products within a pure subcategory, plants with fairly high raw waste BOD_5 concentrations are equally distributed above and below the subcategory long-term average BOD_5 effluent and that even for plants producing the same products that did not have raw waste BOD_5 concentration data, BOD_5 effluents are fairly well-distributed above and below the subcategory median BOD_5 effluent for certain products within selected subcategories. Situations in which there are a disproportionate number of plants either above or below the subcateogry long-term average maybe explained by a number of factors, including the contribution of remaining 20 percent of each plant's product mix to its BOD_5

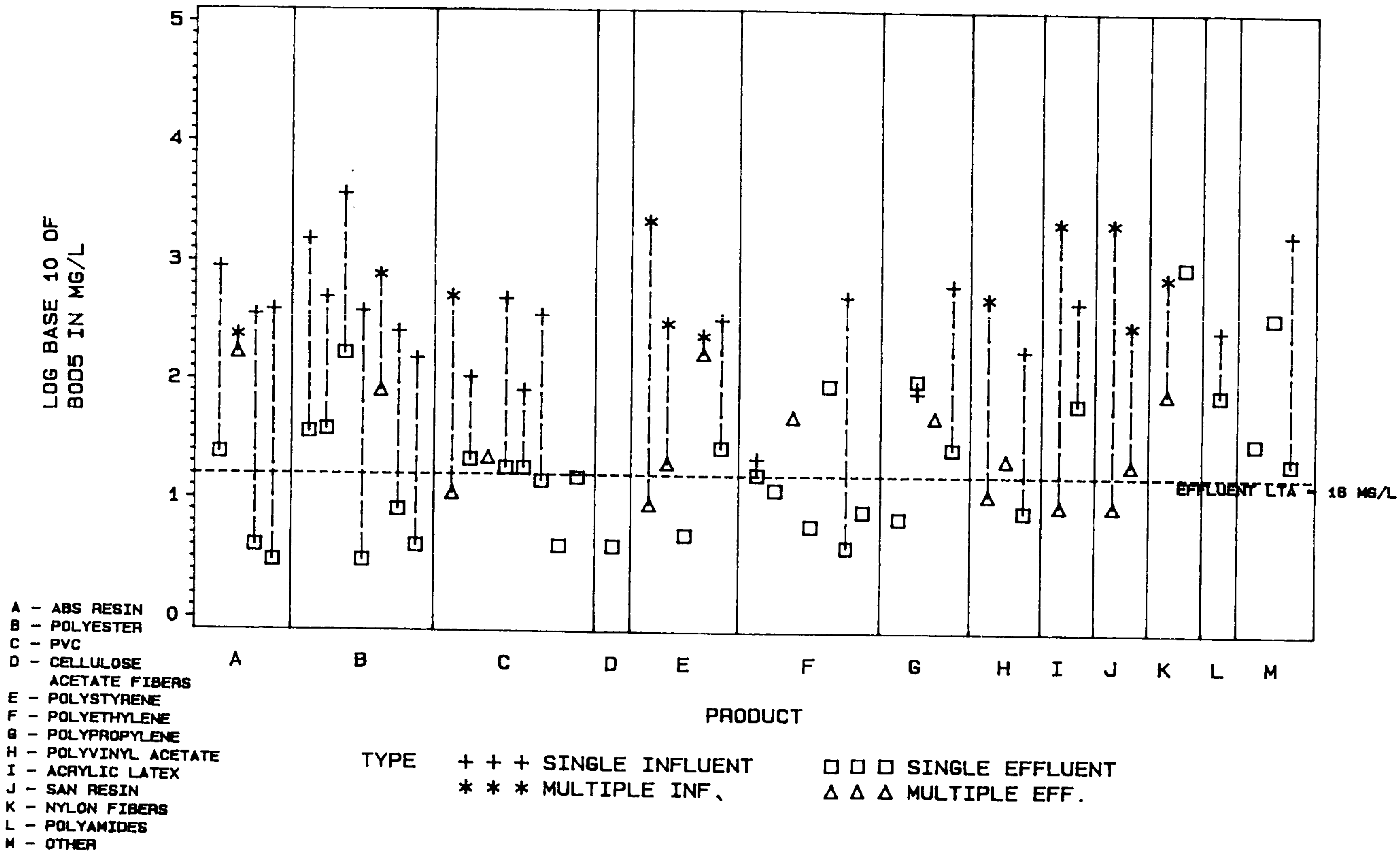


Figure IV-1
Distribution of Plants by
Product and BOD_5
(Thermoplastics)

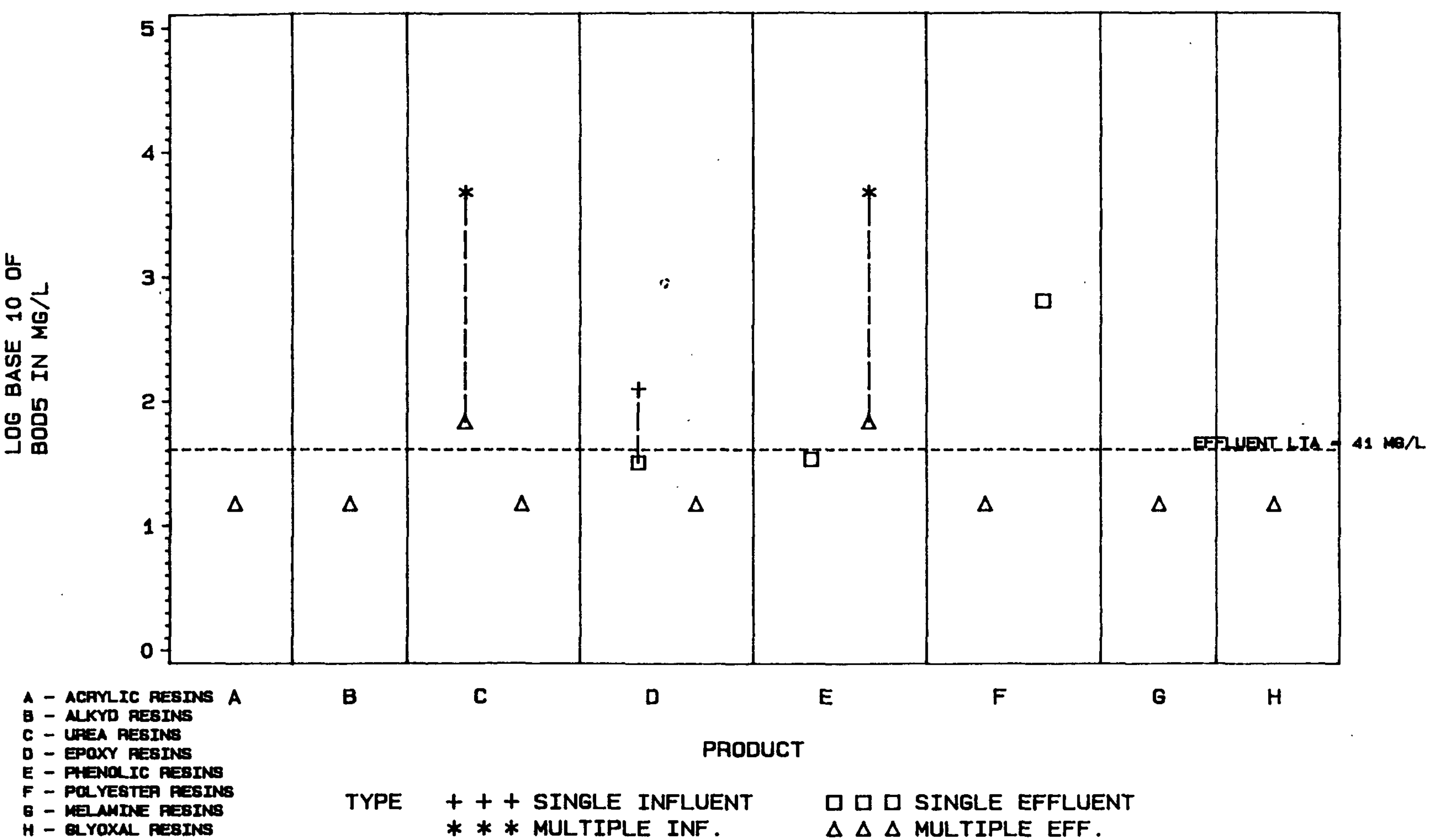


Figure IV-2
Distribution of Plants by Product and BOD_5 (Thermosets)

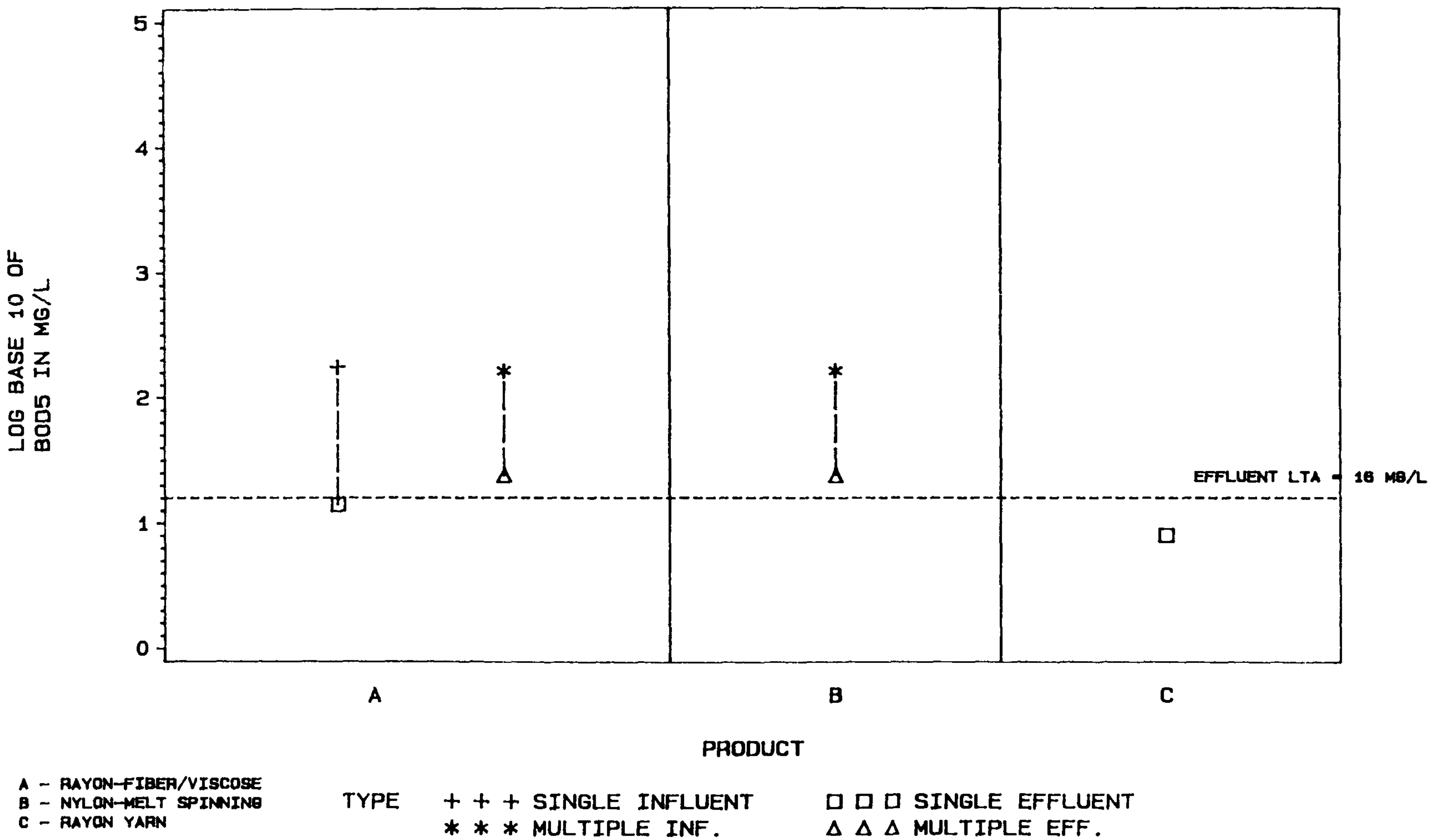


Figure IV-3
Distribution of Plants by
Product and BOD_5
(Rayon)

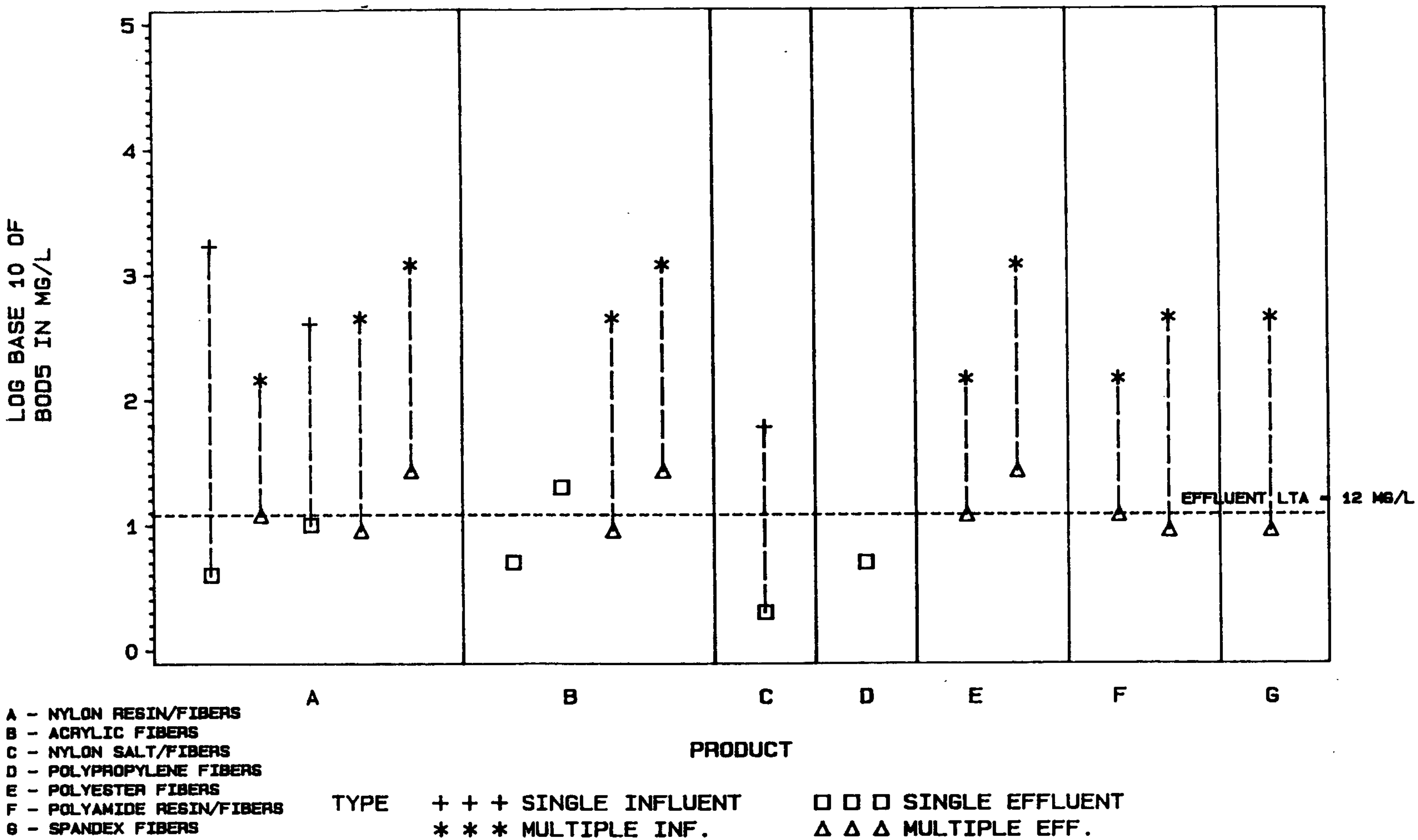
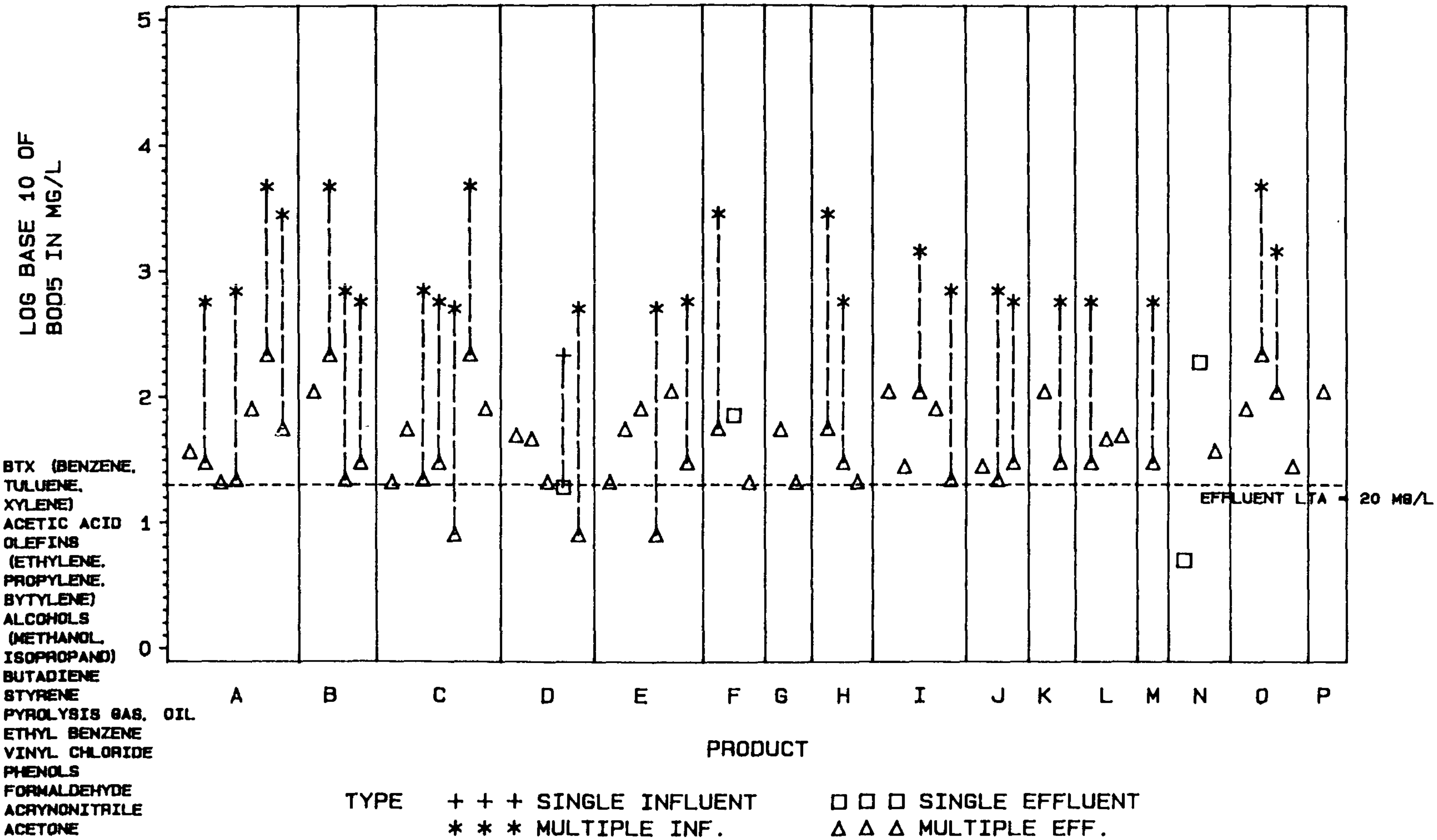


Figure IV-4
Distribution of Plants by
Product and BOD_5
(Fibers)



A - BTX (BENZENE, TULUENE, XYLENE)
B - ACETIC ACID
C - OLEFINS (ETHYLENE, PROPYLENE, BYTYLENE)
D - ALCOHOLS (METHANOL, ISOPROPANO)
E - BUTADIENE
F - STYRENE
G - PYROLYSIS GAS, OIL
H - ETHYL BENZENE
I - VINYL CHLORIDE
J - PHENOLS
K - FORMALDEHYDE
L - ACRYNONITRILE
M - ACETONE
N - PHTHALATE ACIDS
O - 1, 2- DICHLOROETHENES
P - VINYL ACETATE

Figure IV-5
Distribution of Plants by
Product and BOD_5
(Commodity)

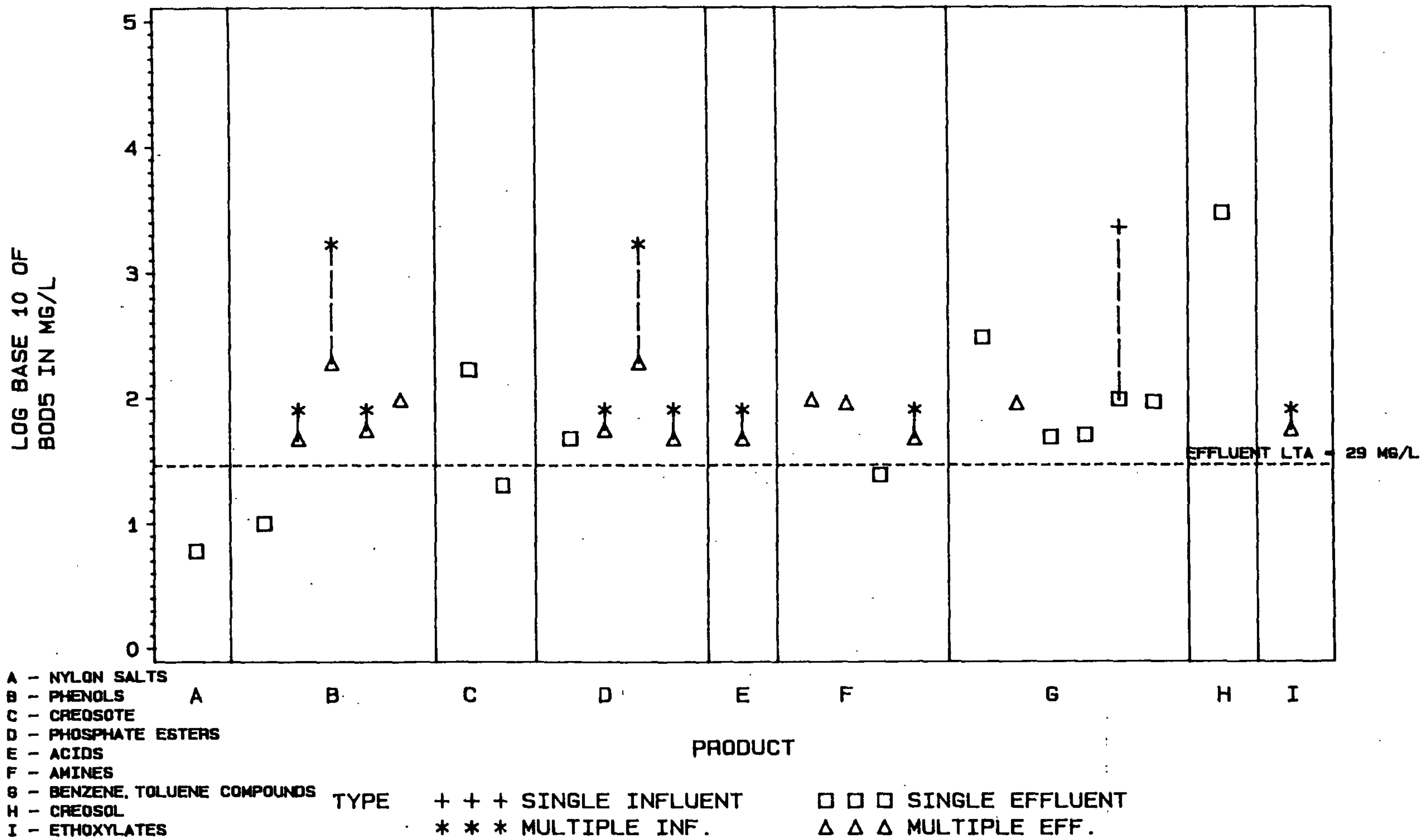


Figure IV-6
Distribution of Plants by Product and BOD_5 (Bulk)

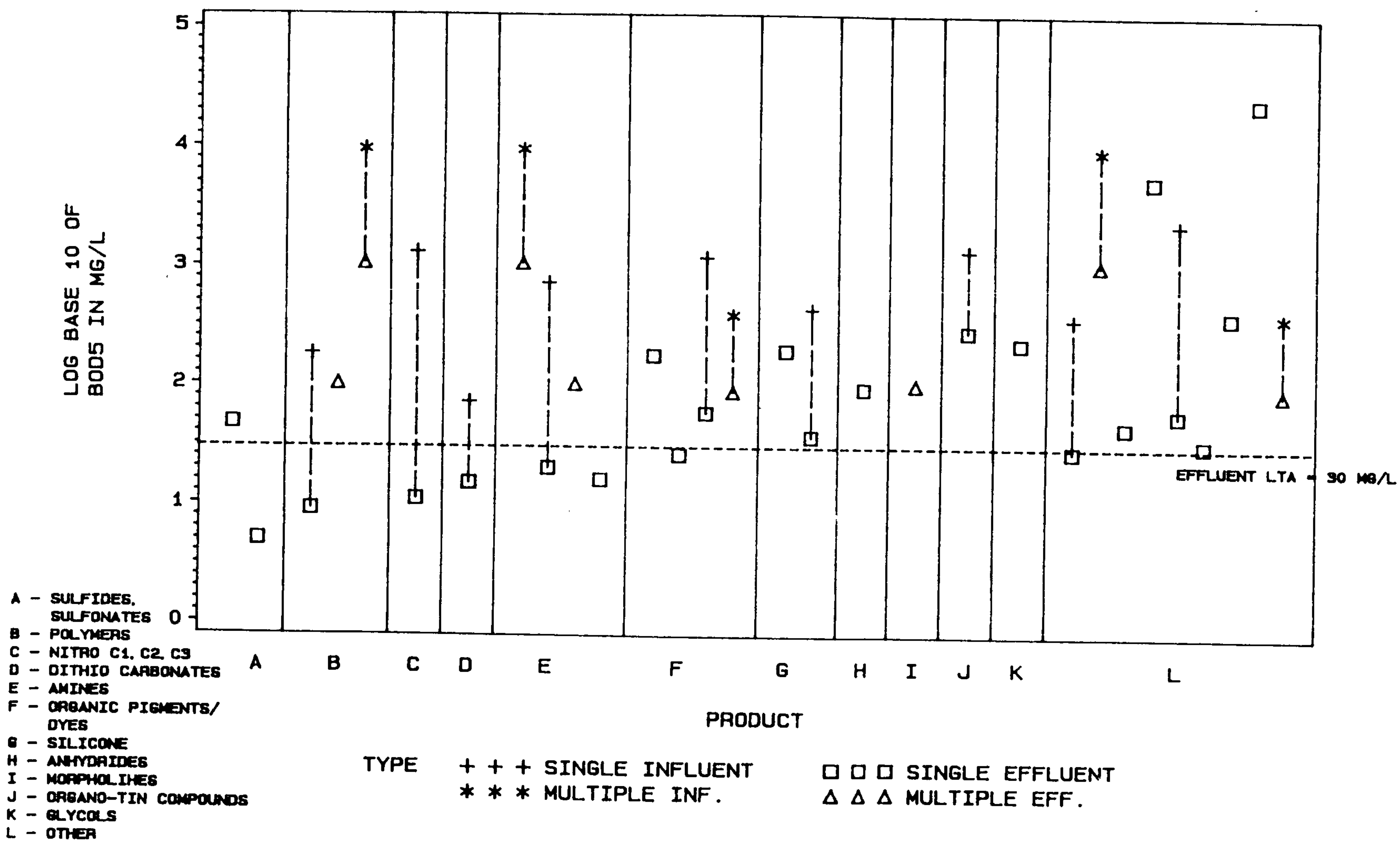


Figure IV-7
Distribution of Plants by
Product and BOD_5
(Specialty)

effluent, the end-of-pipe treatment systems in place at each plant and the in-plant controls currently in place at each plant that may cause raw waste BOD_5 concentrations to be reduced or that may remove toxic pollutants that inhibit biological activity and cause higher BOD_5 effluent concentrations. It should also be noted in any event that for those plants substantially above the subcategory long-term average BOD_5 effluent value, as well as for other plants, EPA's costing methodology and resulting cost estimates and economic impact estimates have fully accounted for any required treatment improvement.

Based on the distribution of raw waste and effluent BOD_5 concentrations, the relative consistency of percent removal data across the final seven subcategories, and BOD_5 effluent data within subcategories and product groups within those subcategories, the Agency has concluded that the adopted BPT subcategorization accounts sufficiently for wastewater characteristics and treatability.

b. BAT Subcategorization

Typically, the treatability of a waste stream is described in terms of its biodegradability, as biological treatment usually provides the most cost-effective means of treating a high volume, high (organic) strength industrial waste (i.e., minimum capital and operating costs). Furthermore, biodegradability serves as an important indicator of the toxic nature of the waste load upon discharge to the environment. Aerobic (oxygen-rich) biological treatment processes achieve accelerated versions of the same type of biodegradation that would occur much more slowly in the receiving water. These treatment processes accelerate biodegradation by aerating the wastewater to keep the dissolved oxygen concentration high and recycling microorganisms to maintain extremely high concentrations of bacteria, algae, fungi, and protozoa in the treatment system. Certain compounds that resist biological degradation in natural waters may be readily oxidized by a microbial population adapted to the waste. As would occur in the natural environment, organic compounds may be removed by volatilization (e.g., aeration) and adsorption on solid materials (e.g., sludge) during biological treatment.

One of the primary limitations of biological treatment of wastewaters from the OCPSF industry is the presence of both refractory (difficult to treat) compounds as well as compounds that are toxic or inhibitory to biological processes. Compounds oxidized slowly by microorganisms can generally be treated by subjecting the wastewater to biological treatment for a longer time, thereby increasing the overall conventional and toxic pollutant removals. Lengthening the duration of treatment, however, requires larger treatment tanks and more aeration, both of which add to the expense of the treatment. Alternatively, pollutants that are refractory, toxic, or inhibitory to biological processes can be removed prior to biological treatment of wastewaters. Removal of pollutants prior to biological treatment is known as pretreatment.

The successful treatment of wastewaters of the OCPSF industries primarily depends on effective physical-chemical pretreatment of wastewaters, the ability to acclimate biological organisms to the remaining pollutants in the waste stream (as in activated sludge processes), the year-round operation of the treatment system at an efficient removal rate, the resistance of the treatment system to toxic or inhibitory concentations, and the stability of the treatment system during variations in the waste loading (i.e., changes in product mixes).

However, as discussed earlier in this section, the Agency determined that a subset of OCPSF plants, based on their low raw waste BOD_5 levels, did not necessarily require biological treatment to comply with BPT effluent limitations. Some of these plants produced chlorinated hydrocarbons that typically generate wastewater characterized by low raw waste BOD_5 concentrations. In these cases, biological treatment would not be effective in treating refractory priority pollutants that would not be amenable to biodegradation. Therefore, the Agency decided that separate BAT effluent limitations based on the performance of physical-chemical treatment technologies only were appropriate and has established a separate subcategory for these plants based on their unique raw wastewater characteristics and treatability.

The Agency also maintains that similar toxic pollutant effluent concentrations can be achieved by plants in differing BPT subcategories, i.e., plants with different product mixes, by installing the best available treatment technologies. These toxic pollutants are being controlled using a combination of in-plant and end-of-pipe treatment technologies. The in-plant controls are based upon specific pollutants or groups of pollutants identified in waste streams and controlled by technologies for which treatment data are available or transferred with appropriate basis (see Section VII of this document). Thus, subcategory groupings of plants based on product mix for BAT are not appropriate. Nevertheless, the Agency has attempted to perform a quantitative assessment of treatability of BAT toxic pollutants by BPT subcategory classification. The capability to perform this assessment is limited because the frequency of occurrence of BAT toxic pollutants is determined by the presence of specific product/processes (or reaction chemistry) within plants that is not totally dependent on BPT subcategory classifications. Table IV-1 presents a comparison of toxic pollutant mean effluent concentrations achieved by 100 percent plastics and organics plants contained in the final, edited BAT toxic pollutant data base that were used in the calculation of BAT effluent limitations. Also included is the same comparison between those 100 percent "pure" BPT subcategory plants contained in the same data base. The first comparison shows that, with the exception of two pollutants (#10 and #32), plastics and organics plants achieve effluent concentrations that approach the analytical minimum level. The same results are found for the second "pure" subcategory comparison, even though fewer plants were available for the analysis. For the two pollutants with disparate results, the Agency believes that these differences are not the result of dissimilar wastewater treatability, but a lack of effluent concentration data for these pollutants from 100 percent plastics plants. EPA notes that when more than one 100 percent plastics plant is available for comparison (e.g., pollutant #86), the effluent concentrations are similar.

In addition to each OCPSF plant's ability to achieve similar effluent concentrations, the Agency also believes that its extensive BAT toxic pollutant data base is representative of OCPSF wastewaters, treatment technologies, processes, and products. In total, 186 plants were sampled in the Agency's screening, verification, 5-plant, and 12-plant studies. After editing the data base so that only quality data (i.e., having adequate QA/QC) representing BAT treatment were used, the edited BAT data base contains sampling data for

TABLE IV-1.
BAT EFFLUENT ESTIMATED LONG-TERM AVERAGE CONCENTRATION COMPARISON
BETWEEN PLASTICS AND ORGANICS PLANTS AND
PURE BPT SUBCATEGORY PLANTS

Plant Numbers	Concentrations (ppb) by Pollutant Number 4	10	32	38	65	86	87
Plastics vs. Organics							
Plastics							
883	-	-	-	10	-	-	-
2221	-	-	-	10	10	10	-
4051	10	1016	923	-	-	103	16
1349	-	-	-	-	-	-	-
1617	-	-	-	-	-	10	-
2536	-	-	-	10	10	-	-
Organics							
12	10	-	-	10	12	10	-
296	10	12	-	-	10	10	-
444	10	-	-	-	-	10	-
1609	10	-	-	-	10	18	10
1753	-	-	-	10	-	-	-
2394	-	-	-	10	59	10	-
2693	-	-	-	-	-	-	-
3033	-	10	13	-	15	-	-
Pure Subcategory							
Thermoplastics							
883	-	-	-	10	-	-	-
1617	-	-	-	-	-	10	-
4051	10	1016	923	-	-	103	16
2536	-	-	-	10	10	-	-
1349	-	-	-	-	-	-	-
Thermosets							
2221	-	-	-	10	10	10	-
Bulk Organics							
444	10	-	-	-	-	10	-
Specialty Organics							
1753	-	-	-	10	-	-	-

36 OCPSF plants (including industry supplied data) representing 232 product/processes. These 36 plants account for approximately 26 percent of production volume and 24 percent of the process wastewater flow of the entire industry. The types of product/processes utilized by these 36 plants represent approximately 13 percent of the types of OCPSF product/processes in use. Since the products manufactured by these facilities are manufactured at other OCPSF facilities, the data obtained from these plants represent even greater percentages of total industry production and flow. Thus, about 68 percent of OCPSF industry production (in total pounds) is represented and about 57 percent of the OCPSF industry wastewater is accounted for by the products and processes utilized by the 36 plants in the limitations data base. Products that could be manufactured by the 232 product/processes utilized at or manufactured by the 36 plants account for 84 percent of industry production and 76 percent of process wastewater.

The OCPSF industry manufactures more than 20,000 individual products; however, overall production is concentrated in a limited number of high-volume chemicals. Excluding consideration of plastics, resins, and synthetic fibers, EPA has identified 36 organic chemicals that are manufactured in quantities greater than 1 billion pounds per year. These chemicals are referred to as commodity chemicals. Two hundred eighteen organic chemicals are manufactured in quantities between 40 million and 1 billion pounds per year. These chemicals are referred to as bulk chemicals. Together, these 254 chemicals account for approximately 91 percent of total annual production volume of organic chemicals as reported in the 308 Questionnaire survey data base for the OCPSF industry. By sampling OCPSF plants that manufacture many of these high-volume chemicals, as well as other types of OCPSF plants, EPA has, in fact, gathered sampling data that are representative of production in the entire industry.

Based on the results of its comparison analysis and the adequate coverage of the OCPSF industry in its sampling programs, the Agency believes that plants within each of its BAT subcategories can achieve BAT effluent limitations despite differing product/process mix.

The Agency has also determined that because of their unique high raw wastewater zinc characteristics and treatability noted in Sections V and VII, respectively, producers of rayon by the viscose process and acrylic fibers by the zinc chloride/solvent process will receive different BAT effluent limitations for zinc than the remainder of the OCPSF industry, whose BAT limitations will be based on the performance of chemical precipitation technology used in the Metal Finishing Point Source Category.

c. Energy and Non-Water Quality Aspects

Energy and non-water quality aspects include the following:

- Sludge production
- Air pollution derived from wastewater generation and treatment
- Energy consumption due to wastewater generation and treatment
- Noise from wastewater treatment.

The basic treatment step, used by virtually all plants in all subcategories that generate raw wastes containing basically BOD_5 and TSS, is biological treatment. Therefore, the generation of sludges, air pollution, noise, and the consumption of energy will be homogeneous across the industry. However, the levels of these factors will relate to the volume of wastewater treated and their associated pollutant loads. Since the volumes of wastewater generated and wastewater characteristics were considered in earlier sections, it is believed that all energy and nonwater quality aspects have been adequately addressed in this final subcategorization approach.

SECTION V

WATER USE AND WASTEWATER CHARACTERIZATION

A. WATER USE AND SOURCES OF WASTEWATER

The Organic Chemicals, Plastics, and Synthetic Fibers (OCPSF) industry uses large volumes of water in the manufacture of products. Water use and wastewater generation occur at a number of points in manufacturing processes and ancillary operations, including: 1) direct and indirect contact process water; 2) contact and noncontact cooling water; 3) utilities, maintenance, and housekeeping waters; and 4) waters from air pollution control systems such as Venturi scrubbers.

The OCPSF effluent limitations and standards apply to the discharge of "process wastewater," which is defined as any water that, 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 (40 CFR 401.11(q)). An example of direct contact process wastewater is the use of aqueous reaction media. The use of water as a medium for certain chemical processes becomes a major high-strength process wastewater source after the primary reaction has been completed and the final product has been separated from the water media, leaving residual product and unwanted by-products formed during secondary reactions in solution.

Indirect contact process wastewaters, such as those discharged from vacuum jets and steam ejectors, involve the recovery of solvents and volatile organics from the chemical reaction kettle. In using vacuum jets, a stream of water is used to create a vacuum, but also draws off volatilized solvents and organics from the reaction kettle into solution. Later, recoverable solvents are separated and reused while unwanted volatile organics remain in solution in the vacuum water, which is discharged as process wastewater. Steam ejector systems are similar to vacuum jets with steam being substituted for water. The steam is then drawn off and condensed to form a source of process wastewater.

The major volume of water used in the OCPSF industry is cooling water. Cooling water may be contaminated, such as contact cooling water (considered process wastewater) from barometric condensers, or uncontaminated noncontact cooling water. "Noncontact cooling water" is defined as water used for cooling that does not come into direct contact with any raw material, intermediate product, waste product, or finished product (40 CFR 401.11(n)). Frequently, large volumes of noncontact cooling water may be used on a once-through basis and discharged after commingling with process wastewater. Many of the wastewater characteristics reported by plants in the data bases were based on flow volumes that included both process wastewater and nonprocess wastewater such as noncontact cooling water. Other types of nonprocess wastewater include: boiler blowdown, water treatment wastes, stormwater, sanitary waste, and steam condensate. An adjustment of the reported volumes of the effluents was therefore required to arrive at performance of treatment systems and other effluent characteristics.

This adjustment was made by eliminating the uncontaminated cooling water volume from the total volume, to arrive at the contaminated wastewater flow at the sampling site. The concentrations of the conventional pollutants BOD_5, COD, TSS, and TOC were adjusted using the simplifying judgment that the uncontaminated cooling water did not contribute to the pollutant level. However, it should be noted that in some cases noncontact cooling water can contribute pollutant loading, especially to typically low-strength plastics and synthetic materials wastewaters.

In some cases, effluent priority pollutant and daily conventional pollutant data submitted by plants were from sample sites that included nonprocess wastewater. Where this dilution with noncontact cooling water or other nonprocess wastewater was significant (i.e., >25 percent of total), such data were considered nonrepresentative of actual treatment systems' daily performance and were excluded from the data base used for assessing treatment system performance variability factors.

B. WATER USE BY MODE OF DISCHARGE

Industry process wastewater flow descriptive statistics are summarized in Table V-1 for 929 OCPSF plants that submitted sufficient information in the 1983 Section 308 Questionnaire. This data base is classified by direct, indirect, or zero discharge status. "Zero" discharge methods include no discharge, land application, deep well injection, incineration, contractor removal, evaporation, off-site treatment by a privately owned treatment system, and discharge to septic and leachate fields.

Some of the plants in the 308 data base discharge waste streams by more than one method. However, for purposes of tabulating wastewater data, each plant was assigned to a single discharge category (i.e., no double counting appears in the direct, indirect, and zero discharge data columns). A plant was classified as a zero or alternate discharger only if all of its waste streams were reported as zero or alternate discharge streams. Plants were classified as direct dischargers if at least one process wastewater stream was direct. Plants whose process wastewater streams were discharged to publicly owned treatment works (POTWs) were classified as indirect dischargers. Many of the indirect discharge plants discharge noncontact cooling water directly to surface waters.

Industry nonprocess wastewater flow descriptive statistics are summarized in Table V-2 for 718 OCPSF plants as classified in Table V-1 by process wastewater discharge status.

C. WATER USE BY SUBCATEGORY

As discussed previously in Section IV, data relating product/process production information to flow was requested from industry in the 1983 Section 308 Questionnaire to facilitate the flow proportioning of individual product subcategory limitations for multiple subcategory plants. This information would have also facilitated the presentation of the wastewater flow data by subcategory. Unfortunately, much of the production/flow information (when supplied) was either estimated or grouped with other product/process flows and was considered too inaccurate or nebulous for use. Since this information

TABLE V-1.
TOTAL OCPSF PLANT PROCESS WASTEWATER
FLOW CHARACTERISTICS BY TYPE OF DISCHARGE

	Process Wastewater Discharge Status		
	Direct	Indirect	Zero
Descriptive Statistics			
Number of Plants*	304	393	232
Percentage of Plants	33%	42%	25%
Total Flow (MGD)	387	94	32
Average Flow (MGD)	1.31	0.25	0.24
Median Flow (MGD)	0.40	0.04	0.007
Frequency Counts (# of Plants) By Flow Range			
<0.005 MGD	25	106	161
0.005 to 0.01 MGD	12	34	11
>0.01 to 0.10 MGD	54	136	30
>0.10 to 0.50 MGD	80	77	16
>0.5 to 1.0 MGD	43	26	4
>1.0 to 5.0 MGD	75	12	10
>5.0 to 10.0 MGD	8	1	0
>10 MGD (up to a maximum of 19.3 MGD)	7	1	0

*(N) = 929 out of 940 scope facilities

Source: 1983 Section 308 Questionnaire Responses

TABLE V-2.
TOTAL OCPSF PLANT NONPROCESS WASTEWATER
FLOW CHARACTERISTICS BY TYPE OF DISCHARGE

	Nonprocess Wastewater Discharge Status		
	Direct	Indirect	Zero
Descriptive Statistics			
Number of Plants*	278	332	108
Percentage of Plants	39%	46%	15%
Total Flow (MGD)	3,973	353	103
Average Flow (MGD)	14.29	1.06	0.95
Median Flow (MGD)	0.40	0.03	0.05
Frequency Counts (# of Plants) By Flow Range			
<0.005 MGD	11	76	21
0.005 to 0.01 MGD	14	36	16
>0.01 to 0.10 MGD	53	117	34
>0.10 to 0.50 MGD	77	56	20
>0.5 to 1.0 MGD	32	22	8
>1.0 to 5.0 MGD	42	19	5
>5.0 to 10.0 MGD	12	3	1
>10 MGD (up to a maximum of 1,732 MGD)	37	3	3

*(N) = 718 out of 940 scope facilities reporting discharge of nonprocess wastewater

Source: 1983 Section 308 Questionnaire Responses could not be used to group these flow data accurately, the Agency has decided to present these data using two methodologies. The first method utilizes an approach similar to the regression model used for subcategorization to proportion these data among subcategories. The second methodology places individual plants completely in one of the seven final subcategories based on a prescribed set of rules. These two methodologies are discusssed in more detail in the following sections.

Tables V-3 through V-16 provide the 1980 process and nonprocess wastewater flow statistics by subcategory and disposal method. Tables V-3 through V-9 present separate tabulations for primary and secondary producers and for process and nonprocess wastewater. In each table, the mean and median flows for multi-subcategory plants have been divided into subcategories using the regression methodology described in Section IV based on plant production volume proportions for each subcategory. Thus, mean and median flows given in some cases may not represent actual plant subcategory flow since, on a unit of production basis, different products produce different flow volumes. However, data constraints preclude direct attribution of process and nonprocess flows to individual products or product subcategory groups. Production weighted mean subcategory flow values were calculated using the following formula:

$$\text{Production Weighted Mean} = \frac{P_1F_1 + P_2F_2 + P_3F_3 + \ldots + P_iF_i}{P_1 + P_2 + P_3 + \ldots + P_i}$$

Where:

P_1 = Decimal subcategory proportion of total OCPSF plant production for plant #1 (range = 0 to 1.0)

F_1 = Total process flow for plant #1.

In determining the median, the wastewater flow of each plant that has at least one product within a subcategory are ranked from lowest to highest. The subcategory decimal production proportions are summed starting from the lowest flow plant until the sum equals or exceeds 50 percent of the total of all the decimal production proportions. The wastewater flow of the plant whose proportions when added to the proportion sum causes the total to exceed

TABLE V-3
PROCESS WASTEWATER FLOW FOR PRIMARY OCPSF PRODUCERS
BY SUBCATEGORY AND DISPOSAL METHOD
DIRECT DISCHARGERS

SUBCATEGORY	MEAN (MGD)	MEDIAN (MGD)	STANDARD DEVIATION	NUMBER OF OBSERVATIONS	NUMBER OF PLANTS
THERMOPLASTICS	1.00	0.43	1.70	60.99	104
THERMOSETS	0.71	0.08	1.66	12.10	31
RAYON	8.04	8.57	2.98	3.19	5
FIBERS	1.14	0.57	2.31	13.73	22
COMMODITY ORGANICS	2.16	1.00	3.73	48.85	84
BULK ORGANICS	1.53	0.29	3.43	47.53	113
SPECIALTY ORGANICS	0.84	0.30	1.74	41.61	103

INDIRECT DISCHARGERS

SUBCATEGORY	MEAN (MGD)	MEDIAN (MGD)	STANDARD DEVIATION	NUMBER OF OBSERVATIONS	NUMBER OF PLANTS
THERMOPLASTICS	0.25	0.05	0.65	68.57	108
THERMOSETS	0.08	0.02	0.28	40.97	80
FIBERS	0.05	0.02	0.06	7.00	8
COMMODITY ORGANICS	0.57	0.04	1.71	18.43	36
BULK ORGANICS	0.48	0.05	1.15	33.71	84
SPECIALTY ORGANICS	0.34	0.06	1.49	106.31	154

TABLE V-4

PROCESS WASTEWATER FLOW DURING 1980 FOR SECONDARY OCPSF PRODUCERS BY SUBCATEGORY AND DISPOSAL METHOD

DIRECT DISCHARGERS

SUBCATEGORY	MEAN (MGD)	MEDIAN (MGD)	STANDARD DEVIATION	NUMBER OF OBSERVATIONS	NUMBER OF PLANTS
THERMOPLASTICS	0.15	0.08	0.26	8.68	12
THERMOSETS	0.50	0.01	0.93	4.03	5
ORGANICS	0.70	0.20	1.27	28.29	30

INDIRECT DISCHARGERS

SUBCATEGORY	MEAN (MGD)	MEDIAN (MGD)	STANDARD DEVIATION	NUMBER OF OBSERVATIONS	NUMBER OF PLANTS
THERMOPLASTICS	0.03	0.01	0.05	16.59	27
THERMOSETS	0.03	0.00	0.08	20.90	30
ORGANICS	0.11	0.02	0.18	52.51	58

TABLE V-5

PROCESS WASTEWATER FLOW FOR PRIMARY & SECONDARY OCPSF PRODUCERS THAT ARE ZERO/ALTERNATIVE DISCHARGERS

SUBCATEGORY	MEAN (MGD)	MEDIAN (MGD)	STANDARD DEVIATION	NUMBER OF OBSERVATIONS	NUMBER OF PLANTS
THERMOPLASTICS	0.08	0.01	0.26	24.92	36
THERMOSETS	0.01	0.00	0.08	33.11	40
ORGANICS	0.42	0.03	0.93	60.71	69
FIBERS	0.33	0.08	0.98	2.31	3
COMMODITY ORGANICS	0.91	0.91	.	0.84	1
BULK ORGANICS	0.31	0.30	0.37	1.30	3
SPECIALTY ORGANICS	0.16	0.11	0.19	2.81	4

TABLE V-6
NON-PROCESS WASTEWATER FLOW DURING 1980
FOR SECONDARY OCPSF PRODUCERS
AND ZERO/ALTERNATIVE DISCHARGERS
BY SUBCATEGORY & DISPOSAL METHOD

SECONDARY AND DIRECT DISCHARGE PLANTS

SUBCATEGORY	MEAN (MGD)	MEDIAN (MGD)	STANDARD DEVIATION	NUMBER OF OBSERVATIONS	NUMBER OF PLANTS
THERMOPLASTICS	0.320	0.190	0.760	8.72	12
THERMOSETS	0.242	0.250	0.242	1.03	2
ORGANICS	3.564	0.255	11.546	27.25	29

SECONDARY AND INDIRECT DISCHARGE PLANTS

SUBCATEGORY	MEAN (MGD)	MEDIAN (MGD)	STANDARD DEVIATION	NUMBER OF OBSERVATIONS	NUMBER OF PLANTS
THERMOPLASTICS	0.072	0.005	0.206	19.50	29
THERMOSETS	0.458	0.020	1.179	17.99	27
ORGANICS	1.240	0.015	6.470	46.51	52

SECONDARY AND OTHER DISCHARGE PLANTS*

SUBCATEGORY	MEAN (MGD)	MEDIAN (MGD)	STANDARD DEVIATION	NUMBER OF OBSERVATIONS	NUMBER OF PLANTS
THERMOPLASTICS	0.242	0.013	1.367	18.00	26
THERMOSETS	0.101	0.019	0.184	27.01	33
ORGANICS	0.658	0.031	2.960	47.67	57
FIBERS	6.455	0.710	20.921	1.31	2

NOTE: THERE ARE 9 PRIMARY PLANTS NOT INCLUDED IN THIS TABLE
THAT ARE ZERO DISCHARGERS.

TABLE V-7

TOTAL OCPSF NON-PROCESS WASTEWATER FLOW IN 1980

FOR PRIMARY PRODUCERS BY SUBCATEGORY & DISPOSAL METHOD

DIRECT DISCHARGERS

SUBCATEGORY	MEAN (MGD)	MEDIAN (MGD)	STANDARD DEVIATION	NUMBER OF OBSERVATIONS	NUMBER OF PLANTS
THERMOPLASTICS	9.266	0.280	67.664	58.905	101
THERMOSETS	5.228	0.450	62.392	11.904	33
RAYON	2.295	2.500	4.263	2.187	4
FIBERS	9.279	1.910	17.113	11.851	19
COMMODITY ORGANICS	55.125	0.720	232.600	45.738	78
BULK ORGANICS	21.990	0.475	128.821	46.253	108
SPECIALTY ORGANICS	8.142	0.200	42.871	35.162	96

INDIRECT DISCHARGERS

SUBCATEGORY	MEAN (MGD)	MEDIAN (MGD)	STANDARD DEVIATION	NUMBER OF OBSERVATIONS	NUMBER OF PLANTS
THERMOPLASTICS	0.211	0.027	1.326	55.056	85
THERMOSETS	0.141	0.020	0.738	29.003	62
FIBERS	0.077	0.024	0.090	4.002	5
COMMODITY ORGANICS	3.434	0.311	11.510	15.329	30
BULK ORGANICS	4.808	0.064	21.021	27.823	67
SPECIALTY ORGANICS	0.418	0.043	1.765	74.786	116

DISCHARGERS OTHER THAN DIRECT OR INDIRECT

SUBCATEGORY	MEAN (MGD)	MEDIAN (MGD)	STANDARD DEVIATION	NUMBER OF OBSERVATIONS	NUMBER OF PLANTS
THERMOPLASTICS	0.027	0.010	0.026	2.122	3
THERMOSETS	0.000	0.000	.	0.878	1
BULK ORGANICS	0.150	0.150	.	0.208	1
SPECIALTY ORGANICS	14.560	0.150	24.171	2.792	3

TABLE V-8
NON-PROCESS COOLING WATER FLOW FOR PRIMARY
OCPSF PRODUCERS BY SUBCATEGORY & DISPOSAL METHOD
DIRECT DISCHARGERS

SUBCATEGORY	MEAN (MGD)	MEDIAN (MGD)	STANDARD DEVIATION	NUMBER OF OBSERVATIONS	NUMBER OF PLANTS
THERMOPLASTICS	0.814	0.182	2.058	58.415	96
THERMOSETS	0.259	0.063	0.661	11.992	33
RAYON	0.140	0.120	0.125	2.187	4
FIBERS	0.369	0.337	0.321	12.153	19
COMMODITY ORGANICS	1.097	0.537	1.651	42.908	75
BULK ORGANICS	0.431	0.100	0.936	43.148	107
SPECIALTY ORGANICS	0.381	0.077	1.042	42.196	100

INDIRECT DISCHARGERS

SUBCATEGORY	MEAN (MGD)	MEDIAN (MGD)	STANDARD DEVIATION	NUMBER OF OBSERVATIONS	NUMBER OF PLANTS
THERMOPLASTICS	0.085	0.012	0.204	45.578	73
THERMOSETS	0.171	0.007	1.015	25.319	52
FIBERS	0.068	0.090	0.057	4.027	5
COMMODITY ORGANICS	0.776	0.118	1.781	13.479	25
BULK ORGANICS	0.213	0.028	0.380	24.790	59
SPECIALTY ORGANICS	0.097	0.011	0.231	68.806	99

DISCHARGERS OTHER THAN DIRECT OR INDIRECT

SUBCATEGORY	MEAN (MGD)	MEDIAN (MGD)	STANDARD DEVIATION	NUMBER OF OBSERVATIONS	NUMBER OF PLANTS
THERMOPLASTICS	0.065	0.043	0.039	2.168	4
THERMOSETS	0.004	0.004	.	0.878	1
COMMODITY ORGANICS	0.121	0.121	.	0.838	1
BULK ORGANICS	0.039	0.003	.	0.302	2
SPECIALTY ORGANICS	0.023	0.003	0.036	2.815	4

TABLE V-9

OCPSF MISCELLANEOUS NON-COOLING NON-PROCESS WASTEWATER FLOW FOR PRIMARY PRODUCERS BY SUBCATEGORY & DISPOSAL METHOD

DIRECT DISCHARGERS

SUBCATEGORY	MEAN (MGD)	MEDIAN (MGD)	STANDARD DEVIATION	NUMBER OF OBSERVATIONS	NUMBER OF PLANTS
THERMOPLASTICS	9.474	0.485	66.066	62.632	107
THERMOSETS	4.956	0.290	59.320	13.183	36
RAYON	1.671	0.240	3.467	3.187	5
FIBERS	9.288	1.585	16.800	12.323	20
COMMODITY ORGANICS	52.918	1.400	226.990	48.535	84
BULK ORGANICS	20.449	0.660	123.687	50.649	118
SPECIALTY ORGANICS	6.504	0.233	37.616	46.491	111

INDIRECT DISCHARGERS

SUBCATEGORY	MEAN (MGD)	MEDIAN (MGD)	STANDARD DEVIATION	NUMBER OF OBSERVATIONS	NUMBER OF PLANTS
THERMOPLASTICS	0.242	0.030	1.318	64.020	100
THERMOSETS	0.236	0.025	1.088	35.707	72
FIBERS	0.116	0.063	0.130	5.002	6
COMMODITY ORGANICS	3.727	0.639	11.519	16.932	32
BULK ORGANICS	4.365	0.106	19.798	31.855	75
SPECIALTY ORGANICS	0.434	0.069	1.708	87.483	131

DISCHARGERS OTHER THAN DIRECT OR INDIRECT

SUBCATEGORY	MEAN (MGD)	MEDIAN (MGD)	STANDARD DEVIATION	NUMBER OF OBSERVATIONS	NUMBER OF PLANTS
THERMOPLASTICS	0.063	0.090	0.048	3.168	5
THERMOSETS	0.004	0.004	.	0.878	1
COMMODITY ORGANICS	0.121	0.121	.	0.838	1
BULK ORGANICS	0.143	0.153	.	0.302	2
SPECIALTY ORGANICS	14.466	0.153	24.107	2.815	4

TABLE V-10
PROCESS WASTEWATER FLOW FOR PRIMARY OCPSF PRODUCERS
BY SUBCATEGORY AND DISPOSAL METHOD
DIRECT DISCHARGERS
(95% & 70% RULES)

SUBCATEGORY	TOTAL FLOW (MGD)	MIN (MGD)	MAX (MGD)	MEAN (MGD)	MEDIAN (MGD)	STANDARD DEVIATION	NUMBER OF PLANTS
THERMOPLASTICS	24.884	0.02100	3.450	0.61	0.31	0.73	41
THERMOSETS	3.080	0.00001	2.680	0.51	0.09	1.06	6
RAYON	24.639	5.03000	11.039	8.21	8.57	3.02	3
FIBERS	7.422	0.24300	1.482	0.82	0.63	0.46	9
COMMODITY ORGANICS	25.909	0.00144	3.890	0.96	0.66	1.04	27
BULK ORGANICS	27.146	0.00020	18.000	1.04	0.11	3.49	26
SPECIALTY ORGANICS	16.985	0.00075	3.450	0.59	0.26	0.91	29
MIXED	194.299	0.00002	19.323	2.23	0.85	3.68	87

INDIRECT DISCHARGERS
(95% & 70% RULES)

SUBCATEGORY	TOTAL FLOW (MGD)	MIN (MGD)	MAX (MGD)	MEAN (MGD)	MEDIAN (MGD)	STANDARD DEVIATION	NUMBER OF PLANTS
THERMOPLASTICS	8.0439	0.0000070	1.240	0.16	0.05	0.27	49
THERMOSETS	0.7884	0.0001000	0.350	0.05	0.00	0.10	16
FIBERS	0.3768	0.0003000	0.160	0.05	0.02	0.06	7
COMMODITY ORGANICS	11.4154	0.0078000	7.970	1.14	0.28	2.46	10
BULK ORGANICS	8.1822	0.0007000	2.963	0.48	0.05	0.92	17
SPECIALTY ORGANICS	32.4242	0.0000100	15.439	0.36	0.07	1.63	90
MIXED	22.3383	0.0000343	4.840	0.26	0.03	0.74	86

TABLE V-11
PROCESS WASTEWATER FLOW DURING 1980 FOR SECONDARY OCPSF
PRODUCERS BY SUBCATEGORY AND DISPOSAL METHOD
(95 % RULE)
DIRECT DISCHARGERS

SUBCATEGORY	MINIMUM (MGD)	MAXIMUM (MGD)	MEAN (MGD)	MEDIAN (MGD)	STANDARD DEVIATION	NUMBER OF OBSERVATIONS
THERMOPLASTICS	0.00016	0.20	0.08	0.05	0.08	8
THERMOSETS	0.00369	1.90	0.50	0.06	0.93	4
ORGANICS	0.00001	4.70	0.69	0.17	1.30	27
MIXED	0.75000	0.97	0.86	0.86	0.16	2

(95 % RULE)
INDIRECT DISCHARGERS

SUBCATEGORY	MINIMUM (MGD)	MAXIMUM (MGD)	MEAN (MGD)	MEDIAN (MGD)	STANDARD DEVIATION	NUMBER OF OBSERVATIONS
THERMOPLASTICS	0.000300	0.0920	0.02	0.01	0.03	11
THERMOSETS	0.000054	0.1400	0.02	0.00	0.04	15
ORGANICS	0.000050	0.6300	0.10	0.02	0.17	48
MIXED	0.000200	0.5585	0.07	0.01	0.15	16

TABLE V-12
PROCESS WASTEWATER FLOW FOR PRIMARY & SECONDARY
OCPSF PRODUCERS THAT ARE ZERO/ALTERNATIVE DISCHARGERS
(95% & 70% RULES)

SUBCATEGORY	MINIMUM (MGD)	MAXIMUM (MGD)	MEAN (MGD)	MEDIAN (MGD)	STANDARD DEVIATION	NUMBER OF PLANTS
THERMOPLASTICS	0.00001	0.34	0.05	0.01	0.09	21
THERMOSETS	0.00004	0.02	0.00	0.00	0.00	27
ORGANICS	0.00000	4.40	0.40	0.03	0.94	55
FIBERS	0.00010	0.08	0.04	0.04	0.06	2
COMMODITY ORGANICS	0.90700	0.91	0.91	0.91	.	1
BULK ORGANICS	0.29700	0.30	0.30	0.30	.	1
SPECIALTY ORGANICS	0.00450	0.33	0.15	0.11	0.16	3
MIXED	0.00006	2.20	0.33	0.01	0.70	16

TABLE V-13
NON-PROCESS WASTEWATER FLOW DURING 1980
FOR SECONDARY OCPSF PRODUCERS
AND ZERO/ALTERNATIVE DISCHARGERS
BY SUBCATEGORY & DISPOSAL METHOD
(95% & 70% RULES)

SECONDARY AND DIRECT DISCHARGE PLANTS

SUBCATEGORY	MINIMUM (MGD)	MAXIMUM (MGD)	MEAN (MGD)	MEDIAN (MGD)	STANDARD DEVIATION	NUMBER OF PLANTS
THERMOPLASTICS	0.00165	0.710	0.234	0.120	0.289	8
THERMOSETS	0.25000	0.250	0.250	0.250	.	1
ORGANICS	0.00200	59.800	3.500	0.125	12.038	25
MIXED	0.19000	7.600	3.510	2.740	3.765	3

(95% & 70% RULES)
SECONDARY AND INDIRECT DISCHARGE PLANTS

SUBCATEGORY	MINIMUM (MGD)	MAXIMUM (MGD)	MEAN (MGD)	MEDIAN (MGD)	STANDARD DEVIATION	NUMBER OF PLANTS
THERMOPLASTICS	0.00010	0.250	0.037	0.003	0.072	14
THERMOSETS	0.00090	5.000	0.492	0.007	1.372	13
ORGANICS	0.00010	44.100	1.317	0.012	6.806	42
MIXED	0.00050	2.100	0.341	0.059	0.590	15

(95% & 70% RULES)
SECONDARY AND OTHER DISCHARGE PLANTS*

SUBCATEGORY	MINIMUM (MGD)	MAXIMUM (MGD)	MEAN (MGD)	MEDIAN (MGD)	STANDARD DEVIATION	NUMBER OF PLANTS
THERMOPLASTICS	0.00050	1.500	0.136	0.010	0.381	15
THERMOSETS	0.00171	0.590	0.092	0.020	0.156	22
ORGANICS	0.00001	5.750	0.360	0.028	0.934	42
FIBERS	0.71000	0.710	0.710	0.710	.	1
MIXED	0.08370	24.700	1.935	0.076	6.559	14

NOTE: THERE ARE 9 PRIMARY PLANTS NOT INCLUDED IN THIS TABLE
THAT ARE ZERO DISCHARGERS.

TABLE V-14

TOTAL OCPSF NON-PROCESS WASTEWATER FLOW IN 1980

FOR PRIMARY PRODUCERS BY SUBCATEGORY & DISPOSAL METHOD

DIRECT DISCHARGERS

(95% & 70% RULES)

SUBCATEGORY	MINIMUM (MGD)	MAXIMUM (MGD)	MEAN (MGD)	MEDIAN (MGD)	STANDARD DEVIATION	NUMBER OF PLANTS
THERMOPLASTICS	0.00022	30.744	2.106	0.212	5.603	39
THERMOSETS	0.00007	15.605	2.659	0.218	5.741	7
RAYON	0.14000	2.500	1.320	1.320	1.669	2
FIBERS	0.07200	44.364	10.727	4.526	15.621	8
COMMODITY ORGANICS	0.00200	648.000	25.595	0.409	126.949	26
BULK ORGANICS	0.00521	38.400	3.267	0.269	8.123	25
SPECIALTY ORGANICS	0.00266	15.626	1.842	0.179	3.613	22
MIXED	0.00010	1731.700	43.023	1.281	195.531	83

INDIRECT DISCHARGERS

(95% & 70% RULES)

SUBCATEGORY	MINIMUM (MGD)	MAXIMUM (MGD)	MEAN (MGD)	MEDIAN (MGD)	STANDARD DEVIATION	NUMBER OF PLANTS
THERMOPLASTICS	0.00000	1.490	0.154	0.021	0.306	40
THERMOSETS	0.00030	0.335	0.052	0.012	0.099	11
FIBERS	0.01770	0.210	0.077	0.040	0.090	4
COMMODITY ORGANICS	0.00520	47.146	6.859	1.159	16.310	8
BULK ORGANICS	0.00290	111.260	8.662	0.060	30.827	13
SPECIALTY ORGANICS	0.00020	8.830	0.439	0.063	1.271	61
MIXED	0.00010	11.157	0.469	0.030	1.648	69

DISCHARGERS OTHER THAN DIRECT OR INDIRECT

(95% & 70% RULES)

SUBCATEGORY	MINIMUM (MGD)	MAXIMUM (MGD)	MEAN (MGD)	MEDIAN (MGD)	STANDARD DEVIATION	NUMBER OF PLANTS
THERMOPLASTICS	0.01000	0.047	0.028	0.028	0.026	2
SPECIALTY ORGANICS	0.05000	40.480	13.560	0.150	23.313	3
MIXED	0.00010	0.000	0.000	0.000	.	1

TABLE V-15
NON-PROCESS COOLING WATER FLOW FOR PRIMARY
OCPSF PRODUCERS BY SUBCATEGORY & DISPOSAL METHOD
DIRECT DISCHARGERS
(95% & 70% RULES)

SUBCATEGORY	MINIMUM (MGD)	MAXIMUM (MGD)	MEAN (MGD)	MEDIAN (MGD)	STANDARD DEVIATION	NUMBER OF PLANTS
THERMOPLASTICS	0.00414	10.045	0.736	0.177	1.969	40
THERMOSETS	0.00007	1.072	0.290	0.038	0.441	7
RAYON	0.10000	0.120	0.110	0.110	0.014	2
FIBERS	0.08300	1.086	0.411	0.325	0.351	8
COMMODITY ORGANICS	0.00500	3.167	0.884	0.468	0.999	24
BULK ORGANICS	0.00165	3.300	0.277	0.078	0.699	22
SPECIALTY ORGANICS	0.00001	2.303	0.229	0.041	0.456	29
MIXED	0.00070	12.400	0.843	0.288	1.791	81

INDIRECT DISCHARGERS
(95% & 70% RULES)

SUBCATEGORY	MINIMUM (MGD)	MAXIMUM (MGD)	MEAN (MGD)	MEDIAN (MGD)	STANDARD DEVIATION	NUMBER OF PLANTS
THERMOPLASTICS	0.00009	0.890	0.077	0.012	0.194	34
THERMOSETS	0.00010	0.029	0.009	0.006	0.009	9
FIBERS	0.00731	0.135	0.067	0.063	0.057	4
COMMODITY ORGANICS	0.02814	2.758	0.786	0.481	0.931	8
BULK ORGANICS	0.00300	0.999	0.172	0.014	0.320	13
SPECIALTY ORGANICS	0.00004	1.600	0.096	0.011	0.232	58
MIXED	0.00001	8.000	0.247	0.016	1.074	56

DISCHARGERS OTHER THAN DIRECT OR INDIRECT
(95% & 70% RULES)

SUBCATEGORY	MINIMUM (MGD)	MAXIMUM (MGD)	MEAN (MGD)	MEDIAN (MGD)	STANDARD DEVIATION	NUMBER OF PLANTS
THERMOPLASTICS	0.04300	0.092	0.067	0.067	0.035	2
COMMODITY ORGANICS	0.12100	0.121	0.121	0.121	.	1
SPECIALTY ORGANICS	0.00120	0.060	0.021	0.003	0.034	3
MIXED	0.00400	0.004	0.004	0.004	.	1

TABLE V-16

OCPSF MISCELLANEOUS NON-COOLING NON-PROCESS WASTEWATER FLOW
FOR PRIMARY PRODUCERS BY SUBCATEGORY & DISPOSAL METHOD

DIRECT DISCHARGERS
(95% & 70% RULES)

SUBCATEGORY	MINIMUM (MGD)	MAXIMUM (MGD)	MEAN (MGD)	MEDIAN (MGD)	STANDARD DEVIATION	NUMBER OF PLANTS
THERMOPLASTICS	0.00100	30.896	2.657	0.396	6.235	42
THERMOSETS	0.00015	15.643	2.949	0.290	5.687	7
RAYON	0.12000	2.500	0.953	0.240	1.341	3
FIBERS	0.22100	44.447	11.138	4.929	15.500	8
COMMODITY ORGANICS	0.01200	651.167	25.432	0.884	125.062	27
BULK ORGANICS	0.00521	41.700	3.135	0.304	8.264	28
SPECIALTY ORGANICS	0.00031	15.703	1.474	0.173	3.097	32
MIXED	0.00080	1739.330	40.435	1.410	188.898	90

INDIRECT DISCHARGERS
(95% & 70% RULES)

SUBCATEGORY	MINIMUM (MGD)	MAXIMUM (MGD)	MEAN (MGD)	MEDIAN (MGD)	STANDARD DEVIATION	NUMBER OF PLANTS
THERMOPLASTICS	0.00000	2.380	0.187	0.028	0.411	47
THERMOSETS	0.00010	0.350	0.047	0.018	0.092	14
FIBERS	0.02411	0.345	0.115	0.063	0.131	5
COMMODITY ORGANICS	0.04480	49.904	6.795	0.898	16.218	9
BULK ORGANICS	0.00300	111.960	7.178	0.081	27.944	16
SPECIALTY ORGANICS	0.00004	9.367	0.449	0.080	1.286	72
MIXED	0.00011	11.417	0.592	0.052	1.797	78

DISCHARGERS OTHER THAN DIRECT OR INDIRECT
(95% & 70% RULES)

SUBCATEGORY	MINIMUM (MGD)	MAXIMUM (MGD)	MEAN (MGD)	MEDIAN (MGD)	STANDARD DEVIATION	NUMBER OF PLANTS
THERMOPLASTICS	0.01000	0.092	0.064	0.090	0.047	3
COMMODITY ORGANICS	0.12100	0.121	0.121	0.121	.	1
SPECIALTY ORGANICS	0.05120	40.540	13.581	0.153	23.347	3
MIXED	0.00410	0.004	0.004	0.004	.	1

50 percent is then chosen as the median. If, however, the total equals 50 percent exactly, then the median is the average of the wastewater flow of that plant and the next plant in the sequence. The tables are divided into primary and secondary producers because less detailed production data were collected from secondary producers. Likewise, less detailed data were collected from both primary and secondary zero discharge plants. Production data are identified only by Standard Industrial Classification (SIC) code for secondary or zero discharge producers, and thus the organics subcategories (i.e., bulk, commodity, specialty) must be grouped together.

In each table, the column for "Number of Plants" represents the total number of plants for whom at least part of their flow was used to derive the subcategory statistics. Therefore, double or multiple counting of plants occurs for multi-subcategory plants. The column for "Number of Observations" represents the sum of plant subcategory production proportions.

Tables V-10 through V-16 also provide 1980 process and nonprocess wastewater flow statistics by subcategory and disposal technique, but use a different method to aggregate plants by subcategory. Plants were placed in one of five categories (Thermoplastics, Thermosets, Rayon, Organics, Fibers) if their production was at least 95 percent contained in that category. Plants having less than 95 percent were placed in a sixth category (Mixed). The organics category was then further subdivided into three subcategories (Commodity, Bulk, Specialty) if the plant's organics production was at least 70 percent contained in one of the subcategories. Plants with less than 70 percent production were also placed in the mixed category. As with the tables generated using the regression methodology, production data are identified only by SIC code for secondary or zero discharge producers, and thus the organics subcategories (Commodity, Bulk, Specialty) were grouped together in the tables for these plants.

Tables V-3 and V-4 provide process wastewater flow statistics for primary and secondary producers, respectively, with each divided into direct and indirect dischargers using the regression methodology. Tables V-10 and V-11 present the same flow statistics using the 95 percent production basis for assigning plants to subcategories for the four nonorganics subcategories and the 70 percent organics production basis for the three organics subcategories (95/70 methodology). Table V-5 provides process wastewater flow statistics for the zero or alternate discharge plants using the regression methodology, while Table V-12 presents the same flow statistics using the 95/70 methodology. Tables V-6 through V-9 provide 1980 flow statistics for nonprocess wastewaters using the regression methodology, while Tables V-13 through V-16 present the same flow statistics using the 95/70 methodology.

The data in each table are grouped by the disposal method of the plants' process wastewater. In general, plants that discharge process wastewater directly will also discharge nonprocess wastewater directly. However, in some cases, plants that discharge process wastewater indirectly or by zero or alternate discharge methods may discharge their non-process wastewaters directly due to the generally lower treatment requirements of many nonprocess waste streams.

Tables V-6 and V-13 provide the nonprocess flow statistics for secondary producers and zero and alternate dischargers. Tables V-7 and V-14 provide the total nonprocess flow statistics for primary producers, while Tables V-8 through V-9 and Tables V-15 through V-16 provide the portions of these flows that are composed of cooling water versus other miscellaneous nonprocess wastewater.

The cooling water in Tables V-8 and V-15 include both once-through noncontact cooling water plus cooling tower blowdown and for some plants may include other nonprocess wastewater where flows were reported as a combined total. It is evident from these tables that cooling water comprises the major portion of nonprocess wastewater for most plants and that direct dischargers produce greater quantities of nonprocess wastewater than indirect dischargers.

In general, the summary statistics for wastewater flow by subcategory that were generated by the two methodologies compare favorably; all of the differences between subcategory medians calculated by the two methodologies fell within the standard deviations calculated by either methodology. Reasons for the differences include the inaccurate nature of assigning individual plants to subcategories, i.e., the arbitrary assignment of plants based on the

95/70 rule, which was determined to be insufficient for previous subcategorization efforts, as well as the relative contribution of the extra 5 or 30 percent of other subcategories' flows depending on if the plant is predominantly plastics or organics, respectively. Based on the inherent limitations of the 95/70 methodology, the Agency has much more confidence in the utility of the regression methodology summary statistics, but has included the 95/70 summary statistics for comparison purposes.

D. WATER REUSE AND RECYCLE

1. Water Conservation and Reuse Technologies

A variety of water conservation practices and technologies are available to OCPSF plants. Because of the diversity within the industry, no one set of conservation practices is appropriate for all plants. Decisions regarding water reuse and conservation depend on plant-specific characteristics, as well as site-specific water supply and environmental factors (e.g., water availability, cost, and quality). Therefore, this section will describe the range of practices and technologies available for water conservation.

Conventional water conservation practices include (McGovern 1973; Holiday 1982):

- Recovery and reuse of steam condensates and process condensates, where possible
- Process modifications to recover more product and solvents
- Effective control of cooling-tower treatment and blowdown to optimize cycles of concentration
- Elimination of contact cooling for off vapors
- Careful monitoring of water uses; maintenance of raw water treatment systems and prompt attention to faulty equipment, leaks, and other problems
- Installation of automatic monitoring and alarm systems on in-plant discharges.

Table V-17 summarizes water conservation technologies, and their applications, limitations, and relative costs to industry plants. Some of these technologies, such as steam stripping, are also considered effluent pollution control technologies. Water conservation, in fact, can often be a benefit of mandated pollution control.

2. Current Levels of Reuse and Recycle

Data on the amount of water reused and recycled in the OCPSF industry from the 1978 Census Bureau survey and the 1983 308 Questionnaires are presented in Tables V-18 and V-19, respectively.

In Table V-18, the Census Bureau defines "recirculated or reused water" as the volume of water recirculated multiplied by the number of times the water was recirculated. Seventy-nine percent of the OCPSF plants surveyed by the Census Bureau reported some recirculation or reuse of water. Census Bureau statistics show that the bulk of recirculated water is used for cooling and condensing operations, such as closed-loop cooling systems for heat transport. Chemical algaecides and fungicides are routinely added to these cooling waters to prevent organism growth and suppress corrosion, both of which can cause exchanger fouling and reduction of heat transfer coefficients.

As water evaporates and leaks from such closed systems, the concentration of minerals in these waters increases, which may lead to scale formation, reducing heat transfer efficiency. To reduce such scaling, a portion of such closed system waters is periodically discharged as blowdown and replaced by clean water.

Table V-19 shows the 1980 recycle flow of process and nonprocess wastewaters for OCPSF plants that are primary producers, excluding zero and alternate dischargers as reported in the 1983 Section 308 Questionnaire. The flow rates shown were for wastewater streams where the final disposal method was reported as recycle. Thus, the data do not reflect the number of times the wastewater is recycled (as in Census Bureau data), nor do they include flow in closed-loop systems such as cooling towers, since water in such

TABLE V-17.
WATER CONSERVATION AND REUSE TECHNOLOGIES

Technique	Applications	Limitations	Relative Costs Capital	Relative Costs Operating	Comments
Vapor-compression	Concentration of wastewater or cooling tower blowdown Concurrent production of high-purity water	Not for organics that form azeotropes or steam-distill Fouling must be controllable	High	High	Rapid growth High-quality distillate handles broad range of contaminants in water
Waste heat evaporation	Concentration of wastewater Condensate recovery	Not for organics that form azeotropes or steam-distill	Medium	Medium	Not widely used now Future potential good
Reverse osmosis, ultrafiltration	Removal of ionized salts, plus many organics Recovery of heavy metals, colloidal material Production of ultrapure water	Fouling-sensitive Stream must not degrade membranes Reject stream may be high-volume	Medium	Medium	Future potential strong Intense application development underway
Electrodialysis	Potable water from saline or brackish source	Limited to ionizable salts	Medium-high	Medium	Modest future potential
Stream stripping	Recovery of process condensates and other contaminated waters Recovery of H_2S, NH_3 plus some light organics	Stripped condensates may need further processing	Medium	Medium-high	Well-established as part of some processes

TABLE V-17.
WATER CONSERVATION AND REUSE TECHNOLOGIES (Continued)

Technique	Applications	Limitations	Relative Costs: Capital	Relative Costs: Operating	Comments
Combination wet/dry cooling towers	Puts part of tower load on airfins Can cut fogging	Costly compared with wet cooling tower	Medium	Medium	Growth expected in arid areas
Air-fin cooling	Numerous process applications	For higher-level heat transfer Can be prone to freeze-up, waxing	Medium	Medium	Well-established Good for higher temperature heat rejection
Sidestream softening	Reduce cooling-tower blowdown	Dissolved solids must be removable Control can be difficult	Low-medium	Low-medium	Not widely used Future potential good

Source: Holiday 1982

TABLE V-18.
WATER RECIRCULATED AND REUSED BY USE FOR THE OCPSF INDUSTRIES
1978 CENSUS DATA (a)

Industry Group (by SIC Code)	No. of Establishments Reporting Recirc/reuse (as % of Est. Surveyed)		Water Recirculated by Use (Billions of Gallons) (b)						
			Total	Process	Cooling and Condensing: Steam Electric Power Generation	Cooling and Condensing: Air Conditioning	Cooling and Condensing: Other	Sanitary Service	Boiler Feed
Organic Chemicals									
2865	51	(67%)	279	1.3	(c)	0.2	274	-	3.4
2869	165	(84%)	3,583	76	(c)	33	3,380	(c)	51
Total	216	(79%)	3,862	78	-	34	3,654	-	54
Plastics/Synthetic Fibers									
2821	102	(77%)	653	62	(c)	(c)	575	(c)	8.8
2823	6	(86%)	89	(c)	(c)	6	45	-	(c)
2824	32	(78%)	458	44	36	163	205	(c)	2.8
Total	140	(78%)	1,200	-	-	-	825	-	-
TOTAL	356	(79%)	5,062	-	-	-	4,479	-	-

SOURCE: Bureau of the Census 1981

(a) Represents data collected in a special 1978 Survey of Water Use for establishments using 20 million gallons or more of water/year in 1977; smaller volume users were excluded in this survey.

(b) Water Recirculated and Reused was defined as the volume of water recirculated multiplied by the number of times recirculated; e.g., if 100 million gallons of intake water were recirculated twice, the manufacturer reported recirculation/reuse of 200 million gallons.

(c) Data withheld to avoid disclosing operations of individual companies.

TABLE V-19.
SUMMARY OF OCPSF PROCESS AND NONPROCESS WASTEWATER
RECYCLE FLOW FOR PRIMARY PRODUCERS EXCLUDING ZERO DISCHARGERS

Plant Group	# of Plants Reporting Recycle	% of All Plants	Total Recycle Flow (MGD)	% of Total Flow of Recyle Plants	% of Total Flow of All Plants
		Process Wastewater Recycle			
Organics Only	17	6.80000	0.6048	6.9487	0.56302
Plastics & Organics	9	7.43802	16.4571	22.5151	4.47080
Plastics Only	10	5.71429	1.7315	10.7613	2.16426
All Plants	36	6.59341	18.7934	19.1990	3.38300
		Nonprocess Wastewater Recycle			
Organics Only	2	0.88496	0.02710	2.5566	0.00447
Plastics & Organics	1	0.85470	0.00010	0.8000	0.00000
Plastics Only	3	1.88679	7.71407	78.4579	2.94295
All Plants	6	1.19522	7.74127	70.9908	0.15497

systems is not considered wastewater until it leaves the system as blowdown. As a result of these differences, Table V-19 shows a much lower number of plants reporting recycle.

The fact that Table V-19 excludes plants that are considered zero dischargers may account for some of this discrepancy, since any plant that recycles 100 percent of its process wastewater would be excluded.

D. WASTEWATER CHARACTERIZATION

1. Conventional Pollutants

A number of different pollutant parameters are used to characterize wastewater discharged by OCPSF manufacturing facilities. These include:

- Biochemical Oxygen Demand (BOD_5)
- Total Suspended Solids (TSS)
- pH
- Chemical Oxygen Demand (COD)
- Total Organic Carbon (TOC)
- Oil and Grease (O&G).

BOD_5 is one of the most important gauges of the pollution potential of a wastewater and varies with the amount of biodegradable matter that can be assimilated by biological organisms under aerobic conditions. Large, complex facilities tend to discharge a higher BOD_5 mass loading, although concentrations are not necessarily different from smaller or less complex plants. 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 tend to exhibit lower BOD_5 values, even though the total organic loading may be much higher than compounds exhibiting substantially higher BOD_5 values.

Raw wastewater TSS is a function of the products manufactured and their processes, as well as the manner in which fine solids that may be removed by a processing step are handled in the operations. It can also be a function of a number of other external factors, including stormwater 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 solids may 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. Many of the manufacturing plants 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. Also, treatment systems that include polishing ponds or lagoons may exhibit this characteristic due to algae growth. However, in plastics and synthetic materials wastewaters, formation of biological solids within the treatment plant may cause this solids increase due to the low strength nature of the influent wastewater.

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 disposition of the wastewater stream (i.e., indirect discharge to a POTW or direct discharge) to maintain favorable conditions for biological treatment system organisms, as well as receiving streams.

COD is a measure of oxidizable material in a wastewater as determined by subjecting the waste to a powerful chemical oxidizing agent (such as dichromate) under standardized conditions. 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 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 plant's wastewater. It is often established by plant 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 compounds not necessarily measured by either BOD or COD tests. TOC can also be related to 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.

Tables V-20 through V-27 provide a statistical analysis of raw wastewater BOD_5, COD, TOC, and TSS by subcategory and disposal method. For multi-subcategory plants, the plants' pollutant values have been production-weighted for calculation of mean values and selection of median values. The following equation illustrates the method for calculating the production-weighted mean concentrations:

Subcategory:

$$\text{Production-weighted Mean} = \frac{P_1C_1 + P_2C_2 + P_3C_3 + \ldots . + P_iC_i}{P_1 + P_2 + P_3 + \ldots . + P_i}$$

Where:

P_1 = Decimal subcategory proportion of total plant production for plant #1 (Range 0 to 1.0)

C_1 = Pollutant concentration for plant #1.

TABLE V-20

SUMMARY STATISTICS OF RAW WASTEWATER BOD CONCENTRATIONS

BY SUBCATEGORY GROUP AND DISPOSAL METHOD

------------------------------ PRODUCER=PRIMARY ------------------------------

DISPOSAL METHOD	SUBCATEGORY	# OF PLANTS	# OF PLANTS (PRODUCTION WEIGHTED)	PRODUCTION WEIGHTED MEAN	PRODUCTION WEIGHTED MEDIAN	PRODUCTION WEIGHTED STD. DEV.
ALL PLANTS	THERMOPLASTICS	108	65.7538	1328.886	351.000	4634.526
	THERMOSETS	44	15.6468	1856.433	572.000	4824.965
	RAYON	4	2.1871	169.756	175.000	11.139
	FIBERS	20	13.1475	921.281	986.000	663.397
	COMMODITY ORGANICS	51	29.9702	1724.727	679.000	2284.493
	BULK ORGANICS	95	34.9281	1465.540	705.000	2120.879
	SPECIALTY ORGANICS	104	60.3664	1320.423	715.000	1819.967
DIR/IND	THERMOPLASTICS	1	1.0000	469.000	469.000	.
	THERMOSETS	1	0.0337	577.000	577.000	.
	BULK ORGANICS	1	0.2863	577.000	577.000	.
	SPECIALTY ORGANICS	2	1.6800	245.745	20.500	429.352
DIRECT	THERMOPLASTICS	62	37.1289	725.190	386.000	830.834
	THERMOSETS	16	4.0231	1569.784	668.000	2119.824
	RAYON	4	2.1871	169.756	175.000	11.139
	FIBERS	18	11.1475	904.556	706.200	724.331
	COMMODITY ORGANICS	38	21.6020	1504.018	694.000	2009.651
	BULK ORGANICS	53	16.8416	1199.871	668.000	1399.325
	SPECIALTY ORGANICS	46	18.0697	1347.053	718.000	2038.317
INDIRECT	THERMOPLASTICS	43	27.4570	2182.704	198.000	7093.989
	THERMOSETS	26	10.7119	2092.435	453.800	5779.452
	FIBERS	2	2.0000	1014.500	1014.500	40.305
	COMMODITY ORGANICS	12	7.5305	2518.558	679.000	3042.237
	BULK ORGANICS	40	17.7067	1738.854	705.000	2665.783
	SPECIALTY ORGANICS	55	40.5939	1353.627	715.000	1766.617
ZERO	THERMOPLASTICS	2	0.1680	323.534	340.000	.
	THERMOSETS	1	0.8781	340.000	340.000	.
	COMMODITY ORGANICS	1	0.8377	280.000	280.000	.
	BULK ORGANICS	1	0.0935	280.000	280.000	.
	SPECIALTY ORGANICS	1	0.0228	280.000	280.000	.

TABLE V-21
SUMMARY STATISTICS OF RAW WASTEWATER BOD CONCENTRATIONS
BY SUBCATEGORY GROUP AND DISPOSAL METHOD

-- PRODUCER=SECONDARY --

DISPOSAL METHOD	SUBCATEGORY	# OF PLANTS	# OF PLANTS (PRODUCTION WEIGHTED)	PRODUCTION WEIGHTED MEAN	PRODUCTION WEIGHTED MEDIAN	PRODUCTION WEIGHTED STD. DEV.
ALL PLANTS	THERMOPLASTICS	30	17.4317	673.612	117.800	1698.067
	THERMOSETS	24	16.6878	796.882	304.000	1459.787
	ORGANICS	62	55.8805	920.621	96.900	2228.595
DIR/IND	THERMOPLASTICS	2	1.0567	42.073	9.230	595.622
	ORGANICS	1	0.9433	621.500	621.500	.
DIRECT	THERMOPLASTICS	9	5.6808	66.951	54.500	73.167
	THERMOSETS	3	2.0319	39.624	24.000	22.498
	ORGANICS	23	21.2874	58.193	41.000	75.010
INDIRECT	THERMOPLASTICS	17	9.1103	1194.172	361.000	2276.641
	THERMOSETS	21	14.6559	901.867	360.000	1533.251
	ORGANICS	37	33.2337	1492.966	451.000	2758.663
ZERO	THERMOPLASTICS	1	0.5839	7.000	7.000	.
	ORGANICS	1	0.4161	7.000	7.000	.
UNKNOWN	THERMOPLASTICS	1	1.0000	434.000	434.000	.

TABLE V-22

SUMMARY STATISTICS OF RAW WASTEWATER COD CONCENTRATIONS

BY SUBCATEGORY GROUP AND DISPOSAL METHOD

--- PRODUCER=PRIMARY ---

DISPOSAL METHOD	SUBCATEGORY	# OF PLANTS	# OF PLANTS (PRODUCTION WEIGHTED)	PRODUCTION WEIGHTED MEAN	PRODUCTION WEIGHTED MEDIAN	PRODUCTION WEIGHTED STD. DEV.
ALL PLANTS	THERMOPLASTICS	95	53.6896	3035.613	1395.000	5851.739
	THERMOSETS	49	20.3799	7497.533	2709.000	10315.211
	RAYON	4	2.1871	503.405	500.000	83.729
	FIBERS	17	11.5417	1657.671	1501.000	1668.644
	COMMODITY ORGANICS	62	33.9393	3457.453	1645.000	5075.267
	BULK ORGANICS	79	27.2478	4811.004	2066.000	8651.988
	SPECIALTY ORGANICS	93	46.0146	3362.890	1772.500	5231.467
DIR/IND	THERMOPLASTICS	2	1.0293	944.575	850.000	3269.370
	THERMOSETS	1	0.0337	6912.000	6912.000	.
	BULK ORGANICS	2	1.2533	4794.021	4167.000	2563.254
	SPECIALTY ORGANICS	2	0.6836	6897.501	6912.000	.
DIRECT	THERMOPLASTICS	56	32.0356	2429.787	1425.000	4783.865
	THERMOSETS	18	6.6961	9414.566	4094.000	11736.815
	RAYON	4	2.1871	503.405	500.000	83.729
	FIBERS	15	9.5417	1632.135	1217.000	1847.690
	COMMODITY ORGANICS	43	24.1352	2600.765	1645.000	2737.533
	BULK ORGANICS	48	13.7100	3291.938	3092.000	3011.197
	SPECIALTY ORGANICS	41	15.6944	2354.756	1756.000	2418.299
INDIRECT	THERMOPLASTICS	35	20.4567	3927.833	1226.800	7041.918
	THERMOSETS	29	12.7719	4870.899	2394.000	7574.041
	FIBERS	2	2.0000	1779.500	1779.500	393.858
	COMMODITY ORGANICS	18	8.9665	6030.363	2709.000	8614.405
	BULK ORGANICS	28	12.1911	6553.362	1435.000	12603.269
	SPECIALTY ORGANICS	49	29.6138	3817.702	1772.500	6242.976
ZERO	THERMOPLASTICS	2	0.1680	22733.387	31105.000	.
	THERMOSETS	1	0.8781	31105.000	31105.000	.
	COMMODITY ORGANICS	1	0.8377	600.000	600.000	.
	BULK ORGANICS	1	0.0935	600.000	600.000	.
	SPECIALTY ORGANICS	1	0.0228	600.000	600.000	.

TABLE V-23

SUMMARY STATISTICS OF RAW WASTEWATER COD CONCENTRATIONS

BY SUBCATEGORY GROUP AND DISPOSAL METHOD

PRODUCER=SECONDARY

DISPOSAL METHOD	SUBCATEGORY	# OF PLANTS	# OF PLANTS (PRODUCTION WEIGHTED)	PRODUCTION WEIGHTED MEAN	PRODUCTION WEIGHTED MEDIAN	PRODUCTION WEIGHTED STD. DEV.
ALL PLANTS	THERMOPLASTICS	24	11.1848	1825.124	800.000	2640.893
	THERMOSETS	19	14.2420	3282.064	1808.000	3996.106
	ORGANICS	49	45.5732	3126.985	636.700	6883.309
DIR/IND	THERMOPLASTICS	2	1.0567	795.978	41.000	13691.642
	ORGANICS	1	0.9433	14115.333	14115.333	.
DIRECT	THERMOPLASTICS	7	3.7185	272.776	141.000	219.334
	THERMOSETS	1	1.0000	274.500	274.500	.
	ORGANICS	19	18.2815	377.963	248.000	571.528
INDIRECT	THERMOPLASTICS	14	5.8257	3157.083	1995.000	2823.567
	THERMOSETS	18	13.2420	3509.187	2340.000	4059.385
	ORGANICS	28	25.9323	4710.872	1698.000	8463.117
ZERO	THERMOPLASTICS	1	0.5839	284.100	284.100	.
	ORGANICS	1	0.4161	284.100	284.100	.

TABLE V-24

SUMMARY STATISTICS OF RAW WASTEWATER TOC CONCENTRATIONS

BY SUBCATEGORY GROUP AND DISPOSAL METHOD

PRODUCER=PRIMARY

DISPOSAL METHOD	SUBCATEGORY	# OF PLANTS	# OF PLANTS (PRODUCTION WEIGHTED)	PRODUCTION WEIGHTED MEAN	PRODUCTION WEIGHTED MEDIAN	PRODUCTION WEIGHTED STD. DEV.
ALL PLANTS	THERMOPLASTICS	42	18.9470	992.384	486.000	1997.567
	THERMOSETS	16	4.8893	426.877	349.000	274.541
	FIBERS	7	3.8143	475.170	391.200	173.191
	COMMODITY ORGANICS	39	20.6337	1096.466	418.000	1385.640
	BULK ORGANICS	56	23.5709	989.221	484.000	1749.485
	SPECIALTY ORGANICS	55	22.1449	1247.866	575.000	2463.687
DIRECT	THERMOPLASTICS	31	14.5154	1132.305	522.000	2124.494
	THERMOSETS	7	1.2449	351.164	349.000	182.526
	FIBERS	7	3.8143	475.170	391.200	173.191
	COMMODITY ORGANICS	37	19.3261	970.419	418.000	1199.265
	BULK ORGANICS	45	17.6060	897.761	358.000	1557.493
	SPECIALTY ORGANICS	41	14.4933	1424.170	424.000	2965.838
INDIRECT	THERMOPLASTICS	11	4.4316	534.079	50.000	1654.798
	THERMOSETS	9	3.6444	452.741	654.000	322.723
	COMMODITY ORGANICS	2	1.3076	2959.352	4660.000	4594.570
	BULK ORGANICS	11	5.9648	1259.177	505.000	2384.023
	SPECIALTY ORGANICS	14	7.6516	913.918	604.000	1120.472

TABLE V-25
SUMMARY STATISTICS OF RAW WASTEWATER TOC CONCENTRATIONS
BY SUBCATEGORY GROUP AND DISPOSAL METHOD

-- PRODUCER=SECONDARY --

DISPOSAL METHOD	SUBCATEGORY	# OF PLANTS	# OF PLANTS (PRODUCTION WEIGHTED)	PRODUCTION WEIGHTED MEAN	PRODUCTION WEIGHTED MEDIAN	PRODUCTION WEIGHTED STD. DEV.
ALL PLANTS	THERMOPLASTICS	9	5.4525	349.877	215.000	698.064
	THERMOSETS	7	4.7260	278.596	78.000	365.633
	ORGANICS	27	24.8216	1478.439	249.000	3094.234
DIR/IND	THERMOPLASTICS	2	1.0567	316.970	15.000	5476.268
	ORGANICS	1	0.9433	5644.333	5644.333	
DIRECT	THERMOPLASTICS	5	2.6737	131.137	118.000	87.972
	THERMOSETS	2	1.0319	68.104	68.000	3.298
	ORGANICS	13	11.2945	174.445	23.800	414.016
INDIRECT	THERMOPLASTICS	2	1.7221	709.665	500.000	381.009
	THERMOSETS	5	3.6941	337.393	145.500	403.957
	ORGANICS	13	12.5838	2336.539	445.000	3957.989

TABLE V-26
SUMMARY STATISTICS OF RAW WASTEWATER TSS CONCENTRATIONS
BY SUBCATEGORY GROUP AND DISPOSAL METHOD

PRODUCER=PRIMARY

DISPOSAL METHOD	SUBCATEGORY	# OF PLANTS	# OF PLANTS (PRODUCTION WEIGHTED)	PRODUCTION WEIGHTED MEAN	PRODUCTION WEIGHTED MEDIAN	PRODUCTION WEIGHTED STD. DEV.
ALL PLANTS	THERMOPLASTICS	113	69.2105	639.742	263.000	971.596
	THERMOSETS	54	21.9417	822.065	212.000	1203.909
	RAYON	3	1.9756	399.500	635.000	339.319
	FIBERS	15	9.8263	135.510	72.000	126.695
	COMMODITY ORGANICS	56	29.1388	378.424	157.000	678.674
	BULK ORGANICS	92	37.3944	1026.209	174.000	2990.516
	SPECIALTY ORGANICS	109	60.5127	526.438	154.000	1236.554
DIR/IND	THERMOPLASTICS	2	1.0293	66.792	63.000	131.090
	THERMOSETS	1	0.0337	6103.000	6103.000	
	BULK ORGANICS	2	1.2533	1545.294	196.000	5515.897
	SPECIALTY ORGANICS	3	1.6836	2485.942	34.700	4672.420
DIRECT	THERMOPLASTICS	55	32.7511	729.522	302.000	1115.037
	THERMOSETS	15	5.4898	1756.192	1598.000	1358.482
	RAYON	3	1.9756	399.500	635.000	339.319
	FIBERS	13	7.8263	158.895	156.000	132.934
	COMMODITY ORGANICS	36	19.4999	302.818	157.000	433.753
	BULK ORGANICS	44	14.5703	603.532	234.000	913.698
	SPECIALTY ORGANICS	37	13.8871	381.469	194.000	473.399
INDIRECT	THERMOPLASTICS	55	35.3082	564.396	202.000	824.529
	THERMOSETS	37	15.5401	347.309	129.400	739.290
	FIBERS	2	2.0000	44.000	44.000	4.243
	COMMODITY ORGANICS	20	9.6390	531.376	186.000	1028.767
	BULK ORGANICS	46	21.5708	1281.553	129.400	3832.206
	SPECIALTY ORGANICS	69	44.9420	497.827	151.800	1229.205
ZERO	THERMOPLASTICS	1	0.1219	3181.000	3181.000	.
	THERMOSETS	1	0.8781	3181.000	3181.000	.

TABLE V-27
SUMMARY STATISTICS OF RAW WASTEWATER TSS CONCENTRATIONS
BY SUBCATEGORY GROUP AND DISPOSAL METHOD

PRODUCER=SECONDARY

DISPOSAL METHOD	SUBCATEGORY	# OF PLANTS	# OF PLANTS (PRODUCTION WEIGHTED)	PRODUCTION WEIGHTED MEAN	PRODUCTION WEIGHTED MEDIAN	PRODUCTION WEIGHTED STD. DEV.
ALL PLANTS	THERMOPLASTICS	31	18.2239	121.241	64.000	122.123
	THERMOSETS	25	17.7299	255.721	168.000	262.125
	ORGANICS	64	58.0462	800.089	76.700	4456.709
DIR/IND	THERMOPLASTICS	2	1.0567	25.286	6.880	333.790
	ORGANICS	1	0.9433	350.000	350.000	.
DIRECT	THERMOPLASTICS	9	5.6808	32.303	29.000	20.124
	THERMOSETS	3	2.0319	38.924	26.000	19.618
	ORGANICS	26	24.2874	76.918	38.900	107.027
INDIRECT	THERMOPLASTICS	18	9.9025	164.678	130.000	112.000
	THERMOSETS	22	15.6980	283.782	168.000	266.163
	ORGANICS	36	32.3995	1365.387	173.000	5943.781
ZERO	THERMOPLASTICS	1	0.5839	14.600	14.600	.
	ORGANICS	1	0.4161	14.600	14.600	.
UNKNOWN	THERMOPLASTICS	1	1.0000	360.000	360.000	.

In determining the median, the actual pollutant concentrations of each plant that has at least one product within a subcategory are ranked from lowest to highest. The subcategory decimal production proportions are summed starting from the lowest concentration plant until the sum equals or exceeds 50 percent of the total of all the decimal production proportions. The pollutant concentration of the plant whose proportions when added to the proportion sum causes the total to exceed 50 percent is then chosen as the median. If, however, the sum equals 50 percent exactly, then the median is the average of the pollutant concentrations of that plant and the next plant in the sequence.

Tables V-28 through V-35 also provide raw wastewater statistics for BOD_5, COD, TOC, and TSS by subcategory and discharge technique, but use the 95/70 methodology discussed earlier in this section to aggregate plants by subcategory. As in previous tables concerning wastewater volumes, these tables are separated into primary producers and a few zero/alternate dischargers versus secondary producers and most zero dischargers. For some indirect and zero dischargers who pretreat their wastewater, the data used are typically from the effluent of their pretreatment system rather than strictly raw wastewater. Most indirect dischargers only sample their wastewater at the point where it enters the POTW collection system. It should also be noted that, as described in Section VII, the concentrations of pollutants for raw wastewater of the primary producers that are direct dischargers have been corrected for dilution by uncontaminated nonprocess wastewater. This correction was not performed on secondary producers, nor on indirect and zero dischargers.

As with the summary statistics for wastewater flow by subcategory, the summary statistics for raw wastewater BOD_5, COD, TOC, and TSS concentrations by subcategory that were generated by the two methodologies compare favorably; most of the differences between subcategory medians calculated by the two methodologies fell within the standard deviations calculated by either methodology. For the reasons stated earlier in this section when discussing the summary statistics for wastewater flow by subcategory, the Agency has much more confidence in the accuracy of the summary statistics calculated by the regression methodology, but has included the summary statistics calculated by the 95/70 methodology for comparison purposes.

TABLE V-28
SUMMARY STATISTICS OF RAW WASTEWATER BOD CONCENTRATIONS
BY SUBCATEGORY GROUP AND DISPOSAL METHOD
(WITH 95% & 70% RULE)

PRODUCER=PRIMARY

DISPOSAL METHOD	SUBCATEGORY	# OF PLANTS	MEAN	MEDIAN	STD. DEV.
ALL PLANTS	THERMOPLASTICS	48	1088.883	266.500	4312.183
	THERMOSETS	5	1191.200	250.000	1991.833
	RAYON	2	169.000	169.000	8.485
	FIBERS	9	739.244	706.200	531.238
	COMMODITY ORGANICS	14	2099.000	629.500	2887.453
	BULK ORGANICS	18	940.156	393.500	1074.395
	SPECIALTY ORGANICS	52	1263.161	704.500	1623.229
	MIXED	74	1814.754	737.000	3811.602
DIR/IND	THERMOPLASTICS	1	469.000	469.000	.
	BULK ORGANICS	0	.	.	.
	SPECIALTY ORGANICS	1	20.500	20.500	.
	MIXED	1	577.000	577.000	.
DIRECT	THERMOPLASTICS	26	647.205	380.500	810.973
	THERMOSETS	2	2415.500	2415.500	3239.256
	RAYON	2	169.000	169.000	8.485
	FIBERS	7	660.600	444.000	586.126
	COMMODITY ORGANICS	9	2209.944	694.000	2959.328
	BULK ORGANICS	8	901.625	264.000	1051.801
	SPECIALTY ORGANICS	12	1534.810	773.500	2567.712
	MIXED	45	1079.856	785.000	920.978
INDIRECT	THERMOPLASTICS	21	1665.240	138.000	6500.336
	THERMOSETS	3	375.000	250.000	436.148
	FIBERS	2	1014.500	1014.500	40.305
	COMMODITY ORGANICS	4	2304.125	766.500	3402.801
	BULK ORGANICS	10	970.980	430.000	1147.855
	SPECIALTY ORGANICS	39	1211.440	694.000	1249.419
	MIXED	27	3140.048	757.000	6037.743
ZERO	THERMOPLASTICS	0	.	.	.
	COMMODITY ORGANICS	1	280.000	280.000	.
	BULK ORGANICS	0	.	.	.
	SPECIALTY ORGANICS	0	.	.	.
	MIXED	1	340.000	340.000	.

TABLE V-29
SUMMARY STATISTICS OF RAW WASTEWATER BOD CONCENTRATIONS
BY SUBCATEGORY GROUP AND DISPOSAL METHOD
(WITH 95% & 70% RULE)

------------------------------ PRODUCER=SECONDARY ------------------------------

DISPOSAL METHOD	SUBCATEGORY	# OF PLANTS	MEAN	MEDIAN	STD. DEV.
ALL PLANTS.	THERMOPLASTICS	12	441.894	161.900	705.702
	THERMOSETS	13	623.608	277.000	871.510
	ORGANICS	51	972.029	82.000	2327.405
	FIBERS	0	.	.	.
	MIXED	14	964.434	302.000	2239.655
DIR/IND	THERMOPLASTICS	1	9.230	9.230	.
	ORGANICS	0	.	.	.
	MIXED	1	621.500	621.500	.
DIRECT	THERMOPLASTICS	5	70.940	54.500	77.758
	THERMOSETS	2	39.950	39.950	22.557
	ORGANICS	20	60.801	43.000	76.557
	MIXED	2	24.500	24.500	30.406
INDIRECT	THERMOPLASTICS	5	900.960	651.000	938.746
	THERMOSETS	11	729.727	360.000	911.519
	ORGANICS	31	1559.918	451.000	2848.442
	MIXED	10	1282.458	402.000	2611.835
ZERO	THERMOPLASTICS	0	.	.	.
	THERMOSETS	0	.	.	.
	ORGANICS	0	.	.	.
	FIBERS	0	.	.	.
	MIXED	1	7.000	7.000	.
UNKNOWN	THERMOPLASTICS	1	434.000	434.000	.
	THERMOSETS	0	.	.	.
	ORGANICS	0	.	.	.

TABLE V-30
SUMMARY STATISTICS OF RAW WASTEWATER COD CONCENTRATIONS
BY SUBCATEGORY GROUP AND DISPOSAL METHOD
(WITH 95% & 70% RULE)

-- PRODUCER=PRIMARY --

DISPOSAL METHOD	SUBCATEGORY	# OF PLANTS	MEAN	MEDIAN	STD. DEV.
ALL PLANTS	THERMOPLASTICS	34	2172.459	1158.000	3478.292
	THERMOSETS	7	5773.143	1700.000	7882.793
	RAYON	2	522.500	522.500	31.820
	FIBERS	8	1132.000	1000.000	875.063
	COMMODITY ORGANICS	15	2914.633	1943.000	3401.295
	BULK ORGANICS	11	2839.545	598.000	3411.839
	SPECIALTY ORGANICS	37	2658.803	1692.000	2746.715
	MIXED	81	5450.385	2066.000	9051.549
DIR/IND	THERMOPLASTICS	1	850.000	850.000	.
	BULK ORGANICS	1	4167.000	4167.000	.
	SPECIALTY ORGANICS	0	.	.	.
	MIXED	1	6912.000	6912.000	.
DIRECT	THERMOPLASTICS	19	1774.974	1286.000	1734.512
	THERMOSETS	4	8865.250	6815.500	9586.722
	RAYON	2	522.500	522.500	31.820
	FIBERS	6	916.167	710.000	904.102
	COMMODITY ORGANICS	10	2579.200	1971.500	2590.289
	BULK ORGANICS	5	5020.200	3796.000	3896.203
	SPECIALTY ORGANICS	12	2173.000	1544.500	2220.908
	MIXED	46	3254.714	1689.500	5735.796
INDIRECT	THERMOPLASTICS	14	2806.365	455.500	5074.226
	THERMOSETS	3	1650.333	509.000	1984.647
	FIBERS	2	1779.500	1779.500	393.858
	COMMODITY ORGANICS	4	4331.875	2229.250	5387.018
	BULK ORGANICS	5	393.400	500.000	238.931
	SPECIALTY ORGANICS	25	2891.989	1692.000	2980.155
	MIXED	33	7689.313	2709.000	11217.300
ZERO	THERMOPLASTICS	0	.	.	.
	COMMODITY ORGANICS	1	600.000	600.000	.
	BULK ORGANICS	0	.	.	.
	SPECIALTY ORGANICS	0	.	.	.
	MIXED	1	31105.000	31105.000	.

TABLE V-31
SUMMARY STATISTICS OF RAW WASTEWATER COD CONCENTRATIONS
BY SUBCATEGORY GROUP AND DISPOSAL METHOD
(WITH 95% & 70% RULE)

PRODUCER=SECONDARY

DISPOSAL METHOD	SUBCATEGORY	# OF PLANTS	MEAN	MEDIAN	STD. DEV.
ALL PLANTS	THERMOPLASTICS	8	1509.000	646.000	2032.859
	THERMOSETS	12	3219.000	1753.500	4181.376
	ORGANICS	40	3007.794	582.500	7111.048
	FIBERS	0	.	.	.
	MIXED	11	3513.803	1364.000	4438.984
DIR/IND	THERMOPLASTICS	1	41.000	41.000	.
	ORGANICS	0	.	.	.
	MIXED	1	14115.333	14115.332	.
DIRECT	THERMOPLASTICS	3	245.333	141.000	214.463
	THERMOSETS	1	274.500	274.500	.
	ORGANICS	17	393.626	248.000	587.223
	MIXED	2	248.200	248.200	341.957
INDIRECT	THERMOPLASTICS	4	2823.750	2247.500	2234.261
	THERMOSETS	11	3486.682	2340.000	4276.269
	ORGANICS	23	4940.004	1698.000	8955.829
	MIXED	7	3393.714	1808.000	2962.999
ZERO	THERMOPLASTICS	0	.	.	.
	THERMOSETS	0	.	.	.
	ORGANICS	0	.	.	.
	FIBERS	0	.	.	.
	MIXED	1	284.100	284.100	.
UNKNOWN	THERMOPLASTICS	0	.	.	.
	THERMOSETS	0	.	.	.
	ORGANICS	0	.	.	.

TABLE V-32

SUMMARY STATISTICS OF RAW WASTEWATER TOC CONCENTRATIONS

BY SUBCATEGORY GROUP AND DISPOSAL METHOD

(WITH 95% & 70% RULE)

PRODUCER=PRIMARY

DISPOSAL METHOD	SUBCATEGORY	# OF PLANTS	MEAN	MEDIAN	STD. DEV.
ALL PLANTS	THERMOPLASTICS	11	470.470	166.000	770.042
	THERMOSETS	0	.	.	.
	RAYON	0	.	.	.
	FIBERS	3	472.733	391.200	160.829
	COMMODITY ORGANICS	10	1811.067	1088.000	1860.990
	BULK ORGANICS	9	637.000	308.000	1013.431
	SPECIALTY ORGANICS	16	1252.500	516.500	2764.300
	MIXED	45	1017.778	505.000	1774.971
DIR/IND	THERMOPLASTICS	0	.	.	.
	BULK ORGANICS	0	.	.	.
	SPECIALTY ORGANICS	0	.	.	.
	MIXED	0	.	.	.
DIRECT	THERMOPLASTICS	8	618.396	418.000	868.222
	THERMOSETS	0	.	.	.
	RAYON	0	.	.	.
	FIBERS	3	472.733	391.200	160.829
	COMMODITY ORGANICS	9	1494.519	389.000	1664.006
	BULK ORGANICS	6	758.667	238.500	1254.864
	SPECIALTY ORGANICS	10	1472.000	408.000	3514.778
	MIXED	35	994.250	486.000	1695.554
INDIRECT	THERMOPLASTICS	3	76.000	35.000	74.505
	THERMOSETS	0	.	.	.
	FIBERS	0	.	.	.
	COMMODITY ORGANICS	1	4660.000	4660.000	.
	BULK ORGANICS	3	393.667	500.000	195.541
	SPECIALTY ORGANICS	6	886.667	777.000	656.135
	MIXED	10	1100.126	579.500	2128.878
ZERO	THERMOPLASTICS	0	.	.	.
	COMMODITY ORGANICS	0	.	.	.
	BULK ORGANICS	0	.	.	.
	SPECIALTY ORGANICS	0	.	.	.
	MIXED	0	.	.	.

TABLE V-33
SUMMARY STATISTICS OF RAW WASTEWATER TOC CONCENTRATIONS
BY SUBCATEGORY GROUP AND DISPOSAL METHOD
(WITH 95% & 70% RULE)

PRODUCER=SECONDARY

DISPOSAL METHOD	SUBCATEGORY	# OF PLANTS	MEAN	MEDIAN	STD. DEV.
ALL PLANTS	THERMOPLASTICS	4	200.337	143.175	216.795
	THERMOSETS	4	259.125	111.750	325.740
	ORGANICS	22	1423.514	259.750	3144.832
	FIBERS	0	.	.	.
	MIXED	5	1353.267	118.000	2434.943
DIR/IND	THERMOPLASTICS	1	15.000	15.000	.
	ORGANICS	0	.	.	.
	MIXED	1	5644.333	5644.332	.
DIRECT	THERMOPLASTICS	2	143.175	143.175	101.576
	THERMOSETS	1	68.000	68.000	.
	ORGANICS	10	191.480	30.400	439.123
	MIXED	2	61.000	61.000	80.610
INDIRECT	THERMOPLASTICS	1	500.000	500.000	.
	THERMOSETS	3	322.833	145.500	367.162
	ORGANICS	12	2450.208	612.500	4024.083
	MIXED	2	500.000	500.000	707.107
ZERO	THERMOPLASTICS	0	.	.	.
	THERMOSETS	0	.	.	.
	ORGANICS	0	.	.	.
	FIBERS	0	.	.	.
	MIXED	0	.	.	.
UNKNOWN	THERMOPLASTICS	0	.	.	.
	THERMOSETS	0	.	.	.
	ORGANICS	0	.	.	.

TABLE V-34
SUMMARY STATISTICS OF RAW WASTEWATER TSS CONCENTRATIONS
BY SUBCATEGORY GROUP AND DISPOSAL METHOD
(WITH 95% & 70% RULE)

PRODUCER=PRIMARY

DISPOSAL METHOD	SUBCATEGORY	# OF PLANTS	MEAN	MEDIAN	STD. DEV.
ALL PLANTS	THERMOPLASTICS	49	640.032	182.000	1066.040
	THERMOSETS	7	1212.000	362.000	1425.356
	RAYON	2	396.500	396.500	337.290
	FIBERS	7	117.286	50.000	126.805
	COMMODITY ORGANICS	10	247.658	140.000	251.969
	BULK ORGANICS	20	1358.959	124.500	3979.027
	SPECIALTY ORGANICS	51	445.072	151.800	1124.192
	MIXED	84	617.603	232.000	1020.412
DIR/IND	THERMOPLASTICS	1	63.000	63.000	.
	BULK ORGANICS	1	196.000	196.000	.
	SPECIALTY ORGANICS	1	34.700	34.700	.
	MIXED	1	6103.000	6103.000	.
DIRECT	THERMOPLASTICS	21	749.452	237.000	1275.399
	THERMOSETS	3	2590.333	2509.000	1035.399
	RAYON	2	396.500	396.500	337.290
	FIBERS	5	146.600	72.000	142.672
	COMMODITY ORGANICS	6	194.222	139.000	143.518
	BULK ORGANICS	6	977.333	180.500	1348.864
	SPECIALTY ORGANICS	10	404.466	193.500	528.479
	MIXED	43	452.398	235.000	584.672
INDIRECT	THERMOPLASTICS	27	576.299	154.000	905.587
	THERMOSETS	4	178.250	155.500	154.675
	FIBERS	2	44.000	44.000	4.243
	COMMODITY ORGANICS	4	327.813	186.500	376.642
	BULK ORGANICS	13	1624.552	83.000	4903.910
	SPECIALTY ORGANICS	40	465.482	151.400	1245.249
	MIXED	39	593.374	187.000	948.802
ZERO	THERMOPLASTICS	0	.	.	.
	COMMODITY ORGANICS	0	.	.	.
	BULK ORGANICS	0	.	.	.
	SPECIALTY ORGANICS	0	.	.	.
	MIXED	1	3181.000	3181.000	.

TABLE V-35

SUMMARY STATISTICS OF RAW WASTEWATER TSS CONCENTRATIONS

BY SUBCATEGORY GROUP AND DISPOSAL METHOD

(WITH 95% & 70% RULE)

-- PRODUCER=SECONDARY --

DISPOSAL METHOD	SUBCATEGORY	# OF PLANTS	MEAN	MEDIAN	STD. DEV.
ALL PLANTS	THERMOPLASTICS	12	98.348	49.200	112.008
	THERMOSETS	14	284.270	168.000	281.031
	ORGANICS	53	861.552	76.700	4663.029
	FIBERS	0	.	.	.
	MIXED	15	157.557	130.000	134.590
DIR/IND	THERMOPLASTICS	1	6.880	6.880	.
	ORGANICS	0	.	.	.
	MIXED	1	350.000	350.000	.
DIRECT	THERMOPLASTICS	5	29.860	29.000	19.646
	THERMOSETS	2	39.450	39.450	19.021
	ORGANICS	23	79.553	38.900	109.397
	MIXED	2	36.400	36.400	27.719
INDIRECT	THERMOPLASTICS	5	132.800	122.000	86.955
	THERMOSETS	12	325.073	189.500	283.886
	ORGANICS	30	1461.083	165.500	6174.386
	MIXED	11	175.087	163.000	127.525
ZERO	THERMOPLASTICS	0	.	.	.
	THERMOSETS	0	.	.	.
	ORGANICS	0	.	.	.
	FIBERS	0	.	.	.
	MIXED	1	14.600	14.600	.
UNKNOWN	THERMOPLASTICS	1	360.000	360.000	.
	THERMOSETS	0	.	.	.
	ORGANICS	0	.	.	.

2. Occurrence and Prediction of Priority Pollutants

The Clean Water Act required the Agency to develop data characterizing the presence (or absence) of 129 priority pollutants in raw and treated wastewaters of the OCPSF industry. These data have been gathered by EPA from industry sources and extensive sampling and analysis of individual OCPSF process wastewaters. An adjunct to these data-collection efforts was the correlation of priority pollutant occurrence with product/process sources by a consideration of the reactants and process chemistry. This approach offers the advantage of qualitative prediction of organic priority pollutants likely to be present in plant wastewaters. A systematic means of anticipating the occurrence of priority pollutants is beneficial to both the development and implementation of regulatory guidelines:

- Industry-wide qualitative product/process coverage becomes feasible without the necessity of sampling and analyzing hundreds of effluents beyond major product/processes.
- Guidance is provided for discharge permit writers, permit applicants, or anyone trying to anticipate priority pollutants that are likely to be found in the combined wastewaters of a chemical plant when the product/processes operating at the facility are known.

Qualitative prediction of priority pollutants for these industries is possible because, claims of uniqueness notwithstanding, all plants within the OCPSF industry are alike in one important sense--all transform feedstocks to products by chemical reactions and physical processes in a stepwise fashion. Although each transformation represents at least one chemical reaction, virtually all can be classified by one or more generalized chemical reactions/ processes. Imposition of these processes upon the eight basic feedstocks lead to commercially produced organic chemicals and plastics. It is the permutation of the feedstock/process combinations that permit the industries to produce such a wide variety of products.

Chemical manufacturing plants share a second important similarity; chemical processes almost never convert 100 percent of the feedstocks to the desired products; that is, the chemical reactions/processes never proceed to total completion. Moreover, because there are generally a variety of reaction pathways available to reactants, undesirable by-products are often unavoidably generated. This results in a mixture of unreacted raw materials and products that must be separated and recovered by unit operations that often generate residues with little or no commercial value. These yield losses appear in process contact wastewater, in air emissions, or directly as chemical wastes. The specific chemicals that appear as yield losses are determined by the feedstock and the process chemistry imposed upon it, i.e., the feedstock/generic process combination.

a. General

Potentially, an extremely wide variety of compounds could form within a given process. The formation of products from reactants depends upon the relationship of the free enthalpies of products and reactants; more important, however, is the existence of suitable reaction pathways. The rate at which such transformations occur cannot (in general) be calculated from first principles and must be empirically derived. Detailed thermodynamic calculations, therefore, are of limited value in predicting the entire spectrum of products produced in a process, since both the identity of true reacting species and the assumption of equilibrium between reacting species are often speculative. Although kinetic models can in principle predict the entire spectrum of products formed in a process, kinetic data concerning minor side reactions are generally unavailable. Thus, neither thermodynamic nor kinetic analyses alone can be used for prediction of species formation.[1] What these analyses do provide, however, is a framework within which pollutant formation may be considered and generalized.

[1]Prediction of pollutant formation is necessarily of a qualitative rather than quantitative nature; although reactive intermediates may be identified without extensive kinetic measurements, their rate of formation (and thus quantities produced) are difficult to predict without kinetic measurements. Other quantitative approaches, for example, detailed calculation of an equilibrium composition by minimization of the free energy of a system, require complete specification of all species to be considered. Because such methods necessarily assume equilibrium, the concentrations generated by such methods represent only trends or, perhaps at best, concentration ratios.

The reaction chemistry of a process sequence is controlled through careful adjustment and maintenance of conditions in the reaction vessel. The physical condition of species present (liquid, solid, or gaseous phase), condition of temperature and pressure, the presence of solvents and catalysts, and the configuration of process equipment are designed to favor a reaction pathway by which a particular product is produced. From this knowledge, it is possible to identify reactive intermediates and thus anticipate species (potential pollutants) formed.

Most chemical transformations performed by the OCPSF industry may be reduced to a small number of basic steps or unit processes. Each step or process represents a chemical modification of the starting matrials and is labeled a "generic process." For example, the generic process " nitration" may represent either the substitution or addition of an "-NO_2" functional group to an organic chemical. Generic processes may be quite complex involving a number of chemical bonds being broken and formed, with the overall transformation passing through a number of distinct (if transitory) intermediates. Simple stoichiometic equations, therefore, are inadequate descriptions of chemical reactions and only rarely account for observed by-products.

Table V-36 lists the major organic chemicals produced by the OCPSF industry (approximately 250) by process, and Table V-37 gives the same information for the plastics/synthetic fibers industry. Certain products shown in Table V-36 are not derived from primary feedstocks, but rather from secondary or higher order materials (e.g., aniline is produced by hydrogenation of nitrobenzene that is produced by nitration of benzene). For such multistep syntheses, generic processes appropriate to each step must be evaluated separately. For many commodity and bulk chemicals, it is sufficient to specify a feedstock and a single generic process, because they are generally manufactured by a one-step process. Nitration of benzene to produce nitrobenzene, for example, is a sufficient description to predict constituents of the process wastewater: benzene, nitrobenzene, phenol, and nitrophenols will be the principal process wastewater constituents. Similarly, oxidation of butane to produce acetic acid results in wastewater containing a wide variety of oxidized species, including formaldehyde, methanol, acetaldehyde, n-propanol, acetone, methyl ethyl ketone, etc.

Table V-36
Generic Processes Used to Manufacture Organic Chemical Products

ACIDS

GENERIC PROCESS	Acetic Acid	Acrylic Acid	Adipic Acid	Benzoic Acid	n-Butyric Acid	Chlorosulfonic Acid	Cyanoacetic Acid	Ethlenediaminotetraacetic Acid	2-Ethyl-Hexanoic Acid	Fumaric Acid	Glutamic Acid	Hydroxyacetic Acid (Glycolic)	Iminodiacetic Acid	Isobutyric Acid	Isophthalic Acid	Methacrylic Acid	N-Methyl Glycine	2-Methyl-5-Nitrobenzene	Sulfonic Acid	Neopentanoic Acid	Propionic Acid	Sulfanilic Acid	Terephthalic Acid	Trimethoxybenzoic Acid
ALKOXYLATION																								
CONDENSATION																								
HALOGENATION						○						○												
OXIDATION	●	●	●	●	○				○					○	○					●	●		●	○
POLYMERIZATION																								
HYDROLYSIS											○	○				●								
HYDROGENATION																								
ESTERIFICATION																								
PYROLYSIS																								
ALKYLATION																								
DEHYDROGENATION																								
AMINATION (AMMONOLYSIS)								○					○				○							
NITRATION																		●						
SULFONATION						○												○				○		
AMMOXIDATION																								
CARBONYLATION																				●				
HYDROHALOGENATION																								
DEHYDRATION																								
DEHYDROHALOGENATION																								
OXYHALOGENATION																								
CATALYTIC CRACKING																								
HYDRODEALKYLATION																								
PHOSGENATION																								
EXTRACTION																								
DISTILLATION																								
OTHER							○			●						●								
HYDRATION																								

ALCOHOLS

GENERIC PROCESS	Allyl Alcohol	1,3-Butanediol	1,4-Butanediol	1-Butanethiol	n-Butanol	Sec-Butanol	Tert-Butanol	Cyclohexanol	1-Decanethiol	Diacetone Alcohol	Dimethylaminoethanol	Dimethyl Benzyl Alcohol	Dipropylene Glycol	Dodecanethiol	Ethanethiol	Ethanol	Ethyl Orthoformate	Ethylene Glycol	2-Ethyl-Hexanol	Glycerine	2-Methyl-2,4-Petanediol	1,6-Hexanediol	Isobutanol	Isopropanol	Methanol	Methylisobutyl Carbinol	Methyl Orthoformate	1-Nonanethiol	1-Octanethiol	Pentaerythritol	1-Propanethiol	n-Propyl Alcohol	Tetraethylene Glycol	Triethylene Glycol	Trimethylolpropane	Tripropylene Glycol	Xylenol
ALKOXYLATION																																	●	●		●	
CONDENSATION		○								○									●		○					○				○					○		
HALOGENATION																																					
OXIDATION							○	●			●							●				○															
POLYMERIZATION																																					
HYDROLYSIS							○							○				●		●								○	○								
HYDROGENATION	●	○			●			●											●		○	○	●		●	○						●					
ESTERIFICATION																						○															
PYROLYSIS																																					
ALKYLATION																																					
DEHYDROGENATION																																					
AMINATION (AMMONOLYSIS)											●																										
NITRATION																																					
SULFONATION																																					
AMMOXIDATION																																					
CARBONYLATION					●																		●		●							●					
HYDROHALOGENATION																																					
DEHYDRATION																			●																		
DEHYDROHALOGENATION																																					
OXYHALOGENATION																																					
CATALYTIC CRACKING																																					
HYDRODEALKYLATION																																					
PHOSGENATION																																					
EXTRACTION																																					○
DISTILLATION																																					
OTHER	●	●	○	○					○			○	●	○	○		○										○	○	○	○	○						
HYDRATION						●										●				●				●													

ALDEHYDES

GENERIC PROCESS	Acetaldehyde	Acrolein	Benzaldehyde	n-Butyraldehyde	Formaldehyde	Glyoxal	Isobutyraldehyde	Propionaldehyde	1,2,3,6-Tetrahydrobenzaldehyde
ALKOXYLATION									
CONDENSATION									
HALOGENATION									
OXIDATION	●	●	●		●	○			○
POLYMERIZATION									
HYDROLYSIS									
HYDROGENATION									○
ESTERIFICATION									
PYROLYSIS									
ALKYLATION									
DEHYDROGENATION									
AMINATION (AMMONOLYSIS)									
NITRATION									
SULFONATION									
AMMOXIDATION									
CARBONYLATION				○			○	●	
HYDROHALOGENATION									
DEHYDRATION									
DEHYDROHALOGENATION									
OXYHALOGENATION									
CATALYTIC CRACKING									
HYDRODEALKYLATION									
PHOSGENATION									
EXTRACTION									
DISTILLATION									
OTHER									
HYDRATION									

AMINES

GENERIC PROCESS	Alkyl Amines	Aminoethylethanolamine	Aniline	Anisidine	1,3-Cyclohexane bis (methylamine)	Diaminodiphenylmethane	Diethylene Triamine	N,N-Dimethylaniline	N,N-Dimethylformamide	Diphenylamine	Ethylamine	Ethylenediamine	Hexamethyleneimine	Hexamethylenetetramine	Hexamethylene diamine	Hydroxylamine	1-Napthyl N-Methylcarbamate	N-Nitrosodiphenylamine	2-Pyrrolidone	p-Nitroaniline	Tetraethylenepentamine	Toluidine	Toluenediamine
ALKOXYLATION		○																					
CONDENSATION					○	●	○	○		○				○									
HALOGENATION																							
OXIDATION																		○					
POLYMERIZATION																							
HYDROLYSIS																○							
HYDROGENATION			●			●							●		●							○	●
ESTERIFICATION																	○						
PYROLYSIS																							
ALKYLATION																							
DEHYDROGENATION																							
AMINATION (AMMONOLYSIS)	○						○	○	○		○	●							○		○		
NITRATION			●																	○			●
SULFONATION																							
AMMOXIDATION																							
CARBONYLATION																							
HYDROHALOGENATION																							
DEHYDRATION																							
DEHYDROHALOGENATION																							
OXYHALOGENATION																							
CATALYTIC CRACKING																							
HYDRODEALKYLATION																							
PHOSGENATION																							
EXTRACTION																							
DISTILLATION																							
OTHER				○																			
HYDRATION																							

AMIDES / ANHYDRIDES

GENERIC PROCESS	AMIDES: Acrylamide	Caprolactam	4-Chloroacetanilide	Dimethylacetamide	Formamide	ANHYDRIDES: Acetic Anhydride	Maleic Anhydride	Phthalic Anhydride	Tetrachlorophthalic Anhydride	Trimellitic Anhydride	Ethylene Oxide	Propylene Oxide
ALKOXYLATION												
CONDENSATION												
HALOGENATION			○						●			
OXIDATION		●					●	●	●	○	●	
POLYMERIZATION												
HYDROLYSIS	○											
HYDROGENATION		●										
ESTERIFICATION												
PYROLYSIS												
ALKYLATION												
DEHYDROGENATION												
AMINATION (AMMONOLYSIS)		●			○							
NITRATION												
SULFONATION												
AMMOXIDATION												
CARBONYLATION												
HYDROHALOGENATION												
DEHYDRATION						●	●	●	●	○		
DEHYDROHALOGENATION												
OXYHALOGENATION												
CATALYTIC CRACKING												
HYDRODEALKYLATION												
PHOSGENATION												
EXTRACTION												
DISTILLATION												
OTHER				○								●
HYDRATION												

ESTERS

GENERIC PROCESS	Acrylic Acid Esters	Amyl Acetate	n-Butyl Acetate	Butyl Benzyl Phthalate	Butyrolactone	n-Butyl Lactate	Dibutyl Phthalate	Diethyl Phenyl Phosphate	Diethyl Phthalate	Dimethyl Malonate	Dimethyl Phthalate	Dimethyl Sulfate	Dimethyl Terephthalate	Dodecylguanidine Acetate	Ethyl Acetate	Ethylcyanoacetate	Ethyl Hexyl Phthalate	Isobutyl Acetate	Isopropyl Acetate	Methacrylic Esters	Methyl Cyanoacetate	Methyl Formate	Methyl Methacrylate	Methyl Salicylate	Nitrilotriacetate	Phenyl Glycine	n-Propyl Acetate	Vinyl Acetate
ALKOXYLATION																												
CONDENSATION																												
HALOGENATION																												
OXIDATION	●												●															
POLYMERIZATION																												
HYDROLYSIS																												
HYDROGENATION																												
ESTERIFICATION	●	●	○	●	○	○	●	○	●	○	●	○	●		○	○	●	○	○	●	○	○	●	●			●	●
PYROLYSIS																												
ALKYLATION																												
DEHYDROGENATION																												
AMINATION (AMMONOLYSIS)														○											○	○		
NITRATION																												
SULFONATION																												
AMMOXIDATION																												
CARBONYLATION																												
HYDROHALOGENATION																												
DEHYDRATION																												
DEHYDROHALOGENATION																												
OXYHALOGENATION																												
CATALYTIC CRACKING																												
HYDRODEALKYLATION																												
PHOSGENATION																												
EXTRACTION																												
DISTILLATION																												
OTHER																○				●			●					●
HYDRATION																												

● Product/Process Effluent Sampled by OCB
○ Product/Process Effluent Not Sampled

Table V-36 (Continued)
Generic Processes Used to Manufacture Organic Chemical Products

GENERIC PROCESS	ETHERS	HALOCARBONS	HYDROCARBONS	KETONES	NITRILES	NITROCARBONS	PHENOLS	SALTS	MISCELLANEOUS
ALKOXYLATION	○ Ethylene Glycol Monomethyl Ether								
CONDENSATION	○ Bis-(2-Chloroisopropyl) Ether			○ Anthraquinone; ○ Isophorone; ○ Mesityl Oxide; ○ Methylisobutyl Ketone			● Bisphenol A; ○ 2,2-Methylenebis(6-butyl-p-cresol); ○ 2,2-Methylenebis(6-butyl-4-ethylphenol)		○ Cyanuric Acid; ○ 2,2-Dithiobis (benzothiazole); ● Methylene Diphenyl Diisocyanate; ○ Tetrahydrothiophene
HALOGENATION	○ 4-Chlorophenyl Phenyl Ether	● Allyl Chloride; ● Benzyl Chloride; ● Carbon Tetrachloride; ● Chlorobenzene; ● m-Chloronitrobenzene; ○ Chlorobutadiene (Chloroprene); ● Chloroform; ○ 4-Chloronitrobenzene; ● Dichlorodifluoromethane; ○ 1,1-Dichloroethane; ● 1,2-Dichloroethane; ○ Dichloronitrobenzene; ○ 1,2-Dichloropropene; ● Dichloropropane; ● Epichlorohydrin; ○ Hexachlorobenzene; ○ Hexachloroethane; ● Methyl Chloride; ● Methylene Chloride; ● o,p-Dichlorobenzenes; ○ Pentachlorobenzene; ○ Phosgene; ● 1,2,3,4-Tetrachlorobenzene; ○ 1,1,2,2-Tetrachloroethane; ● Tetrachloroethene; ● Trichlorobenzene; ○ 1,1,1-Trichloroethane; ● Trichloroethene; ○ Trichloropropene; ○ Vinyl Chloride; ● Vinylidene Chloride			○ Adiponitrile				
OXIDATION				● Acetone; ○ Anthraquinone; ● Cyclohexanone	● Adiponitrile		● Hydroquinone; ● Phenol	● Sodium Benzoate	○ Benzoyl Peroxide; ○ 2,2-Dithiobis (benzothiazole); ○ Furazolidone
POLYMERIZATION									
HYDROLYSIS									
HYDROGENATION	○ Sulfolane		● Isobutene	○ Methylisobutyl Ketone			○ p-Aminophenol		○ Tetrahydrothiophene; ● Toluene-2,4-Diisocyanate
ESTERIFICATION									
PYROLYSIS			● Acetylene; ● Benzene; ● Ethene; ○ Isoamylene; ● Propene; ● Toluene; ● Xylenes						
ALKYLATION			● Cumene; ● Diisopropyl Benzene; ● Ethylbenzene; ● Methylstyrene; ● Styrene	● Acetone			● Alkyl Phenols; ● Phenol		○ Tetramethyl Lead
DEHYDROGENATION		○ Chlorobutadiene (Chloroprene)	○ Biphenyl; ○ Butadiene; ○ Butene; ● Methylstyrene; ● Styrene	● Cyclohexanone; ● Methyl Ethyl Ketone					○ Carbon Disulfide; ○ Thiophene
AMINATION (AMMONOLYSIS)					● Adiponitrile			○ Choline Chloride	○ 2-(Thiomorpholine)-Benzothiazole; ○ Toluene Sulfonamide
NITRATION		● m-Chloronitrobenzene; ○ 4-Chloronitrobenzene; ○ Dichloronitrobenzene				○ Dinitrobenzenes; ● Dinitrotoluenes; ● Nitrobenzene; ○ 4-Nitroethoxybenzene; ● Nitrotoluene	○ 2-Nitrophenol; ○ 4-Nitrophenol		○ Furazolidone; ● Toluene-2,4-Diisocyanate
SULFONATION									○ Dichlorodiphenyl Sulfone; ○ Toluene Sulfonamide; ○ Toluenesulfonyl Chloride; ○ Xylenesulfonic Acid
AMMOXIDATION					○ Acetonitrile; ● Acrylonitrile				
CARBONYLATION									
HYDROHALOGENATION		● Chlorodifluoromethane; ○ Chloroform; ○ Ethyl Chloride; ○ Methyl Bromide; ○ Methyl Chloride; ○ 1,1,1-Trichloroethane; ● Trichlorofluoromethane							
DEHYDRATION	○ Dimethyl Ether		● Isobutene	● Diketene; ○ Isophorone; ○ Mesityl Oxide; ○ Methylisobutyl Ketone	● Adiponitrile				
DEHYDROHALOGENATION		○ 1,2-Dichloropropene; ● Epichlorohydrin; ○ Vinyl Chloride; ● Vinylidene Chloride							
OXYHALOGENATION		● 1,2-Dichloroethane; ● Trichloroethene; ○ Vinyl Chloride							
CATALYTIC CRACKING			○ Isoamylene						
HYDRODEALKYLATION			● Benzene; ○ Xylenes						
PHOSGENATION									● Methylene Diphenyl Diisocyanate; ● Toluene-2,4-Diisocyanate
EXTRACTION			● Butadiene; ● Butene; ● Cyclopentadiene Dimer; ● Isobutene; ● Isoprene				○ o-Cresol; ○ 2,6-Diethylphenol; ○ Phenol		
DISTILLATION			○ Acenaphthene; ○ Anthracene; ● Benzene; ○ Benzopyrene; ● Butadiene; ○ Butane; ● Butene; ● Cyclopentadiene Dimer; ● Ethane; ● Ethylbenzene; ○ Heptane; ○ Hexane; ● Isobutene; ○ Isopentane; ● Isoprene; ● Naphthalene; ○ Octane; ○ Pentane; ○ Propane; ● Toluene; ● Xylenes				○ o-Cresol; ● Creosote; ○ 2,6-Diethylphenol; ○ Phenol		
OTHER	○ Diethyl Sulfide; ○ Dimethyl Sulfide; ○ Methoxydihydropyran; ○ Sulfolane	● Epichlorohydrin	○ Methane; ● Xylenes	● Acetone; ○ Acetophenone; ● Diketene; ● Methyl Ethyl Ketone	● Adiponitrile; ○ n-Butyronitrile; ○ Isobutyronitrile		○ Alkyl Phenols; ● Phenol	● Sodium Benzoate; ○ Sodium Formate	○ 2-Benzothiazolethiol; ○ Cyanuric Acid; ○ Toluenesulfonyl Chloride; ○ N-Vinyl-2-Pyrrolidone; ○ N-Methyl-2-Pyrrolidone
HYDRATION									

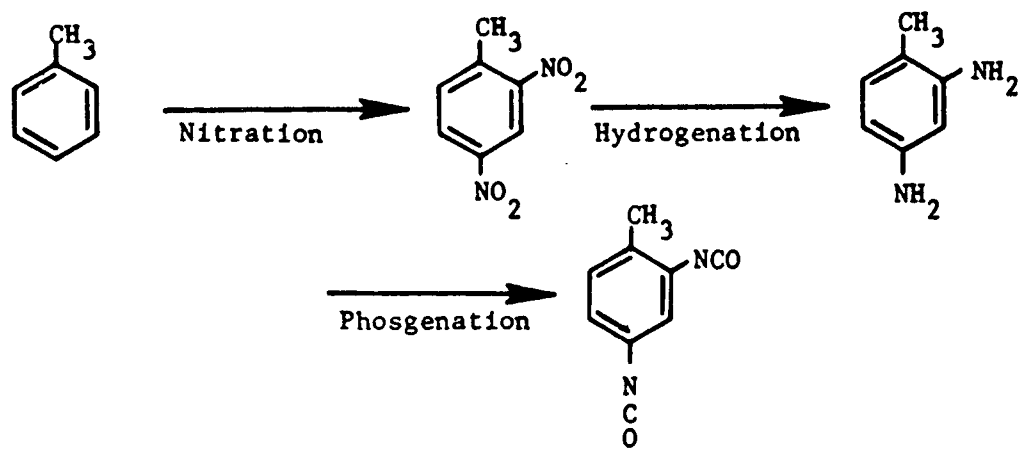
● Product/Process Effluent Sampled by OCB
○ Product/Process Effluent Not Sampled

GENERIC PROCESS	ABS RESINS	ACRYLIC RESINS	ACRYLIC FIBERS	ACRYLIC LATEX	ACRYLAMIDE RESINS	ALKYD RESINS	CARBOXYMETHYL CELLULOSE	CELLOPHANE	CELLULOSE ACETATE	CELLULOSE NITRATE	CELLULOSE SPONGE	EPOXIDIZED ESTERS	EPOXY RESINS	MELAMINE RESINS	METHYL CELLULOSE	MODACRYLIC RESINS	NYLON SALT	NYLON RESIN	NYLON 66 RESIN	PETROLEUM HYDROCARBON RESINS	POLYACETAL RESINS	POLYAMIDES	POLYBUTADIENE RESINS	POLYESTER FIBERS	POLYESTER RESINS	POLYETHYLENE OXIDE	POLYETHYLENE RESINS	POLYMERIC METRYLENE DIPHENYL DIISOCYANATE	POLYPROPYLENE RESINS	POLYOXYPROPYLENE GLYCOL	POLYSTYRENE	POLYSULFONIC RESINS	POLYVINYL ACETATE RESINS	POLYVINYL CHLORIDE	POLYVINYL PYRROLIDONE	RAYON	SAN RESINS	STYRENE-BUTADIENE RESIN	STYRENE MALEIC ANHYDRIDE RESINS	STYRENE METHYL METHACRYLATE RESINS	UNSATURATED POLYESTER RESINS	UREA RESINS
ADDITION POLYMERIZATION MASS																																		●			●					
EMULATION	●	●																															●	●				●				
SUSPENSION			●																								●				●			●			●			●		
SOLVENT					●												●												●													
SOLVENT-NONSOLVENT																																										
OTHER[A]							●		●	●																	●															
CONDENSATION POLYMERIZATION						●						●	●	●	●			●	●			●			●			●		●						●			●		●	●

[A]Ring opening and other "addition" polymerization processes in which the polymer grows in a manner other than by a chain reaction.

TABLE V-37
Major Plastics and Synthetic Fibers Products by Generic Process

Specialty chemicals, on the other hand, may involve several chemical reactions and require a fuller description. For example, preparation of toluene diisocyanate from commodity chemicals involves four synthetic steps and three generic processes as shown below:



This example is relatively simple and manufacture of other specialty chemicals may be more complex. Thus, as individual chemicals become further removed from the basic feedstocks of the industry, fuller description is required for unique specification of process wastewaters. A mechanistic analysis of individual generic processes permits a spectrum of product classes to be associated with every generic process provided a feedstock is specified. Each product class represents compounds that are structurally related to the feedstock through the chemical modification afforded by the generic process.

b. Product/Process Chemistry Overview

The primary feedstocks of the OCPSF industry include: benzene, toluene, o,p-xylene, ethene, propene, butane/butene, and methane; secondary feedstocks include the principal intermediates of the synthetic routes to high-volume organic chemicals and plastics/synthetic fibers. Other products that are extraneous to these routes, but are priority pollutants, are also considered because of their obvious importance to guidelines development.

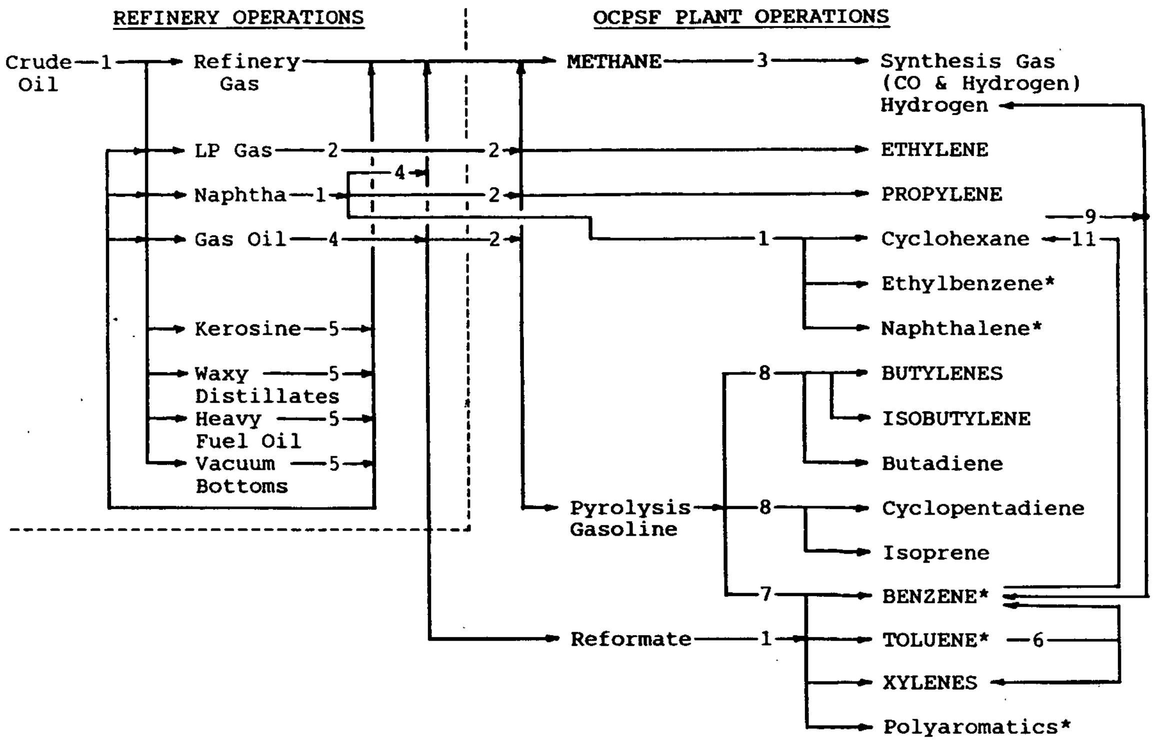
Flow charts used to illustrate a profile of the key products of the two categories were constructed by compositing the synthetic routes from crude oil fractions, natural gas, and coal tar distillates (three sources of primary feedstocks) to the major plastics and synthetic fibers. Figures V-1 through V-7 depict the routes through the eight primary feedstocks and various intermediates to commercially produced organic chemicals; Figures V-8 and V-9 show the combinations of monomers that are polymerized in the manufacture of major plastics and synthetic fiber products. Also shown in Figures V-1 through V-7 are processes in current use within these industries.

These charts illustrate the tree-shaped structure of this industry's product profile (i.e., several products derived from the same precursor). By changing the specific conditions of a process, or use of a different process, several different groups of products can be manufactured from the same feedstock. There is an obvious advantage in having to purchase and maintain a supply of as few precursors (feedstocks) and solvents as possible. It is also important to integrate the product mix at a plant so that one product provides feedstock for another. A typical chemical plant is a community of production areas, each of which may produce a different product group. While the product mix at a given plant is self-consistently interrelated, a different mix of products may be manufactured from plant to plant. Thus, a plant's product mix may be independent of, or may complement the product mix at, other plants within a corporate system.

The synthetic routes to priority pollutants are illustrated in Figures V-10 through V-14; these flow charts provide a separate scheme for each of the following five classes of generic groups of priority pollutants:

1. Nitroaromatic compounds, nitrophenols, phenols, benzidines and nitrosamines

2. Chlorophenols, chloroaromatic compounds, chloropolyaromatic compounds, haloaryl ethers and PCBs

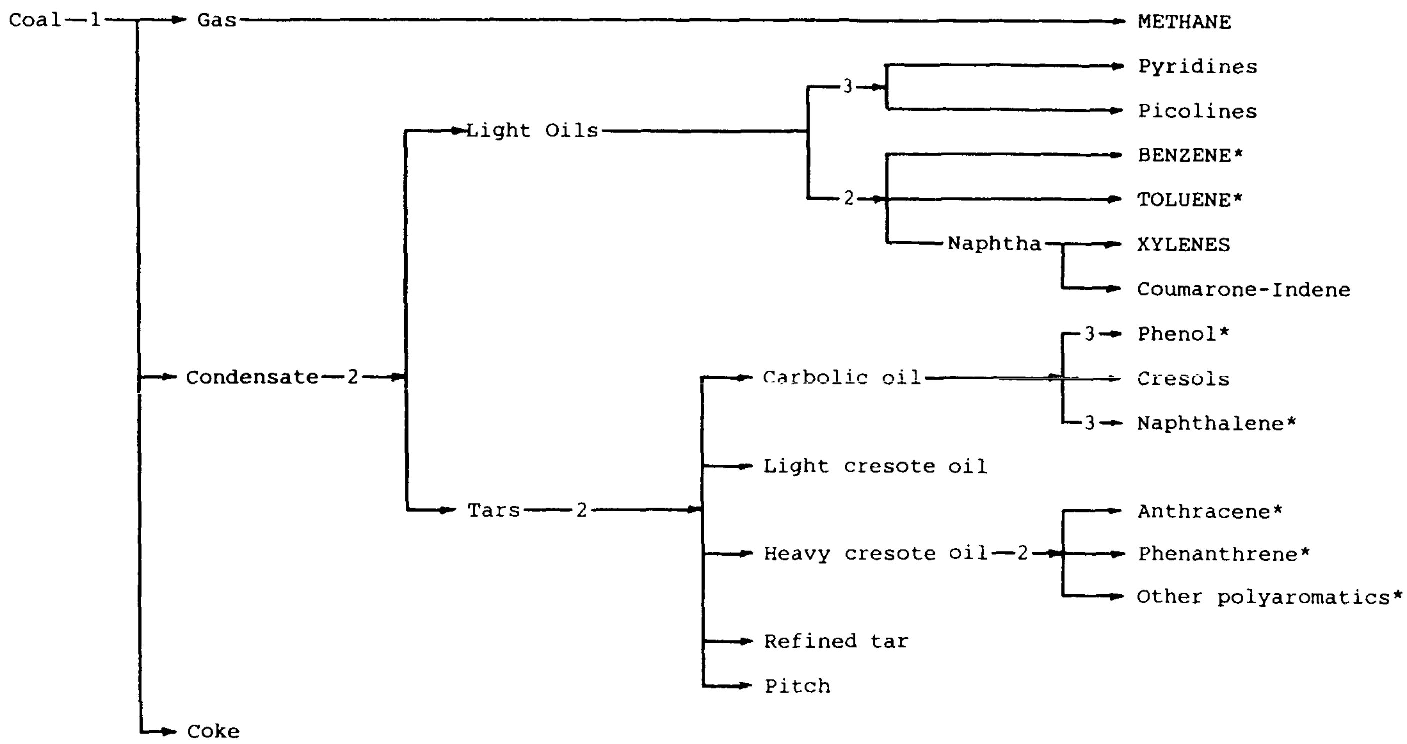


Generic Processes
1. Distillation
2. Steam cracking(pyrolysis)
3. Steam reforming
4. Catalytic reforming
5. Hydrocracking
6. Hydrodealkylation
7. Liquid-liquid extraction
8. Extractive distillation
9. Dehydrogenation
10. Alkylation
11. Hydrogenation

Notes
——— Major routes to feedstocks
----- Division between refinery operations and typical OCPSF plant operations.
* Priority pollutant(PRIPOL)

Source: Wise & Fahrenthold, 1981.

Figure V-1
Primary Feedstock Sources

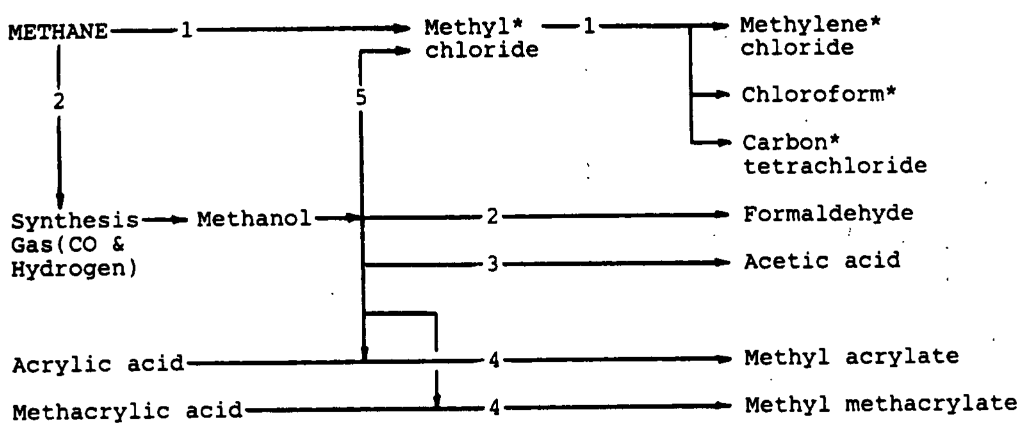


Generic Processes
1. Pyrolysis
2. Distillation
3. Liquid-liquid extraction (after adjusting pH to >11)

Notes
----- Product recovery route
* Priority pollutant(PRIPOL)

Source: Wise & Fahrenthold, 1981.

Figure V-2
Coal Tar Refining

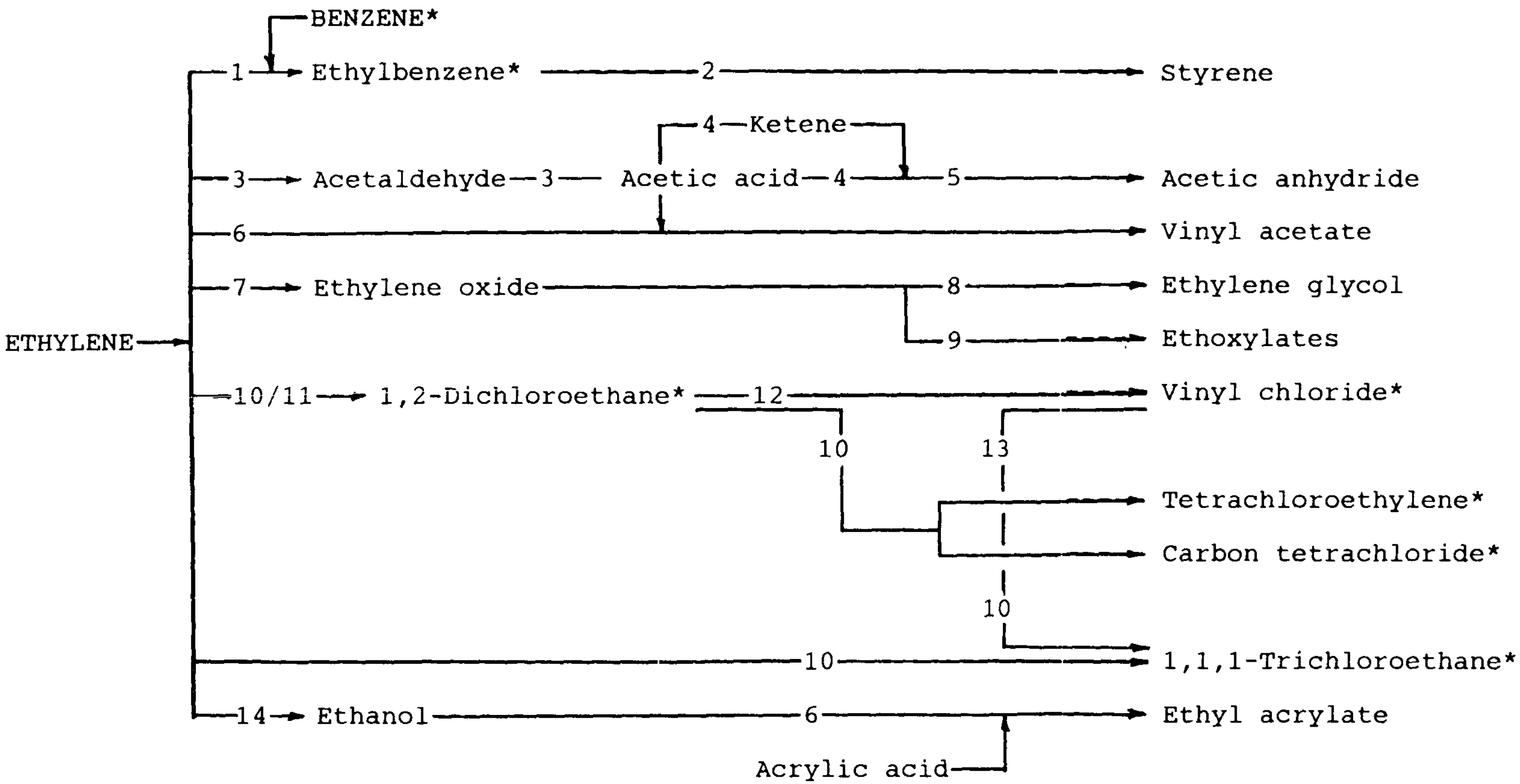


<u>Generic Processes</u>
1. Chlorination
2. Oxidation
3. Oxo(carbonylation
4. Esterification
5. Hydrochlorination

<u>Notes</u>
----- Major synthetic route
* Priority pollutant(PRIPOL)

Source: Wise & Fahrenthold, 1981.

Figure V-3
Methane



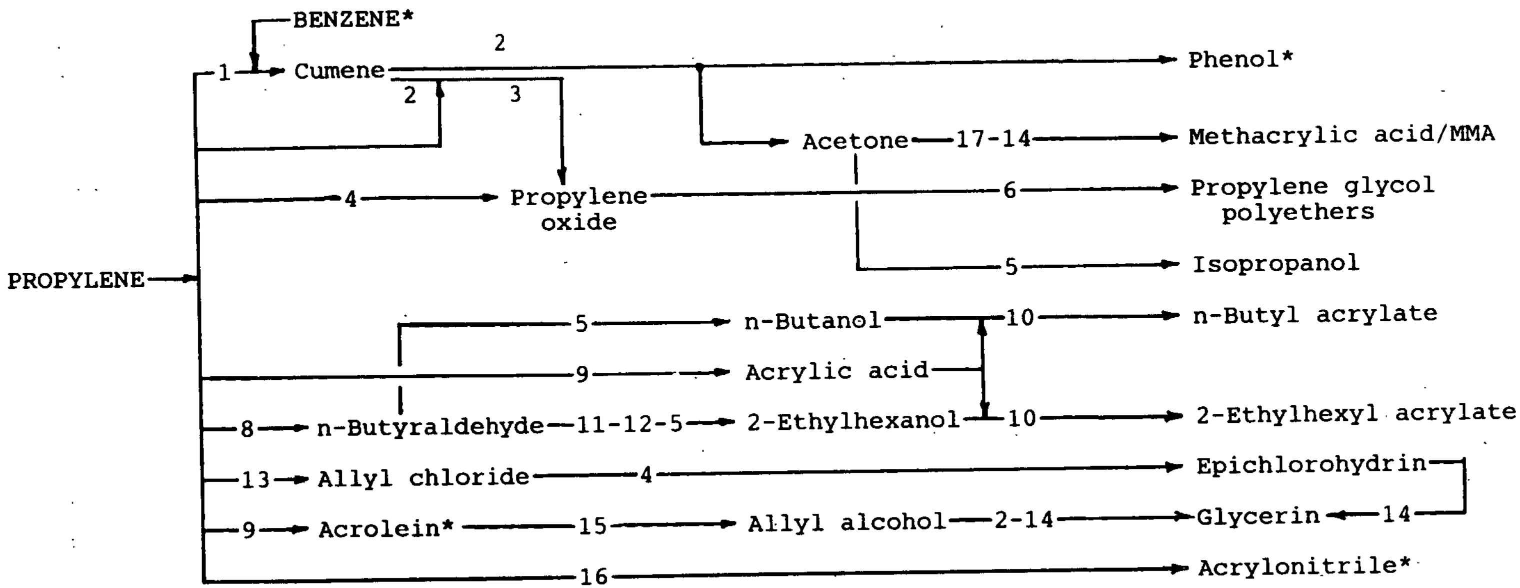
Generic Processes
1. Alkylation
2. Dehydrogenation
3. Oxidation
4. Dehydration
5. Condensation
6. Esterification
7. Epoxidation
8. Hydrolysis
9. Ethoxylation
10. Chlorination
11. Oxyhydrochlorination
12. Dehydrochlorination
13. Hydrochlorination
14. Direct hydration

Notes
——— Major synthetic route

* Priority pollutant(PRIPOL)

Source: Wise & Fahrenthold, 1981.

Figure V-4
Ethylene



Generic Processes
1. Alkylation
2. Peroxidation
3. Epoxidation
4. Chlorohydrination
5. Hydrogenation
6. Propoxylation
7. Direct hydration
8. Oxo (carbonylation)
9. Oxidation
10. Esterification
11. Aldol condensation
12. Dehydration
13. Chlorination
14. Hydrolysis
15. Reduction
16. Ammoxidation
17. Cyanation

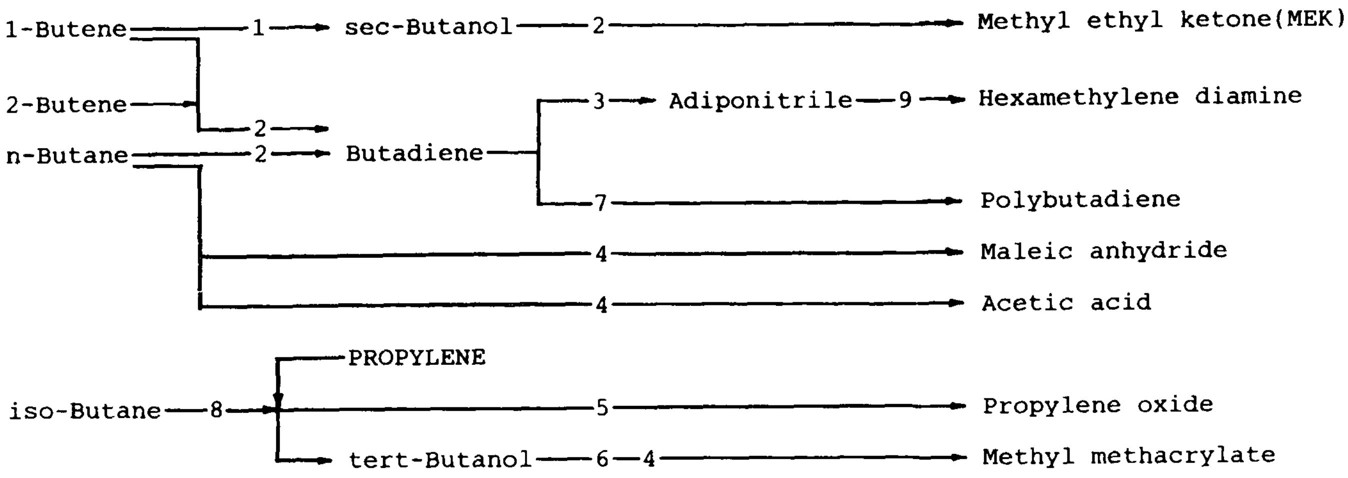
Notes

—— Major synthetic route

* Priority pollutant(PRIPOL)

Source: Wise & Fahrenthold, 1981

Figure V-5
Propylene

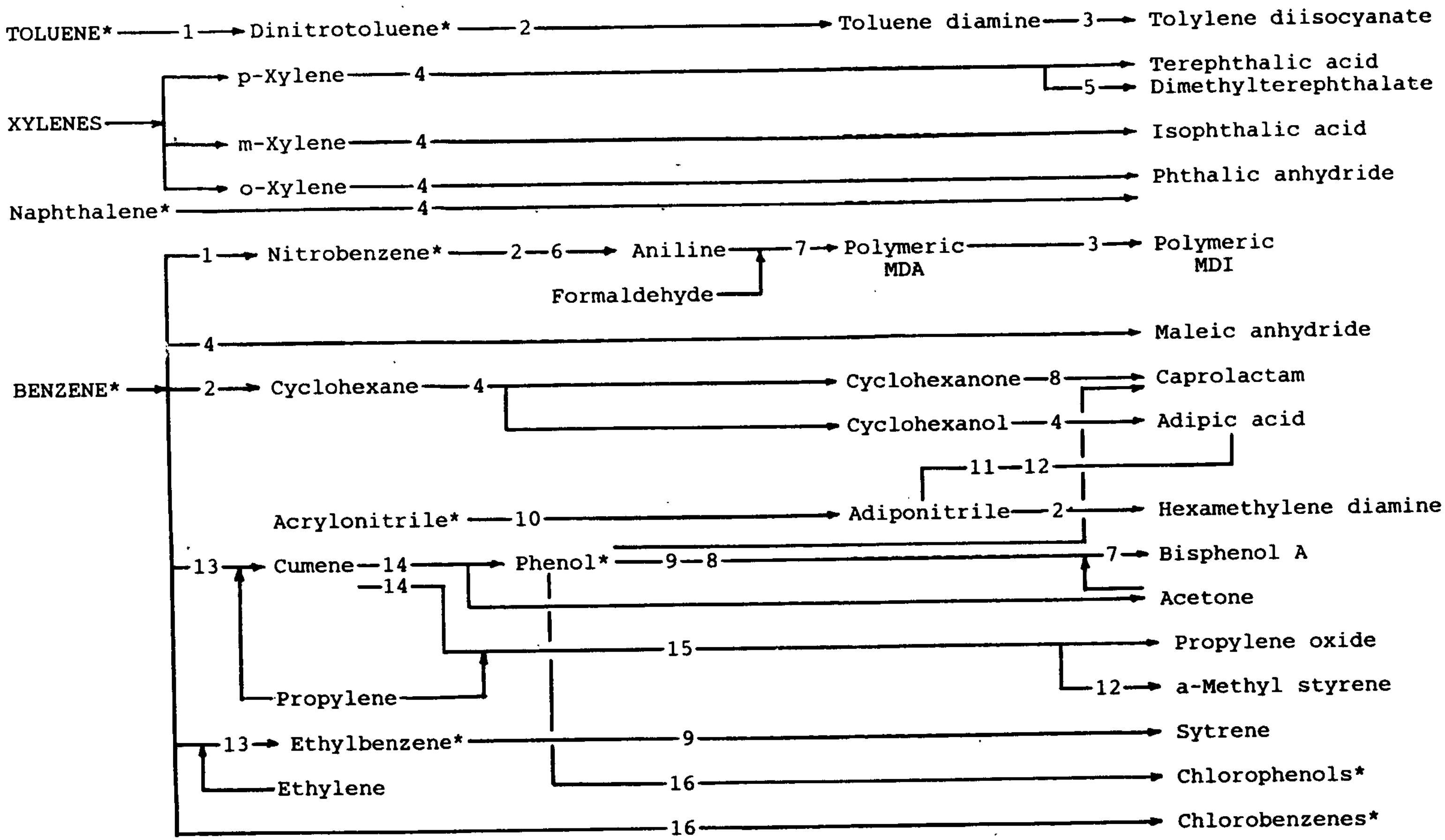


Generic Processes
1. Hydration
2. Dehydrogenation
3. Hydrocyanation
4. Oxidation
5. Epoxidation
6. Dehydration
7. Polymerization
8. Peroxidation
9. Hydrogenation

Notes
——— Major synthetic routes

Source: Wise & Fahrenthold, 1981.

Figure V-6
Butanes/Butenes

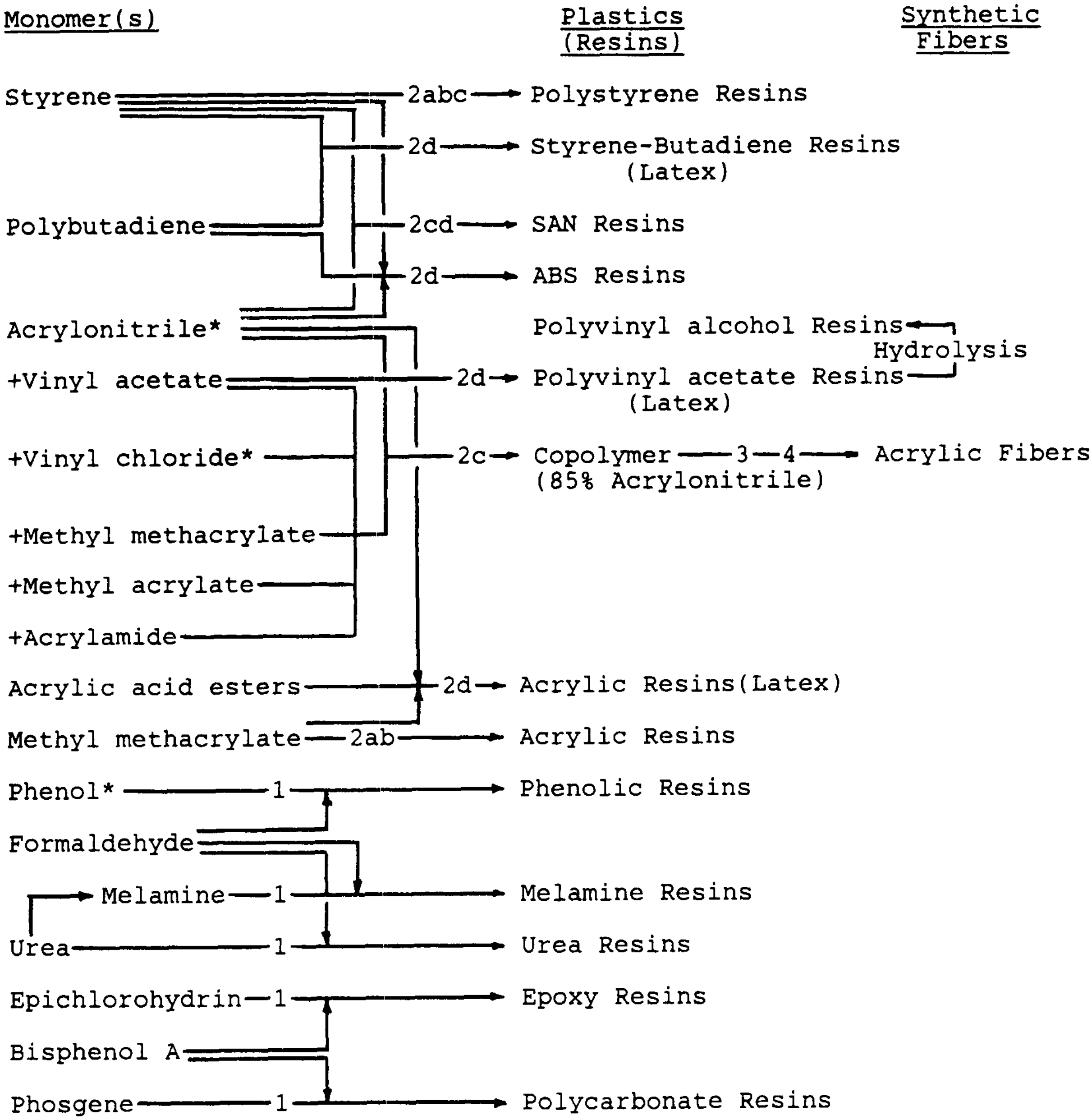


<u>Generic Processes</u>
1. Nitration
2. Hydrogenation
3. Phosgenation
4. Oxidation
5. Esterification
6. Reduction(Iron catalyst)
7. Condensation
8. Oximation/Rearrangement
9. Dehydrogenation
10. Hydrodimerization
11. Amidification
12. Dehydration
13. Alkylation
14. Peroxidation
15. Epoxidation
16. Chlorination

<u>Notes</u>
——— Major synthetic route
* Priority pollutant(PRIPOL)

Source: Wise & Fahrenthold, 1981.

Figure V-7
Aromatics



Generic Processes

Plastics Polymerization
1. Condensation
2. Addition
a. Mass c. Suspension
b. Solution d. Emulsion

Fibers Spinning
3. Wet
4. Dry
5. Melt

Notes
—— Synthetic route
* Priority pollutant
\+ Variable comonomer

Source: Wise & Fahrenthold, 1981.

Figure V-8
Plastics and Fibers

Monomer(s)		Plastics (Resins)		Synthetic Fibers
Terephthalic acid Dimethyl terephthalate Ethylene glycol	1	Polyester Resins	5	Polyester Fiber
Glycerin Isophthalic acid Phthalic anhydride	1	Alkyd Resins		
Phthalic anhydride Maleic anhydride Propylene glycol Styrene	1	Unsaturated Polyester Resin		
Cellulose		Cellulose xanthate	3	Rayon Fiber
Cellulose Acetic anhydride Diketene	1	Cellulose acetate	4	Cellulose acetate Fiber
Coumarone-Indene	2b	Petroleum hydrocarbon Resins		
Dicyclopentadiene	2b	Petroleum hydrocarbon Resins		
ETHYLENE	2a	LD Polyethylene Resins		
ETHYLENE	2b	HD Polyethylene Resins		
PROPYLENE	2c	Polypropylene Resins	5	Polypropylene Fiber
Vinyl chloride*	2bcd	Polyvinyl chloride Resins		
Hexamethylene diamine Adipic acid → Nylon salt	1	Nylon 66 Resins	5	Nylon 66 Fiber
Caprolactam	1	Nylon 6 Resins	5	Nylon 6 Fiber
Tolylene diisocyanate Polymeric MDI Propylene glycol polyethers	1	Polyurethane Resins and Foams		

Generic Processes

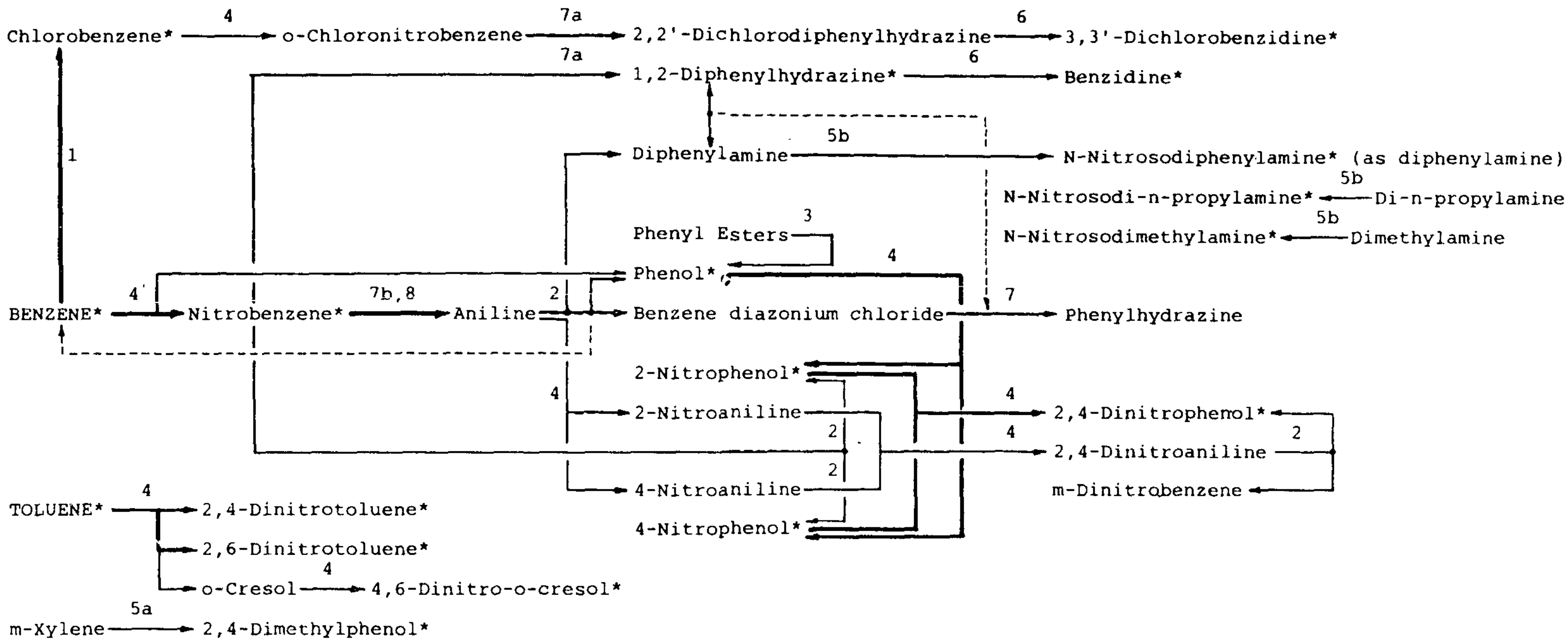
Plastics Polymerization
1. Condensation
2. Addition
a. Mass
b. Solution
c. Suspension
d. Emulsion

Fiber Spinning
3. Wet
4. Dry
5. Melt

Notes
—— Synthetic route
* Priority pollutant

Source: Wise & Fahrenthold, 1981.

Figure V-9
Plastics and Fibers

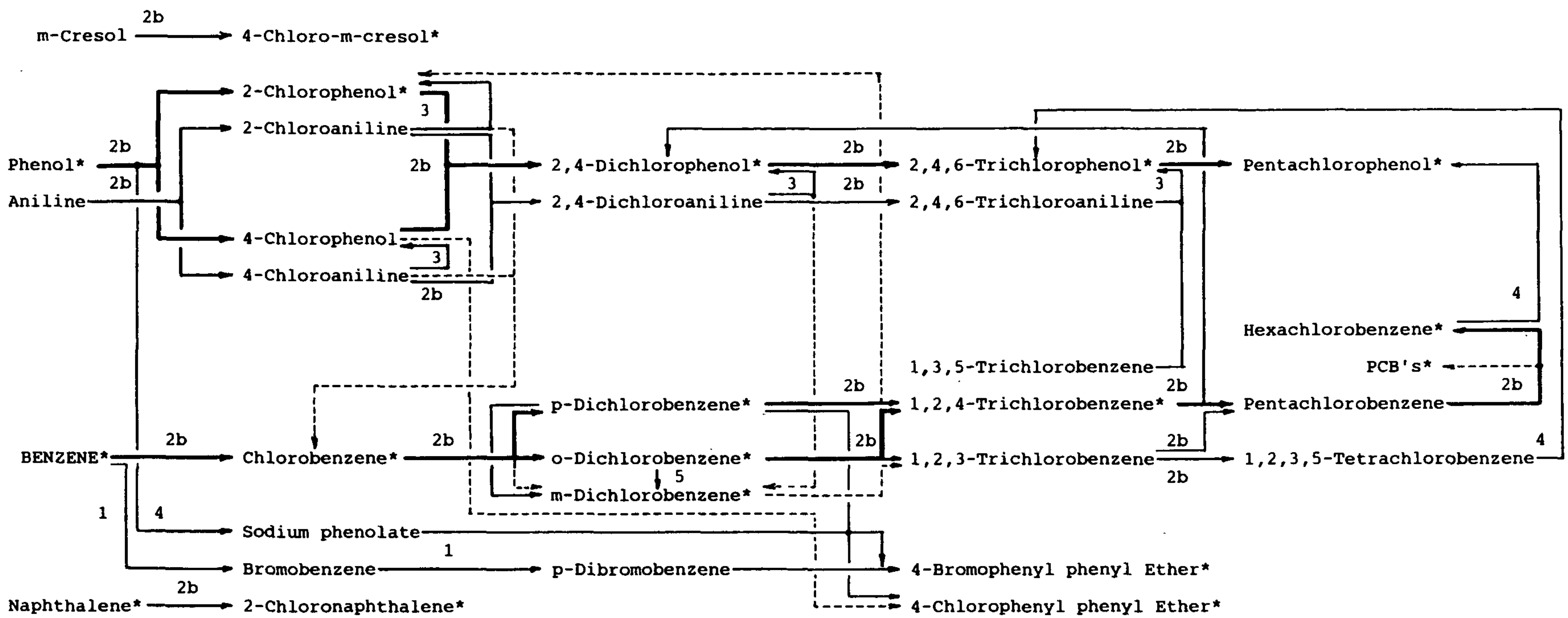


Generic Processes
1. Chlorination (Fe+3 catalyst)
2. Diazotization
3. Hydrolysis
4. Nitration
5. Oxidation (a. Oxygen, b. Nitric acid)
6. Rearrangement (Acid catalyzed)
7. Reduction (a. Zinc/caustic, b. Iron/acid)
8. Hydrogenation (Nickel catalyst)

Notes
——— Major synthetic route
——— Principal coproduct
----- Minor coproduct
* PRIPOL

Source: Wise & Fahrenthold, 1981.

Figure V-10
Nitroaromatics, Nitrophenols, Benzidines, Phenols, Nitrosamines



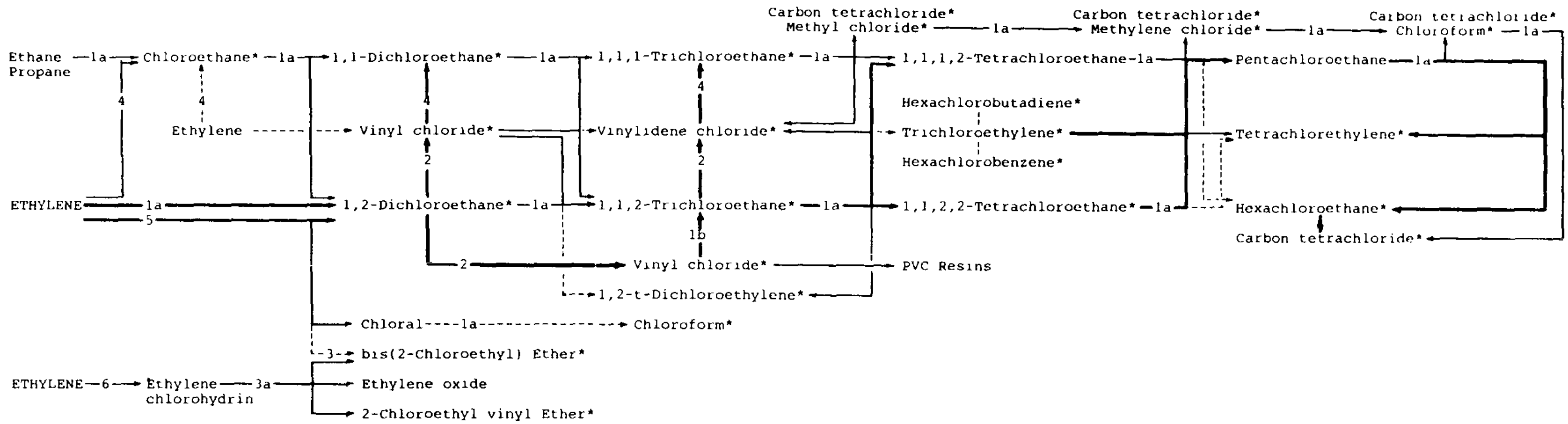
Generic Processes
1. Bromination
2. Chlorination (a. Thermal, b. Fe+3 catalyzed)
3. Diazotization
4. Hydrolysis (Alkaline)
5. Rearrangement (AlCl3 catalyst)

Notes

━━ Major synthetic route
—— Principal coproduct
----- Minor coproduct
* Priority Pollutant(PRIPOL)

Source: Wise & Fahrenthold, 1981.

Figure V-11
Chlorophenols, Chloroaromatics, Haloaryl Ethers, PCB's

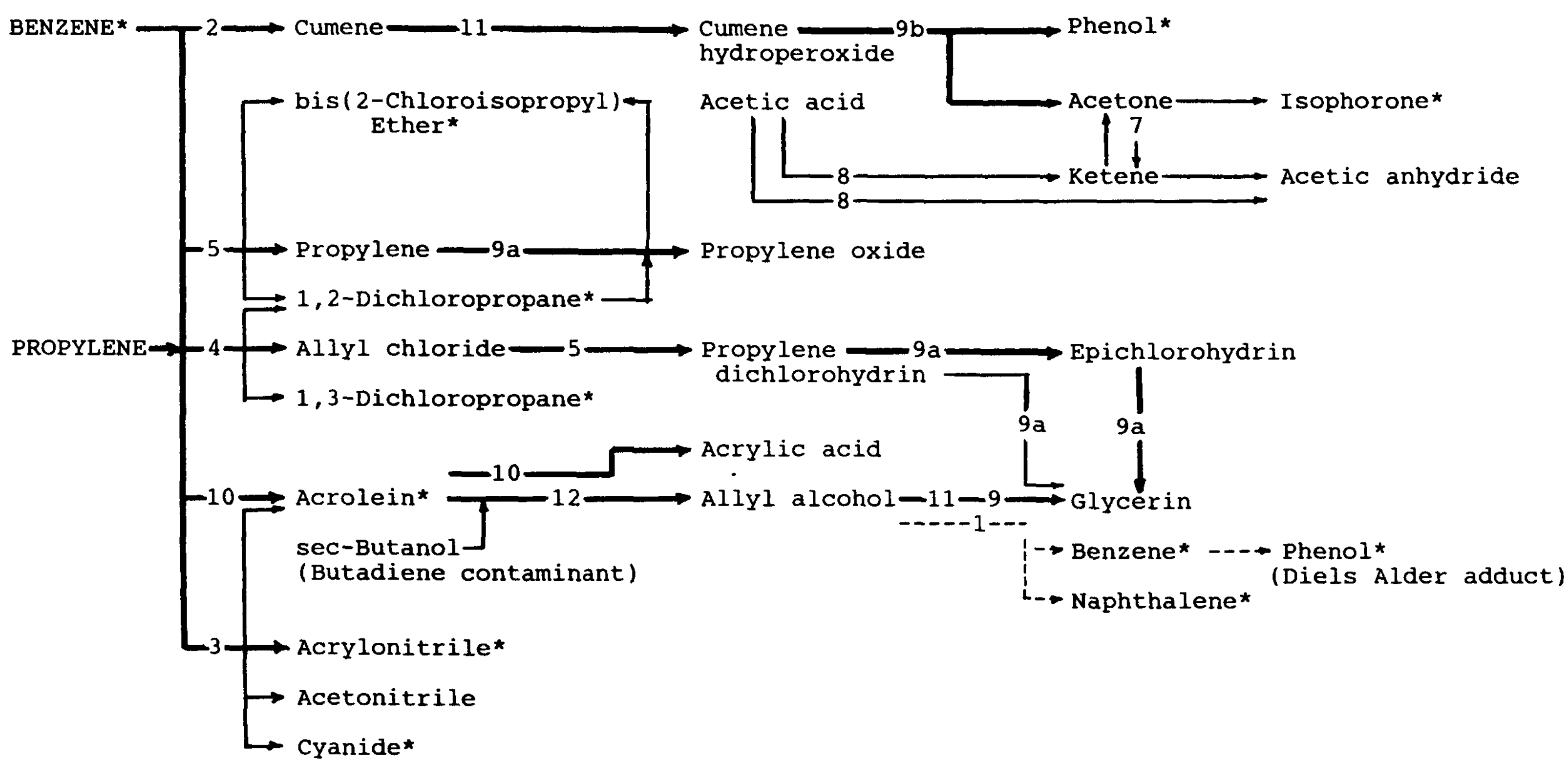


Generic Processes
1. Chlorination(a. Thermal, b. Ferric chloride catalyst)
2. Dehydrochlorination
3. Hydrolysis(a. Alkaline, b. Acid)
4. Hydrochlorination (Ferric chloride catalyst)
5. Oxyhydrochlorination
6. Hypochlorination (Chlorine/Caustic)

Notes
═══ Major synthetic route
——— Principal coproduct
----- Minor coproduct
* Priority pollutant(PRIPOL)

Source: Wise & Fahrenthold, 1981.

Figure V-12
Chlorinated C2's, C4, Chloroalkyl Ethers

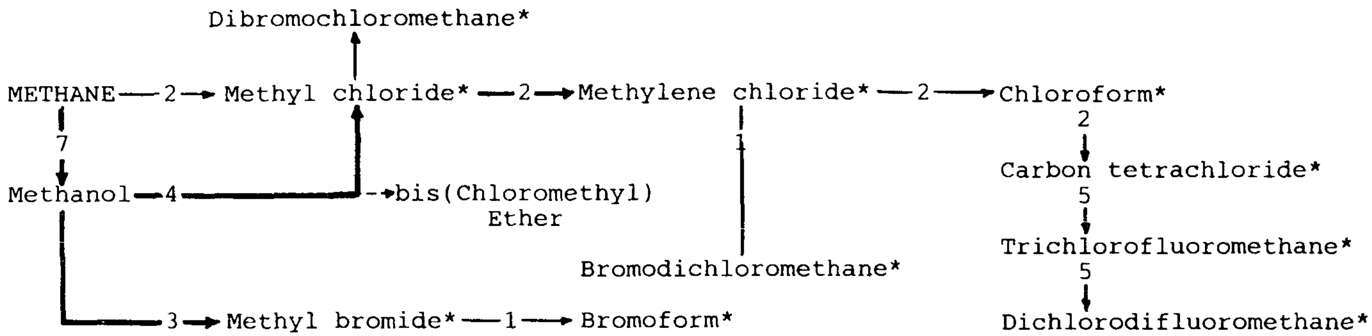


Generic Processes
1. Addition (Diels Alder)
2. Alkylation
3. Ammoxidation
4. Chlorination
5. Hypochlorination (Chlorine/Caustic)
6. Condensation
7. Dehydrogenation
8. Dehydration
9. Hydrolysis (a. Alkaline, b. Acid)
10. Oxidation
11. Peroxidation
12. Reduction(Isoalkoxide)

Notes
▬▬ Major synthetic route
—— Principal coproduct
----- Minor coproduct
* Priority pollutant(PRIPOL)

Source: Wise & Fahrenthold, 1981.

Figure V-13
Clorinated C3's, Chloralkyl Ethers, Acrolein, Acrylonitrile, Isophorone



Generic Processes
1. Bromination
2. Chlorination(Thermal)
3. Hydrobromination
4. Hydrochlorination
   (Zinc chloride catalyst)
5. Hydrofluorination
6. Hydrolysis(Acid)
7. Via Synthesis Gas
   (CO & Hydrogen)

Notes
━━━ Major synthetic route
----- Minor coproduct
* Priority pollutant(PRIPOL)

Source: Wise & Fahrenthold, 1981.

Figure V-14
Halogenated Methanes

3. Chlorinated C2 and C4 hydrocarbons; chloroalkyl ethers

4. Chlorinated C3 hydrocarbons, acrolein, acrylonitrile, isophorone, and chloroalkyl ethers

5. Halogenated methanes.

The generic processes associated with these synthesis routes are denoted by numbers individually keyed to each chart.

The precursor(s) for each of these classes is reasonably obvious from the generic group name. Classes 1 and 2 are, for the most part, substituted aromatic compounds, while Classes 3, 4, and 5 are derivatives of ethylene, propylene, and methane, respectively. The common response of these precursors to the chemistry of a process has important implications, not only for the prediction of priority pollutants, but for their regulation as well; that is, group members generally occur together.

It is significant to note that among the many product/processes of the industry, the collection of products and generic processes shown in Figures V-10 through V-14 are primarily responsible for the generation of priority pollutants. The critical precursor-generic process combinations associated with these products are summarized in Table V-38. While there may be critical combinations other than those considered here, Table V-38 contains the most obvious and probably the most likely combinations to be encountered in the OCPSF industrial categories.

c. Product/Process Sources of Priority Pollutants

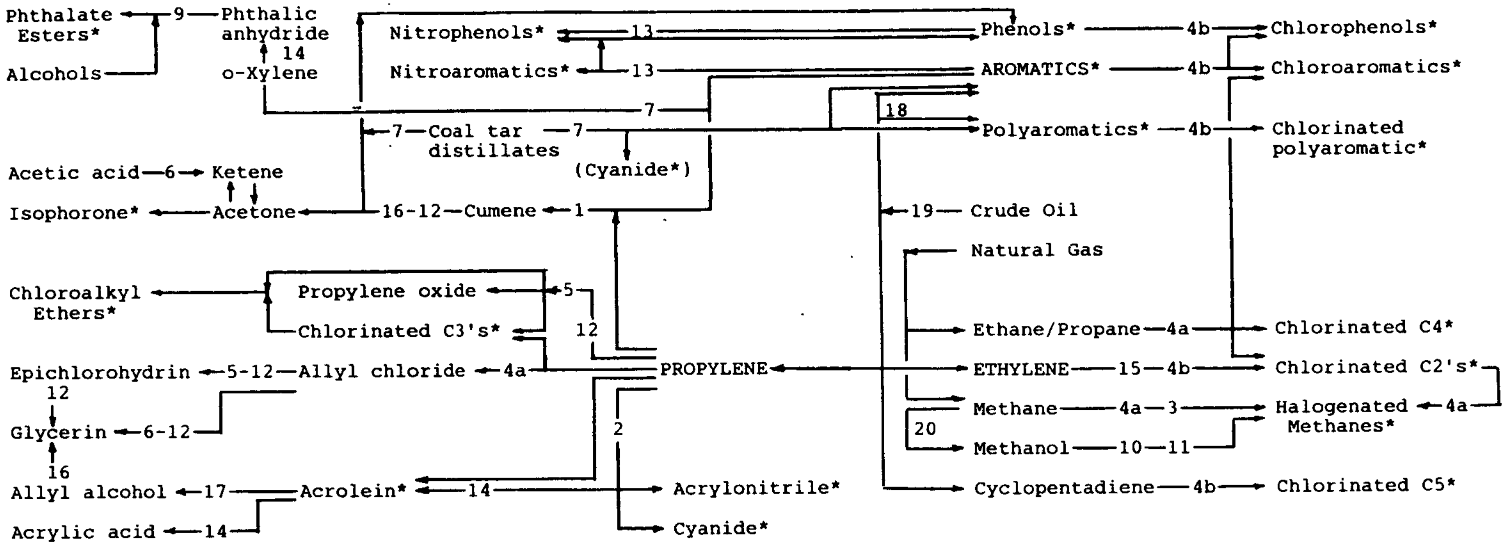
The product/processes that generate priority pollutants become obvious if the synthesis routes to the priority pollutants are, in effect, superimposed upon the synthesis routes employed by the industry in the manufacture of its products. Figure V-15 represents a priority pollutant profile of the OCPSF industry by superimposing Figure V-1 through V-9 and V-10 through V-14 upon one another so as to relate priority pollutants to feedstocks and products.

TABLE V-38.
CRITICAL PRECURSOR/GENERIC PROCESS COMBINATIONS THAT GENERATE PRIORITY POLLUTANTS

Feedstock	Generic Process Oxidation	Chlorination	Nitration	Diazotization	Reduction
Benzene	Phenol	Chloroaromatics Chlorophenols	Nitroaromatics Nitrophenols		
Toluene	0,M-Cresol		Nitroaromatics		
Xylene	2,4-Dimethylphenol		2,4-Dimethylphenol		
Naphthalene		2-Chloronaphthalene			
Phenol		Chlorophenols	Nitrophenols		
Cresols		4-Chloro-m-cresol	4,6-Dinitro-o-cresol		
Chloroanilines				Chlorophenols Chloroaromatics Aromatics	
Nitroanilines				Nitrophenols Nitroaromatics Aromatics	
Nitrobenzene				N-Nitrosodiphenylamine*	Aniline* (Diphenylamine)
m-Chloronitrobenzene				Benzidines**	1,2-Diphenylhydrazines*
Ethene		Chlorinated C2's Chlorinated C4 Chloroaromatics			
Propene	Acrolein	Chlorinated C3's			
Methane		Chlorinated Methanes			

*Derived directly from aniline, or indirectly via phenylhydrazine, diphenylamine is one of three secondary amines that are precursors for nitrosamines, when exposed to nitrites (as in diazotization or NO_x.

**Diphenylhydrazines rearrange to benzidines under acid concitions (as in diazotization).



Generic Processes

1. Alkylation
2. Ammoxidation
3. Bromination(Thermal)
4. Chlorination
   a. Thermal
   b. Ferric chloride
      Aluminum chloride
5. Hypochlorination (Chlorine/Caustic)
6. Dehydration
7. Distillation
8. Dehydrogenation
9. Esterification
10. Hydrobromination (Zinc bromide)
11. Hydrochlorination
    a. Ferric chloride
    b. Zinc chloride
12. Hydrolysis
13. Nitration
14. Oxidation
15. Oxyhydrochlorination
16. Peroxidation
17. Reduction (Alkoxide)
18. Solvent extraction
19. Steam pyrolysis
20. Via Synthesis Gas

Notes

——— Synthetic route

* Priority pollutants(PRIPOLs)

Source: Wise & Fahrenthold, 1981.

Figure V-15

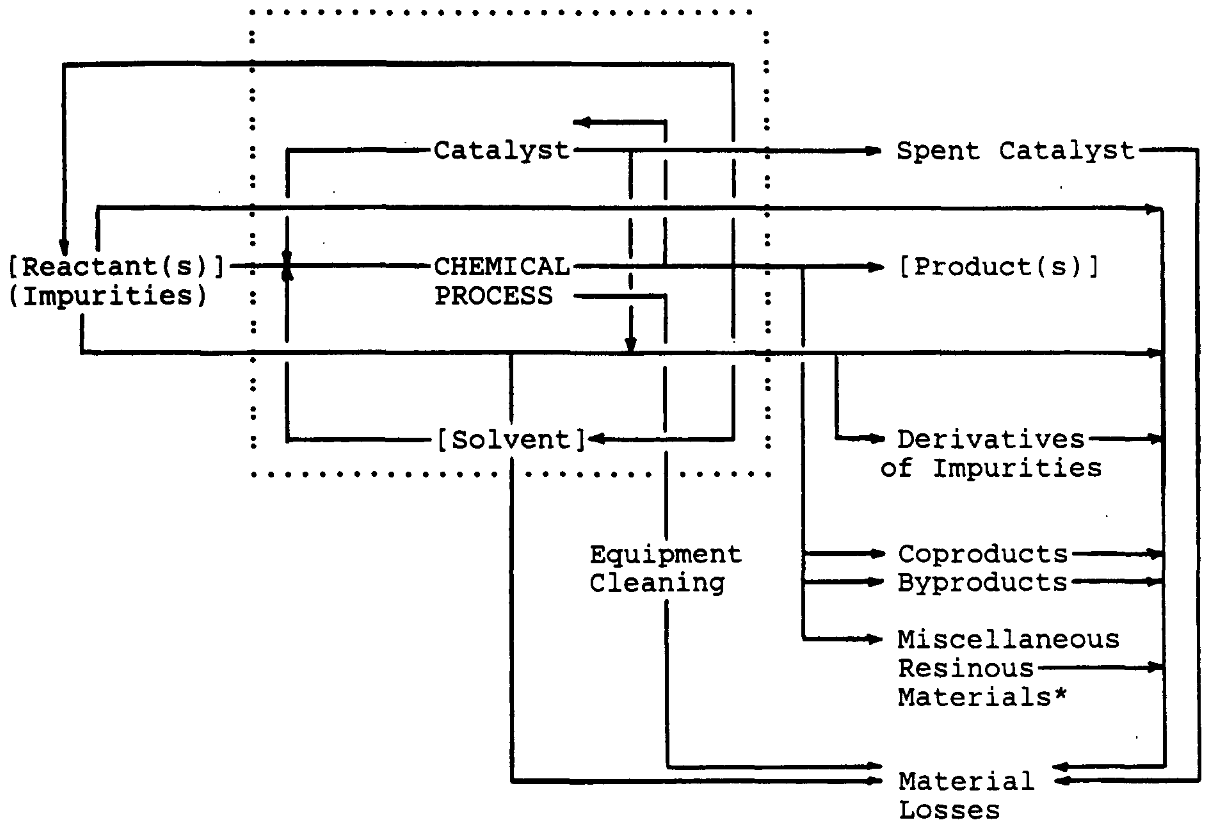
Priority Pollutant (PRIPOL) Profile of the OCPSF Industry

In any product/process, as typified by Figure V-16, if the feedstock (reactant), solvent, catalyst system, or product is a priority pollutant, then it is likely to be found in that product/process wastewater effluent. Equally obvious are metallic priority pollutants, which are certainly not transformed to another metal (transmutation) by exposure to process conditions. Since side reactions are inevitable and characteristic of all co-products of the main reaction, priority pollutants may appear among the several co-products of the main reaction. Subtler sources of priority pollutants are the impurities in feedstocks and solvents.

Priority pollutant impurities may remain unaffected, or be transformed to other priority pollutants, by process conditions. Commercial grades of primary feedstocks and solvents commonly contain 0.5 percent or more of impurities. While 99.5 percent purity approaches laboratory reagent quality, 0.5 percent is nevertheless equal to 5,000 ppm. Thus, it is not surprising that water coming into direct contact with these process streams will acquire up to 1 ppm (or more) of the impurities. It is not unusual to find priority pollutants representing raw material impurities or their derivatives reported in the 0.1-1 ppm concentration range in analyses of product/process effluents. Sensitive instrumental methods currently employed in wastewater analysis have the ability of measuring priority pollutants at concentrations below 0.1 ppm. Specifications or assays of commercial chemicals at these trace levels are seldom available, or were not previously (before BAT) of any interest, since even 0.5 percent impurity in the feedstock and/or solvent would typically have a negligible effect on process efficiency or product quality. Only in cases where impurities affect a process (e.g., poisoning of a catalyst) are contaminants specifically limited.

d. Priority Pollutants in Product/Process Effluents

During the Verification sampling program, representative samples were taken from the effluents of 147 product/processes manufacturing organic chemicals and 29 product/processes manufacturing plastics/synthetic fibers. These 176 product/processes included virtually all those shown in Figures V-1 through V-9. Analyses of these samples, averaged and summarized by individual product/processes, showed the priority pollutants observed in these effluents



Notes

..... Limits of the process area in the plant.

* Still bottoms, reactor coke, etc.

Source: Wise & Fahrenthold, 1981.

Figure V-16
A Chemical Process

to be consistent with those that can be predicted, based on the precursor (with impurities) generic process combinations.

Consistency between observation and prediction was most evident at concentrations >0.5 ppm. Below that level, an increasing number of extraneous priority pollutants were reported that were unrelated to the chemistry or feedstock of the process, and typically reported at concentrations less than 0.1 ppm. These anomalies could usually be attributed to one or more of the following sources:

- Extraction solvent (methylene chloride), or its associated impurities, e.g., as residuals in the GC/MS system from previous runs
- Sample contamination during sampling or during sample preparation at the laboratory (e.g., phthalate leached from anhydrous sodium sulfate used to dry the concentrated extract prior to injection into the GC)
- In-situ generation in the wastewater collection system (sewer).

In the reconciliation of product/process effluent analytical data, it was expedient to initially sort out the extraneous from the significant priority pollutants. In most cases, only the latter can be related to the product/process. Less than half of the effluents of key product/processes manufacturing organic chemicals contained priority pollutants at concentrations greater than 0.5 ppm. The generic groups of priority pollutants associated with these product/processes are summarized in Table V-39 and are consistent with those predicted in Table V-36. Many product/process effluents have little potential to contain greater than 0.5 ppm of priority pollutants, because they do not involve critical precursor-generic process combinations.

Generic classes of priority pollutants reported at >0.5 ppm in the effluent of product/processes manufacturing plastics/synthetic fibers are summarized in Table V-40. The priority pollutants found in polymeric product/process effluents are usually restricted to the monomer(s) and its impurities or derivatives. Since all monomers or accompanying impurities are not priority pollutants, some plastics and synthetic fibers effluents are essentially free of priority pollutants.

TABLE V-39.
ORGANIC CHEMICALS EFFLUENTS WITH SIGNIFICANT CONCENTRATION
(>0.5 PPM) OF PRIORITY POLLUTANTS

Product	Generic Process	Feedstock(s)	Associated Priority Pollutants
Acetone	Alkylation, Peroxidation	Benzene, Propylene	Aromatics
Acetylene	Dehydrogenation	Methane	Aromatics, Polyaromatics
Acrolein	Oxidation	Propylene	Acrolein, Aromatics, Phenol
Acrylic acid	Oxidation	Propylene	Acrolein
Adiponitrile	Ammonolysis, Dehydration	Adipic acid	Acrylonitrile
	Hydrodimerization	Acrylonitrile, Hydrogen	Acrylonitrile
Alkyl (C13, C19) amines	Cyanation, Hydrogenation	C12-C18 alpha olefin, HCN	Cyanide
Alkyl (C8, C9) phenols	Alkylation	Phenol, C8-C9 Olefins	Phenol, Aromatics
Allyl alcohol	Reduction (by alkoxide)	Acrolein, sec-Butanol	Acrolein, Phenol, Aromatics, Polyaromatics
Aniline	Hydrogenation	Nitrobenzene	Aromatics
Benzene	Hydrodealkylation	Toluene	Aromatics, Polyaromatics
	BTX Extraction	Catalytic Reformate	Aromatics
	BTX Extraction	Coal tar light oil	Aromatics, Polyaromatics, Phenols, Cyanide
	BTX Extraction	Pyrolysis Gasoline	Aromatics, Polyaromatics
Benzyl chloride	Chlorination	Toluene	Aromatics
Bisphenol A	Condensation	Phenol, Acetone	Phenol, Aromatics
Butadiene	Extractive distillation	C4 Pyrolysates	Acrylonitrile (acetonitrile solvent)
Butenes			Aromatics, Polyaromatics
Butylbenzyl phthalate	Esterification	n-Butanol, Benzyl chloride Phthalic anhydride	Phthalates
Caprolactam	Oxidation, Oximation	Cyclohexane	Aromatics
	Dehydrogenation, Oximation	Phenol	Aromatics, Phenol
Carbon tetrachloride	Chlorination	Methane	Chloromethanes, Chlorinated C2's
	Chlorination	Ethylene dichloride	Chloromethanes, Chlorinated C2's
Chlorobenzenes	Chlorination	Benzene	Chloroaromatics, Aromatics
Chloroform	Chlorination	Methane, Methyl chloride	Chloromethanes, Chlorinated C2's
m-Chloronitrobenzene	Chlorination	Nitrobenzene	Aromatics, Nitroaromatics, Chloroaromatics
Creosote	Distillation	Coal tar light oil	Phenols, Aromatics, Polyaromatics
Cumene	Alkylation	Benzene	Aromatics

TABLE V-39.
ORGANIC CHEMICALS EFFLUENTS WITH SIGNIFICANT CONCENTRATION
(>0.5 PPM) OF PRIORITY POLLUTANTS
(Continued)

Product	Generic Process	Feedstock(s)	Associated Priority Pollutants
Cyclohexanol/-one	Oxidation	Cyclohexane	Phenols, Aromatics
1,2-Dichloroethane	Oxychlorination	Ethylene, HCl	Chlorinated C2's
Dicyclopentadiene	Extraction, Dimerization	C5 Pyrolysate	Aromatics, Polyaromatics
Diethylphthalate	Esterification	Ethanol, Phthalic anhydride	Phthalates
Diketene	Dehydration	Acetic acid	Isophorone
Dimethyl terephthalate	Esterification	Methanol, TPA	Phthalates, Phenol
Dinitrotoluenes	Nitration	Toluene	Nitroaromatics, Aromatics, Nitrophenols
Diphenylisodecyl phosphate ester	Esterifcation	Phenol, Isodecanol $POCl_3$	Phenol, Chlorophenols Aromatics
Epichlorohydrin	Chlorohydrination	Allyl chloride	Chlorinated C3's
Ethoxylates-Alkylphenol	Ethoxylation	Alkylphenol, Ethylene oxide	Phenol, Aromatics
Ethylbenzene	Alkylation	Benzene, Ethylene	Aromatics, Polyaromatics, Phenol
	Extraction from BTX	BTX Extract	Aromatics, Polyaromatics Acrylonitrile (acetonitrile solvent)
Ethylene	Steam Pyrolysis	LPG, Naphtha, or Gas oil	Aromatics, Polyaromatics, Phenol
Ethylene amines	Ammonation	1,2-Dichloroethane, NH_3	Chlorinated C2's
Ethylene diamine	Ammonation	1,2-Dichloroethane, NH_3	Chlorinated C2's
Ethylene oxide	Oxidation	Ethylene	1,2-Dichloroethane (CO_2 inhibitor)
	Chlorohydrination	Ethylene	Chlorinated C2's, Chloroalkyl ethers
2-Ethylhexyl phthalate	Esterification	2-Ethylhexanol Phthalic anhydride	Phthalates
Glycerine	Hydrolysis	Epichlorohydrine	Chlorinated C3's
Hexamethylene diamine	Hydrogenation	Adiponitrile	Acrylonitrile
Isobutylene	Extraction	C4 Pyrolysate	Aromatics
Isoprene	Extractive distillation	C5 Pyrolysate	Aromatics, Polyaromatics Acrylonitrile (Acetonitrile solvent)
Maleic anhydride	Oxidation	Benzene	Aromatics
Methacrylic acid	Cyanohydrination	Acetone	Cyanide
Methyl chloride	Chlorination	Methane	Chloromethanes, Chlorinated C2's
	Hydrochlorination	Methanol	Chloromethanes

TABLE V-39.
ORGANIC CHEMICALS EFFLUENTS WITH SIGNIFICANT CONCENTRATION
(>0.5 PPM) OF PRIORITY POLLUTANTS
(Continued)

Product	Generic Process	Feedstock(s)	Associated Priority Pollutants
Methylene chloride	Chlorination	Methane Methyl chloride	Chloromethanes, Chlorinated C2's
Methylethyl Ketone	Reduction (alkoxide)	Acrolein, sec-Butanol	Acrolein, Aromatics, Polyaromatics, Phenol
a-Methyl styrene	Peroxidation	Cumene	Aromatics, Phenol
Naphthalene	Distillation	Coal tar distillates	Aromatics, Polyaromatics, Phenols, Cyanide
	Distillation	Pyrolysis Gasoline	Aromatics, Polyaromatics
Nitrobenzene	Nitration	Benzene	Aromatics, Nitroaromatics Nitrophenols
Phenol	Peroxidation	Cumene	Aromatics, Phenols
Phthalic anhydride	Oxidation	Naphthalene	Polyaromatics
	Oxidation	o-Xylene	Aromatics
Polymeric methylene dianiline	Condensation	Aniline, Formaldehyde	Nitroaromatics
Polymeric methylene diphenyl diisocyanate	Phosgenation	Polymeric methylene dianiline, Phosgene	Chloroaromatics (phosgenation solvent)
Propylene	Steam Pyrolysis	LPG, Naphtha, Gas oil	Aromatics, Polyaromatics, Phenols
Propylene oxide	Chlorohydrination	Propylene	Chlorinated C3's, Chloroalkyl ethers
Styrene	Dehydrogenation	Ethylbenzene	Aromatics, phenol
Tetrachloroethylene	Chlorination	1,2-Dichloroethane RCl Heavies	Chloromethanes, Chlorinated C2's, Chlorinated C3's
Tetrachlorophthalic anhydride	Chlorination	Phthalic anhydride	Chloroaromatics
Toluene	BTX Extraction	Catalytic reformate	Aromatics
	BTX Extraction	Coal tar light oil	Aromatics, Polyaromatics, Phenols, Cyanide
	BTX Extraction	Pyrolysis gasoline	Aromatics
Toluenediisocyanate	Phosgenation	Toluenediamine	Chloroaromatics
1,2,4-Trichlorobenzene	Chlorination	1,4-Dichlorobenzene	Chloroaromatics
Trichloroethylene	Chlorination	1,2-Dichloroehtane RCl heavies	Chlorinated C2's, Chloromethanes
Vinyl acetate	Acetylation	Ethylene, Acetic acid	Acrolein
Vinyl chloride	Dehydrochlorination	1,2-Dichloroethane	Chlorinated C2's, Chloromethanes

TABLE V-39.
ORGANIC CHEMICALS EFFLUENTS WITH SIGNIFICANT CONCENTRATION
(>0.5 PPM) OF PRIORITY POLLUTANTS
(Continued)

Product	Generic Process	Feedstock(s)	Associated Priority Pollutants
Vinylidene chloride	Dehydrochlorination	1,1,2-Trichloroethane	Chlorinated C2's, Chloromethanes
Xylenes (mixed)	BTX Extraction	Pyrolysis gasoline	Aromatics
	BTX Extraction	Catalytic reformate	Aromatics
	BTX Extraction	Coal tar distillates	Phenols, Aromatics, Polyaromatics, Cyanide
M,p-Xylenes	Distillation	BTX extract	Aromatics, Polyaromatics
o-Xylene	Distillation	BTX extract	Aromatics, Polyaromatics

TABLE V-40.
PLASTICS/SYNTHETIC FIBERS EFFLUENTS WITH SIGNIFICANT CONCENTRATIONS (>0.5 ppm) OF PRIORITY POLLUTANTS

Product	Monomer(s)	Associated Priority Pollutants
ABS resins	Acrylonitrile Styrene Polybutadiene	Acrylonitrile Aromatics
Acrylic fibers	Acrylonitrile Comonomer (variable) Vinyl chloride	Acrylonitrile Chlorinated C2's
Acrylic resins (Latex)	Acrylonitrile Acrylate Ester Methylmethacrylate	Acrylonitrile Acrolein
Acrylic resins	Methylmethacrylate	Cyanide
Alkyd resins	Glycerine Isophthalic acid Phthalic anhydride	Acrolein Aromatics Polyaromatics
Cellulose acetate	Diketene (acetylating agent)	Isophorone
Epoxy resins	Bisphenol A Epichlorohydrin	Phenol Chlorinated C3's Aromatics
Phenolic resins	Phenol Formaldehyde	Phenol Aromatics
Polycarbonates	Bisphenol A	(Not investigated) Predicted: Phenol Chloroaromatics Halomethanes
Polyester	Terephthalic acid/ Dimethylterephalate Ethylene glycol	Phenol Aromatics

TABLE V-40.
PLASTICS/SYNTHETIC FIBERS EFFLUENTS WITH
SIGNIFICANT CONCENTRATIONS (>0.5 ppm)
OF PRIORITY POLLUTANTS (Continued)

Product	Monomer(s)	Associated Priority Pollutants
HD Polyethylene resin	Ethylene	Aromatics
Polypropylene resin	Propylene	Aromatics
Polystyrene	Styrene	Aromatics
Polyvinyl chloride resin	Vinyl chloride	Chlorinated C2's
SAN resin	Styrene Acrylonitrile	Aromatics Acrylonitrile
Styrene - Butadiene resin (Latex)	Styrene (>50%) Polybutadiene	Aromatics
Unsaturated polyester	Maleic anhydride Phthalic anhydride Propylene glycol (Styrene added later)	Phenol Aromatics

In comparison with effluents from product/processes manufacturing organic chemicals, effluents from polymeric product/processes generally contained fewer priority pollutants at lower concentrations. The polymeric plastics and fibers considered in this report have virtually no water solubility. Furthermore, the process is designed to drive the polymerization as far to completion as is practical and to recover unreacted monomer (often with its impurities) for recycle to the process. Thus, the use of only a few priority pollutant-related monomers, the limited solubility of polymeric products, and monomer recovery, results in the reduction of the number of priority pollutants and their relative loading in plastics/synthetic fibers effluents.

Table V-41 lists priority pollutants detected in OCPSF process wastewaters by precursor/generic process combinations. Priority pollutants are generically grouped and the groups are arrayed horizontally. Priority pollutants reported from Verification analyses of product/process effluents are noted in four concentration ranges, reading across from each precursor. This arrangement makes it more apparent, particularly at higher concentration ranges, that reported priority pollutants tend to aggregate within those groups that would be expected from the corresponding precursor-generic process combination.

In contrast with organic priority pollutants that are co-produced from other organic chemicals, metallic priority pollutants cannot be formed from other metals. Except for a possible change of oxidation state, metals remain immutable throughout the generic process. Thus, to anticipate metallic priority pollutants, the metals that were introduced into a generic process must be known.

Metallic priority pollutants, individually and in combinations, are most often related to a generic process via the catalyst system. The metals comprising catalyst systems that are commonly employed with particular precursor/generic process combinations to manufacture important petrochemical products have been generally characterized in the technical literature (especially in patents). An obvious way to offer clues for predicting metallic priority pollutants was to expand the generic process descriptors in the listing of Table V-41 to include this information.

Table V-41
Priority Pollutants in Effluents of Precursor-Generic Process Combinations

PRODUCT PROCESS CODE	PRIORITY POLLUTANT GROUPS / PRECURSOR (FEEDSTOCK)	AROMATICS			PHENOLS		POLYAROMATICS																		
		Benzene	Toluene	Ethylbenzene	Phenol	2,4-Dimethylphenol	Naphthalene	Acenaphthene	Acenaphthylene	Anthracene	Benzo(a)anthracene	Benzo(a)pyrene	3,4-Benzofluoranthene	Benzo(k)fluoranthene	Benzo(ghi)perylene	Chrysene	Dibenzo(a,h)anthracene	Fluorene	Fluoranthene	Ideno(1,2,3-cd)pyrene	Phenanthrene	Pyrene	2-Chloronaphthalene	PCB's
	DIRECT CHLORINATION																							
0890-01	Benzene [3]	*	o	o	o	o																		
0530-01	Toluene	*	●	o	◊					o											o		◊	
3393-01	1,4-Dichlorobenzene	*	o	o	◊	o																		
0949-01	Nitrobenzene	●	o	o	o	o																		
3300-01	Phthalic anhydride	o	◊																					
1244-01	Ethylene	◊	◊	o	o																			
3295-02	Ethylene dichloride [4]	*			o																			
3410-03	Ethylene dichloride [5]	*	*	o	◊		*			o								*			o			
0810-01	Methane [6]	*			o																			
	CHLOROHYDRINATION																							
1650-01	Allyl chloride	◊			o		◊		o															
1980-02	Ethylene [7]	o																						
3120-02	Propylene [7]	o																						
	DEHYDROCHLORINATION																							
3520-80	Ethylene dichloride																							
3530-02	1,1,2-Trichloroethane	◊	●[1]	◊	●[1]																			
	HYDROFLUORINATION																							
1221-01	Carbon tetrachloride																							
3535-01	1,1,1-Trichloroethane																							
	PHOSGENATION																							
3015-01	Poly MDA [8]	◊	o																					
3354-01	2,4-Tolylenediamine	◊	◊		◊		●																	
	AMMONATION																							
0185-04	Adipic acid					●																		
1700-01	Ethanol																							
1800-01	Ethylene dichloride [9]	o	*	o																				
	ACETYLATION																							
0820-03	Cellulose/Acetic anhyd.				o																			
	DEHYDRATION																							
0080-02	Acetic acid	*	◊	o	o																			
2690-01	Cumene hydroperoxide	●	*		*		◊																	
2265-02	t-Butanol	o	o	o	●[1]	o	o			o	o					o		o			o	o		
1450-01	Acetic acid	●[10]			◊																			

PRODUCT PROCESS CODE	PRECURSOR (FEEDSTOCK)	CHLOROAROMATICS						CHLOROPHENOLS					HALOARYL ETHERS		NITROAROMATICS			NITROPHENOLS				NITROSAMINES			BENZIDINES		
		Chlorobenzene	o-Dichlorobenzene	m-Dichlorobenzene	p-Dichlorobenzene	1,2,4-Trichlorobenzene	Hexachlorobenzene	2-Chlorophenol	4-Chloro-m-cresol	2,4-Dichlorophenol	2,4,6-Trichlorophenol	Pentachlorophenol	4-Chlorophenylphenyl ether	4-Bromophenylphenyl ether	Nitrobenzene	2,4-Dinitrotoluene	2,6-Dinitrotoluene	2-Nitrophenol	4-Nitrophenol	2,4-Dinitrophenol	4,6-Dinitrophenol	N-Nitrosodimethyl amine	N-Nitrosodiphenyl amine	N-Nitrosodi-n-propyl amine	1,2-Diphenylhydrazine	Benzidine	3,3'-Dichlorobenzidine
	DIRECT CHLORINATION																										
0890-01	Benzene [3]	o[2]	●	●	●	*		o		o	o	◊															
0530-01	Toluene	o						◊		◊																	
3393-01	1,4-Dichlorobenzene	o	●	●	●	*		o		o	o	◊															
0949-01	Nitrobenzene	o	*	●	●	◊		o		◊	◊	◊															
3300-01	Phthalic anhydride	◊				◊	●				o																
1244-01	Ethylene																										
3295-02	Ethylene dichloride [4]																										
3410-03	Ethylene dichloride [5]							o																			
0810-01	Methane [6]																										
	CHLOROHYDRINATION																										
1650-01	Allyl chloride																										
1980-02	Ethylene [7]																										
3120-02	Propylene [7]																										
	DEHYDROCHLORINATION																										
3520-80	Ethylene dichloride											●[1]															
3530-02	1,1,2-Trichloroethane							●[1]		●[1]	◊																
	HYDROFLUORINATION																										
1221-01	Carbon tetrachloride																										
3535-01	1,1,1-Trichloroethane																										
	PHOSGENATION																										
3015-01	Poly MDA [8]	●	●					o		o	◊				*	o	o										
3354-01	2,4-Tolylenediamine		●		o	o		◊		◊	o																
	AMMONATION																										
0185-04	Adipic acid																										
1700-01	Ethanol																										
1800-01	Ethylene dichloride [9]	o																									
	ACETYLATION																										
0820-03	Cellulose/Acetic anhyd.																										
	DEHYDRATION																										
0080-02	Acetic acid										o	o															
2690-01	Cumene hydroperoxide		o																								
2265-02	t-Butanol							o											o								
1450-01	Acetic acid																										

PRODUCT PROCESS CODE	PRECURSOR (FEEDSTOCK)	PHTHALATES						HALOGENATED METHANES										CHLORINATED C2's											
		Dimethyl phthalate	Diethyl	Di-n-butyl	Di-n-octyl	bis(2-Ethylhexyl)	Butylbenzyl	Methyl bromide	Methyl chloride	Methylene chloride	Bromoform	Chloroform	Bromodichloromethane	Dibromochloromethane	Dichlorodifluoromethane	Trichlorofluoromethane	Carbon tetrachloride	Chloroethane	Chloroethylene	1,2-Dichloroethane	1,2-t-Dichloroethylene	1,1-Dichloroethylene	1,1-Dichloroethane	1,1,2-Trichloroethane	1,1,1-Trichloroethane	Trichloroethylene	Tetrachloroethylene	1,1,2,2-Tetrachloroethane	Hexachloroethane
	DIRECT CHLORINATION																												
0890-01	Benzene [3]											●	o				◊												
0530-01	Toluene											*					o	●								◊			
3393-01	1,4-Dichlorobenzene											●	o				◊												
0949-01	Nitrobenzene											*	o				*												
3300-01	Phthalic anhydride											*	o				◊									o	◊		
1244-01	Ethylene									◊		◊								◊						o	◊		
3295-02	Ethylene dichloride [4]								●	●		●					●	o		●		●	*	●		●	●		o
3410-03	Ethylene dichloride [5]									●																			
0810-01	Methane [6]								●	●		●					●	o		●		●	*	●		●	●		o
	CHLOROHYDRINATION																												
1650-01	Allyl chloride									◊		*					●								o	◊			
1980-02	Ethylene [7]								◊	◊		●					*	o		●		◊	o			◊			
3120-02	Propylene [7]								◊	◊		●					*	o		●		◊	o			◊			
	DEHYDROCHLORINATION																												
3520-80	Ethylene dichloride									●		●					●	◊	●	●					o	●	●		
3530-02	1,1,2-Trichloroethane									●		●					*	●	◊	●		●	●	●	◊	*	◊		
	HYDROFLUORINATION																												
1221-01	Carbon tetrachloride									●		o	o		●	●	●			●	o		o		o	o		o	
3535-01	1,1,1-Trichloroethane									*		●	o		◊		●			●	●	●		●	●	*	◊	o	
	PHOSGENATION																												
3015-01	Poly MDA [8]											*					◊									◊			
3354-01	2,4-Tolylenediamine									◊		●					◊								◊	o	◊		◊
	AMMONATION																												
0185-04	Adipic acid											*					●[1]								*		o		
1700-01	Ethanol											◊																	
1800-01	Ethylene dichloride [9]									o							o		●	●						◊	o		
	ACETYLATION																												
0820-03	Cellulose/Acetic anhyd.																							o					
	DEHYDRATION																												
0080-02	Acetic acid											o									o								
2690-01	Cumene hydroperoxide											◊																	
2265-02	t-Butanol									o	o	o													o				
1450-01	Acetic acid		●[10]	●[10]																									

PRODUCT PROCESS CODE	PRECURSOR (FEEDSTOCK)	CHLORINATED C3's		Hexachlorobutadiene	Hexachlorocyclopentadiene	CHLOROALKYL ETHERS					MISCELLANEOUS				METALS												
		1,2-Dichloropropane	1,3-Dichloropropylene			bis(Chloromethyl)ether	bis(Chloroethyl)ether	bis(2-Chloroisopropyl)ether	2-Chloroethylvinyl ether	bis(2-Chloroethoxy)methane	Acrolein	Acrylonitrile	Cyanide	Isophorone	Antimony	Arsenic	Beryllium	Cadmium	Chromium	Copper	Lead	Mercury	Nickel	Selenium	Silver	Thallium	Zinc
	DIRECT CHLORINATION																										
0890-01	Benzene [3]		o													o			*	*		◊		o			
0530-01	Toluene	◊											o		*			◊	*	*	●		●		*		o
3393-01	1,4-Dichlorobenzene		o													o			*	●		◊		o			
0949-01	Nitrobenzene		o													◊			*	*		◊		o			
3300-01	Phthalic anhydride														●		◊	◊	*	*	●		●		*		o
1244-01	Ethylene												◊							◊							o
3295-02	Ethylene dichloride [4]	●		*									◊							*							
3410-03	Ethylene dichloride [5]			o						◊			◊							◊							o
0810-01	Methane [6]	●											◊							*							o
	CHLOROHYDRINATION																										
1650-01	Allyl chloride	●	●										◊						◊	*			*				
1980-02	Ethylene [7]	●					●	●					◊							*							
3120-02	Propylene [7]	●					●	●					◊							*							
	DEHYDROCHLORINATION																										
3520-80	Ethylene dichloride	o	◊										◊						●	*			*				o
3530-02	1,1,2-Trichloroethane												*							◊							◊
	HYDROFLUORINATION																										
1221-01	Carbon tetrachloride														o			o	o	o	◊	o			◊		
3535-01	1,1,1-Trichloroethane														o			o	*	*	*	o		o	o		
	PHOSGENATION																										
3015-01	Poly MDA [8]												o		o	◊	o	o	◊	o	o	o	o	o	o		o
3354-01	2,4-Tolylenediamine												◊							◊							
	AMMONATION																										
0185-04	Adipic acid											●							●	●			●		◊		
1700-01	Ethanol																		●	◊							
1800-01	Ethylene dichloride [9]												◊						◊	◊							*
	ACETYLATION																										
0820-03	Cellulose/Acetic anhyd.																o	*	*	o	o						
	DEHYDRATION																										
0080-02	Acetic acid													o					o	o		o					
2690-01	Cumene hydroperoxide												o		*	o		◊	*	o	◊	o	o	●	o	◊	o
2265-02	t-Butanol												o						o	o			o				o
1450-01	Acetic acid													◊		o		o	o	o	o	o					

Notes:
1. Extraneous to product/process.
2. False negative.
3. 1218-01,1220-01 have similar analyses.
4. 0810-04, has similar analysis.
5. Chlorinated C2's are missing from this analysis.
6. 0830-02,2820-02,2560-03 have similar analyses.
7. Common wastewater effluent.
8. 3355-01 has similar analysis.
9. 3011-01 has similar analysis.
10. Acetic acid recovered from oxidation of o-xylene.

KEY: ● = >0.5 ppm
* = 0.1 - 0.5 ppm
◊ = .01 - 0.1 ppm
o = <.01 ppm, or analysis failed to detect

Table V-41 (Continued)
Priority Pollutants in Effluents of Precursor-Generic Process Combinations

Product Process Code	Precursor (Feedstock)	Benzene	Toluene	Ethylbenzene	Phenol	2,4-Dimethylphenol	Naphthalene	Acenaphthene	Acenaphthylene	Anthracene	Benzo(a)anthracene	Benzo(a)pyrene	3,4-Benzofluoranthene	Benzo(k)fluoranthene	Benzo(ghi)perylene	Chrysene	Dibenzo(a,h)anthracene	Fluorene	Fluoranthene	Ideno(1,2,3-cd)pyrene	Phenanthrene	Pyrene
	Priority pollutant groups	AROMATICS			PHENOLS		POLYAROMATICS															
	CRACKING																					
1770-01	LPG[2]	●	●	●	●		●	◊	●	*	o	o						●	◊		●	*
1770-02	Naphtha/Gas oil[3]	●	●	●	●	●	●	●	o	●	*	◊		◊	o	◊		*	●	o	●	*
1770-04	Naphtha/LPG[4]	●	●		●	o			◊	◊								◊	o		◊	◊
0130-03	Naphtha/LPG	●	●		●	o			◊	◊								◊	o		◊	◊
	EXTRACTION/DISTILLATION																					
0380-02	Catalytic reformate[5]	●	●	●	◊	o	*			o	o					o		o			o	o
0380-04	Coal tar light oil[6]	●	●		●	●		●	●	●	●					●			●		●	●
0380-09	Pyrolysis gasoline[7]	●	●	●	◊		●			*	*	◊		o				●	◊	◊	●	*
0590-01	C4 Pyrolyzates	●	●	●	o		●	o	o	●	*	o	◊	◊	◊			●	◊	◊	●	*
1171-01	C5 Pyrolyzates	●	●	●			●			●	*	◊	◊	◊	◊			●	◊	◊	●	●
2701-02	Pyrolysis gasoline	●	●	●			●			●	*	◊	◊	◊	◊			●	◊	◊	●	●
2265-01	C4 Pyrolyzates	●	●	◊	o	o	*	o	o	o								o	o		o	o
1710-02	BTX Extract	●	●	●			●			●	*	◊	◊	◊	◊			●	◊	◊	●	●
2350-02	C5 Pyrolyzates	●	●	◊	◊	o	●	o	o	◊	◊	o	o	o	o			●	o	o	*	◊
0720-01	C4 Pyrolyzates[8]	●	●	●			●			●	*	◊	◊	◊	◊			●	◊	◊	●	●
	ALKYLATION																					
1710-01	Benzene/Ethylene	●	●	●	●		●			o	o	*				o		◊			o	◊
1060-01	Benzene/Propylene[9]	●																				
0195-01	Phenol/Octene/Nonene		●		●																	
	HYDRODEALKYLATION																					
0380-01	Toluene/Xylene	●	●	●	◊		●	◊	o	●	*	o	◊	◊	◊			●		◊	●	*
	OXIMATION																					
0785-06	Phenol/Cyclohexanone	o	●		●																	
0785-09	Cyclohexane/Cyclohexanone	●	●	o	●																	
	DIMERIZATION																					
1171-01	Cyclopentadiene	●	●	●			●			●	*	◊	◊	◊	◊			●	◊	◊	●	●
1450-01	Ketene	●			◊																	
	CARBOXYLATION																					
3170-01	Phenol	o	o		●																	
	NITRATION																					
1550-01	Toluene	●	●																			
2770-01	Benzene	●			◊																	
	DIAZOTIZATION																					
Uncoded	2,4,6-Trichloroaniline																					
Uncoded	Aniline				●																	
Uncoded	4-Nitroaniline																					
Uncoded	2-Nitroaniline																					

Product Process Code	Precursor (Feedstock)	2-Chloronaphthalene	PCB's	Chlorobenzene	o-Dichlorobenzene	m-Dichlorobenzene	p-Dichlorobenzene	1,2,4-Trichlorobenzene	Hexachlorobenzene	2-Chlorophenol	4-Chloro-m-cresol	2,4-Dichlorophenol	2,4,6-Trichlorophenol	Pentachlorophenol	4-Chlorophenylphenyl ether	4-Bromophenylphenyl ether	Nitrobenzene	2,4-Dinitrotoluene	2,6-Dinitrotoluene	2-Nitrophenol	4-Nitrophenol	2,4-Dinitrophenol	4,6-Dinitrophenol
	Priority pollutant groups			CHLOROAROMATICS						CHLOROPHENOLS					HALOARYL ETHERS		NITROAROMATICS			NITROPHENOLS			
	CRACKING																						
1770-01	LPG[2]			o						o													
1770-02	Naphtha/Gas oil[3]									◊							◊						
1770-04	Naphtha/LPG[4]																						
0130-03	Naphtha/LPG																						
	EXTRACTION/DISTILLATION																						
0380-02	Catalytic reformate[5]				◊																o		
0380-04	Coal tar light oil[6]																						
0380-09	Pyrolysis gasoline[7]			◊	◊									o									
0590-01	C4 Pyrolyzates				◊																		
1171-01	C5 Pyrolyzates				◊																		
2701-02	Pyrolysis gasoline				◊																		
2265-01	C4 Pyrolyzates											o	o							◊			
1710-02	BTX Extract				◊							o											
2350-02	C5 Pyrolyzates				o								o							◊			
0720-01	C4 Pyrolyzates[8]				◊																		
	ALKYLATION																						
1710-01	Benzene/Ethylene			◊						◊		◊	◊										
1060-01	Benzene/Propylene[9]																						
0195-01	Phenol/Octene/Nonene																						
	HYDRODEALKYLATION																						
0380-01	Toluene/Xylene			o	◊																		
	OXIMATION																						
0785-06	Phenol/Cyclohexanone			o																*			
0785-09	Cyclohexane/Cyclohexanone													o						◊	o		
	DIMERIZATION																						
1171-01	Cyclopentadiene																						
1450-01	Ketene																						
	CARBOXYLATION																						
3170-01	Phenol									●[10]													
	NITRATION																						
1550-01	Toluene																●	●	●	*	◊	*	
2770-01	Benzene													o			●	●		●	●	●	●
	DIAZOTIZATION																						
Uncoded	2,4,6-Trichloroaniline			o						◊		o	◊										
Uncoded	Aniline																						
Uncoded	4-Nitroaniline																				●	o	
Uncoded	2-Nitroaniline																			◊		o	

Product Process Code	Precursor (Feedstock)	N-Nitrosodimethyl amine	N-Nitrosodiphenyl amine	N-Nitrosodi-n-propyl amine	1,2-Diphenylhydrazine	Benzidine	3,3'-Dichlorobenzidine	Dimethyl phthalate	Diethyl	Di-n-butyl	Di-n-octyl	bis(2-Ethylhexyl)	Butylbenzyl	Methyl bromide	Methyl chloride	Methylene chloride	Bromoform	Chloroform	Bromodichloromethane	Dibromochloromethane	Dichlorodifluoromethane	Trichlorofluoromethane	Carbon tetrachloride
	Priority pollutant groups	NITROSAMINES			BENZIDINES			PHTHALATES						HALOGENATED METHANES									
	CRACKING																						
1770-01	LPG[2]															o		o					
1770-02	Naphtha/Gas oil[3]															o		*	o				o
1770-04	Naphtha/LPG[4]															o							
0130-03	Naphtha/LPG															o							
	EXTRACTION/DISTILLATION																						
0380-02	Catalytic reformate[5]															o	o	◊					
0380-04	Coal tar light oil[6]															●[1]			o				
0380-09	Pyrolysis gasoline[7]															o	◊	◊	◊				
0590-01	C4 Pyrolyzates															o			o				
1171-01	C5 Pyrolyzates															o			◊				
2701-02	Pyrolysis gasoline															o			◊				
2265-01	C4 Pyrolyzates														◊	◊		o	o			o	o
1710-02	BTX Extract															o			◊				
2350-02	C5 Pyrolyzates														●[1]	o		o	o			o	o
0720-01	C4 Pyrolyzates[8]															o			◊				
	ALKYLATION																						
1710-01	Benzene/Ethylene				*											*		o					
1060-01	Benzene/Propylene[9]																						
0195-01	Phenol/Octene/Nonene															o		o					
	HYDRODEALKYLATION																						
0380-01	Toluene/Xylene															◊		o		◊		●[1]	
	OXIMATION																						
0785-06	Phenol/Cyclohexanone		o																				
0785-09	Cyclohexane/Cyclohexanone															o		o				o	o
	DIMERIZATION																						
1171-01	Cyclopentadiene															o				◊			
1450-01	Ketene																						
	CARBOXYLATION																						
3170-01	Phenol																						
	NITRATION																						
1550-01	Toluene																	o					o
2770-01	Benzene																	o					o
	DIAZOTIZATION																						
Uncoded	2,4,6-Trichloroaniline																						
Uncoded	Aniline																						
Uncoded	4-Nitroaniline																						
Uncoded	2-Nitroaniline																						

Product Process Code	Precursor (Feedstock)	Chloroethane	Chloroethylene	1,2-Dichloroethane	1,2-t-Dichloroethylene	1,1-Dichloroethylene	1,1-Dichloroethane	1,1,2-Trichloroethane	1,1,1-Trichloroethane	Trichloroethylene	Tetrachloroethylene	1,1,2,2-Tetrachloroethane	Hexachloroethane	1,2-Dichloropropane	1,3-Dichloropropylene	Hexachlorobutadiene	Hexachlorocyclopentadiene	bis(Chloromethyl)ether	bis(Chloroethyl)ether	bis(2-Chloroisopropyl)ether	2-Chloroethylvinyl ether	bis(2-Chloroethoxy)methane
	Priority pollutant groups	CHLORINATED C2's												CHLORINATED C3's				CHLOROALKYL ETHERS				
	CRACKING																					
1770-01	LPG[2]			o																		
1770-02	Naphtha/Gas oil[3]	o				o	o	o	o			o		o								
1770-04	Naphtha/LPG[4]								◊													
0130-03	Naphtha/LPG								◊													
	EXTRACTION/DISTILLATION																					
0380-02	Catalytic reformate[5]								o													
0380-04	Coal tar light oil[6]																					
0380-09	Pyrolysis gasoline[7]			o					o													
0590-01	C4 Pyrolyzates			o			◊															
1171-01	C5 Pyrolyzates																					
2701-02	Pyrolysis gasoline																					
2265-01	C4 Pyrolyzates			o		o	o	o				o		o	o							
1710-02	BTX Extract																					
2350-02	C5 Pyrolyzates			o		o	o		o			o		o	o							
0720-01	C4 Pyrolyzates[8]																					
	ALKYLATION																					
1710-01	Benzene/Ethylene	◊		o		*																
1060-01	Benzene/Propylene[9]																					
0195-01	Phenol/Octene/Nonene																					
	HYDRODEALKYLATION																					
0380-01	Toluene/Xylene	◊				o	◊															
	OXIMATION																					
0785-06	Phenol/Cyclohexanone																					
0785-09	Cyclohexane/Cyclohexanone			o	o	o			o	o		o										
	DIMERIZATION																					
1171-01	Cyclopentadiene																					
1450-01	Ketene																					
	CARBOXYLATION																					
3170-01	Phenol																					
	NITRATION																					
1550-01	Toluene									o												
2770-01	Benzene									o					o							
	DIAZOTIZATION																					
Uncoded	2,4,6-Trichloroaniline																					
Uncoded	Aniline																					
Uncoded	4-Nitroaniline																					
Uncoded	2-Nitroaniline																					

Product Process Code	Precursor (Feedstock)	Acrolein	Acrylonitrile	Cyanide	Isophorone	Antimony	Arsenic	Beryllium	Cadmium	Chromium	Copper	Lead	Mercury	Nickel	Selenium	Silver	Thallium	Zinc
	Priority pollutant groups	MISCELLANEOUS				METALS												
	CRACKING																	
1770-01	LPG[2]			o						●	◊	o						◊
1770-02	Naphtha/Gas oil[3]		●[1]	◊			o		o	●	◊	o	o	o	o		o	◊
1770-04	Naphtha/LPG[4]									o	◊		o			o		
0130-03	Naphtha/LPG									o	◊		o			o		
	EXTRACTION/DISTILLATION																	
0380-02	Catalytic reformate[5]			o						●	o			o				●
0380-04	Coal tar light oil[6]			●			o			*	◊		◊		◊			
0380-09	Pyrolysis gasoline[7]		*								◊	o	o	◊				
0590-01	C4 Pyrolyzates		●	o							●	◊	o	o				o
1171-01	C5 Pyrolyzates		●								◊	◊	o	◊				
2701-02	Pyrolysis gasoline		●[1]								◊	◊	o	o				
2265-01	C4 Pyrolyzates									o	*	*	o		o		o	
1710-02	BTX Extract		●								◊	◊	o	◊				
2350-02	C5 Pyrolyzates		◊							o	*	*	o		o		o	
0720-01	C4 Pyrolyzates[8]		●								◊	◊	o	◊				
	ALKYLATION																	
1710-01	Benzene/Ethylene			◊							*							●
1060-01	Benzene/Propylene[9]			◊						o	o			o				o
0195-01	Phenol/Octene/Nonene			o						◊	o							◊
	HYDRODEALKYLATION																	
0380-01	Toluene/Xylene		●[1]	o							◊	◊	o	◊				o
	OXIMATION																	
0785-06	Phenol/Cyclohexanone									*	◊		o					
0785-09	Cyclohexane/Cyclohexanone			o			o			*	◊		o	o	◊			
	DIMERIZATION																	
1171-01	Cyclopentadiene		●[12]								◊	◊	o	◊				
1450-01	Ketene				*		o		o	o	o	o	o	o	o			
	CARBOXYLATION																	
3170-01	Phenol					o	o	o	o	◊	*	o	o	o[11]	o	o	o	o
	NITRATION																	
1550-01	Toluene			●[1]		*	◊	o	o	*	◊	◊	o	*	◊	o	o	o
2770-01	Benzene			*		●	●	◊	◊	*	o	◊	o	●	◊	o	◊	o
	DIAZOTIZATION																	
Uncoded	2,4,6-Trichloroaniline																	
Uncoded	Aniline																	
Uncoded	4-Nitroaniline																	
Uncoded	2-Nitroaniline																	

Notes:
1. Extraneous to product/process.
2. 3090-02 has similar analysis.
3. 3090-05 has similar analysis.
4. 3090-11 has similar analysis.
5. 3349-01,3541-03 have similar analyses.
6. 1007-01,2981-01,2701-01 have similar analyses.
7. 3349-07,3541-01,3541-08 have similar analyses.
8. 3560-01 has similar analysis.
9. 1442-01 has similar analysis.
10. Chlorine source probably 50% caustic [illegible].
11. Less than verification criterion.
12. Possible contaminant from acetonitrile extraction solvent.

KEY: ● = >0.5 ppm
* = 0.1 - 0.5 ppm
◊ = .01 - 0.1 ppm
o = <.01 ppm, or analysis failed to detect

Table V-41 (Continued)
Priority Pollutants in Effluents of Precursor-Generic Process Combinations

Priority pollutant groups: Aromatics; Phenols; Polyaromatics

Product Process Code	Precursor (Feedstock)	Benzene	Toluene	Ethylbenzene	Phenol	2,4-Dimethylphenol	Naphthalene	Acenaphthene	Acenaphthylene	Anthracene	Benzo(a)anthracene	Benzo(a)pyrene	3,4-Benzofluoranthene	Benzo(k)fluoranthene	Benzo(ghi)perylene	Chrysene	Dibenzo(a,h)anthracene	Fluorene	Fluoranthene	Ideno(1,2,3-cd)pyrene	Phenanthrene	Pyrene	2-Chloronaphthalene
	OXIDATION																						
2430-01	Benzene	*	*	●	o[2]	◊	o																o
0091-01	Cumene[4]	●	*		*		◊																
1135-01	Cyclohexane	●	◊	o	●																		
0180-80	Cyclohexane/-ol/-one	◊	o				o	o			o												
2960-01	Naphthalene	o	◊		◊		●																
2960-02	o-Xylene						o			◊											◊		
3280-01	p-Xylene[5]	o	*	o																			
0030-02	Ethylene		*		◊																		
1980-01	Ethylene	●	●	●	*		*	◊	◊	o								◊			◊		
0140-01	Propylene[6]	●	*		●		*	o															
0160-80	Propylene				*	◊																	
0180-01	Cyclohexanol	◊	*		◊																		
2640-07	sec-Butanol/Acrolein	●	●	◊	●		●		●														
0070-04	Acetaldehyde				◊																		
3066-01	Propionaldehyde																						
2200-01	Aniline				◊																		
0130-01	Methane	●	*	◊	*		●	o	●	o								◊	o		o	◊	
0180-03	Cyclohexanol/one mix	◊	◊																				
0430-01	Toluene[8]	●	●		●																		
	HYDROGENATION																						
0200-01	Acrolein/sec-Butanol	●	●	◊	●		●		●														
2165-02	Adiponitrile	◊			●																		
0640-02	n-Butyraldehyde[9]	◊	●	o	*		*	*	●	o								o			o	o	
2500-02	Carbon monoxide	o	o	o	o	o																	
3351-01	Dinitrotoluene		*																				
0300-04	Nitrobenzene	●	o		◊																		
2000-01	2-Ethyl-2-hexenal	o	o	o	*																		
3070-01	Propionaldehyde	◊	o	o			o	o	o	o		o	o	o	o		o	o	o	o	o	o	
	DEHYDROGENATION																						
0185-04	Adipoamide				●																		
3230-01	Ethylbenzene	●	●	●	●		◊		◊	o	◊							◊					
2500-02	Methane	o	o	o	o	o																	
2040-01	Methanol		*																				
0090-11	Isopropanol	*	◊		o																		
2640-01	sec-Butanol																						
	HYDROFORMYLATION/CARBONYLATION																						
3050-01	Ethylene	◊	o	o			o	o	o	o		o	o	o	o		o	o	o	o	o	o	
2750-01	Isobutylene	◊	◊	o	*	o	o	o	o	o									o		o	o	
0640-02	Propylene	◊	●[1]	o	*		◊	*	●[1]	o								o			o	o	
0070-05	Methanol		o	o																			
0160-03	Acetylene	*	◊	◊	◊																		

Priority pollutant groups: PCB's; Chloroaromatics; Chlorophenols; Haloaryl ethers; Nitroaromatics; Nitrophenols; Nitrosamines; Benzidines; Phthalates

Product Process Code	PCB's	Chlorobenzene	o-Dichlorobenzene	m-Dichlorobenzene	p-Dichlorobenzene	1,2,4-Trichlorobenzene	Hexachlorobenzene	2-Chlorophenol	4-Chloro-m-cresol	2,4-Dichlorophenol	2,4,6-Trichlorophenol	Pentachlorophenol	4-Chlorophenylphenyl ether	4-Bromophenylphenyl ether	Nitrobenzene	2,4-Dinitrotoluene	2,6-Dinitrotoluene	2-Nitrophenol	4-Nitrophenol	2,4-Dinitrophenol	4,6-Dinitrophenol	N-Nitrosodimethyl amine	N-Nitrosodiphenyl amine	N-Nitrosodi-n-propyl amine	1,2-Diphenylhydrazine	Benzidine	3,3'-Dichlorobenzidine	Dimethyl phthalate	Diethyl	Di-n-butyl	Di-n-octyl	bis(2-Ethylhexyl)	Butylbenzyl
OXIDATION																																	
2430-01																																	
0091-01			o																														
1135-01		o										o						o	o														
0180-80																																	
2960-01	o							◊										o	o														
2960-02																																	
3280-01																																	
0030-02												●[1]						◊	●[1]	●[1]													
1980-01																																	
0140-01																																	
0160-80																																	
0180-01																																	
2640-07																																	
0070-04																																	
3066-01												◊								*													
2200-01											◊	◊																					
0130-01								◊																									
0180-03																																	
0430-01								◊																									
HYDROGENATION																																	
0200-01																																	
2165-02																																	
0640-02		◊						o				◊						*	◊	o													
2500-02											o																						
3351-01		o								o					◊	*	◊																
0300-04		*	o					o		o		o			●	◊	◊	o	o	o													
2000-01		◊										◊						*	◊														
3070-01			◊																														
DEHYDROGENATION																																	
0185-04																																	
3230-01					*													o															
2500-02			o								o																						
2040-01																																	
0090-11																																	
2640-01																																	
HYDROFORMYLATION/CARBONYLATION																																	
3050-01																																	
2750-01										o	o							o															
0640-02		◊						o				◊						*	◊	o													
0070-05																																	
0160-03		o										◊						◊	o														

Priority pollutant groups: Halogenated methanes; Chlorinated C2's; Chlorinated C3's

Product Process Code	Methyl bromide	Methyl chloride	Methylene chloride	Bromoform	Chloroform	Bromodichloromethane	Dibromochloromethane	Dichlorodifluoromethane	Trichlorofluoromethane	Carbon tetrachloride	Chloroethane	Chloroethylene	1,2-Dichloroethane	1,2-t-Dichloroethylene	1,1-Dichloroethylene	1,1-Dichloroethane	1,1,2-Trichloroethane	1,1,1-Trichloroethane	Trichloroethylene	Tetrachloroethylene	1,1,2,2-Tetrachloroethane	Hexachloroethane	1,2-Dichloropropane	1,3-Dichloropropylene	Hexachlorobutadiene	Hexachlorocyclopentadiene
OXIDATION																										
2430-01																							o	o		
0091-01					◊																					
1135-01			o		o				o	o			o	o	o			o	o		o					
0180-80																										
2960-01			◊								◊															
2960-02																										
3280-01																	o									
0030-02			o		●					o					●			o								
1980-01			◊		o							*	●[3]							o						
0140-01																								o		
0160-80			o		o																					
0180-01																										
2640-07					o						o		o					o	o	o			o			
0070-04					o					o						●										
3066-01			o						o									o								
2200-01																										
0130-01			◊		◊	o				o													◊			
0180-03																		◊								
0430-01																										
HYDROGENATION																										
0200-01					o						o		o					o	o	o			o			
2165-02			*		*					●[1]								◊		o						
0640-02			◊		o	o			o	o	o		o	o	o	o	o	o					◊			
2500-02																										
3351-01					o					o								*	o							
0300-04					o					o									◊				o			
2000-01			◊		o				o	o			o	o	o			o			o					
3070-01				o		o	o						*						o	o		o				
DEHYDROGENATION																										
0185-04					*					●[1]								*		o						
3230-01			●[1]		o					o					●								◊	*		
2500-02																										
2040-01																										
0090-11																										
2640-01																										
HYDROFORMYLATION/CARBONYLATION																										
3050-01				o		o	o						*							o		o				
2750-01	o		o		o	o			o	o			o		o	o		o	o		o		o	o		
0640-02			◊		o	o			o	o	o		o	o	o	o		o			o		◊			
0070-05					o	o																				
0160-03			◊		o				o	o			o	o	o			o	o		o					

Priority pollutant groups: Chloroalkyl ethers; Miscellaneous; Metals

Product Process Code	bis(Chloromethyl)ether	bis(Chloroethyl)ether	bis(2-Chloroisopropyl)ether	2-Chloroethylvinyl ether	bis(2-Chloroethoxy)methane	Acrolein	Acrylonitrile	Cyanide	Isophorone	Antimony	Arsenic	Beryllium	Cadmium	Chromium	Copper	Lead	Mercury	Nickel	Selenium	Silver	Thallium	Zinc
OXIDATION																						
2430-01						o	●[1]							●	*		o					
0091-01				o				o		*	o		◊	*	o	◊	o	o	●	o	◊	o
1135-01								o			o			*	*		o	o	o	o		
0180-80								●							*							o
2960-01										*				●	o	◊		o		o		●
2960-02														◊	◊		o					o
3280-01													o	o	◊	◊	o					
0030-02							●[1]							◊	●	◊				o		
1980-01			◊					◊						o	◊							o
0140-01						●									●							
0160-80						●								o	o		o					o
0180-01						●		◊						◊	*							
2640-07														o	*			o				●
0070-04						*	●[1]	o						o	◊	◊	o			o		
3066-01																						
2200-01								◊			*		o	*	●	●	o					
0130-01								●			◊			●	◊							o
0180-03								●[1]						●	●							
0430-01										o	o	o	o[7]	o[7]	o[7]	o	o	o[7]	◊	o	o	o
HYDROGENATION																						
0200-01						●									*			o				●
2165-02							●						◊	●	●	o		●		◊		*
0640-02						o		o			o		o	*	*	◊	o	*	o	o	o	●
2500-02											o			o	o			o				o
3351-01								◊		o	*	o	o	*		◊	o	●	◊	o	o	o
0300-04								o		o	◊	o	o	●	*	◊	o	●	*	◊	o	o
2000-01								o			o			*	o		o	o	o			
3070-01		o	o		o	o	o			o	o		o	●	*	*	*	●	◊		o	o
DEHYDROGENATION																						
0185-04							●							●	●			●		◊		
3230-01								o							*							*
2500-02											o			o	o			o				o
2040-01														o	◊	o		o				o
0090-11														o	o			o				o
2640-01														◊	●			o				*
HYDROFORMYLATION/CARBONYLATION																						
3050-01		o	o		o	o	o			o	o		o	●	*	*	*	●	◊		o	o
2750-01														◊	◊	◊	o		o		o	
0640-02								o			o		o	*	*	◊	o	*	o	o	o	●
0070-05											o			●		o						◊
0160-03								o			o			◊	●		o	*	o			

Notes:
1. Extraneous to product/process.
2. False negative.
3. Added to process to suppress CO_2 formation.
4. 2810-02 has similar analysis.
5. 0070-18 has similar analysis.
6. 0030-08 has similar analysis.
7. Less than verification selection criterion.
8. 0380-03 has similar analysis.
9. 2250-01 has similar analysis.

KEY. ● = >0.5 ppm
* = 0.1 - 0.5 ppm
◊ = .01 - 0.1 ppm
o = <.01 ppm, or analysis failed to detect

Table V-41 (Continued)
Priority Pollutants in Effluents of Precursor-Generic Process Combinations

PRODUCT PROCESS CODE	PRECURSOR (FEEDSTOCK)	AROMATICS			PHENOLS		POLYAROMATICS																	
		Benzene	Toluene	Ethylbenzene	Phenol	2,4-Dimethylphenol	Naphthalene	Acenaphthene	Acenaphthylene	Anthracene	Benzo(a)anthracene	Benzo(a)pyrene	3,4-Benzofluoranthene	Benzo(k)fluoranthene	Benzo(ghi)perylene	Chrysene	Dibenzo(a,h)anthracene	Fluorene	Fluoranthene	Idenol(1,2,3-cd)pyrene	Phenanthrene	Pyrene	2-Chloronaphthalene	PCB's
	ADDITION POLYMERIZATION																							
0005-01	ACN/Polybutadiene/Styrene		◊	◊	◊																			
3172-01	ACN/Styrene		*	*	*																			
3235-01	Styrene/Butadiene	◊	◊	●	●[1]																			
3030-02	Styrene (suspension)	*	◊	*	◊																			
3030-04	Styrene (bulk)	●	●	●	*																			
0153-01	ACN/AA esters/MMA				o																			
0155-03	Methylmethacrylate		●																					
2856-01	Dicyclopentadiene	●	*	*	*	o	*	o	o	o								o	o		o	o		
3008-01	Ethylene (HDPE)	*	●		o		o				o													
3008-04	Ethylene (LDPE)	o	o	o	◊		o	o	◊	o		o	o	o	o		o	o	o	o	o	o		
3020-03	Propylene	*	●	●	o	o	o			o	o					o		o			o	o		
3040-01	Vinyl acetate		o	o																				
3048-02	Vinyl chloride (susp.)			o	*																			
3048-01	Vinyl chloride (emul.)				o																			
3048-04	Vinyl chloride (bulk)				o																			
	FIBER SPINNING																							
0156-01	Acrylic resin				o																			
3145-01	Cellulose				*																			
	CONDENSATION/POLYMERIZATION																							
0560-01	Acetone/Phenol	o	●	o	●		o	o	o	o								o			o	o		
2000-01	n-Butyraldehyde	o	o	o	*																			
1656-01	Epichlorohydrin/Bisphenol A		●[4]	◊	●																			
2443-01	Melamine/Formaldehyde																							
2905-01	Phenol/Formaldehyde		●		●		*																	
3506-01	Urea/Formaldehyde		o		◊																			
2825-01	Caprolactam	*	◊	o																				
2825-03	Nylon salt	o			*																			
3013-01	Aniline/Formaldehyde				*																			
	ETHOXYLATION																							
1830-01	Ethylene oxide/water	●	●	●	*		*	◊	◊	o								◊			o			
1300-01	Ethylene glycol[2]																							
3325-02	Ethylene glycol still btm's[3]	o	o	o	◊		o	o		o	o	o	o	o	o	o	o	o	o	o	o	o		
1666-03	C11, C12 Linear alcohols[3]	o	o	o			o	o		o	o	o	o	o	o	o	o	o	o	o	o	o		
1666-02	Alkylphenol		●		●																			
	PROPOXYLATION																							
3025-01	Propylene glycol	◊	o		*		◊											◊						
3025-02	Glycerin	◊	◊	◊	o																			

PRODUCT PROCESS CODE	PRECURSOR (FEEDSTOCK)	CHLOROAROMATICS						CHLOROPHENOLS					HALOARYL ETHERS		NITROAROMATICS			NITROPHENOLS				NITROSAMINES			BENZIDINES			PHTHALATES					
		Chlorobenzene	o-Dichlorobenzene	m-Dichlorobenzene	p-Dichlorobenzene	1,2,4-Trichlorobenzene	Hexachlorobenzene	2-Chlorophenol	4-Chloro-m-cresol	2,4-Dichlorophenol	2,4,6-Trichlorophenol	Pentachlorophenol	4-Chlorophenylphenyl ether	4-Bromophenylphenyl ether	Nitrobenzene	2,4-Dinitrotoluene	2,6-Dinitrotoluene	2-Nitrophenol	4-Nitrophenol	2,4-Dinitrophenol	4,6-Dinitrophenol	N-Nitrosodimethyl amine	N-Nitrosodiphenyl amine	N-Nitrosodi-n-propyl amine	1,2-Diphenylhydrazine	Benzidine	3,3'-Dichlorobenzidine	Dimethyl phthalate	Diethyl	Di-n-butyl	Di-n-octyl	bis(2-Ethylhexyl)	Butylbenzyl
	ADDITION POLYMERIZATION																																
0005-01	ACN/Polybutadiene/Styrene								o																								
3172-01	ACN/Styrene																	◊															
3235-01	Styrene/Butadiene	o						◊				◊																					
3030-02	Styrene (suspension)																																
3030-04	Styrene (bulk)																																
0153-01	ACN/AA esters/MMA																																
0155-03	Methylmethacrylate																																
2856-01	Dicyclopentadiene									o	o							o															
3008-01	Ethylene (HDPE)																																
3008-04	Ethylene (LDPE)																																
3020-03	Propylene							o											o														
3040-01	Vinyl acetate																																
3048-02	Vinyl chloride (susp.)																																
3048-01	Vinyl chloride (emul.)																																
3048-04	Vinyl chloride (bulk)																																
	FIBER SPINNING																																
0156-01	Acrylic resin																																
3145-01	Cellulose																																
	CONDENSATION/POLYMERIZATION																																
0560-01	Acetone/Phenol	*						◊																									
2000-01	n-Butyraldehyde	◊										◊						*	◊														
1656-01	Epichlorohydrin/Bisphenol A	●[4]						◊																									
2443-01	Melamine/Formaldehyde																																
2905-01	Phenol/Formaldehyde																																
3506-01	Urea/Formaldehyde																																
2825-01	Caprolactam	o										◊						o	o														
2825-03	Nylon salt																																
3013-01	Aniline/Formaldehyde										◊	o			●	●			◊	◊													
	ETHOXYLATION																																
1830-01	Ethylene oxide/water																																
1300-01	Ethylene glycol[2]																																
3325-02	Ethylene glycol still btm's[3]																																
1666-03	C11, C12 Linear alcohols[3]																																
1666-02	Alkylphenol																																
	PROPOXYLATION																																
3025-01	Propylene glycol																																
3025-02	Glycerin																																

PRODUCT PROCESS CODE	PRECURSOR (FEEDSTOCK)	HALOGENATED METHANES										CHLORINATED C2's												CHLORINATED C3's			
		Methyl bromide	Methyl chloride	Methylene chloride	Bromoform	Chloroform	Bromodichloromethane	Dibromochloromethane	Dichlorodifluoromethane	Trichlorofluoromethane	Carbon tetrachloride	Chloroethane	Chloroethylene	1,2-Dichloroethane	1,2-t-Dichloroethylene	1,1-Dichloroethylene	1,1-Dichloroethane	1,1,2-Trichloroethane	1,1,1-Trichloroethane	Trichloroethylene	Tetrachloroethylene	1,1,2,2-Tetrachloroethane	Hexachloroethane	1,2-Dichloropropane	1,3-Dichloropropylene	Hexachlorobutadiene	Hexachlorocyclopentadiene
	ADDITION POLYMERIZATION																										
0005-01	ACN/Polybutadiene/Styrene			o																							
3172-01	ACN/Styrene																										
3235-01	Styrene/Butadiene			◊		*					●[1]		◊			◊											
3030-02	Styrene (suspension)							o					◊											◊			
3030-04	Styrene (bulk)							o						o										◊			
0153-01	ACN/AA esters/MMA			o		◊					o				o	o	o		o								
0155-03	Methylmethacrylate																										
2856-01	Dicyclopentadiene			o		o	o			o	o			o		o	o		o	o	o			o	o		
3008-01	Ethylene (HDPE)					o																					
3008-04	Ethylene (LDPE)				o		o	o						o						o	o		o				
3020-03	Propylene			o	o	◊													o								
3040-01	Vinyl acetate					◊							◊							◊							
3048-02	Vinyl chloride (susp.)			o									●			o											
3048-01	Vinyl chloride (emul.)					o	o						●		o				o								
3048-04	Vinyl chloride (bulk)												●														
	FIBER SPINNING																										
0156-01	Acrylic resin			*		o										◊											
3145-01	Cellulose																										
	CONDENSATION/POLYMERIZATION																										
0560-01	Acetone/Phenol	*		*		◊	o				o	o				o	o	o	*	*		o		*	●[1]		
2000-01	n-Butyraldehyde			◊		o				o	o			o	o	o			o	o		o					
1656-01	Epichlorohydrin/Bisphenol A			●[4]		◊								◊					◊	*	◊			*	*		
2443-01	Melamine/Formaldehyde																										
2905-01	Phenol/Formaldehyde					◊																					
3506-01	Urea/Formaldehyde					o														o	o						
2825-01	Caprolactam			◊		o				o	o			o	o	o			◊	o		o					
2825-03	Nylon salt			o															*		*						
3013-01	Aniline/Formaldehyde					o					o									◊							
	ETHOXYLATION																										
1830-01	Ethylene oxide/water			◊		o							*	●							o						
1300-01	Ethylene glycol[2]			◊										◊													
3325-02	Ethylene glycol still btm's[3]				o		o	o						◊						o	o		o				
1666-03	C11, C12 Linear alcohols[3]				o		o	o						◊						o	o		o				
1666-02	Alkylphenol			o		o																					
	PROPOXYLATION																										
3025-01	Propylene glycol			◊		◊					◊									o	◊			o			
3025-02	Glycerin			●[1]		◊					*			●[1]							◊	◊					

PRODUCT PROCESS CODE	PRECURSOR (FEEDSTOCK)	CHLOROALKYL ETHERS					MISCELLANEOUS				METALS												
		bis(Chloromethyl)ether	bis(Chloroethyl)ether	bis(2-Chloroisopropyl)ether	2-Chloroethylvinyl ether	bis(2-Chloroethoxy)methane	Acrolein	Acrylonitrile	Cyanide	Isophorone	Antimony	Arsenic	Beryllium	Cadmium	Chromium	Copper	Lead	Mercury	Nickel	Selenium	Silver	Thallium	Zinc
	ADDITION POLYMERIZATION																						
0005-01	ACN/Polybutadiene/Styrene							●	o						o	◊	o						
3172-01	ACN/Styrene							●	*							◊							
3235-01	Styrene/Butadiene								o							◊							o
3030-02	Styrene (suspension)														◊	o	o						
3030-04	Styrene (bulk)																						
0153-01	ACN/AA esters/MMA						●	●	◊						o		o			o			
0155-03	Methylmethacrylate														o								
2856-01	Dicyclopentadiene														o	◊	o	o		o		o	
3008-01	Ethylene (HDPE)															o							o
3008-04	Ethylene (LDPE)		o	o	o		o	o			o	o	o		●	*	o	o	o	o		o	o
3020-03	Propylene								o						●	o							●
3040-01	Vinyl acetate													o	●	◊	o						
3048-02	Vinyl chloride (susp.)						◊		o						o		o			o			
3048-01	Vinyl chloride (emul.)						o	o	o						o		o			o			
3048-04	Vinyl chloride (bulk)						o		o						●		*			o			
	FIBER SPINNING																						
0156-01	Acrylic resin							●	*														
3145-01	Cellulose											o		o	*	*	●	o		o			●
	CONDENSATION/POLYMERIZATION																						
0560-01	Acetone/Phenol											o		o	o	o	◊	o		o		o	◊
2000-01	n-Butyraldehyde								o			o			*	o		o	o	o			
1656-01	Epichlorohydrin/Bisphenol A															●							o
2443-01	Melamine/Formaldehyde														o								
2905-01	Phenol/Formaldehyde							*			◊			◊	*	o	◊	o		●			
3506-01	Urea/Formaldehyde														o	o		o					
2825-01	Caprolactam								o			o			*	◊		o	o	o			
2825-03	Nylon salt															●			o		o		
3013-01	Aniline/Formaldehyde								o		●	●	◊	●	●	*	●	o	●	●	*	◊	o
	ETHOXYLATION																						
1830-01	Ethylene oxide/water			◊					◊						o	◊							o
1300-01	Ethylene glycol[2]														◊								
3325-02	Ethylene glycol still btm's[3]		o	o		o	o	o			o	o	o		●	*	o	o	o	o		o	*
1666-03	C11, C12 Linear alcohols[3]		o	o		o	o	o			o	o	o		●	*	o	o	o	o		o	*
1666-02	Alkylphenol								o						◊	o							◊
	PROPOXYLATION																						
3025-01	Propylene glycol															*							o
3025-02	Glycerin		*													◊							o

KEY: ● = >0.5 ppm
* = 0.1 - 0.5 ppm
◊ = .01 - 0.1 ppm
o = <.01 ppm, or analysis failed to detect

Notes:
1. Extraneous to product/process.
2. 3480-01 has similar analysis.
3. 3480-03 has similar analysis.
4. Epoxy resin process proximal to TDI process.

Abbreviations:
ACN – Acrylonitrile
AA – Acrylic acid
MMA – Methacrylic acid

Table V-41 (Continued)
Priority Pollutants in Effluents of Precursor-Generic Process Combinations

Aromatics, Phenols, Polyaromatics, 2-Chloronaphthalene, PCB's

Product Process Code	Precursor (Feedstock)	Benzene	Toluene	Ethylbenzene	Phenol	2,4-Dimethylphenol	Naphthalene	Acenaphthene	Acenaphthylene	Anthracene	Benzo(a)anthracene	Benzo(a)pyrene	3,4-Benzofluoranthene	Benzo(k)fluoranthene	Benzo(ghi)perylene	Chrysene	Dibenzo(a,h)anthracene	Fluorene	Fluoranthene	Ideno(1,2,3-cd)pyrene	Phenanthrene	Pyrene	2-Chloronaphthalene	PCB's
	Priority pollutant groups	AROMATICS			PHENOLS		POLYAROMATICS																	
	ESTERIFICATION/POLYMERIZATION																							
2665-02	Acetone cyanohydrin				◊																			
3068-01	Acetic acid/n-Propanol	0	0	0	◊		0	0	0	0		0	0	0	0		0	0	0	0	0	0		
0240-01	Acetic acid/Pentanol (Amyl)	0	0	0	◊		0	0	0	0		0	0	0	0		0	0	0	0	0	0		
3510-05	Acetic acid/Ethylene			◊	◊																			
0165-09	Acrylic acid/n-Butanol	◊	0	0	*																			
0165-10	Acrylic acid/Ethanol	*			●[1]																			
0165-02	Acrylic acid/Isobutanol		*		●[1]																			
0165-11	Acrylic acid/2-Ethylhexanol	◊	0	0	*																			
2470-02	MMA/Butanol		●[1]		0																			
1530-01	TPA/Methanol				●																			
3006-21	TPA/Ethylene glycol			●	●		*																	
2883-01	PA/Ethanol				◊																			
2859-01	PA/2-Ethylhexanol	*			◊																			
2863-01	PA/C11-C14 Alcohols	◊	◊	*	●	●	0	0	0	0								0	0		0	0		
2886-01	PA/Butanol/Benzyl chloride	*	●	0	◊					0											0		◊	
0189-01	PA Glycerin	◊	●	*	●		●																	
3501-01	PA/MA/Propylene glycol				●																			
2951-02	$POCl_3$/Phenol/Isodecanol	0	●	*	●					0											0			0
2680-01	Salicylic acid/Methanol	0	0		●																			
	HYDRATION/HYDROLYSIS																							
2090-01	Allyl alcohol				◊		*		◊															
2090-03	Epichlorohydrin	●[1]	0		0																			
2460-01	Acetone cyanohydrin																							
3042-80	Polyvinyl acetate [2]			◊	0	0																		
1660-01	Ethylene	◊	0	0	◊	◊	0	◊	◊	0								0			0	◊		
2360-01	Propylene	●[1]	◊	0	◊	0	*	0	0	0								0	0		0	0		
0650-01	Butene				◊		◊																	
	HYDROCYANATION																							
2460-01	Acetone																							
2665-02	Acetone/Methanol				◊																			
0192-04	C13-C19 Olefins				*																			
	HYDRODIMERIZATION																							
0185-05	Acrylonitrile				●[1]																			
	ISOMERIZATION																							
2070-01	Maleic acid	0	0		0																			
3570-02	m-Xylene	◊	*	0	◊	◊	◊			0	0					0		0			0	0		

Chloroaromatics, Chlorophenols, Haloaryl ethers, Nitroaromatics, Nitrophenols, Nitrosamines, Benzidines

Product Process Code	Precursor (Feedstock)	Chlorobenzene	o-Dichlorobenzene	m-Dichlorobenzene	p-Dichlorobenzene	1,2,4-Trichlorobenzene	Hexachlorobenzene	2-Chlorophenol	4-Chloro-m-cresol	2,4-Dichlorophenol	2,4,6-Trichlorophenol	Pentachlorophenol	4-Chlorophenylphenyl ether	4-Bromophenylphenyl ether	Nitrobenzene	2,4-Dinitrotoluene	2,6-Dinitrotoluene	2-Nitrophenol	4-Nitrophenol	2,4-Dinitrophenol	4,6-Dinitrophenol	N-Nitrosodimethyl amine	N-Nitrosodiphenyl amine	N-Nitrosodi-n-propyl amine	1,2-Diphenylhydrazine	Benzidine	3,3'-Dichlorobenzidine
	Priority pollutant groups	CHLOROAROMATICS						CHLOROPHENOLS					HALOARYL ETHERS		NITROAROMATICS			NITROPHENOLS				NITROSAMINES			BENZIDINES		
	ESTERIFICATION/POLYMERIZATION																										
2665-02	Acetone cyanohydrin																										
3068-01	Acetic acid/n-Propanol																										
0240-01	Acetic acid/Pentanol (Amyl)																										
3510-05	Acetic acid/Ethylene																		◊								
0165-09	Acrylic acid/n-Butanol	0										*						0	●[1]								
0165-10	Acrylic acid/Ethanol																										
0165-02	Acrylic acid/Isobutanol											◊						0									
0165-11	Acrylic acid/2-Ethylhexanol	0										*							●[1]								
2470-02	MMA/Butanol																										
1530-01	TPA/Methanol																										
3006-21	TPA/Ethylene glycol																										
2883-01	PA/Ethanol																										
2859-01	PA/2-Ethylhexanol																										
2863-01	PA/C11-C14 Alcohols										0																
2886-01	PA/Butanol/Benzyl chloride	0								◊	◊							*									
0189-01	PA Glycerin							◊		◊																	
3501-01	PA/MA/Propylene glycol																										
2951-02	$POCl_3$/Phenol/Isodecanol																										
2680-01	Salicylic acid/Methanol							●			0																
	HYDRATION/HYDROLYSIS																										
2090-01	Allyl alcohol							*																			
2090-03	Epichlorohydrin																										
2460-01	Acetone cyanohydrin																										
3042-80	Polyvinyl acetate [2]																										
1660-01	Ethylene							0																			
2360-01	Propylene									0	*							◊									
0650-01	Butene																										
	HYDROCYANATION																										
2460-01	Acetone																										
2665-02	Acetone/Methanol																										
0192-04	C13-C19 Olefins																										
	HYDRODIMERIZATION																										
0185-05	Acrylonitrile																										
	ISOMERIZATION																										
2070-01	Maleic acid							0																			
3570-02	m-Xylene							0											0								

Phthalates, Halogenated methanes

Product Process Code	Precursor (Feedstock)	Dimethyl phthalate	Diethyl	Di-n-butyl	Di-n-octyl	bis(2-Ethylhexyl)	Butylbenzyl	Methyl bromide	Methyl chloride	Methylene chloride	Bromoform	Chloroform	Bromodichloromethane	Dibromochloromethane	Dichlorodifluoromethane	Trichlorofluoromethane	Carbon tetrachloride
	Priority pollutant groups	PHTHALATES						HALOGENATED METHANES									
	ESTERIFICATION/POLYMERIZATION																
2665-02	Acetone cyanohydrin																
3068-01	Acetic acid/n-Propanol									0		0					
0240-01	Acetic acid/Pentanol (Amyl)										0		0	0			
3510-05	Acetic acid/Ethylene										0		0	0			
0165-09	Acrylic acid/n-Butanol											0					0
0165-10	Acrylic acid/Ethanol									0		◊				0	0
0165-02	Acrylic acid/Isobutanol									0		0					
0165-11	Acrylic acid/2-Ethylhexanol																
2470-02	MMA/Butanol									0		◊				0	0
1530-01	TPA/Methanol																
3006-21	TPA/Ethylene glycol	●[3]		●[3]													
2883-01	PA/Ethanol																
2859-01	PA/2-Ethylhexanol	0	●	◊								0					
2863-01	PA/C11-C14 Alcohols					●				0		0					
2886-01	PA/Butanol/Benzyl chloride		0	0		0			0	0		0	0			0	0
0189-01	PA Glycerin						●					*					0
3501-01	PA/MA/Propylene glycol			*						*							
2951-02	$POCl_3$/Phenol/Isodecanol											0					
2680-01	Salicylic acid/Methanol											◊				0	◊
	HYDRATION/HYDROLYSIS																
2090-01	Allyl alcohol																
2090-03	Epichlorohydrin											*					
2460-01	Acetone cyanohydrin									0		*					
3042-80	Polyvinyl acetate [2]									◊		◊	0				
1660-01	Ethylene									0		0					
2360-01	Propylene									0		0	0				0
0650-01	Butene								0	0		0	0			0	0
	HYDROCYANATION																
2460-01	Acetone																
2665-02	Acetone/Methanol									◊		◊	0				
0192-04	C13-C19 Olefins									◊		◊	0				
	HYDRODIMERIZATION																
0185-05	Acrylonitrile									0		0					
	ISOMERIZATION																
2070-01	Maleic acid											*					●[1]
3570-02	m-Xylene									◊	0	0					

Chlorinated C2's, Chlorinated C3's, Hexachlorobutadiene, Hexachlorocyclopentadiene

Product Process Code	Precursor (Feedstock)	Chloroethane	Chloroethylene	1,2-Dichloroethane	1,2-t-Dichloroethylene	1,1-Dichloroethylene	1,1-Dichloroethane	1,1,2-Trichloroethane	1,1,1-Trichloroethane	Trichloroethylene	Tetrachloroethylene	1,1,2,2-Tetrachloroethane	Hexachloroethane	1,2-Dichloropropane	1,3-Dichloropropylene	Hexachlorobutadiene	Hexachlorocyclopentadiene
	Priority pollutant groups	CHLORINATED C2's												CHLORINATED C3's			
	ESTERIFICATION/POLYMERIZATION																
2665-02	Acetone cyanohydrin																
3068-01	Acetic acid/n-Propanol																
0240-01	Acetic acid/Pentanol (Amyl)			*						0	0		0				
3510-05	Acetic acid/Ethylene			*						0	0		0				
0165-09	Acrylic acid/n-Butanol								◊								
0165-10	Acrylic acid/Ethanol			0	0	0			0	0		0					
0165-02	Acrylic acid/Isobutanol																
0165-11	Acrylic acid/2-Ethylhexanol								0	0		0					
2470-02	MMA/Butanol			0	0	0											
1530-01	TPA/Methanol																
3006-21	TPA/Ethylene glycol																
2883-01	PA/Ethanol																
2859-01	PA/2-Ethylhexanol				0												
2863-01	PA/C11-C14 Alcohols					0		0									
2886-01	PA/Butanol/Benzyl chloride			0		0	0		0	0		0		0	0		
0189-01	PA Glycerin	●								◊				◊			
3501-01	PA/MA/Propylene glycol																
2951-02	$POCl_3$/Phenol/Isodecanol																
2680-01	Salicylic acid/Methanol				0					*		0					
	HYDRATION/HYDROLYSIS																
2090-01	Allyl alcohol																
2090-03	Epichlorohydrin									0				0	0		
2460-01	Acetone cyanohydrin					◊	*	●		●		0		●	●		
3042-80	Polyvinyl acetate [2]																
1660-01	Ethylene		0	0				0		◊	0						
2360-01	Propylene	0				0	0	0	0			0		0			
0650-01	Butene			0		0	0		0	0		0		0	0		
	HYDROCYANATION																
2460-01	Acetone																
2665-02	Acetone/Methanol																
0192-04	C13-C19 Olefins																
	HYDRODIMERIZATION																
0185-05	Acrylonitrile																
	ISOMERIZATION																
2070-01	Maleic acid								*		0						
3570-02	m-Xylene								0								

Chloroalkyl ethers, Miscellaneous

Product Process Code	Precursor (Feedstock)	bis(Chloromethyl)ether	bis(Chloroethyl)ether	bis(2-Chloroisopropyl)ether	2-Chloroethylvinyl ether	bis(2-Chloroethoxy)methane	Acrolein	Acrylonitrile	Cyanide	Isophorone
	Priority pollutant groups	CHLOROALKYL ETHERS					MISCELLANEOUS			
	ESTERIFICATION/POLYMERIZATION									
2665-02	Acetone cyanohydrin									
3068-01	Acetic acid/n-Propanol								◊	
0240-01	Acetic acid/Pentanol (Amyl)		0	0		*	0	0		
3510-05	Acetic acid/Ethylene		0	0		*	0	0		
0165-09	Acrylic acid/n-Butanol						●	●[1]	0	
0165-10	Acrylic acid/Ethanol								0	
0165-02	Acrylic acid/Isobutanol									
0165-11	Acrylic acid/2-Ethylhexanol									
2470-02	MMA/Butanol								0	
1530-01	TPA/Methanol								◊	
3006-21	TPA/Ethylene glycol									
2883-01	PA/Ethanol							●[1]	0	
2859-01	PA/2-Ethylhexanol									
2863-01	PA/C11-C14 Alcohols			*						
2886-01	PA/Butanol/Benzyl chloride									
0189-01	PA Glycerin								0	
3501-01	PA/MA/Propylene glycol						●			
2951-02	$POCl_3$/Phenol/Isodecanol									
2680-01	Salicylic acid/Methanol								◊	
	HYDRATION/HYDROLYSIS									
2090-01	Allyl alcohol									
2090-03	Epichlorohydrin									
2460-01	Acetone cyanohydrin								0	
3042-80	Polyvinyl acetate [2]								◊	
1660-01	Ethylene								◊	
2360-01	Propylene								0	
0650-01	Butene									
	HYDROCYANATION									
2460-01	Acetone									
2665-02	Acetone/Methanol								◊	
0192-04	C13-C19 Olefins								◊[4]	
	HYDRODIMERIZATION									
0185-05	Acrylonitrile								●	
	ISOMERIZATION									
2070-01	Maleic acid							●		
3570-02	m-Xylene									
									0	

Metals

Product Process Code	Precursor (Feedstock)	Antimony	Arsenic	Beryllium	Cadmium	Chromium	Copper	Lead	Mercury	Nickel	Selenium	Silver	Thallium	Zinc
	ESTERIFICATION/POLYMERIZATION													
2665-02	Acetone cyanohydrin													
3068-01	Acetic acid/n-Propanol		0			●	*							●
0240-01	Acetic acid/Pentanol (Amyl)	0	0		0	*	●	*	◊	0	0		0	0
3510-05	Acetic acid/Ethylene	0	0		0	*	●	*	◊	0	0		0	0
0165-09	Acrylic acid/n-Butanol					●	*	◊				◊		
0165-10	Acrylic acid/Ethanol		0			*	*		0	0	0			
0165-02	Acrylic acid/Isobutanol		◊			*	*							0
0165-11	Acrylic acid/2-Ethylhexanol					0	◊		0		◊	0		
2470-02	MMA/Butanol		0			*	*		0	0	0			
1530-01	TPA/Methanol		●			*	*							◊
3006-21	TPA/Ethylene glycol				0	0	0	0	0					
2883-01	PA/Ethanol								0					
2859-01	PA/2-Ethylhexanol					*	●		◊					
2863-01	PA/C11-C14 Alcohols		0		0	0	0	0	0					
2886-01	PA/Butanol/Benzyl chloride					◊	0	◊	0		◊		0	
0189-01	PA Glycerin	*			◊	*	*	●		●		*		0
3501-01	PA/MA/Propylene glycol						0		0					
2951-02	$POCl_3$/Phenol/Isodecanol								0					
2680-01	Salicylic acid/Methanol	0	*			*	◊	◊		*		◊		◊
	HYDRATION/HYDROLYSIS													
2090-01	Allyl alcohol	0	0	0	0	0	●	*	0	0	0	0	0	0
2090-03	Epichlorohydrin					◊	*							
2460-01	Acetone cyanohydrin						*							
3042-80	Polyvinyl acetate [2]		0			*	*							
1660-01	Ethylene				0	*	◊	0						
2360-01	Propylene		0		0	*	◊	0	0		0		0	◊
0650-01	Butene					◊	●	*	0		0		0	
	HYDROCYANATION													
2460-01	Acetone					◊	*			0				0
2665-02	Acetone/Methanol		0			*	*							●
0192-04	C13-C19 Olefins		0			●	*							●
	HYDRODIMERIZATION													
0185-05	Acrylonitrile		◊			●	●							●
	ISOMERIZATION													
2070-01	Maleic acid					●	●							●
3570-02	m-Xylene	0	0	0	0[5]	0[5]	◊[5]	0	0	0	0	0	0	0
						●	0			0				0

Notes:
1. Extraneous to product/process.
2. 0070-13 has similar analysis.
3. May be attributable to o-xylene impurity, or misidentification of the terephthalate ester.
4. Value probably higher, sampled after cyanide removal system.
5. Less than verification selection criterion.

Abbreviations:
MMA – Methacrylic acid
TPA – Terephthalic acid
PA – Phthalic acid
MA – Maleic anhydride
$POCl_3$ – Phosphoryl trichloride

KEY:
● = >0.5 ppm
* = 0.1 - 0.5 ppm
◊ = .01 - 0.1 ppm
0 = <.01 ppm, or analysis failed to detect

Copper, chromium, and zinc were the metallic priority pollutants most frequently reported in the higher concentration ranges for all product/process effluents. Copper and chromium are used in many catalyst systems. Another significant source of chromium, as well as zinc, is the "blowdown" that is periodically wasted from an in-plant production area's recycled noncontact cooling water. These metals find application in noncontact cooling waters as corrosion inhibitors. In some wastewater collection systems, it is possible for the blowdown to become mixed with product/process effluent before the combined flow leaves the production area to join the main body of wastewater within the plant. Another source of metallic priority pollutants is the normal deterioration of production equipment that comes into contact with process water.

Extraneous or unexpected priority pollutants were also reported in product/process effluents. Priority pollutants may be considered extraneous when they cannot be reconciled with the precursor (or its impurities) and the process chemistry. In Table V-41, extraneous priority pollutants were noted only when they were reported at greater than 0.5 ppm. Thus, the failure to flag a priority pollutant at less than 0.5 ppm does not necessarily preclude it from being extraneous. As a general rule, one extraneous generic group member indicates that the entire group is probably anomalous. These data are presented here to assist NPDES permit writers in establishing effective monitoring requirements for OCPSF plants' end-of-pipe discharges. The phthalate esters are an example of such a group that persisted throughout the Verification data. Except for processes that manufacture phthalate esters, these priority pollutants are now recognized as analytical artifacts and edited out of the BAT and PSES effluent limitations data base.

E. RAW WASTEWATER CHARACTERIZATION DATA

1. General

As described under "Water Usage" earlier in this section, the OCPSF industry generates significant volumes of process wastewater containing a variety of pollutants. Most of this raw wastewater receives some treatment, either as an individual process waste stream or at a wastewater treatment plant serving waste streams from the whole manufacturing facility (see Section VII). To decide what pollutants merit regulation and evaluate what technologies effectively reduce discharge of these pollutants, data characterizing the raw wastewaters were collected and evaluated. This section describes the Agency's approach to this important task and summarizes the results.

2. Raw Wastewater Data Collection Studies

Section III of this document introduced the many wastewater data collection efforts undertaken for development of these regulations. Studies that produced significant data on raw wastewater characteristics include the 308 Surveys, the Phase I and II screening studies, the Verification Study, the EPA/CMA Five-Plant Study and the New 12-Plant Sampling Program. The 308 Surveys have been described in Section III; the remaining studies are summarized in Table V-42 and are discussed below. The results of the studies are presented in the "Wastewater Data Summary" at the end of this Section.

3. Screening Phase I

The wastewater quality data reported in the 1976 Section 308 Questionnaire were the result of monitoring and analyses by each of the individual plants and their contract laboratories. To expand its priority pollutant data base and improve data quality by minimizing the discrepancies among sampling and analysis procedures, EPA in 1977 and 1978 performed its Phase I Screening Study. The Agency and its contractors sampled at 131 plants, chosen because they operated product/processes that produce the highest volume organic chemicals and plastics/synthetic fibers.

Samples were taken of the raw plant water, some product/process influents and effluents, and influents and effluents at the plant wastewater treatment facilities. Samples were analyzed for all priority pollutants except asbestos, and for several conventional and nonconventional pollutants. Screening samples were collected and analyzed in accordance with procedures described in the 1977 EPA Screening Procedures Manual. Samples for liquid-liquid extraction (all organic pollutants except the volatile fraction) and for metals analyses were collected in glass compositing bottles over a 24-hour period, using an automatic sampler generally set for a constant

TABLE V-42.
OVERVIEW OF WASTEWATER SAMPLING PROGRAMS INCLUDED IN
BAT RAW WASTE STREAM DATA BASE

	Sampling Program				
Element	Phase I Screening	Phase II Screening	Verification	CMA5-Plant	New 12-Plant
Dates	August 1977 to March 1978	December 1979	1978 to 1980	June 1980 to May 1981	March 1983 thru May 1984
Number of plants	131	40	37	5	12
Direct dischargers	-	14	30	5	11
Indirect dischargers	-	24	5	-	1
Other dischargers	-	2	2	-	-
Plant selection objective	Raw water. Treatment influent and effluent. Some product/process effluent	Same as Phase I.	Verify specific pollutants from product/processes	Chemical plants with well-designed and well-operated activated sludge treatment systems	Plants with pollutants of concern and with treatment technologies under consideration for BAT
Sampling locations			Product/process influents and effluents in 29 plastic, 147 organic. Treatment system influent and effluent. Raw water.	Treatment influent and effluent. "Treatment" included neutralization and clarification.	End-of-Pipe Treatment influent and effluent. Also influent and effluent of selected BAT treatment technologies, sludge.
Sampling duration (a)	1 day	1 day	3 days	4 to 6 weeks	2 to 4 weeks
Pollutants tested:	All priority pollutants but asbestos	Same as Phase I	Specific pollutants from specific product/processes selected organic pollutants, no PCB's or pesticides	Conventionals and TOC, COD; no heavy metals	Conventionals and priority pollutants

TABLE V-42.
OVERVIEW OF WASTEWATER SAMPLING PROGRAMS INCLUDED IN
BAT RAW WASTE STREAM DATA BASE (Continued)

Element	Phase I Screening	Phase II Screening	Verification	CMA5-Plant	New 12-Plant
Analytical methods for organic pollutants	GC/MS, 1977 QA/QC protocol; 4-AAP for phenols.	GC/MS, 1979 QA/QC protocol.	GC/CD with confirmatory GC/MS (624/625) on 10% of samples.	Mostly GC/MS (624/625) or GC	GC/MS (1624/1625)
Labs participating	EPA Regions VII, VI, IV; Envirodyne, Midwest Research Institute (MRI).	Environmental Science & Engineering	Labs: Envirodyne, MRI, Southwest Research Institute, Gulf South Research Institute, Jacobs (PJB Labs), Acurex.	3 EPA contract labs, 1 CMA contract lab, & 4 chemical plant labs.	Labs: IT Analytical, S-Cubed, Centec, EMS Laboratories, Radian, Hazelton-Raltech, US Testing, MRI

(a) Generally, samples were 24-hour composites; cyanide, phenols, and volatile organics were generally grab samples or a series of grab samples.

aliquot volume and constant time, although flow- or time-proportional sampling was allowed. For metals analysis, an aliquot of the final composite sample was poured into a clean bottle. Some samples were preserved by acid addition in the field, in accordance with the 1977 EPA Screening Procedures Manual; acid was added to the remaining samples when they arrived at the laboratory.

For purge and trap (volatile organic) analysis, wastewater samples were collected in 40- or 125-ml vials, filled to overflowing, and sealed with Teflon-faced rubber septa. Where dechlorination of the samples was required, sodium thiosulfate or sodium bisulfite was used.

Cyanide samples were collected in 1-liter plastic bottles as separate grab samples. These samples were checked for chlorine by using potassium-iodide starch test-paper strips, treated with ascorbic acid to eliminate the chlorine, then preserved with 2 ml of 10N sodium hydroxide/liter of sample (pH 12).

Samples for total (4AAP) phenol colorimetric analysis were collected in glass bottles as separate grab samples. These samples were acidified with phosphoric or sulfuric acid to pH 4, then sealed.

All samples were maintained at 4°C for transport and storage during analysis. Where sufficient data were available, other sample preservation requirements (e.g., those for cyanide, phenol, and VOAs by purge and trap as described above) were deleted as appropriate (e.g., if chlorine was known to be absent). No analysis was performed for asbestos during the Phase I screening effort.

In general, the Phase I Screening Study generated data that were qualitative in nature due to false positive pollutant identification, which occurs as a result of the procedures used for interpreting ambiguous pollutant identification based on the 1977 screening level GC/MS analytical protocols and QA/QC procedures. These procedures are discussed in more detail in Section VI of this document.

4. Screening Phase II

In December 1979, samples were collected from an additional 40 plants (known as Phase II facilities) manufacturing products such as dyes, flame retardants, coal tar distillates, photographic chemicals, flavors, surface active agents, aerosols, petroleum additives, chelating agents, microcrystalline waxes, and other low-volume specialty chemicals. As in the Phase I Screening study, samples were analyzed for all the priority pollutants except asbestos. The 1977 EPA Screening Procedures Manual was followed in analyzing priority pollutants. As in Screening Phase I, some samples for metals analysis were preserved by addition of acid in the field (in accordance with the 1977 Screening Manual) and acid was added to the remaining samples when they arrived at the laboratory. In addition, the organic compounds producing peaks not attributable to priority pollutants with a magnitude of at least 1 percent of the total ion current were identified by computer matching.

Intake, raw influent, and effluent samples were collected for nearly every facility sampled. In addition, product/process wastewaters that could be isolated at a facility were also sampled, as were influents and effluents from some treatment technologies in place. Fourteen direct dischargers, 24 indirect dischargers, and 2 plants discharging to deep wells were sampled. Table V-43 lists the product/process and other waste streams sampled at each plant.

As with the Phase I Screening Study, data from this study were considered as qualitative in nature for the same reasons stated for Phase I.

5. Verification Program

The Verification Program was designed to verify the occurrence and concentrations of specific priority pollutants in waste streams from individual product/processes and to determine the performance of end-of-pipe treatment systems.

The product/processes to be sampled were generally chosen to maximize coverage of the product/processes used to manufacture organic priority pollutants, chemicals derived from priority pollutants, and chemicals produced in

TABLE V-43.
PHASE II SCREENING - PRODUCT/PROCESS AND OTHER
WASTE STREAMS SAMPLED AT EACH PLANT

Plant Number	Waste Streams Sampled
1	Combined raw waste (fluorocarbon)
2	Anthracene Coal tar pitch
3	Combined raw wastes (dyes)
4	Combined raw wastes (coal tar)
5	Combined raw wastes (dyes)
6	Oxide Polymer
7	Freon
8	Freon
9	Ethoxylation
10	Nonlube oil additives Lube oil additives
11	Combined raw wastes (dyes)
12	Combined raw wastes (flavors)
13	Combined raw wastes (specialty chemicals)
14	Combined raw wastes (flavors)
15	Hydroquinone
16	Esters Polyethylene Sorbitan monosterate
17	Dyes
18	Combined raw wastes (surface active agents)
19	Fatty acids

TABLE V-43.
PHASE II SCREENING - PRODUCT/PROCESS AND OTHER
WASTE STREAMS SAMPLED AT EACH PLANT (Continued)

Plant Number	Waste Streams Sampled
20	Organic pigments Salicylic acid Fluorescent brightening agent
21	Surfactants
22	Dyes
23	Combined raw wastes (flavors)
24	Chlorination of paraffin
25	Phthalic anhydride
26	Combined raw waste (unspecified)
27	Dicyclohexyl phthalate
28	Plasticizers Resins
29	Combined raw waste (unspecified)
30	Polybutyl phenol Zinc Dialkyldithiophosphate Calcium phenate Mannich condensation product Oxidized co-polymers
31	Tris (β-chloroethyl) phosphate
32	Ether sulfate sodium salt Lauryl sulfate sodium salt Cylene distillation
33	Dyes
34	Maleic anhydride Formox formaldehyde Phosphate ester Hexamethylenetetramine

TABLE V-43.
PHASE II SCREENING - PRODUCT/PROCESS AND OTHER
WASTE STREAMS SAMPLED AT EACH PLANT (Continued)

Plant Number	Waste Streams Sampled
35	Acetic acid
36	Combined raw waste (coal tar)
37	"680" Brominated fire retardants Tetrabromophthalic anhydride Hexabromodyclododecane
38	Hexabromodyclododecane
39	Fatty acid amine ester Calcium suylfonate in solvent (alcohol) Oil field deemulsifier blend (aromatic solvent) Oxylakylated phenol--formaldehyde resin Ethoxylated monyl phenol Ethoxylated phenol--formaldehyde resin
40	Combined raw waste (surface active agents)

excess of 5 million pounds per year. The priority pollutants selected for analysis in the waste stream from each product/process were chosen to meet either of two criteria:

- They were believed to be raw materials, precursors, or products, in the product/process, according to the process chemistry; or
- They had been detected in the grab samples taken several weeks before the 3-day Verification exercise (see below) at concentrations exceeding the threshold concentrations listed in Table V-44.

The threshold concentrations listed in Table V-44 were selected as follows. The concentrations for pesticides, PCBs, and other organics are approximate quantitative detection limits. The concentrations for arsenic, cadmium, chromium, lead, and mercury are one half the National Drinking Water Standard (40 FR 59556 to 74; December 24, 1975).

The Agency sampled at six integrated manufacturing facilities for the pilot program to develop the "Verification Protocol." Thirty-seven plants were eventually involved in the Verification effort. Samples were taken from the effuents of 147 product/processes manufacturing organic chemicals and 29 product/processes manufacturing plastics/synthetic fibers, as well as from treatment system influents and effluents at each facility.

Each plant was visited about 4 weeks before the 3-day Verification sampling to discuss the sampling program with plant personnel, to determine in-plant sampling locations, and to take a grab sample at each designated sampling site. These samples were analyzed to develop the analytical methods used at each plant for the 3-day sampling exercise and to develop the target list of pollutants (analytes) for analyses at each site during the 3-day sampling. Some pollutants that were targeted for Verification, since they were raw materials, precursors, or co-products, were not detected in the Verification program grab samples. If such a pollutant was also not detected in the sample from the first day of the 3-day verification sampling, it was dropped from the targeted list of analytes for that sample location. Other compounds were added to the analysis list, since they were found in the grab sample at a concentration exceeding the threshold criteria in Table V-44.

Priority pollutants known by plant personnel to be present in the plant's wastewater were also added to the Verification list.

At each plant, Verification samples generally included: process water supply, product/process effluents, and treatment facility influent and effluent. Water being supplied to the process was sampled to establish the background concentration of priority pollutants. Product/process samples were taken at locations that would best provide representative samples. At various plants, samples were taken at the influent to and effluent from both "in-process" and "end-of-pipe" wastewater treatment systems.

Samples were taken on each of 3 days during the Verification exercise. Twenty-four hour composite samples for extractable organic compounds and metals were taken with automatic samplers. Where automatic sampling equipment would violate plant safety codes requiring explosion-proof motors, equal volumes of sample were collected every 2 hours over an 8-hour day and manually composited. Raw water supply samples were typically collected as daily grab samples because of the low variability of these waters.

Samples for cyanide analysis were collected as either a single grab sample each day or as an equal-volume, 8-hour composite of four aliquots every 2 hours.

For purge and trap (volatile organic) analysis, duplicate grab samples were collected four times over an 8-hour period each day.

The temperature and pH of the sample, the measured or estimated wastewater flow at the time of sampling, and the process production levels were all recorded, particularly in connection with operational upsets (in the production units or wastewater treatment facilities) that could result in the collection of an unrepresentative sample.

It should be noted that for organic priority pollutants, gas chromatography with conventional detectors (GC/CD) was used instead of GC/MS. GC/MS analysis was used on 10 ten percent of the samples to confirm the presence or absence of pollutants whose GC peaks overlapped other peaks. The analytical

TABLE V-44.
SELECTION CRITERIA FOR TESTING
PRIORITY POLLUTANTS IN VERIFICATION SAMPLES

Parameter	Criterion (ug/l)
Pesticides and PCBs	0.1
Other Organics	10
Total Metals:	
Antimony	100
Arsenic	25
Beryllium	50
Cadmium	5
Chromium	25
Copper	20
Lead	25
Mercury	1
Nickel	500
Selenium	10
Silver	5
Thallium	0
Zinc	1,000
TOTAL Cyanide	20

methods finally developed for a given plant were usually applicable (with minor modifications) to all sampling sites at that plant.

Raw data from a laboratory's reporting form were encoded on computer data tapes. The encoded data were verified to be consistent with the raw data submitted in the reporting forms. Data across injections, extracts, and laboratories were averaged to derive a concentration value identified uniquely by plant, chemical number, sample site, and date.

The data were then reviewed by EPA for consistency with the process chemistry in operation at the plant during the sampling period. After being judged acceptable for use in the OCPSF rulemaking, the data were provided to statisticians for analysis.

6. EPA/CMA Five-Plant Sampling Program

From June 1980 to May 1981, EPA, with cooperation from the Chemical Manufacturers Association (CMA), and five participating chemical plants, performed the EPA/CMA Five-Plant Study to gather longer-term data on biological treatment of toxic pollutants at organic chemical plants. The three primary objectives of the program were to:

- Assess the effectiveness of biological wastewater treatment for the removal of toxic organic pollutants
- Investigate the accuracy, precision, and reproducibility of the analytical methods used for measuring toxic organic pollutants in OCPSF industry wastewaters
- Evaluate potential correlations between biological removal of toxic organic pollutants and biological removal of conventional and nonconventional pollutants.

Since the biological wastewater treatment system influent samples were taken upstream of any preliminary neutralization and settling of each chemical plant's combined waste stream, the samples of influent to biological treatment reflect each facility's raw waste load following any in-plant treatment of waste streams from individual product/processes.

EPA selected the five participants because of the specific toxic organic pollutants expected to be found. The five participating OCPSF plants were characterized as having well-designed and well-operated activated sludge treatment systems. Typically, 30 sets of influent and effluent samples (generally 24-hour composites) were collected at each plant over a 4- to 6-week sampling period.

Only selected toxic organic pollutants were included in this study; pesticides, PCBs, metals, and cyanides were not measured. Samples were analyzed for a selected group of toxic organic pollutants that were specific to each plant as well as for specified conventional and nonconventional pollutants. Not all toxic organic pollutants included in this study were analyzed at all locations.

EPA's contract laboratories analyzed all influent and effluent samples for toxic organic pollutants using GC/MS or GC/CD procedures (44 FR 69464 et seq., December 3, 1979, or variations acceptable to the EPA Industrial Technology Division). One EPA laboratory used GC coupled with flame ionization detection (GC/FID). Approximately 25 percent of the influent and effluent samples collected at each participating plant were analyzed by the CMA contractor using GC/MS procedures (44 FR 69464 et seq., December 3, 1979, or equivalent). Some variation occurred in the analytical procedures for the toxic organic pollutants used by both the EPA contract laboratories and CMA laboratory during this study. An extensive QA/QC program was included to define the precision and accuracy of the analytical results.

Each participant analyzed conventional and nonconventional pollutants in their influent and effluent wastewaters using the methods found in "Methods of Chemical Analysis of Water and Wastes," EPA 600/4-79-020, March 1979. Additionally, four of the participating plants analyzed from 25 to 100 percent of the samples collected by EPA for some of the toxic organic pollutants being discharged by the plant. The influent concentrations measured in this study prior to end-of-pipe treatment are discussed later in this chapter. The biological treatment effluent results are discussed and used in Section VII and IX.

7. <u>12-Plant Long-Term Sampling Program</u>

In response to concerns about the limited amount of long-term toxic pollutant data contained in the data base, EPA conducted a long-term sampling program from March 1983 through May 1984. Twelve plants were selected based upon the products manufactured, the pollutants generated, and the in-plant and end-of-pipe treatment technologies employed. Special emphasis was placed on identifying plants with pollutants for which existing data were limited.

The number of sampling days at the 12 plants sampled are presented in Table V-45. The plants were visited several weeks prior to the long-term sampling. During these visits, background data were collected, sample sites were selected, and grab samples were collected. The grab samples enabled EPA to confirm the presence of suspected pollutants and enabled the laboratory to determine the proper dilutions to be used during analysis.

Samples were collected for each plant's end-of-pipe treatment system, and included influent, effluent, and sludge samples. Where plants utilized in-plant control or tertiary treatment, samples were also collected at the influent and effluent of these systems. Samples were analyzed for conventional, nonconventional, and priority pollutants.

Organic priority pollutants were analyzed by EPA Method 1624, "Volatile Organic Compounds by Isotope Dilution GC/MS"; and Method 1625, "Semi-volatile Organic Compounds by Isotope Dilution GC/MS." These methods employ GC/MS for separation, detection, and quantitation of organic priority pollutants, based on the capability of the mass spectrometer to distinguish the isotopically labeled analogs of the organic priority pollutants that were spiked into every sample prior to extraction. Metal priority pollutants were analyzed by atomic absorption (AA) spectrophotometry, using the 200 series methods in EPA publication USEPA 600/4-79-020, "Methods for Chemical Analysis of Water and Wastes." Dioxin was analyzed by EPA Method 613. Asbestos was analyzed using the transmission electron microscopy (TEM) methods described in EPA publication USEPA 600/4-80-005, "Interim Methodology for Determining Asbestos in Water."

TABLE V-45.
NUMBER OF SAMPLING DAYS
FOR 12-PLANT LONG-TERM SAMPLING PROGRAM

Number of Plants	Number of Days Sampled
1	20
7	15
1	12
2	10
1	1

For the first four plants, data were reported by the laboratory on manually transcribed data sheets to EPA's Sample Control Center (SCC) for encoding and quality assurance. For the last eight plants, data were transmitted by the laboratories to the SCC via magnetic tape. The data were also reviewed by EPA for consistency with the process chemistry in operation at the plant during the sampling period. After having been judged to be acceptable for use in the OCPSF rulemaking, the data were transmitted by SCC to the IBM computer at EPA's National Computer Center in Research Triangle Park, North Carolina, for loading into the OCPSF data base.

In addition to data collected in the sampling studies discussed above, the Agency also received data as part of public comments on the March 1983 Proposal and the July 17, 1985 and December 9, 1986 Federal Register Notices of Availability (NOA). These data were reviewed by the Agency to determine their accuracy and validity and selected data were included in EPA's final BAT toxic pollutant data base, which was used in limitations development. A discussion of the Agency's review and the selection of plant data for the final toxic pollutant data base is presented in Section VII.

F. WASTEWATER DATA SUMMARY

1. Organic Toxic Pollutants

The Agency's wastewater data collection studies as well as data submitted during public comment periods on the proposal and NOAs discussed above yielded substantial long- and short-term priority pollutant concentration data for 50 data sets from 43 manufacturing plants. Tables V-46 through V-49 provide a statistical summary of the priority pollutant concentrations in the combined influent to the end-of-pipe treatment systems for these plants. For illustrative purposes, the data for all plants are presented in Table V-46 with Tables V-47 through V-49 sorted into organics only, plastics only, and organics and plastics plants, respectively.

TABLE V-46
SUMMARY STATISTICS FOR INFLUENT CONCENTRATIONS FOR
ALL OCPSF PLANTS

CHEMICAL NUMBER	CHEMICAL NAME	THRESHOLD VALUE	FRACTION	# OF NONDETECTS	# OF DETECTS	# OF PLANTS	MINIMUM VALUE	MAXIMUM VALUE	MEAN VALUE	MEDIAN VALUE
1	ACENAPHTHENE	10	BASE/NEUTRAL	43	30	8	10.00	7000	773.8	513.0
2	ACROLEIN	50	VOLATILES	0	3	1	2500.00	34500	13633.3	3900.0
3	ACRYLONITRILE	50	VOLATILES	2	66	7	290.00	890000	94771.4	31500.0
4	BENZENE	10	VOLATILES	24	178	23	11.00	713740	24389.6	812.3
6	CARBON TETRACHLORIDE	10	VOLATILES	6	30	7	10.00	44000	2203.1	543.0
7	CHLOROBENZENE	10	VOLATILES	40	51	8	10.00	49775	3028.7	382.0
8	1,2,4-TRICHLOROBENZENE	10	BASE/NEUTRAL	23	355	4	20.00	2955	571.6	301.0
9	HEXACHLOROBENZENE	10	BASE/NEUTRAL	0	18	2	13.00	920	242.9	121.5
10	1,2-DICHLOROETHANE	10	VOLATILES	39	106	13	10.00	1272220	20730.2	410.0
11	1,1,1-TRICHLOROETHANE	10	VOLATILES	32	17	6	10.00	7234	594.1	30.5
12	HEXACHLOROETHANE	10	BASE/NEUTRAL	0	18	2	38.00	3400	516.7	156.5
13	1,1-DICHLOROETHANE	10	VOLATILES	20	5	2	11.00	640	163.5	15.0
14	1,1,2-TRICHLOROETHANE	10	VOLATILES	17	14	4	10.50	1201	299.4	23.3
15	1,1,2,2-TETRACHLOROETHANE	10	VOLATILES	38	5	4	10.00	192	111.1	121.5
16	CHLOROETHANE	50	VOLATILES	30	16	4	60.00	2840	522.7	104.0
18	BIS (2-CHLOROETHYL)ETHER	10	BASE/NEUTRAL	6	13	2	25.00	1700	413.5	54.0
21	2,4,6-TRICHLOROPHENOL	10	ACIDS	11	79	7	10.00	16780	427.7	59.0
23	CHLOROFORM	10	VOLATILES	66	96	17	10.00	5250	643.0	216.0
24	2-CHLOROPHENOL	10	ACIDS	31	34	5	10.33	247370	13206.0	117.5
25	1,2-DICHLOROBENZENE	10	BASE/NEUTRAL	31	399	12	10.50	23326	1039.6	829.0
26	1,3-DICHLOROBENZENE	10	BASE/NEUTRAL	3	20	2	11.50	4616	417.3	25.5
27	1,4-DICHLOROBENZENE	10	BASE/NEUTRAL	36	22	4	10.00	721	105.6	42.0
28	3,3-DICHLOROBENZIDINE	50	BASE/NEUTRAL	0	10	1	371.00	38351	6147.5	1700.0
29	VINYLIDENE CHLORIDE	10	VOLATILES	49	40	8	10.50	1300	348.2	262.5
30	1,2-TRANSDICHLOROETHYLENE	10	VOLATILES	26	9	4	12.83	515	255.9	236.3
31	2,4-DICHLOROPHENOL	10	ACIDS	4	27	4	60.00	72912	7153.6	665.0
32	PROPYLENE CHLORIDE	10	VOLATILES	4	58	6	28.50	11000	1405.7	505.0
33	1,3-DICHLOROPROPENE	10	VOLATILES	14	28	4	10.00	4850	447.7	178.5
34	2,4-DIMETHYLPHENOL	10	ACIDS	3	42	7	10.00	73537	11932.6	4470.0
35	2,4-DINITROTOLUENE	10	BASE/NEUTRAL	0	22	3	715.00	17500	3301.3	1659.0
36	2,6-DINITROTOLUENE	10	BASE/NEUTRAL	8	24	4	29.00	4675	775.0	379.5
38	ETHYLBENZENE	10	VOLATILES	31	143	20	15.50	80000	2382.5	220.0
39	FLUORANTHENE	10	BASE/NEUTRAL	2	31	6	14.87	7175	1249.9	1040.0
42	BIS-(2-CHLOROISOPROPYL) ETHER	10	BASE/NEUTRAL	3	18	2	193.00	19486	2267.9	787.0
44	DICHLOROMETHANE	10	VOLATILES	36	109	13	10.00	19000	2469.7	1091.0
45	CHLOROMETHANE	50	VOLATILES	7	8	1	51.00	129	83.4	90.0
47	BROMOFORM	10	VOLATILES	18	2	1	24.00	71	47.5	47.5
52	HEXACHLOROBUTADIENE	10	BASE/NEUTRAL	0	18	2	83.00	9100	2006.3	1111.0
54	ISOPHORONE	16	BASE/NEUTRAL	1	1	1	253.00	253	253.0	253.0
55	NAPHTHALENE	10	BASE/NEUTRAL	25	76	14	12.00	37145	4579.1	623.6
56	NITROBENZENE	14	BASE/NEUTRAL	27	382	6	86.00	90500	3881.6	2802.0

TABLE V-46
SUMMARY STATISTICS FOR INFLUENT CONCENTRATIONS FOR
ALL OCPSF PLANTS

CHEMICAL NUMBER	CHEMICAL NAME	THRESHOLD VALUE	FRACTION	# OF NONDETECTS	# OF DETECTS	# OF PLANTS	MINIMUM VALUE	MAXIMUM VALUE	MEAN VALUE	MEDIAN VALUE
57	2-NITROPHENOL	20	ACIDS	24	31	5	26.000	1625	308.1	155.00
58	4-NITROPHENOL	50	ACIDS	32	16	4	83.000	5990	856.1	455.00
59	2,4-DINITROPHENOL	50	ACIDS	35	18	5	67.000	6748	1881.5	1662.50
64	PENTACHLOROPHENOL	50	ACIDS	9	31	4	53.500	490	205.3	137.00
65	PHENOL	10	ACIDS	35	205	32	13.000	978672	58641.1	640.00
66	BIS-(2-ETHYLHEXYL) PHTHALATE	10	BASE/NEUTRAL	0	40	2	11.000	18830	1591.8	168.50
68	DI-N-BUTYL PHTHALATE	10	BASE/NEUTRAL	0	40	2	19.000	5930	660.2	208.25
69	DI-N-OCTYL PHTHALATE	10	BASE/NEUTRAL	5	4	2	10.000	64	28.3	13.50
70	DIETHYL PHTHALATE	10	BASE/NEUTRAL	5	40	4	10.000	15000	1109.4	550.00
71	DIMETHYL PHTHALATE	10	BASE/NEUTRAL	13	21	3	10.000	625	204.9	166.92
72	BENZO(A)ANTHRACENE	10	BASE/NEUTRAL	6	20	5	12.030	2400	447.0	275.50
73	BENZO(AH)PYRENE	10	BASE/NEUTRAL	7	15	2	11.462	426	149.3	132.50
74	BENZO-B-FLUORANTHENE	10	BASE/NEUTRAL	6	12	2	12.000	374	187.2	208.25
75	BENZO(K)FLUORANTHENE	10	BASE/NEUTRAL	7	11	2	12.000	352	170.9	157.00
76	CHRYSENE	10	BASE/NEUTRAL	15	21	4	17.000	2167	510.1	251.00
77	ACENAPHTHYLENE	10	BASE/NEUTRAL	23	35	9	10.000	18500	1058.7	208.50
78	ANTHRACENE	10	BASE/NEUTRAL	39	33	8	10.000	2900	535.2	430.75
79	BENZO(GHI)PERYLENE	20	BASE/NEUTRAL	4	3	1	22.500	23	22.5	22.50
80	FLUORENE	10	BASE/NEUTRAL	16	36	8	10.000	1873	508.8	153.90
81	PHENANTHRENE	10	BASE/NEUTRAL	15	47	10	10.000	11000	1792.5	683.00
82	DIBENZO(A,H)ANTHRACENE	20	BASE/NEUTRAL	4	3	1	22.500	25	23.3	22.50
83	INDENO(1,2,3-C,D)PYRENE	20	BASE/NEUTRAL	4	3	1	22.500	23	22.5	22.50
84	PYRENE	10	BASE/NEUTRAL	16	33	7	10.000	5500	735.7	590.00
85	PERCHLOROETHYLENE	10	VOLATILES	29	35	6	11.000	31500	2558.7	405.00
86	TOLUENE	10	VOLATILES	26	201	31	13.000	160000	8108.1	3720.00
87	TRICHLOROETHYLENE	10	VOLATILES	39	31	9	10.000	484	68.6	24.00
88	CHLOROETHYLENE	50	VOLATILES	0	21	3	233.500	17950	3217.6	2316.00

NUMBER OF DATASETS=50, NUMBER OF PLANTS=43

TABLE V-47

SUMMARY STATISTICS FOR INFLUENT CONCENTRATIONS FOR

ORGANICS-ONLY OCPSF PLANTS

CHEMICAL NUMBER	CHEMICAL NAME	THRESHOLD VALUE	FRACTION	# OF NONDETECTS	# OF DETECTS	# OF PLANTS	MINIMUM VALUE	MAXIMUM VALUE	MEAN VALUE	MEDIAN VALUE
1	ACENAPHTHENE	10	BASE/NEUTRAL	21	24	4	38.5	7000	992	742.3
4	BENZENE	10	VOLATILES	1	30	5	157.0	380000	36466	737.9
6	CARBON TETRACHLORIDE	10	VOLATILES	24	1	1	25.0	25	25	25.0
7	CHLOROBENZENE	10	VOLATILES	18	5	2	10.0	1772	598	326.5
8	1,2,4-TRICHLOROBENZENE	10	BASE/NEUTRAL	17	3	1	23.0	124	65	47.3
10	1,2-DICHLOROETHANE	10	VOLATILES	0	3	1	445.0	1967	994	570.0
11	1,1,1-TRICHLOROETHANE	10	VOLATILES	1	2	1	94.5	215	155	154.8
21	2,4,6-TRICHLOROPHENOL	10	ACIDS	4	3	1	17.5	18	18	17.5
23	CHLOROFORM	10	VOLATILES	0	3	1	217.0	870	445	248.0
24	2-CHLOROPHENOL	10	ACIDS	1	2	1	13890.0	15540	14715	14715.0
25	1,2-DICHLOROBENZENE	10	BASE/NEUTRAL	16	4	1	1350.0	4387	2434	1998.8
27	1,4-DICHLOROBENZENE	10	BASE/NEUTRAL	16	4	1	150.0	721	337	238.3
31	2,4-DICHLOROPHENOL	10	ACIDS	1	2	1	674.0	842	758	758.0
34	2,4-DIMETHYLPHENOL	10	ACIDS	1	24	3	385.7	73537	18872	18898.5
38	ETHYLBENZENE	10	VOLATILES	16	18	3	76.0	80000	15573	1955.0
39	FLUORANTHENE	10	BASE/NEUTRAL	1	24	3	22.4	7175	1594	1475.8
47	BROMOFORM	10	VOLATILES	18	2	1	24.0	71	48	47.5
55	NAPHTHALENE	10	BASE/NEUTRAL	18	24	3	28.0	37145	12897	15612.5
56	NITROBENZENE	14	BASE/NEUTRAL	19	1	1	140.0	140	140	140.0
57	2-NITROPHENOL	20	ACIDS	16	4	1	389.0	1352	908	946.2
58	4-NITROPHENOL	50	ACIDS	17	3	1	370.7	1251	720	538.0
59	2,4-DINITROPHENOL	50	ACIDS	16	4	1	2254.0	6748	4113	3724.0
65	PHENOL	10	ACIDS	19	32	6	259.0	978672	345381	15548.5
72	BENZO(A)ANTHRACENE	10	BASE/NEUTRAL	3	15	2	191.0	2400	584	331.0
73	BENZO(AH)PYRENE	10	BASE/NEUTRAL	7	15	2	11.5	426	149	132.5
74	BENZO-B-FLUORANTHENE	10	BASE/NEUTRAL	5	10	1	90.0	374	222	231.0
75	BENZO(K)FLUORANTHENE	10	BASE/NEUTRAL	5	10	1	75.5	352	187	165.0
76	CHRYSENE	10	BASE/NEUTRAL	4	14	2	198.0	1500	477	287.5
77	ACENAPHTHYLENE	10	BASE/NEUTRAL	3	25	4	12.0	18500	1437	275.0
78	ANTHRACENE	10	BASE/NEUTRAL	20	18	3	20.0	2900	891	754.5
79	BENZO(GHI)PERYLENE	20	BASE/NEUTRAL	4	3	1	22.5	23	23	22.5
80	FLUORENE	10	BASE/NEUTRAL	4	21	3	20.8	1873	788	804.0
81	PHENANTHRENE	10	BASE/NEUTRAL	3	18	3	37.8	11000	3965	3479.5
82	DIBENZO(A,H)ANTHRACENE	20	BASE/NEUTRAL	4	3	1	22.5	25	23	22.5
83	INDENO(1,2,3-C,D)PYRENE	20	BASE/NEUTRAL	4	3	1	22.5	23	23	22.5
84	PYRENE	10	BASE/NEUTRAL	1	24	3	23.4	5500	1007	897.8
86	TOLUENE	10	VOLATILES	17	34	6	95.0	60000	10834	745.0
87	TRICHLOROETHYLENE	10	VOLATILES	2	4	2	13.0	224	134	149.0

NUMBER OF DATASETS= 7, NUMBER OF PLANTS= 7

TABLE V-48

SUMMARY STATISTICS FOR INFLUENT CONCENTRATIONS FOR PLASTICS-ONLY OCPSF PLANTS

CHEMICAL NUMBER	CHEMICAL NAME	THRESHOLD VALUE	FRACTION	# OF NONDETECTS	# OF DETECTS	# OF PLANTS	MINIMUM VALUE	MAXIMUM VALUE	MEAN VALUE	MEDIAN VALUE
2	ACROLEIN	50	VOLATILES	0	3	1	2500.00	34500	13633	3900
3	ACRYLONITRILE	50	VOLATILES	0	21	3	1200.00	414785	154682	163600
4	BENZENE	10	VOLATILES	1	5	2	14.00	190	81	62
10	1,2-DICHLOROETHANE	10	VOLATILES	0	1	1	1534.00	1534	1534	1534
13	1,1-DICHLOROETHANE	10	VOLATILES	0	1	1	140.10	140	140	140
14	1,1,2-TRICHLOROETHANE	10	VOLATILES	0	1	1	21.00	21	21	21
15	1,1,2,2-TETRACHLOROETHANE	10	VOLATILES	0	1	1	188.20	188	188	188
23	CHLOROFORM	10	VOLATILES	0	3	1	13.75	23	17	14
29	VINYLIDENE CHLORIDE	10	VOLATILES	0	1	1	52.50	53	53	53
32	PROPYLENE CHLORIDE	10	VOLATILES	0	1	1	2258.00	2258	2258	2258
33	1,3-DICHLOROPROPENE	10	VOLATILES	0	3	1	175.00	1095	550	380
34	2,4-DIMETHYLPHENOL	10	ACIDS	0	1	1	13.50	14	14	14
38	ETHYLBENZENE	10	VOLATILES	1	25	5	22.00	3565	435	112
44	DICHLOROMETHANE	10	VOLATILES	2	1	1	10.00	23	17	17
55	NAPHTHALENE	10	BASE/NEUTRAL	0	9	3	25.00	3600	463	40
65	PHENOL	10	ACIDS	0	24	4	62.00	1900	498	472
86	TOLUENE	10	VOLATILES	0	12	4	60.00	1900	525	230
87	TRICHLOROETHYLENE	10	VOLATILES	0	1	1	483.70	484	484	484
88	CHLOROETHYLENE	50	VOLATILES	0	3	1	233.50	2396	993	350

NUMBER OF DATASETS= 7, NUMBER OF PLANTS= 7

TABLE V-49
SUMMARY STATISTICS FOR INFLUENT CONCENTRATIONS FOR
ORGANICS & PLASTICS OCPSF PLANTS

CHEMICAL NUMBER	CHEMICAL NAME	THRESHOLD VALUE	FRACTION	# OF NONDETECTS	# OF DETECTS	# OF PLANTS	MINIMUM VALUE	MAXIMUM VALUE	MEAN VALUE	MEDIAN VALUE
1	ACENAPHTHENE	10	BASE/NEUTRAL	22	6	4	10.000	57	24.5	23.0
3	ACRYLONITRILE	50	VOLATILES	2	45	4	290.000	890000	66813.2	23000.0
4	BENZENE	10	VOLATILES	22	143	16	11.000	713740	22706.0	990.0
6	CARBON TETRACHLORIDE	10	VOLATILES	4	29	6	10.000	44000	2275.7	666.3
7	CHLOROBENZENE	10	VOLATILES	22	46	6	11.500	49775	3345.7	426.0
8	1,2,4-TRICHLOROBENZENE	10	BASE/NEUTRAL	6	352	3	20.000	2955	575.9	305.5
9	HEXACHLOROBENZENE	10	BASE/NEUTRAL	0	18	2	13.000	920	242.9	121.5
10	1,2-DICHLOROETHANE	10	VOLATILES	39	102	11	10.000	1272220	21491.4	374.5
11	1,1,1-TRICHLOROETHANE	10	VOLATILES	31	15	5	10.000	7234	642.9	23.5
12	HEXACHLOROETHANE	10	BASE/NEUTRAL	0	18	2	38.000	3400	516.7	156.5
13	1,1-DICHLOROETHANE	10	VOLATILES	20	4	1	11.000	640	169.4	13.5
14	1,1,2-TRICHLOROETHANE	10	VOLATILES	17	13	3	10.500	1201	320.8	23.5
15	1,1,2,2-TETRACHLOROETHANE	10	VOLATILES	38	4	3	10.000	192	95.7	120.0
16	CHLOROETHANE	50	VOLATILES	30	16	4	60.000	2840	522.7	104.0
18	BIS (2-CHLOROETHYL)ETHER	10	BASE/NEUTRAL	6	13	2	25.000	1700	413.5	54.0
21	2,4,6-TRICHLOROPHENOL	10	ACIDS	7	76	6	10.000	16780	443.5	59.5
23	CHLOROFORM	10	VOLATILES	66	90	15	10.000	5250	669.0	216.0
24	2-CHLOROPHENOL	10	ACIDS	30	32	4	10.333	247370	13111.7	96.8
25	1,2-DICHLOROBENZENE	10	BASE/NEUTRAL	15	395	11	10.500	23326	1025.5	824.0
26	1,3-DICHLOROBENZENE	10	BASE/NEUTRAL	3	20	2	11.500	4616	417.3	25.5
27	1,4-DICHLOROBENZENE	10	BASE/NEUTRAL	20	18	3	10.000	220	61.5	32.0
28	3,3-DICHLOROBENZIDINE	50	BASE/NEUTRAL	0	10	1	371.000	38351	6147.5	1700.0
29	VINYLIDENE CHLORIDE	10	VOLATILES	49	39	7	10.500	1300	355.8	270.0
30	1,2-TRANSDICHLOROETHYLENE	10	VOLATILES	26	9	4	12.833	515	255.9	236.3
31	2,4-DICHLOROPHENOL	10	ACIDS	3	25	3	60.000	72912	7665.2	655.0
32	PROPYLENE CHLORIDE	10	VOLATILES	4	57	5	28.500	11000	1390.8	480.0
33	1,3-DICHLOROPROPENE	10	VOLATILES	14	25	3	10.000	4850	435.9	173.0
34	2,4-DIMETHYLPHENOL	10	ACIDS	2	17	3	10.000	8787	3342.0	3415.0
35	2,4-DINITROTOLUENE	10	BASE/NEUTRAL	0	22	3	715.000	17500	3301.3	1659.0
36	2,6-DINITROTOLUENE	10	BASE/NEUTRAL	8	24	4	29.000	4675	775.0	379.5
38	ETHYLBENZENE	10	VOLATILES	14	100	12	15.500	3850	495.2	223.5
39	FLUORANTHENE	10	BASE/NEUTRAL	1	7	3	14.870	289	69.2	30.0
42	BIS-(2-CHLOROISOPROPYL) ETHER	10	BASE/NEUTRAL	3	18	2	193.000	19486	2267.9	787.0
44	DICHLOROMETHANE	10	VOLATILES	34	108	12	10.000	19000	2514.3	1110.5
45	CHLOROMETHANE	50	VOLATILES	7	8	1	51.000	129	83.4	90.0
52	HEXACHLOROBUTADIENE	10	BASE/NEUTRAL	0	18	2	83.000	9100	2006.3	1111.0
54	ISOPHORONE	16	BASE/NEUTRAL	1	1	1	253.000	253	253.0	253.0
55	NAPHTHALENE	10	BASE/NEUTRAL	7	43	8	12.000	4018	797.9	399.5
56	NITROBENZENE	14	BASE/NEUTRAL	8	381	5	86.000	90500	3891.4	2802.0
57	2-NITROPHENOL	20	ACIDS	8	27	4	26.000	1625	219.2	147.0
58	4-NITROPHENOL	50	ACIDS	15	13	3	83.000	5990	887.6	450.0

TABLE V-49
SUMMARY STATISTICS FOR INFLUENT CONCENTRATIONS FOR
ORGANICS & PLASTICS OCPSF PLANTS

CHEMICAL NUMBER	CHEMICAL NAME	THRESHOLD VALUE	FRACTION	# OF NONDETECTS	# OF DETECTS	# OF PLANTS	MINIMUM VALUE	MAXIMUM VALUE	MEAN VALUE	MEDIAN VALUE
59	2,4-DINITROPHENOL	50	ACIDS	19	14	4	67.00	3900	1244.00	817.50
64	PENTACHLOROPHENOL	50	ACIDS	9	31	4	53.50	490	205.34	137.00
65	PHENOL	10	ACIDS	16	149	22	13.00	245000	6424.69	555.00
66	BIS-(2-ETHYLHEXYL) PHTHALATE	10	BASE/NEUTRAL	0	40	2	11.00	18830	1591.76	168.50
68	DI-N-BUTYL PHTHALATE	10	BASE/NEUTRAL	0	40	2	19.00	5930	660.18	208.25
69	DI-N-OCTYL PHTHALATE	10	BASE/NEUTRAL	5	4	2	10.00	64	28.25	13.50
70	DIETHYL PHTHALATE	10	BASE/NEUTRAL	5	40	4	10.00	15000	1109.43	550.00
71	DIMETHYL PHTHALATE	10	BASE/NEUTRAL	13	21	3	10.00	625	204.94	166.92
72	BENZO(A)ANTHRACENE	10	BASE/NEUTRAL	3	5	3	12.03	89	37.36	26.25
74	BENZO-B-FLUORANTHENE	10	BASE/NEUTRAL	1	2	1	12.00	16	14.00	14.00
75	BENZO(K)FLUORANTHENE	10	BASE/NEUTRAL	2	1	1	12.00	12	12.00	12.00
76	CHRYSENE	10	BASE/NEUTRAL	11	7	2	17.00	2167	575.89	73.00
77	ACENAPHTHYLENE	10	BASE/NEUTRAL	20	10	5	10.00	841	199.74	22.00
78	ANTHRACENE	10	BASE/NEUTRAL	19	15	5	10.00	1124	134.49	51.97
80	FLUORENE	10	BASE/NEUTRAL	12	15	5	10.00	946	142.35	50.00
81	PHENANTHRENE	10	BASE/NEUTRAL	12	29	7	10.00	4990	488.92	127.00
84	PYRENE	10	BASE/NEUTRAL	15	9	4	10.00	539	85.68	22.00
85	PERCHLOROETHYLENE	10	VOLATILES	29	35	6	11.00	31500	2558.70	405.00
86	TOLUENE	10	VOLATILES	9	155	21	13.00	160000	8097.24	4120.83
87	TRICHLOROETHYLENE	10	VOLATILES	37	26	6	10.00	182	44.50	21.88
88	CHLOROETHYLENE	50	VOLATILES	0	18	2	627.00	17950	3588.42	2452.00

NUMBER OF DATASETS=36, NUMBER OF PLANTS=29

In each table, the number of nondetects is the number of daily samples that were taken at or below the threshold concentrations and the number of detects are the number of daily samples that exceeded the threshold value. In the calculation of the statistical values, all nondetect samples were assigned the threshold value (the analytical method nominal detection limit). Specific pollutant data for each plant were retained only if they were detected in at least one sample.

2. <u>Toxic Pollutant Metals</u>

There are process sources of certain metal priority pollutants[1] in the process wastewaters of the OCPSF industry. These metals (including cyanide) and their affiliated process sources may be anticipated from published generic process chemistry that is typically used to manufacture each of the industry's products. Analytical data in the Master Process File from verification sampling, in which the process effluents of 176 of the major product/processes of the industry were characterized for both metal and organic priority pollutants, offered confirmation of some of the metals (and cyanide) that were anticipated. Confirmation was also found in the industry's response to the 1983 '308' Questionnaire, in which plants were asked to affiliate priority pollutants with each of the product/processes in operation.

Concentrations of metals in wastewater from individual in-plant processes are typically low (less than 1.0 ppm). Few of the treatment systems in the OCPSF industry have precipitation technology being applied to a process's wastewater prior to its joining the combined flow. Many OCPSF wastewater treatment systems do not have a primary clarifier. This implies the absence of solids in the combined flow that results from metals fortuitously precipitated by contact with various precipitants, and a concentration of metals in the combined flow that is typically too low to utilize precipitation technology. One obvious exception to this generalization is plants manufacturing rayon that are controlling zinc losses by chemical precipitation, using lime or caustic.

[1]For the purposes of this discussion, total cyanide is included in the metal priority pollutants (or toxic pollutants) term.

In the 1983 308 Questionnaire, each plant was asked to affiliate priority pollutants with the various product/processes in operation at the plant in 1980. They were also asked to indicate the priority pollutants' role within the product process, i.e., catalyst, solvent, raw material, or contaminant in the raw material, by-product, or waste product. This file, containing the priority pollutant metal-product/process affiliations, was retrieved from the 308 data base and a listing was prepared for each metal. Another file, containing product/process-plant affiliations, was also retrieved and listed for reference.

Of the five roles, the role of solvent was dismissed for metals. In addition in contrast to organics chemicals, metals cannot be generated by the process chemistry, only lost from the process. For this reason, by-product sources were also ignored. The plants frequently affiliated a metal with the waste products of the product/process, but affiliation with waste products was considered to have merit only when the metal was also listed as a catalyst or raw material for the product/process. Thus, editing focused mainly on catalyst and raw material roles of the metal in validating the product/process.

The editing criteria for validation of product/processes and plants were as follows:

- Invalidate a product/process affiliated with a metal listed as a by-product or waste product, unless it was also listed as a catalyst or raw material. Exclude solvent affiliations.
- Invalidate a product/process affiliated with a metal listed as a catalyst or raw material, if affiliation is inconsistant with the chemistry of the generic process or is an otherwise anomalous affiliation. Add a product/process when a metal is generally associated with the chemistry of the process (or can be confirmed by plant contact), but was not listed by plants that operate the product/process.
- Invalidate a product/process affiliated with a metal listed as part of the catalyst system, if the metal is a minor constituent (less than 5% by weight) of the catalyst, process reactor design severely limits catalyst losses, and/or the catalyst is exposed only to non-aqueous process streams.

- Invalidate a product/process that is a valid source of a metal, if the metal is unlikely to emerge in the wastewater from the process at a treatable level (less than 1 mg/l), before mixing with the wastewater from other processes in operation at the plant.

- Invalidate a product/process, if less than half of the plants that operate the product/process listed the metal as being affiliated with the product/process.

- Invalidate a plant affiliated with a valid product/process, if the plant no longer operates the product/process.

A summary of the results of this validation analysis is presented in Table V-50. A listing of the product/processes that have been determined to be process sources of metals and cyanide is presented in Section X of this document. Based on these results, the Agency determined that a total of eight toxic pollutant metals (including cyanide) had a substantial number of process sources in the OCPSF industry. Also, as discussed in the following section, the remaining seven toxic pollutants (including arsenic) were eliminated from further consideration for regulation under this rulemaking.

TABLE V-50.
SUMMARY OF PRIORITY POLLUTANT METAL-PRODUCT/PROCESS-PLANT VALIDATION

Priority Pollutant Metals		No. of PP[1] Before Validation	No. of Plants Before Validation	No. of PP[1] After Validation	No. of Plants After Validation
114 Antimony	(Sb)	43	126	15	29
115 Arsenic	(As)	46	113	25	18
117 Beryllium	(Be)	8	19		
118 Cadmium	(Cd)	34	85		
119 Chromium	(Cr)	116	207	24	41
120 Copper	(Cu)	131	240	62	71
121 Cyanide	(CN)	47	73	41	62
122 Lead	(Pb)	46	149	13	37
123 Mercury	(Hg)	31	93	1	1
124 Nickel	(Ni)	124	163	63	64
125 Selenium	(Se)	20	46		
126 Silver	(Ag)	19	68		
127 Thallium	(Th)	9	20		
128 Zinc	(Zn)	152	298	46	81

[1] product/processes

SECTION VI

SELECTION OF POLLUTANT PARAMETERS

A. INTRODUCTION

Specific toxic, conventional, and nonconventional pollutant parameters were determined to be potentially significant in the Organic Chemicals, Plastics, and Synthetic Fibers (OCPSF) Industry and were selected for evaluation based on: 1) an industry characterization, 2) data collected from field sampling efforts, 3) historical data collected from the literature, and 4) data provided by industry either by questionnaire (Section 308 Questionnaire Survey) or through public comment on the proposed regulations or subsequent Federal Register Notices of Availability of New Information.

The U.S. Environmental Protection Agency (EPA) has considered for regulation the following conventional pollutant parameters for the final BPT effluent limitations presented in this document: five-day biochemical oxygen demand (BOD_5), total suspended solids (TSS), pH, and oil and grease (O&G). Nonconventional pollutant parameters considered by the Agency for the final BPT, BAT, NSPS, PSES, and PSNS effluent limitations guidelines and standards include chemical oxygen demand (COD) and total organic carbon (TOC).

In developing its BAT, NSPS, PSES, and PSNS effluent limitations guidelines and standards for toxic pollutants, the Agency specifically addressed a list of 126 toxic pollutants, which are presented in Appendix VI-A. As the list of 65 toxic pollutants and classes of pollutants includes potentially thousands of specific pollutants, EPA limited its data collection efforts to the 126 specific compounds referred to as "priority" pollutants. The criteria that were used in the late 1970's to classify these pollutants as "priority" pollutants included the frequency of their occurrence in water, their chemical stability and structure, the amount of the chemical produced, and the availability of chemical standards and analytical methods for measurement.

This section presents descriptions of each of the conventional, nonconventional, and toxic pollutant parameters considered by the Agency and discusses the selection criteria used to select pollutants for control under BPT, BAT, NSPS, PSES, and PSNS.

B. CONVENTIONAL POLLUTANT PARAMETERS

1. Five-Day Biochemical Oxygen Demand (BOD_5)

The Five-Day Biochemical Oxygen Demand (BOD_5) test traditionally has been used to determine the pollutant strength of domestic and industrial wastewaters. It is a measure of the oxygen required by biological organisms to assimilate the biodegradable portion of a waste under aerobic conditions (6-1). Substances that may contribute to the BOD_5 include carbonaceous materials usable as a food source by aerobic organisms; oxidizable nitrogen derived from organic nitrogen compounds, ammonia and nitrates that are oxidized by specific bacteria; and chemically oxidizable materials such as ferrous compounds, sulfides, sulfite, and similiar reduced-state inorganics that will react with dissolved oxygen or that are metabilized by bacteria.

The BOD_5 of a wastewater is a measure of the dissolved oxygen depletion that might be caused by the discharge of that wastewater to a body of water. This depletion reduces the oxygen available to fish, plant life, and other aquatic species. Total exhaustion of the dissolved oxygen in water results in anaerobic conditions, and the subsequent dominance of anaerobic species that can produce undesirable gases such as hydrogen sulfide and methane. The reduction of dissolved oxygen can be detrimental to fish populations, fish growth rates, and organisms used as fish food. A total lack of oxygen can result in the death of all aerobic aquatic inhabitants in the affected area.

The BOD_5 test is widely used to estimate the oxygen demand of domestic and industrial wastes and to evaluate the performance of waste treatment facilities by measuring the amount of oxygen depletion in a standard size flask after 5 days incubation. The test is widely used for measuring potential pollution, since no other test methods have been developed that are as suitable or as widely accepted for evaluating the deoxygenation effect of a waste on a receiving water body.

The BOD_5 test measures the weight of dissolved oxygen utilized by microorganisms as they oxidize or transform the gross mixture of chemical compounds in the wastewater. The degree of biochemical reaction involved in the oxidation of carbon compounds is related to the period of incubation and the rate of biodegradation of the compound(s) within the mixture. When municipal sewage is tested, BOD_5 normally measures only 60 to 80 percent of the total carbonaceous biochemical oxygen demand of the sample. When testing OCPSF wastewaters, however, the fraction of total carbonaceous oxygen demand measured can range from less than 10 percent to more than 80 percent. The actual percentage for a given waste stream will depend on the degradation characteristics of the organic components present, the degree to which the seed is acclimated to these components, and the degree to which toxic or inhibitory components are present in the waste (6-1).

2. <u>Total Suspended Solids (TSS)</u>

Suspended solids can include both organic and inorganic materials. The inorganic materials include sand, silt, and clay and may include insoluble toxic metal compounds. The organic fraction includes such materials as grease, oils, animal and vegetable waste products, fibers, microorganisms, and many other dispersed insoluble organic compounds (6-2). These solids may settle rapidly and form bottom deposits that are often a mixture of both organic and inorganic solids.

Solids may be suspended in water for a time and then settle to the bottom of a stream or lake. They may be inert, slowly biodegradable materials, or they may be rapidly decomposable substances. While in suspension, they increase the turbidity of the water, reduce light penetration, and impair the photosynthetic activity of aquatic plants. After settling to the stream or lake bed, the solids can form sludge banks, which, if largely organic, create localized anaerobic and undesirable benthic conditions. Aside from any toxic effect attributable to substances leached out by water, suspended solids may kill fish and shell-fish by causing abrasive injuries, clogging gills and respiratory passages, screening light, and by promoting and maintaining noxious conditions through oxygen depletion. Suspended solids may also reduce the recreational value of a waterway and can cause problems in water used for domestic purposes. Suspended solids in intake water may interfere with many industrial processes, and cause foaming in boilers, or encrustations on exposed equipment, especially at elevated temperatures.

3. pH

The term pH describes the hydrogen ion-hydroxyl ion equilibria in water. Technically, pH is a measure of the hydrogen ion concentration or activity present in a given solution. A pH number is the negative logarithm of the hydrogen ion concentration. A pH of 7.0 indicates neutrality or a balance between free hydrogen and free hydroxyl ions. A pH above 7.0 indicates that a solution is alkaline; a pH below 7.0 indicates that a solution is acidic.

The pH of discharge water is of concern because of its potential impact on the receiving body of water. Wastewater effluent, if not neutralized before release, may alter the pH of the receiving water. The critical range suitable for the existence of most biological life is quite narrow, lying between pH 6 and pH 9.

Extremes of pH or rapid pH changes can harm or kill aquatic life. Even moderate changes from acceptable pH limits can harm some species. A change in the pH of water may increase or decrease the relative toxicity of many materials to aquatic life. A drop of even 1.5 units, for example, can increase the toxicity of metalocyanide complexes a thousandfold. The bactericidal effect of chlorine in most cases lessens as the pH increases.

Waters with a pH below 6.0 corrode waterworks structures, distribution lines, and household plumbing fixtures. This corrosion can add to drinking water constituents such as iron, copper, zinc, cadmium, and lead. Low pH waters not only tend to dissolve metals from structures and fixtures, but also tend to redissolve or leach metals from sludges and bottom sediments.

Normally, biological treatment systems are maintained at a pH between 6 and 9; however, once acclimated to a narrow pH range, sudden deviations (even in the 6 to 9 range) can cause upsets in the treatment system with a resultant decrease in treatment efficiency.

4. Oil and Grease (O&G)

Oil and grease analyses do not actually measure the quantity of a specific substance, but measure groups of substances whose common characteristic is their solubility in freon. Substances measured may include hydrocarbons, fatty acids, soaps, fats, oils, wax, and other materials extracted by the solvent from an acidified sample and not volatilized by the conditions of the test. As a result, the term "oil and grease" is more properly defined by the conditions of the analysis rather than by a specific compound or group of compounds. Additionally, the material identified in the O&G determination is not necessarily free floating. It may be actually in solution but still extractable from water by the solvent (6-3).

Oils and greases of hydrocarbon derivatives, even in small quantities, cause troublesome taste and odor problems. Scum lines from these agents are produced on water treatment basin walls and other containers. Fish and water fowl are adversely affected by oils in their habitat. Oil emulsions may cause the suffocation of fish by adhering to their gills and may taint the flesh of fish when microorganisms exposed to waste oil are eaten. Deposition of oil in the bottom sediments of natural waters can serve to inhibit normal benthic growth. Oil and grease can also exhibit an oxygen demand.

Levels of oil and grease that are toxic to aquatic organisms vary greatly depending on the oil and grease components and the susceptibility of the species exposed to them. Crude oil in concentrations as low as 0.3 mg/l can be extremely toxic to freshwater fish. Oil slicks prevent the full aesthetic enjoyment of water. The presence of oil in water can also increase the toxicity of other substances being discharged into the receiving bodies of water. Municipalities frequently limit the quantity of oil and grease that can be discharged to their wastewater treatment systems.

There are several approved modifications of the analysis for oil and grease. Each is designed to increase the accuracy or enhance the selectivity of the analysis. Depending on the procedure and detection method employed, the accuracy of the test can vary from 88 percent for the Soxhlet Extraction Method to 99 percent for the Partition-Infrared Method.

C. NONCONVENTIONAL POLLUTANT PARAMETERS

1. Chemical Oxygen Demand (COD)

COD is a chemical oxidation test devised as an alternate method of estimating the oxygen demand of a wastewater. Since the method relies on the oxidation-reduction system of a chemical reaction rather than a biological reaction, it is more precise, accurate, and rapid than the BOD_5 test. The COD test is sometimes used to estimate the total oxygen (ultimate rather than the five-day BOD_5) required to oxidize the compounds in a wastewater. In the COD test, strong chemical oxidizing agents under acid conditions, with the assistance of certain inorganic catalysts, can oxidize most organic compounds, including many that are not biodegradable. However, it should be noted that the COD test may not measure the oxygen demand of certain aromatic species such as benzene, toluene, and pyridine (6-4).

The COD test measures organic components that may exert a biological oxygen demand and may affect public health. It is a useful analytical tool for pollution control activities. Most pollutants measured by the BOD_5 test will be measured by the COD test. In addition, pollutants resistant to biochemical oxidation will also be measured as COD.

Compounds resistant to biochemical oxidation are of great concern because of their slow, continuous oxygen demand on the receiving water and also, in some cases, because of their potential health effects on aquatic life and humans. Many of these compounds result from industrial discharges and some of the compounds have been found to have carcinogenic, mutagenic, and similar adverse effects. Concern about these compounds has increased as a result of demonstrations that their long life in receiving water (the result of a low biochemical oxidation rate) allows them to contaminate downstream water intakes. The commonly used systems of water purification are not effective in removing these types of materials and disinfection with chlorine may convert them into even more objectionable materials.

2. Total Organic Carbon (TOC)

TOC measures all oxidizable organic material in a waste stream, including the organic chemicals not oxidized (and therefore not detected) in BOD_5 and

COD tests. TOC analysis is a rapid test for estimating the total organic carbon in a waste stream.

When testing for TOC, the organic carbon in a sample is converted to carbon dioxide (CO_2) by catalytic combustion or by wet chemical oxidation. The CO_2 formed can be measured directly by an infrared detector or it can be converted to methane (CH_4) and measured by a flame ionization detector. The amount of CO_2 or CH_4 is directly proportional to the concentration of carbonaceous material in the sample. TOC tests are usually performed on commercially available automatic TOC analyzers. Inorganic carbons, including carbonates and bicarbonates, interfere with these analyses and must be removed during sample preparation (6-5).

D. TOXIC POLLUTANT PARAMETERS

Paragraph 8 of the Settlement Agreement contains provisions authorizing EPA to exclude toxic pollutants and industry subcategories from regulation under certain circumstances. Paragraph 8(a)(iii) authorizes the Administrator to exclude from regulation: toxic pollutants not detectable by Section 304(h) analytical methods or other state-of-the-art methods; toxic pollutants present in amounts too small to be effectively reduced by available technologies; toxic pollutants present only in trace amounts and neither causing nor likely to cause toxic effects; toxic pollutants detected in the effluent from only a small number of sources within a subcategory and uniquely related to only those sources; toxic pollutants that will be effectively controlled by the technologies upon which are based other effluent limitations and standards; or toxic pollutants for which more stringent protection is already provided under Section 307(a) of the Act.

Pursuant to the Paragraph 8(a)(iii) criteria, the Agency decided early in the rulemaking to eliminate from further consideration 26 toxic pollutants, consisting of 18 pesticides, seven polychlorinated biphenyls (PCBs), and asbestos. These toxic pollutants are listed in Table VI-1, and are excluded because they are not produced as products or co-products and are unlikely to appear as raw material contaminants in OCPSF product/processes. At facilities manufacturing OCPSF product/processes, but where pesticide pollutants are also

TABLE VI-1.
TWENTY-SIX TOXIC POLLUTANTS
PROPOSED FOR EXCLUSION

Aldrin	alpha-BHC
Dieldrin	beta-BHC
Chlordane	gamma-BHC
4,4′-DDT	delta-BHC
4,4′-DDE	Toxaphene
4,4′-DDD	PCB-1242 (Arochlor 1242)
alpha-Endosulfan	PCB-1254 (Arochlor 1254)
beta-Endosulfan	PCB-1221 (Arochlor 1221)
Endosulfansulfate	PCB-1232 (Arochlor 1232)
Endrin	PCB-1248 (Arochlor 1248)
Endrin aldehyde	PCB-1260 (Arochlor 1260)
Heptachlor	PCB-1016 (Arochlor 1016)
Heptachlor epoxide	Asbestos

synthesized by product/processes in SIC Codes corresponding to the pesticides category, pesticide discharges will be regulated under effluent limitations for the separate pesticide category. On occasion, pesticides may appear in discharges that contain OCPSF effluents only but can be attributed to application of pesticide formulations around the plant grounds. PCBs are no longer manufactured in the United States; however, PCBs may occasionally appear in OCPSF effluents and are probably the result of leaking transformers containing PCB-contaminated oil which finds its way into the wastewater through stormwater runoff or plant floor drains. Asbestos is neither manufactured nor utilized as a raw material or catalyst by the OCPSF industry. In any event, none of the 18 pesticides, 7 PCBs, and asbestos are currently related to OCPSF production.

With the exception of dioxin, all remaining priority pollutants were considered for regulation; however, as described later in this section, some were ultimately excluded from regulation under Paragraph 8. Regulation of dioxin (TCDD) has been reserved even though it was not detected at any of the sample locations. The minimum detection or analytical threshold level of the 2,3,7,8-tetrachlorodibenzo-p-dioxin analytical method used at the time of the EPA laboratory studies that included dioxin (March 1983 to May 1984/12-plant study) was significantly higher than the level presently being used by the Agency. The minimum detection level used for the OCPSF dioxin analyses was 3×10^{-7} grams/liter, which is five orders of magnitude higher than the current minimum detection level being used by the Agency to study industrial sources of dioxin in wastewater discharges. Thus, the Agency decided to reserve dioxin rather than use the higher analytical detection level as a basis for exclusion from regulation.

E. SELECTION CRITERIA

1. Conventional Pollutants

The Agency has decided to control five-day biochemical oxygen demand (BOD_5), total suspended solids (TSS), and pH under its final BPT effluent limitations guidelines. While the Agency considered developing limitations for oil and grease, EPA determined that the effluent levels of oil and grease observed at BPT treatment systems were achieved through incidental removal by a treatment system primarily designed to remove BOD_5 and TSS. It should be noted that certain plants install oil and grease treatment technologies to ensure that subsequent treatment units (e.g., other physical/chemical or biological treatment) can operate properly. Therefore, based on these reasons, the Agency decided not to establish BPT effluent limitations for oil and grease.

2. Nonconventional Pollutants

While the Agency had considered the development of BPT, BAT, NSPS, PSES, and PSNS effluent limitations guidelines and standards for specific nonconventional pollutants, EPA has determined that the regulation of nonconventional pollutants will be deferred. One reason for this deferment is the enormity of the task of developing analytical methods for many of the nonconventional toxic pollutants. Another reason for not regulating the more familiar nonconventional pollutants such as COD and TOC is that much of the performance data obtained by the Agency is the result of incidental removals by treatment technologies installed to remove conventional and/or toxic (priority) pollutants and not designed for the removal of the nonconventional pollutants present, including COD and TOC. The Agency believes that the proper installation of treatment technologies to meet BPT, BAT, NSPS, PSES, and PSNS effluent limitations guidelines and standards will result in significant reductions of nonconventional pollutants. For example, nonconventional volatile pollutants such as xylene that are present in BTX process wastewaters will be removed by steam strippers installed for removal of benzene and toluene.

3. Toxic Pollutants

Toxic pollutant parameters are controlled under BAT and NSPS for direct dischargers and PSES and PSNS for indirect dischargers and the criteria for selecting toxic pollutants for regulation for each mode of discharge is different. Therefore, discussion of the selection criteria for BAT and NSPS and PSES and PSNS are presented separately in the following sections.

a. Selection Criteria for BAT and NSPS Toxic Pollutants

As stated previously, dioxin was reserved from regulation at this time. In addition, Paragraph 8 of the Settlement Agreement contains provisions authorizing EPA to exclude toxic pollutants and industry subcategories from regulation under certain circumstances. Pursuant to these criteria (as stated previously), the Agency eliminated 18 pesticides, 7 PCBs, and asbestos from further regulatory consideration. The remaining 99 toxic pollutants were then evaluated based on the specific criteria set forth in Paragraph 8 of the Settlement Agreement.

Table VI-2 presents the frequency of occurrence of 99 toxic pollutants sampled for in untreated wastewaters (discharged to the end-of-pipe treatment systems) during the following EPA toxic pollutant sampling studies: 1) Phase I Screening, 2) Phase II Screening, 3) Verification, 4) EPA/CMA 5-Plant Study, and 5) EPA 12-Plant Study. Also presented are the minimum and maximum reported concentrations from the last three studies.

Only the last three studies for the minimim/maximum values were used because the analytical methods used for the two screening studies allow the data only to be used qualitatively. False positive pollutant identification could occur in the Phase I and II screening studies as a result of the procedures used for interpreting ambiguous pollutant identification based on the 1977 screening level GC/MS analytical protocols and QA/QC procedures. The screening level analytical procedures based pollutant identification on three peaks of the mass spectrum. If these peaks did not agree exactly with the reference or library spectrum, then judgement calls were generally made in favor of compound presence. These judgement calls were made approximately 10 to 20 percent of the time. This was a conservative approach for identifying pollutants of concern for future organic priority pollutant field sampling and analysis studies because it minimized the occurrence of false negative reporting. Use of the screening analytical protocols also led to the reporting of a range of analytical threshold levels or "detection limits" for various toxic compounds. In general, the analytical threshold levels that were reported as "less than" values are associated with raw waste sample matrix interferences. The reporting of data as such does not imply the presence of the toxic compounds at the reported "less than" values. Rather, it means that the presence or absence of these compounds cannot be verified due to analytical limitations. The frequency counts presented in Table VI-2 treats reported "less than" values as non-detected. (The initial frequency counts presented

TABLE VI-2
FREQUENCY OF OCCURENCE AND CONCENTRATION RANGES FOR
SELECTED PRIORITY POLLUTANTS IN UNTREATED WASTEWATER

OBS	POLLUTANT NAME	FRACTION	POLLUTANT NUMBER	N	DET	RATIO	NUMBER OF PLANTS	MIN CONCENTRATION	MAX CONCENTRATION
1	ZINC (TOTAL)	M	128	137	131	95.620	21	14.000	450000
2	COPPER (TOTAL)	M	120	134	123	91.791	19	23.500	4834
3	MERCURY (TOTAL)	M	123	126	95	75.397	13	0.500	900
4	PHENOL	A	65	148	110	74.324	29	13.000	978672
5	CHROMIUM (TOTAL)	M	119	141	102	72.340	26	60.000	5330
6	TOLUENE	V	86	137	96	70.073	26	13.000	160000
7	NICKEL (TOTAL)	M	124	126	80	63.492	10	49.000	37500
8	BENZENE	V	4	134	78	58.209	20	12.500	713740
9	ETHYLBENZENE	V	38	130	75	57.692	18	15.500	80000
10	DICHLOROMETHANE	V	44	122	69	56.557	7	10.310	12480
11	CHLOROFORM	V	23	131	71	54.198	13	11.000	5250
12	ARSENIC (TOTAL)	M	115	120	62	51.667	6	5.000	711
13	SILVER (TOTAL)	M	126	122	58	47.541	1	3.634	18
14	BIS-(2-ETHYLHEXYL) PHTHALATE	B	66	127	57	44.882	1	11.000	18830
15	CYANIDE (TOTAL)	M	121	118	49	41.525	3	130.000	5063
16	CADMIUM (TOTAL)	M	118	126	48	38.095	3	5.519	10
17	LEAD (TOTAL)	M	122	131	49	37.405	8	103.800	430000
18	ANTIMONY (TOTAL)	M	114	123	42	34.146	7	5.000	630
19	NAPHTHALENE	B	55	125	42	33.600	14	12.000	37145
20	SELENIUM (TOTAL)	M	125	119	38	31.933	4	3.000	250
21	1,1,1-TRICHLOROETHANE	V	11	112	35	31.250	6	11.000	7234
22	1,2-DICHLOROETHANE	V	10	115	34	29.565	11	12.000	1272220
23	CHLOROBENZENE	V	7	115	33	28.696	7	11.500	49775
24	THALLIUM (TOTAL)	M	127	118	33	27.966	2	2.000	5
25	PERCHLOROETHYLENE	V	85	112	28	25.000	5	11.000	31500
26	CARBON TETRACHLORIDE	V	6	113	28	24.779	6	15.000	44000
27	2,4-DIMETHYLPHENOL	A	34	117	28	23.932	7	13.500	73537
28	VINYLIDENE CHLORIDE	V	29	106	25	23.585	7	10.500	1300
29	DI-N-BUTYL PHTHALATE	B	68	118	25	21.186	1	19.000	5930
30	TRICHLOROETHYLENE	V	87	113	23	20.354	8	10.222	484
31	ACENAPHTHENE	B	1	117	23	19.658	7	11.000	7000
32	PHENANTHRENE	B	81	117	23	19.658	10	18.500	11000
33	ANTHRACENE	B	78	117	21	17.949	7	15.000	2900
34	FLUORENE	B	80	118	21	17.797	9	10.500	1873
35	ACENAPHTHYLENE	B	77	118	19	16.102	8	12.000	18500
36	BERYLLIUM(TOTAL)	M	117	118	19	16.102	.	.	.
37	PYRENE	B	84	119	18	15.126	6	11.000	5500
38	2,4,6-TRICHLOROPHENOL	A	21	113	17	15.044	6	11.000	16780
39	2-CHLOROPHENOL	A	24	115	17	14.783	5	10.333	247370
40	FLUORANTHENE	B	39	117	17	14.530	6	14.870	7175
41	2,4-DICHLOROPHENOL	A	31	114	15	13.158	4	60.000	72912
42	1,2-TRANSDICHLOROETHYLENE	V	30	107	14	13.084	4	12.833	515
43	PROPYLENE CHLORIDE	V	32	107	14	13.084	5	28.500	11000
44	1,2-DICHLOROBENZENE (O-DICHLOROBENZENE)	B	25	116	15	12.931	9	10.500	23326
45	1,4-DICHLOROBENZENE (P-DICHLOROBENZENE)	B	27	113	14	12.389	4	10.500	721
46	DIETHYL PHTHALATE	B	70	112	13	11.607	2	13.500	15000
47	DIMETHYL PHTHALATE	B	71	113	13	11.504	1	10.333	625
48	BUTYLBENZYL PHTHALATE	B	67	115	13	11.304	.	.	.
49	1,1,2,2-TETRACHLOROETHANE	V	15	109	12	11.009	3	34.000	192
50	BENZO(A)ANTHRACENE	B	72	112	12	10.714	5	12.030	2400

ALL CONCENTRATION IN UNITS OF PPB

RATIO = 100*DET/N(100 * # DETECTED/TOTAL)

TABLE VI-2(CON'T.)
FREQUENCY OF OCCURENCE AND CONCENTRATION RANGES FOR
SELECTED PRIORITY POLLUTANTS IN UNTREATED WASTEWATER

OBS	POLLUTANT NAME	FRACTION	POLLUTANT NUMBER	N	DET	RATIO	NUMBER OF PLANTS	MIN CONCENTRATION	MAX CONCENTRATION
51	CHRYSENE	B	76	114	12	10.526	4	17.00	2167
52	DICHLOROBROMOMETHANE	V	48	108	11	10.185	.	.	.
53	BROMOFORM	V	47	105	10	9.524	1	24.00	71
54	ACRYLONITRILE	V	3	111	10	9.009	6	290.00	890000
55	NITROBENZENE	B	56	111	10	9.009	4	140.00	330000
56	PENTACHLOROPHENOL	A	64	113	10	8.850	4	53.50	490
57	1,1,2-TRICHLOROETHANE	V	14	105	9	8.571	3	10.50	1201
58	2,6-DINITROTOLUENE	B	36	110	9	8.182	3	29.00	4675
59	4-NITROPHENOL	A	58	112	9	8.036	4	83.00	10000
60	2-NITROPHENOL	A	57	113	9	7.965	5	26.00	30000
61	CHLOROMETHANE	V	45	101	8	7.921	1	51.00	129
62	1,1-DICHLOROETHANE	V	13	107	8	7.477	2	11.00	640
63	1,3-DICHLOROPROPENE	V	33	109	8	7.339	2	17.00	4850
64	BIS-(2-CHLOROISOPROPYL) ETHER	B	42	112	8	7.143	2	193.00	19486
65	2,4-DINITROPHENOL	A	59	112	8	7.143	5	67.00	360000
66	BIS (2-CHLOROETHYL)ETHER	B	18	114	8	7.018	2	25.00	1700
67	CHLOROETHANE	V	16	103	7	6.796	2	60.00	1040
68	CHLORODIBROMOMETHANE	V	51	105	7	6.667	.	.	.
69	1,3-DICHLOROBENZENE (M-DICHLOROBENZENE)	B	26	112	7	6.250	2	11.50	4616
70	DI-N-OCTYL PHTHALATE	B	69	112	7	6.250	1	12.50	64
71	1,2,4-TRICHLOROBENZENE	B	8	110	6	5.455	3	20.00	1927
72	BENZO-B-FLUORANTHENE	B	74	110	6	5.455	2	12.00	374
73	HEXACHLOROBENZENE	B	9	109	5	4.587	1	13.00	920
74	HEXACHLOROETHANE	B	12	109	5	4.587	1	38.00	3400
75	N-NITROSODIPHENYLAMINE	B	62	109	5	4.587	.	.	.
76	PARA-CHLORO-META-CRESOL	A	22	108	4	3.704	.	.	.
77	2,4-DINITROTOLUENE	B	35	108	4	3.704	2	38.00	17500
78	BENZO(AH)PYRENE	B	73	108	4	3.704	2	11.46	426
79	1,2-DIPHENYLHYDRAZINE	B	37	109	4	3.670	.	.	.
80	CHLOROETHYLENE	V	88	99	3	3.030	2	233.50	17950
81	BENZO(K)FLUORANTHENE	B	75	107	3	2.804	2	12.00	352
82	BENZIDINE	B	5	108	3	2.778	.	.	.
83	ISOPHORONE	B	54	109	3	2.752	1	253.00	253
84	4,6-DINITRO-O-CRESOL	A	60	109	3	2.752	1	7100.00	14888
85	ACROLEIN	V	2	96	2	2.083	1	2500.00	34500
86	2-CHLOROETHYLVINYL ETHER	V	19	99	2	2.020	.	.	.
87	BIS-(2-CHLOROETHOXY) METHANE	B	43	108	2	1.852	.	.	.
88	BENZO(GHI)PERYLENE	B	79	111	2	1.802	1	22.50	23
89	INDENO(1,2,3-C,D)PYRENE	B	83	111	2	1.802	1	22.50	23
90	BROMOMETHANE	V	46	96	1	1.042	.	.	.
91	N-NITROSODI-N-PROPYLAMINE	B	63	106	1	0.943	.	.	.
92	2-CHLORONAPHTHALENE	B	20	107	1	0.935	.	.	.
93	4-CHLOROPHENYLPHENYL ETHER	B	40	107	1	0.935	.	.	.
94	3,3-DICHLOROBENZIDINE	B	28	108	1	0.926	1	371.00	38351
95	4-BROMOPHENYLPHENYL ETHER	B	41	108	1	0.926	.	.	.
96	HEXACHLOROBUTADIENE	B	52	109	1	0.917	1	83.00	9100
97	DIBENZO(A,H)ANTHRACENE	B	82	109	1	0.917	1	22.50	25
98	HEXACHLOROCYCLOPENTADIENE	B	53	109	0	0.000	.	.	.
99	N-NITROSODIMETHYLAMINE	B	61	100	0	0.000	.	.	.

ALL CONCENTRATION IN UNITS OF PPB
RATIO = 100*DET/N(100 * # DETECTED/TOTAL)

in Table VI-2, Vol II of the proposed Development Document (EPA 440/1-83/009, February 1983) had tabulated "less than" values as detected.)

It should also be noted that the selected untreated wastewater sampling locations at some plants may be downstream of in-plant controls that may treat one or more OCPSF product/process sources of wastewater before commingling with other OCPSF process wastewater at the influent to the end-of-pipe treatment system. Therefore, the end-of-pipe raw wastewater summaries include some partially treated wastewater. This situation is unavoidable for several reasons. Foremost is the practical difficulties of accurately sampling and flow proportioning multiple in-plant sources of wastewater to obtain completely untreated wastewater characteristics. The Agency's in-plant sampling efforts often required the cooperation of plant personnel to modify existing plumbing to accommodate sampling and flow measurement devices. The OCPSF industry does not measure most in-plant sources of wastewater (the vast majority of in-plant flows reported in the 1983 Section 308 survey were qualified estimates). In addition, many of these in-plant controls are operated as product recovery rather than wastewater treatment units. For example, many existing in-plant controls such as steam stripping were originally installed for product recovery purposes, but may be operated more efficiently or upgraded for pollution control purposes. Also, some in-plant controls that precede biological treatment protect the biota and otherwise ensure that the biological system functions effectively and consistently. Sampling prior to product recovery and prior to necessary in-plant control elements of biological treatment would tend to overestimate typical raw waste concentrations. For these reasons, the Agency believes that sampling of raw wastewater prior to end-of-pipe treatment provides the most reasonable available basis for assessing typical current OCPSF industry plant-level priority pollutant concentrations.

In reviewing Table VI-2, two pollutants (hexachlorocyclopentadiene and N-nitrosodimethylamine) were not detected at any of the 186 OCPSF plants sampled. An additional five pollutants (2-chloronaphthalene, 4-chlorophenyl phenyl ether, 4-bromophenyl phenyl ether, methyl bromide, and N-nitrosodi N-propylamine) were detected at only one OCPSF facility, three pollutants (2-chloroethyl vinyl ether, acrolein, and bis(2-chloroethoxy)methane) were detected at only two OCPSF facilities, one pollutant (benzidine) was detected at only three OCPSF facilities, two pollutants (parachlorometa cresol and 1,2,-diphenylhydrazine) were detected at only four OCPSF facilities, and one pollutant (N-nitrosodiphenylamine) was detected at only five OCPSF facilities. These pollutants (with the exception of acrolein) were not detected in any of the samples from the quantitative minimum/maximum data set and were found at this limited number of plants out of a total plant population of 186 facilities. In addition, one pollutant (butyl benzyl phthalate), which was found at a higher percentage of OCPSF facilities was never detected in the quantitative minimum/maximum data set.

Based on the limited number of plants at which these pollutants occur, the fact that all but one of these pollutants were never quantitatively identified and that the qualitative data from the two screening studies tend to exhibit false positive values, the Agency believes that these 15 organic toxic pollutants described above and an additional 7 priority toxic metals (discussed later in this section) and listed in Table VI-3 should be excluded as follows: two pollutants should be excluded from regulation under BAT on the basis of Paragraph 8(a)(iii) of the Settlement Agreement because these pollutants were "... not detected by Section 304(h) analytical methods or other state-of-the-art methods ..." and the remaining 13 organic toxic pollutants and 7 metals should be excluded from regulation under BAT on the basis of Paragraph 8(a)(iii) of the Settlement Agreement because these pollutants were "... detected in the effluent from a small number of sources and are uniquely related to those sources ..."

Also, three toxic pollutants (benzo (ghi) perylene, dibenzo (a,h) anthracene, and indeno (1,2,3-c,d) pyrene) were detected in two or fewer OCPSF plants in the qualitative frequency of occurrence data base, were reported at less than 25 ppb in the quantitative minimum/maximum concentration data base and are part of the polynuclear aromatic (PNA) pollutant class, which generally occur together and for which 11 of 14 pollutants in the class are being regulated under BAT. Based on these factors, the Agency has decided to exclude these three toxic pollutants (also presented in Table VI-3) from regulation under BAT on the basis of Paragraph 8(a)(iii) of the Settlement Agreement because these pollutants were "...effectively controlled by the technologies upon which are based other effluent limitations guidelines and standards..."

TABLE VI-3.
TWO TOXIC POLLUTANTS EXCLUDED FROM REGULATION FOR BAT SUBCATEGORIES ONE AND TWO UNDER PARAGRAPH 8(a)(iii) OF THE SETTLEMENT AGREEMENT BECAUSE THEY WERE "... NOT DETECTED BY SECTION 304(h) ANALYTICAL METHODS OR OTHER STATE-OF-THE-ART METHODS ..."

Hexachlorocyclopentadiene
N-Nitrosodimethylamine

TWENTY TOXIC POLLUTANTS EXCLUDED FROM REGULATION FOR BAT SUBCATEGORIES ONE AND TWO UNDER PARAGRAPH 8(a)(iii) BECAUSE THEY WERE "... DETECTED IN THE EFFLUENT FROM A SMALL NUMBER OF SOURCES AND ARE UNIQUELY RELATED TO THOSE SOURCES ..."

Acrolein
2-Chloronaphthalene
4-Chlorophenyl phenyl ether
4-Bromophenyl phenyl ether
Methyl Bromide
N-Nitrosodi-n-propylamine
2-Chloroethyl vinyl ether
Bis (2-chloroethoxy) ether
Benzidine
Parachlorometa Cresol
1,2-Diphenylhydrazine
N-Nitrosodiphenylamine
Butyl Benzyl Phthalate
Arsenic
Beryllium
Cadmium
Mercury
Selenium
Silver
Thallium

THREE TOXIC POLLUTANTS EXCLUDED FROM REGULATION FOR BAT SUBCATEGORIES ONE AND TWO UNDER PARAGRAPH 8(a)(iii) OF THE SETTLEMENT AGREEMENT BECAUSE THEY WERE "...EFFECTIVELY CONTROLLED BY TECHNOLOGIES UPON WHICH ARE BASED OTHER EFFLUENT LIMITATIONS, GUIDELINES, AND STANDARDS..."

Benzo(ghi)Perylene
Dibenzo(a,h)Anthracene
Indeno(1,2,3-c,d) Pyrene

TABLE VI-3. (Continued)
EIGHT TOXIC POLLUTANTS EXCLUDED FROM REGULATION FOR BAT SUBCATEGORIES ONE AND TWO UNDER PARAGRAPH 8(a)(iii) OF THE SETTLEMENT AGREEMENT BECAUSE THEY WERE "...PRESENT ONLY IN TRACE AMOUNTS AND NEITHER CAUSING NOR LIKELY TO CAUSE TOXIC EFFECTS..."

1,1,2,2-Tetrachloroethane
Bis(2-Chloroethyl)Ether
Chlorodibromomethane
Isophorone
Pentachlorophenol
Di-n-Octyl Phthalate
Bromoform
Dichlorobromomethane

In addition to the 18 organic toxic pollutants (listed in Table VI-3) that were excluded for the reasons mentioned above, another eight organic toxic pollutants (also shown in Table VI-3) are being excluded after examining the Agency's toxic pollutant wastewater loadings estimates for direct and indirect dischargers. Table VI-4 presents a summary of the toxic pollutant wastewater loadings estimates by direct and indirect dischargers for these eight toxic pollutants. Three toxic pollutants (bis(2-chloroethyl)ether, bromoform, and dichlorobromomethane), while being detected at a relatively high number of plants (8, 10, and 11 plants, respectively) in the qualitative frequency of occurrence data base, were estimated never to occur in the Agency's current toxic pollutant wastewater loadings calculations for direct and indirect dischargers. These wastewater loadings were calculated on a plant-by-plant basis utilizing each plant's current product/process mix as reported in the 1983 Section 308 Questionnaire Survey and are considered an up-to-date quantitative measurement of a toxic pollutant's industry-wide presence. Five toxic pollutants (1,1,2,2-tetrachloroethane, chlorodibromomethane, isophorone, pentachlorophenol, and di-n-octyl phthalate) had relatively low current wastewater loadings predicted using this up-to-date product/process mix information with average current discharge loadings ranging from 0.007 to 0.237 lbs/day. Based on these factors, the Agency has decided to exclude these eight toxic pollutants from regulation under BAT on the basis of paragraph 8(a)(iii) of the Settlement Agreement because these pollutants were "...present only in trace amounts and neither causing nor likely to cause toxic effects..."

In addition to the 26 organic toxic pollutants excluded from regulation above under BAT, the Agency had intended to reserve 10 pollutants (in addition to dioxin) in the subcategory with end-of-pipe biological treatment (BAT Subcategory One) and 14 toxic pollutants (in addition to dioxin) from regulation in the subcategory without end-of-pipe biological treatment (BAT Subcategory Two) because the in-plant control performance data for carbon adsorption and chemical precipitation that had been collected via the sampling programs, Section 308 Questionnaire Survey or technology transfer prior to promulgation was not adequate in the Agency's judgment to support regulation of these pollutants. However, based on an analysis of pollutant loading estimates for these pollutants at direct discharge OCPSF facilities, seven pollutants (all metals) did not appear in the wastewater loadings estimates revised by EPA

TABLE VI-4.
WASTEWATER LOADINGS FOR EIGHT TOXIC POLLUTANTS
BEING CONSIDERED FOR PARAGRAPH EIGHT EXCLUSION

Pollutant Number	Pollutant Name	Direct		Indirect		Total
		No. of Plants	Current Daily Loading* (lbs/day)	No. of Plants	Current Daily Loading* (lbs/day)	Average Plant Daily Loading (lbs/day/plant)
15	1,1,2,2-Tetrachloroethane	30	5.358	—	—	0.179
18	Bis(2-chloroethyl) ether	—	—	—	—	—
47	Bromoform	—	—	—	—	—
48	Dichlorobromomethane	—	—	—	—	—
51	Chlorodibromomethane	64	0.436	—	—	0.007
54	Isophorone	34	8.055	—	—	0.237
64	Pentachlorophenol	—	—	13	0.318	0.024
69	Di-N-Octyl Phthalate	45	2.681	—	—	0.060

*Daily loadings are calculated from annual loadings assuming discharge 365 days per year.

after conducting a thorough analysis, which was discussed in Section V, to validate the Verification Master Process File to include only the metals concentration data for product/processes that are confirmed process sources. This validation found a limited number of plants that utilized these seven metals in their processes. Therefore, based on the analysis and validation activities, the Agency has decided to exclude an additional seven pollutants (arsenic, beryllium, cadmium, mercury, selenium, silver, and thallium) because they were "...detected in the effluent from a small number of sources and are uniquely related to those sources ..." (see Table VI-3).

This leaves a total of four pollutants that the Agency intends to reserve from regulation under BAT Subcategory One and eight pollutants that the Agency intends to reserve from regulation under BAT Subcategory Two. Tables VI-5 and VI-6 present the pollutants which have been reserved from regulation under the two BAT subcategories. Based on these decisions, the Agency will regulate a total of 63 toxic pollutants in BAT Subcategory One and 59 toxic pollutants in BAT Subcategory Two.

b. Selection Criteria for PSES and PSNS Toxic Pollutants

As discussed in Section XI, Pretreatment Standards for Existing Sources (PSES) and Pretreatment Standards for New Sources (PSNS), indirect dischargers need only address those pollutants that upset, inhibit, pass-through, or contaminate sludges at Publicly Owned Treatment Works (POTWs). The Agency has assumed for purposes of this analysis and based upon the available data, that within each subcategory, the raw wastewaters at indirect discharging OCPSF plants are not significantly different from those at direct discharging OCPSF plants. In selecting pollutants regulated for pretreatment standards, the toxic pollutants that the Agency considered as candidates for BAT regulation in both subcategories were evaluated with respect to the pass-through criteria. In the final regulation, the Agency addressed the 59 pollutants regulated for BAT Subcategory Two because it was determined that the end-of-pipe biological treatment used for BAT Subcategory One was not the appropriate PSES technology. The Agency evaluated data on removal of these pollutants at POTWs and at industrial treatment plants meeting BAT, to establish which pollutants pass through POTWs. Pollutants found not to pass through were eliminated from

TABLE VI-5.
FOUR TOXIC POLLUTANTS RESERVED FROM REGULATION
UNDER BAT FOR SUBCATEGORY ONE

2,4,6-Trichlorophenol
3,3′-Dichlorobenzidine
Antimony
Dioxin (TCDD)

TABLE VI-6.
EIGHT TOXIC POLLUTANTS RESERVED FROM
REGULATION UNDER BAT FOR SUBCATEGORY TWO

2,4,6 - Trichlorophenol
2 - Chlorophenol
3,3′ - Dichlorobenzidine
2,4 - Dichlorophenol
2,4 - Dinitrotoluene
2,6 - Dinitrotoluene
Antimony
Dioxin (TCDD)

consideration for regulation under PSES and PSNS. The remaining pollutants were then selected as candidates for regulation. The procedure used for the pass-through analysis is described below. Results of this procedure for both BAT subcategories are shown in Tables VI-7 and VI-8.

c. PSES Pass-Through Analysis

Prior to establishing pretreatment standards for a toxic pollutant, the Agency must determine whether the pollutant passes through POTWs or interferes with POTW operation or sludge disposal practices. In determining whether pollutants pass through a POTW, the Agency generally compares the percentage of a pollutant removed by POTWs with the percent of a pollutant removed by direct discharging industrial facilities applying BAT. Under this approach, a pollutant is deemed to pass through the POTW when the average percentage removed by POTWs nationwide is less than the percentage removed by direct discharging industrial facilities applying BAT for that pollutant.

This approach to the definition of pass-through satisfies two competing objectives set by Congress: that standards for indirect dischargers be analogous to standards for direct dischargers, and that the treatment capability and performance of POTWs be recognized and taken into account in regulating the discharge of pollutants from indirect dischargers. Rather than compare the mass or concentration of pollutants discharged by POTWs with the mass or concentration of pollutants discharged by direct dischargers, EPA compares the percentage of the pollutants removed with POTWs' removals. EPA takes this approach because a comparison of mass or concentration of pollutants in a POTW effluent with pollutants in a direct discharger's effluent would not take into account the mass of pollutants discharged to the POTW from nonindustrial sources nor the dilution of the pollutants in the POTW effluent to lower concentrations from the addition of large amounts of nonindustrial wastewater.

Presented below are brief descriptions of PSES pass-through analysis methodologies utilized for proposal and the two Federal Register NOAs as well as a more detailed discussion of the methodology and results of the PSES pass-through analysis used for the final regulation.

TABLE VI-7.
FINAL PSES PASS-THROUGH ANALYSIS
RESULTS (NON-END-OF-PIPE BIOLOGICAL SUBCATEGORY DATA)

Pollutant Number	Pollutant Name	10*ML Editing Pass-Thru Analysis OCPSF % REM.	10*ML Editing Pass-Thru Analysis POTW % REM.	Pass Through	20 PPB Editing Pass-Thru Analysis OCPSF % REM.	20 PPB Editing Pass-Thru Analysis POTW % REM.	Pass Through	Volatile Override
1	Acenaphthene	98.9	98.3	Yes	NA	NA	NA	NA
3	Acrylonitrile	99.9	---	---	99.9	---	---	---
4	Benzene	99.9	94.8	Yes	NA	NA	NA	NA
6	Carbontetrachloride	99.6(A)	87.9	Yes	NA	NA	NA	NA
7	Chlorobenzene	99.6(A)	96.4	Yes	NA	NA	NA	NA
8	1,2,4-Trichlorobenzene	99.6(A)	91.5	Yes	NA	NA	NA	NA
9	Hexachlorobenzene	99,6(A)	---	---	99.6(A)	---	---	Yes
10	1,2-Dichloroethane	99.9	89.0	Yes	---	---	---	---
11	1,1,1-Trichloroethane	99.9	90.5	Yes	NA	NA	NA	NA
12	Hexachloroethane	99.6(A)	---	---	99.6(A)	---	---	Yes
13	1,1-Dichloroethane	99.9	---	---	99.9	70.0	Yes	NA
14	1,1,2-Trichloroethane	99.9	---	---	99.9	56.0	Yes	NA
16	Chloroethane	99.7	---	---	99.7	27.7	Yes	NA
23	Chloroform	99.9	73.4	Yes	NA	NA	NA	NA
25	1,2-Dichlorobenzene	99.6(A)	89.0	Yes	NA	NA	NA	NA
26	1,3-Dichlorobenzene	99.6(A)	---	---	99.6(A)	88.9	Yes	NA
27	1,4-Dichlorobenzene	99.6(A)	---	---	99.6(A)	52.4	Yes	NA
29	1,1-Dichloroethylene	99.8	(92.0)	Yes	NA	NA	NA	NA
30	1,2-Trans-Dichloroethylene	99.9	---	---	99.9	70.9	Yes	NA
32	1,2-Dichloropropane	99.6(A)	97.7	Yes	NA	NA	NA	NA
33	1,3-Dichloropropylene	99.6(A)	---	---	99.6(A)	60.0	Yes	NA
34	2,4-Dimethylphenol	99.9	---	---	99.9	51.2	Yes	NA
38	Ethylbenzene	97.2	93.8	Yes	NA	NA	NA	NA
39	Fluoranthene	99.3	---	---	99.3	42.5	Yes	NA
42	Bis(2-Chloroisopropyl)Ether	99.6(A)	---	---	99.6(A)	---	---	---
44	Methylene Chloride	99.5	54.3	Yes	NA	NA	NA	NA
45	Methyl Chloride	99.9	---	---	99.9	48.2	Yes	NA
52	Hexachlorbutadiene	99.6(A)	---	---	99.6(A)	---	---	Yes
55	Naphthalene	99.9	94.7	Yes	NA	NA	NA	NA
56	Nitrobenzene	99.8	(98.0)	Yes	NA	NA	NA	NA
57	2-Nitrophenol	99.2	---	---	99.2	26.8	Yes	NA
58	4-Nitrophenol	99.8	---	---	98.8	75.4	Yes	NA
59	2,4-Dinitrophenol	98.9	---	---	98.9	---	---	---

TABLE VI-7.
FINAL PSES PASS-THROUGH ANALYSIS
RESULTS (NON-END-OF-PIPE BIOLOGICAL SUBCATEGORY DATA) (Continued)

Pollutant Number	Pollutant Name	10*ML Editing Pass-Thru Analysis OCPSF % REM.	10*ML Editing Pass-Thru Analysis POTW % REM.	Pass Through	20 PPB Editing Pass-Thru Analysis OCPSF % REM.	20 PPB Editing Pass-Thru Analysis POTW % REM.	Pass Through	Volatile Override
60	4,6-Dinitro-O-Cresol	99.8	(93.0)	Yes	NA	NA	NA	NA
65	Phenol	99.9	95.2	Yes	NA	NA	NA	NA
66	Bis(2-Ethylhexyl)Phthalate	95.9	59.8	Yes	NA	NA	NA	NA
68	Di-N-Butyl phthalate	96.5	---	---	96.5	79.3	Yes	NA
70	Diethyl Phthalate	98.1	---	---	98.1	59.7	Yes	NA
71	Dimethyl Phthalate	93.4	---	---	93.4	63.2	Yes	NA
72	Benzo(A)Anthracene	96.8	---	---	96.8	(98.0)	No	No
73	Benzo(A)Pyrene	93.8	---	---	93.8	(99.0)	No	No
74	3,4 Benzofluoranthene	94.1	---	---	94.1	---	---	---
75	Benzo(K)Fluoranthene	93.2	---	---	93.2	---	---	---
76	Chrysene	96.2	---	---	96.2	(97.0)	No	No
77	Acenaphthylene	97.9	---	---	97.9	---	---	---
78	Anthracene	98.6	95.6	Yes	NA	NA	NA	NA
80	Fluorene	99.2	---	---	99.2	69.8	Yes	NA
81	Phenanthrene	99.7	94.9	Yes	NA	NA	NA	NA
84	Pyrene	99.0	(95.0)	Yes	NA	NA	NA	NA
85	Tetrachloroethylene	99.9	84.6	Yes	NA	NA	NA	NA
86	Toluene	99.9	96.2	Yes	NA	NA	NA	NA
87	Trichloroethylene	99.6	86.9	Yes	NA	NA	NA	NA
88	Vinyl Chloride	98.6	93.4	Yes	NA	NA	NA	NA
119	Chromium	-40.6(P/C)	91.3	No	NA	NA	NA	NA
120	Copper	76.8(P/C)	84.1	No	NA	NA	NA	NA
121	Cyanide	99.9(P/C)	70.4	Yes	NA	NA	NA	NA
122	Lead	99.9(P/C)	91.8	Yes	NA	NA	NA	NA
124	Nickel	28.4(P/C)	51.4	No	NA	NA	NA	NA
128	Zinc	90.2(P/C)	78.0	Yes	NA	NA	NA	NA

NA - Not Applicable
( ) - Bench- or Pilot-Scale POTW Percent Removal
(A) - Average of Steam Stripping Percent Removal Data
ML - Minimum Level
(P/C) - Percent Removal using Effluents Long-Term Average Based on Metal Finishing Industry Physical/Chemical Treatment

TABLE VI-8.
FINAL PSES PASS-THROUGH ANALYSIS
RESULTS (END-OF-PIPE BIOLOGICAL SUBCATEGORY DATA)

Pollutant Number	Pollutant Name	10*ML Editing Pass-Thru Analysis OCPSF % REM.	10*ML Editing Pass-Thru Analysis POTW % REM.	Pass Through	20 PPB Editing Pass-Thru Analysis OCPSF % REM.	20 PPB Editing Pass-Thru Analysis POTW % REM.	Pass Through	Volatile Override
1	Acenaphthene	98.9	98.3	Yes	NA	NA	NA	NA
3	Acrylonitrile	99.9	---	---	99.9	---	---	---
4	Benzene	99.5	94.8	Yes	NA	NA	NA	NA
6	Carbontetrachloride	99.1	87.9	Yes	NA	NA	NA	NA
7	Chlorobenzene	99.1	96.4	Yes	NA	NA	NA	NA
8	1,2,4-Trichlorobenzene	88.3	91.5	No	84.6	90.3	No	Yes
9	Hexachlorobenzene	96.5	---	---	82.0	---	---	Yes
10	1,2-Dichloroethane	97.4	89.0	Yes	NA	NA	NA	NA
11	1,1,1-Trichloroethane	98.9	90.5	Yes	NA	NA	NA	NA
12	Hexachloroethane	96.6	---	---	96.6	---	---	Yes
13	1,1-Dichloroethane	93.4	---	---	72.6	70.0	Yes	NA
14	1,1,2-Trichloroethane	97.2	---	---	97.2	56.0	Yes	NA
16	Chloroethane	96.0	---	---	67.4	27.7	Yes	NA
23	Chloroform	98.0	73.4	Yes	NA	NA	NA	NA
25	1,2-Dichlorobenzene	96.2	89.0	Yes	NA	NA	NA	NA
26	1,3-Dichlorobenzene	96.9	---	---	74.3	88.9	No	Yes
27	1,4-Dichlorobenzene	97.0	---	---	92.0	52.4	Yes	NA
29	1,1-Dichlorobenzene	97.0	(92.0)	Yes	NA	NA	NA	NA
30	1,2-Trans-Dichloroethylene	81.5	---	---	81.5	70.9	Yes	NA
32	1,2-Dichloropropane	98.2	97.7	Yes	NA	NA	NA	NA
33	1,3-Dichloropropylene	92.9	---	---	92.9	60.0	Yes	NA
34	2,4-Dimethylphenol	99.8	---	---	99.8	51.2	Yes	NA
38	Ethylbenzene	98.4	93.8	Yes	NA	NA	NA	NA
39	Fluoranthene	99.3	---	---	95.8	42.2	Yes	NA
42	Bis(2-Chloroisopropyl)Ether	72.2	---	---	72.2	---	---	---
44	Methylene Chloride	98.7	54.3	Yes	NA	NA	NA	NA
45	Methyl Chloride	---	---	---	---	48.2	---	Yes
52	Hexachlorobutadiene	95.7	---	---	95.7	---	---	Yes
55	Naphthalene	99.0	94.7	Yes	NA	NA	NA	NA
56	Nitrobenzene	98.9	(98.0)	Yes	NA	NA	NA	NA
57	2-Nitrophenol	96.1	---	---	69.3	26.8	Yes	NA
58	4-Nitrophenol	93.1	---	---	90.9	75.4	Yes	NA
59	2,4-Dinitrophenol	97.4	---	---	97.4	---	---	---
60	4,6-Dinitro-o-cresol	99.8*	(93.0)	Yes	---	---	---	---

TABLE VI-8.
FINAL PSES PASS-THROUGH ANALYSIS
RESULTS (END-OF-PIPE BIOLOGICAL SUBCATEGORY DATA) (Continued)

		10*ML Editing Pass-Thru Analysis			20 PPB Editing Pass-Thru Analysis			
Pollutant Number	Pollutant Name	OCPSF % REM.	POTW % REM.	Pass Through	OCPSF % REM.	POTW % REM.	Pass Through	Volatile Override
65	Phenol	98.4	95.2	Yes	NA	NA	NA	NA
66	Bis(2-Ethylhexyl)Phthalate	97.4	59.8	Yes	NA	NA	NA	NA
68	Di-N-Butyl phthalate	97.6	---	---	97.6	79.3	Yes	NA
70	Diethyl Phthalate	92.0	---	---	92.0	59.7	Yes	NA
71	Dimethyl Phthalate	87.4	---	---	87.4	63.2	Yes	NA
72	Benzo(A)Anthracene	96.6	---	---	96.6	(98.0)	No	No
73	Benzo(A)Pyrene	93.8	---	---	93.8	(99.0)	No	No
74	3,4-Benzofluorathene	94.1	---	---	94.1	---	---	---
75	Benzo(K)Fluoranthene	93.1	---	---	93.1	---	---	---
76	Chrysene	96.8	---	---	96.8	(97.0)	No	No
77	Acenaphthylene	98.4	---	---	98.2	---	---	---
78	Anthracene	98.6	95.6	Yes	NA	NA	NA	NA
80	Fluorene	97.9	---	---	94.0	69.8	Yes	NA
81	Phenanthrene	99.6	94.9	Yes	NA	NA	NA	NA
84	Pyrene	99.0	(95.0)	Yes	NA	NA	NA	NA
85	Tetrachloroethylene	98.6	84.6	Yes	NA	NA	NA	NA
86	Toluene	99.6	96.2	Yes	NA	NA	NA	NA
87	Trichloroethylene	94.3	86.9	Yes	NA	NA	NA	NA
88	Vinyl Chloride	97.5	93.4	Yes	NA	NA	NA	NA
119	Chromium	-40.6(P/C)	91.3	No	---	---	---	---
120	Copper	76.8(P/C)	84.1	No	---	---	---	---
121	Cyanide	99.9(P/C)	70.4	Yes	---	---	---	---
122	Lead	99.9(P/C)	91.8	Yes	---	---	---	---
124	Nickel	28.4(P/C)	51.4	No	---	---	---	---
128	Zinc	90.2(P/C)	78.0	Yes	---	---	---	---

NA - Not Applicable
( ) - Bench- or Pilot-Scale POTW Percent Removal
ML - Minimum Level
(P/C) - Percent Removal Using effluent Long-Term Average based on Metal Finishing Industry Physical/Chemical Treatment
*OCPSF removal based on in-plant treatment for this pollutant

March 1983 Proposal Approach

In the March 21, 1983 proposal (48 FR 11828), the Agency modified the general pass-through analysis methodology discussed above. Cognizant of the analytical variability typical of organic toxic pollutants in POTW and OCPSF wastewater, EPA proposed to find that pass-through occurs only if the percentage removed of a certain pollutant by direct dischargers applying BAT is at least 5 percent greater than the percent removed by well-operated POTWs ("Five percent differential"). The methodology used for calculating POTW and industrial percent removals was as follows: 1) for an individual POTW or OCPSF plant, the influent and effluent data around the particular treatment system were paired on a daily basis; 2) daily percent removals were calculated for each pollutant; 3) an average daily percent removal was calculated for each pollutant by OCPSF plant or POTW; and 4) for each pollutant, a median percent removal was calculated using average daily percent removals for each OCPSF plant or POTW. Also, the Agency assumed pass-through for all pollutants that did not have POTW percent removals, but were regulated under BAT and had OCPSF industry percent removal data.

Using the above methodology, EPA determined that six pollutants in the Plastics-Only subcategory and 29 pollutants in the Not Plastics-Only subcategory should be controlled under PSES and PSNS on the basis of pass-through. (These subcategories appeared in the proposal, but have not been retained in the final regulation.)

July 1985 NOA Approach

In the July 17, 1985 Federal Register NOA, the Agency retained the same methodology used for the March 1983 proposal, but introduced several different approaches for public comment and included additional OCPSF sampling data (i.e., the EPA 12-Plant Sampling Study) in the OCPSF percent removal calculations. These approaches included the use of either a 0 percent differential or a 10 percent differential between POTW and OCPSF percent removals in determining pass-through and the possible finding of pass-through for selected volatile pollutants that are air stripped in POTW collection and treatment systems, regardless of whether they passed through using the traditional pass-through analysis. A list of these volatile pollutants is presented in Table VI-9. Section VIII discusses air emissions from wastewater treatment systems and the derivation of this list.

Based on this methodology, the Agency proposed control of 48 toxic pollutants under PSES and PSNS using the traditional pass-through methodology and identifying pollutants of concern for which POTW percent removal data were not available. The Agency also proposed to find pass-through for 12 toxic volatile and semivolatile pollutants on the basis of volatilization.

December 1986 NOA Approach

After assessing the public comments on the July 17, 1985 NOA, a number of different pass-through analysis methodology changes were examined, including: 1) the use of all published literature sources in determining a representative POTW percent removal for all pollutants without full-scale POTW percent removal data; 2) the continued finding of pass-through for pollutants volatilized rather than treated by POTWs; 3) modifying the typical pass-through analysis in order to not regulate certain acid and base/neutral pollutants that were regulated based on pass-through analysis results, but might be shown not to pass-through based on certain means of evaluating industry and POTW removals for comparable ranges of influent pollutant concentrations; 4) changing the methodology for calculating the POTW and OCPSF percent removals; and 5) modifying the 5 percent differential rule between POTW and OCPSF percent removals.

The first revision of the original POTW pass-through analysis incorporated literature, pilot- and bench-scale plant percent removal data for POTWs for those toxic pollutants that were not adequately covered by the 40 POTW Study data base. In the previous pass-through analyses, toxic pollutants with no full-scale POTW percent removal data were considered to pass through POTW treatment systems, requiring them to be regulated under PSES. For those pollutants without full-scale POTW removal data, the PSES cost estimates for the December 1986 NOA were based on POTW percent removals from a number of sources that were utilized to perform the revised pass-through analysis. These sources included a report to Congress that presented the results of a study

TABLE VI-9.
VOLATILE AND SEMIVOLATILE TOXIC POLLUTANTS
TARGETED FOR CONTROL DUE TO AIR STRIPPING

(1) Acenaphthene*	(27) 1,4-Dichlorobenzene
(3) Acrylonitrile*	(29) 1,1-Dichloroethylene
(4) Benzene	(30) 1,2-Trans-dichloroethylene
(6) Carbon Tetrachloride	(32) 1,2-Dichloropropane
(7) Chlorobenzene	(33) 1,3-Dichloropropylene
(8) 1,2,4-Trichlorobenzene	(38) Ethylbenzene
(9) Hexachlorobenzene	(42) Bis (2-chloroisopropyl) Ether*
(10) 1,2-Dichloroethane	(44) Methylene Chloride
(11) 1,1,1-Trichloroethane	(45) Methyl Chloride
(12) Hexachloroethane	(48) Dichlorobromomethane
(13) 1,1-Dichloroethane	(52) Hexachlorobutadiene
(14) 1,1,2-Trichloroethane	(55) Naphthalene*
(16) Chloroethane	(85) Tetrachloroethylene
(23) Chloroform	(86) Toluene
(25) 1,2-Dichlorobenzene	(87) Trichloroethylene
(26) 1,3-Dichlorobenzene	(88) Vinyl Chloride

*These pollutants were determined to be less susceptible to air stripping and removed from the list of volatiles for which volatilization overrides the percent removal pass-through analysis.

examining the discharge of listed hazardous wastes to POTWs (the February 1986 Domestic Sewage Study), the General Pretreatment Regulations (40 CFR 128 and 403), and the best professional judgment estimates of EPA's Wastewater Engineering Research Laboratory (EPA-WERL) and other Agency personnel based on various pilot-plant studies performed by or for EPA-WERL.

The second revision involved the permanent incorporation of the finding of pass-through for volatile pollutants that are air stripped rather than treated in POTWs (see Table V-9).

In addition to evaluating alternative data sources to replace missing full-scale POTW percent removals, the Agency also performed further analyses using the 40 POTW Study and the OCPSF data bases to evaluate treatability of toxic pollutants as it relates to influent concentration levels. Specifically, these data were first plotted to show a relationship between percent removal and influent concentration and then a comparison of the POTW and OCPSF plots were made. To facilitate the analysis, the toxic pollutants were combined into groups that have previously been used in the calculation of toxic pollutant variability factors (See Section VII). In general, few of the groups had both adequate POTW and OCPSF data to draw any firm conclusions. Since POTWs and OCPSF facilities do not have equivalent influent concentrations for most pollutants (because of the dilution effects of domestic sewage and other industry wastewaters on POTW influents), POTW percent removals tend to be based upon calculations using lower average influent concentration. Thus, the percent removal results may be strongly influenced by the influent concentration. Another factor influencing the percent removals is related to effluent concentration. From the groups with adequate data, a definite asymptotic relationship was observed for certain groups, that generally occurs because of the analytical minimum levels ("limits of detection") at the low end of the concentration range. For many of the pollutant groups, this does not indicate an inability to remove pollutants but the lack of quantification below the analytical minimum level that limits the maximum percent removal that can be calculated.

Based on these results, selected pollutants were identified for further analysis from the following groups:

- Group 1 - Halogenated Methanes
- Group 2 - Chlorinated C2s
- Group 11 - Aromatics
- Group 12 - Polyaromatics (PNAs)
- Group 13 - Chloroaromatics
- Group 16 - Phthalate Esters
- Group 18 - Benzidienes
- Group 19 - Phenols.

Comparing POTW and OCPSF percent removals at individual influent ranges, a detailed pass-through analysis was performed for each selected pollutant. The results of this analysis were that seven pollutants (acenaphthene, benzene, chloroform, phenol, anthracene, phenanthrene, and toluene) that had previously been considered to require regulation based on pass-through analysis results were now shown not to pass-through. However, since all but three of these pollutants were contained in the list of volatile pollutants, only phenol, anthracene, and phenanthrene were selected for consideration in this alternative regulatory option as not passing through.

The fourth revision involved the evaluation of the methodology used to calculate the POTW and OCPSF percent removals used in the PSES pass-through analysis, which was revised to conform with other calculations being used for limitations development and to avoid the use of daily influent/effluent pairs in order to accommodate retention times in treatment systems larger than 24 hours. The new data editing methodology was as follows: 1) all influent and effluent data around the biological treatment system were assembled; 2) average influent and effluent concentrations were calculated for each pollutant; 3) an average percent removal was calculated for each pollutant (instead of an average daily percent removal); and 4) for each pollutant, a median percent removal was calculated using the average percent removals for each OCPSF plant or POTW. Also, based on revised BAT industry data editing techniques, industrial percent removal data were no longer available for six toxic pollutants (1,1-dichloroethane, bromoform, dichlorobromomethane, pentachlorophenol, cadmium, and silver). Therefore, these pollutants were eliminated. Also, these revised BAT data editing techniques eliminated some industrial data, thus changing (raising or lowering, depending on the pollutant) the calculated industrial percent removals.

Finally, the Agency decided not to use a 5 or 10 percent differential and concluded that the most reasonable approach is to accept the available data as the best information on the relative percent removals of BAT and POTWs and to perform BAT/POTW comparisons directly based on that data. EPA decided that such an approach was unbiased in that it does not favor either the over-statement or under-statement of pass-through for the pollutants.

Adopted Approach and Rationale

After reviewing public comments received on the December 1986 NOA pass-through methodology revisions, the Agency again examined its procedures and instituted a final set of changes. As stated previously, the Agency decided not to use a 5 or 10 percent differential. In urging EPA to adopt a 5 or 10 percent differential, commenters stated that use of the differential would address the problem of low POTW effluent concentrations that may mask the full extent of POTW treatment. These commenters also supported the rationale that, in addition to analytical variability, a differential was supported by the fact that POTW influent concentrations are typically much lower than industry treatment system influent concentrations, and many POTW effluent samples are below detection, preventing a complete accounting of all pollutants removed by the POTW.

The problem with using a differential is that it is uncertain whether the POTWs are treating to levels substantially below detection or not, since the data analyses results were from measurements only to the detection limits. Thus, it is difficult to determine the extent to which POTW removals are underestimated and the degree to which compensation is justified. (It should be noted that the risk of underestimation exists also with respect to calculating BAT removals with data reflecting effluent levels below the detection level.) Moreover, a 5 or 10 percent differential, unless restrictively drafted, would often result in overcompensating for the uncertainty. It should be noted that to allow even a few pollutants to go unregulated based on the 5 percent differential could be significant in terms of the number of pounds of unregulated toxic pollutants discharged. Finally, the potential effect discussed by the commenters will be greatly mitigated by changes in the data editing criteria, which are discussed below.

EPA has modified the criteria under which the full-scale POTW data for conducting the pass-through comparison test were selected. In previous analyses, EPA used data when influent concentrations exceeded 20 ppb. For pollutants with low influent concentrations, i.e., not much higher than 20 ppb, the effluent concentrations were consistently below the detection level and could not be precisely quantified. The conservative technique of estimating the effluent by rounding it up to the detection limit had the effect of understating the POTW's percent removal. In many cases, in fact, both POTW and BAT treatment systems with relatively low influent concentrations yielded effluents below detection, and the resulting percent removals were not true measures of treatment effectiveness, but rather were primarily functions of the influent concentrations. The percent removal comparison thus had the effect of determining pass-through if and only if the POTW had a lower pollutant influent concentration, rather than basing the determination on true treatability criteria. A second concern with the 20 ug/l criterion is its inconsistency with the criteria used to select industry data that EPA considers generally acceptable for assessing treatability and calculating BAT effluent limitations. One of EPA's criteria for using industry data to set effluent limitations is that the influent data must exceed 10 times the pollutant's minimum analytical threshold level for that plant. When an influent concentration is below this level, effluent concentrations below the pollutant's analytical minimum level often may be achieved using less than BAT level treatment. The editing criterion ensures that effluent limitations generally reflect the technical capability of BAT level treatment rather than low influent concentrations.

Consistent with the general BAT editing approach, EPA has used the "ten times the minimum level" (i.e., 100 ppb for most pollutants) criterion for BAT and POTW influents for purposes of selecting the data used to perform pass-through comparisons for the final rule when available. When BAT or POTW influents greater than "ten times the minimum level" were not available, pass-through comparisons were made using the 20 ppb criterion for BAT and POTW influents. For the final pass-through determination, 28 of the pollutants were found to pass-through using data edited at 10 times the minimum level; three pollutants demonstrated no pass-through at this level of editing.

EPA also retained the modified approach of calculating plants' percent removals using average plant removals. Previously, for each plant, EPA had averaged daily percent removals. This is technically inappropriate. First, many OCPSF treatment systems have retention times exceeding one day's time. Thus, it is improper to compare influent and effluent samples taken on the same day. Second, even if the retention time is shorter than a full day, any sampled influent, after mixture and dispersal within the treatment system, cannot be traced to a particular sample leaving the system. In fact, in the typical biological treatment system, a portion of the biological solids are recirculated within the system. Thus again, it is improper to compare any influent and effluent samples as a pair. Third, due to the low concentrations found in both OCPSF treatment and POTW biological systems (due to dilution by other wastewaters), small daily changes in pollutant concentrations yield a misleading picture of variability in the daily efficiency of these systems. Therefore, EPA has modified its approach to calculate a plant's percent removal by averaging all influent samples, averaging all effluent samples, and calculating percent removals using these averages.

The Agency also decided to retain the use of qualified bench- or pilot-scale POTW percent removal data in the absence of sufficient full-scale POTW removal data on specific pollutants to perform the removal comparison. A summary of the bench/pilot-scale data results and the studies that are the sources of these data is presented in Table VI-10. Despite the fact that EPA sampled 50 POTWs in addition to conducting many OCPSF sampling efforts, there are 12 pollutants regulated at BAT for which EPA lacks sufficient full-scale POTW data to perform this analysis. In the 1983 proposal, EPA adopted the approach of assuming pass-through in the absence of data to the contrary. Some industrial commenters objected to this approach arguing that Section 307(b) authorizes EPA to promulgate pretreatment standards only for pollutants that pass-through or interfere with the POTW, and that EPA is thus required to affirmatively find pass-through or interference as a precondition to promulgating pretreatment standards. Environmental groups argued to the contrary saying that EPA has an obligation to require pretreatment if there may be pass-through or interference and that in the absence of adequate data, the possibility of pass-through must be assumed. In subsequent notices, EPA requested comment on an alternative approach of using qualitative data to determine POTW removal rates in the absence of full-scale quantitative data

TABLE VI-10.
ESTIMATED POTW REMOVAL DATA FROM PILOT- OR BENCH-SCALE
STUDIES FOR SELECTED TOXIC POLLUTANTS

Pollutant Number	Pollutant Name	(Influent concentration, μg/l) and % Removal from Reference Number Shown Below 1	2	3	4	5	SRT, days	6
13	1,1-Dichloroethane			(144) 94				
18	Bis(2-Chloroethyl) Ether			(143) 80				
27	1,4-Dichlorobenzene			(93) 94				
29	1,1-Dichloroethylene		(79) >99	(212) 92				
32	1,2-Dichloropropane		(309) >98					
34	2,4-Dimethylphenol	(96) 99						
47	Bromoform			(90) 65				
48	Dichlorobromomethane		(89) >99					
56	Nitrobenzene				(118) 98			
60	4,6-Dinitro-o-cresol					(20,000) 93	3	
						(20,000) 92	5	
						(20,000) 97	7	
						(20,000) 99	11	
71	Dimethyl Phthalate	(47) 98						
72	Benzo(a)anthracene	(24) 98						
73	Benzo(a)pyrene							(35) >99
								(0.4) 84
76	Chrysene	(39) 97						
84	Pyrene	(30) 94		(104) 95				

TABLE VI-10.
ESTIMATED POTW REMOVAL DATA FROM PILOT- OR BENCH-SCALE
STUDIES FOR SELECTED TOXIC POLLUTANTS (Continued)

REFERENCES

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2. Petrasek, A.C., et al. Removal and Partitioning of Volatile Organic Priority Pollutants in Wastewater Treatment Presented at 9th U.S. Japan Conference on Sewage Treatment Technology, Tokyo, Japan. Sept. 13-29 (1983). Means for 20 sample sets. Pilot scale 35 gpm. Acclimated activated sludge.

3. Hannah, S.A., et al. Comparative Removal of Toxic Pollutants by Six Wastewater Treatment Processes. Jour. WPCF 58, 27 (1986). Means from 11-14 sample sets. Pilot scale 1.5 gpm. Acclimated activated sludge.

4. Weber, W.J., Jr. and B.E. Jones. Toxic Substance Removal in Activated Sludge and PAC Treatment Systems. EPA/600/52-86-045, June 1986. Data from 40 days run after acclimation in bench scale reactor with 6 day SRT.

5. Kirsch, E.J. and R.F. Wukasch. Fate of Eight Organic Priority Pollutants in Biological Waste Treatment. Summary Report for EPA Cooperative Agreement CR-807638 (1982). Bench scale acclimated reactors with different SRTs.

6. Borneff, J. and H. Kunte. Carcinogenic Substances in Water and Soil XIX: The Effect of Sewage Purification on PAH. Arch. Hyg. Bakt. 151, 202 (1967). As referenced by Harrison, R., Perry, R. and Wellings, R. in Water Research 9, 331 (1975). Data from secondary reference not available.

and to use that data for the comparative analysis. EPA made the alternative approach data available for comment. After considering public comments on this approach and on the data to be used, EPA has decided in the final rule to use certain pilot- and bench-scale data when adequate full-scale POTW data are lacking. These alternative data were used for seven pollutants, and four of these pollutants were found to pass-through.

EPA disagrees with the comment that it must assume pass-through in the absence of quantitative data to the contrary. Section 307(b) of the Act requires EPA to promulgate pretreatment standards "for those pollutants which are determined not to be susceptible to treatment by (the POTW) or which would interfere with the operation of such treatment works." Thus, at least one reasonable interpretation of the statute is that EPA must make a determination of pass-through or interference prior to promulgating pretreatment standards, rather than assume pass-through. In any event, the statute does not prohibit the use of bench- or pilot-scale data when they are the best available data. Certainly, EPA has a preference for full-scale POTW data and has expended considerable resources to obtain such data for the OCPSF rulemaking. However, to address remaining full-scale POTW data gaps, EPA believes that it is appropriate to use the best alternative information available. Some industry commenters objected that the alternative data are of lesser quality than the full-scale POTW data and have a larger range of potential error. EPA acknowledges that this may be the case with estimates not based on pilot- or bench-scale studies. However, EPA believes that the pilot- or bench-scale data used for the seven pollutants for which pass-through is evaluated for this rulemaking are of sufficient technical quality to use in the comparative analysis and may thus be used in the absence of adequate full-scale POTW data. Further, EPA does not agree that the use of a 5 or 10 percent differential to compare BAT and POTW removal efficiencies is compelled when using alternative data. As discussed previously, any error in the data, whether full-scale or not, can affect results in either direction.

Finally, the Agency has retained the override of the pass-through analysis results for three volatile pollutants where the overall percent removal includes in substantial part the emission of these pollutants to air rather than actual treatment. As discussed in Section VIII, EPA has decided to regard these three pollutants (hexachlorobenzene, hexachloroethane, and hexachlorobutadiene), as passing through the POTW due to volatilization and thus warranting promulgation of pretreatment standards.

Table VI-11 presents the results of the final PSES pass-through analysis for the 59 toxic pollutants being regulated under the non-end of pipe biological subcategory (BAT Subcategory Two). Based on the results of this final analysis, 47 toxic pollutants have been determined to pass-through POTWs and thus require regulation under PSES and PSNS. Summaries of the results for pollutants not regulated are presented in Tables VI-12 through VI-16.

The Agency performed an additional PSES pass-through analysis, which used the same methodology as discussed above except that OCPSF percent removals were calculated using the end-of-pipe biological (BAT Subcategory One) performance data base. The results of this alternative pass-through analysis (presented in Table VI-8) show that a total of 47 toxic pollutants pass through. Because the final PSES are based upon physical-chemical treatment (including in-plant biological treatment for certain organic pollutants), unlike the proposed PSES which were based upon biological treatment, the final pass-through analysis calculated OCPSF percent removals based upon the performance required by BAT Subcategory Two (non-end-of-pipe biological treatment). This ensured that PSES would be required only if the PSES limits (which are based upon BAT Subcategory Two limits) would result in percent removals exceeding those achieved by POTWs. These results are reflected in Table VI-7. The six toxic pollutants, listed in Table VI-12, could not be evaluated by the PSES pass-through analysis because estimated volatilization rates are low and POTW percent removal data could not be obtained. An analysis was conducted of pollutant loading estimates for these pollutants at indirect, full response OCPSF facilities revealed that the toxic pollutants 2,4-dinitrophenol, benzo(k) fluoranthene, and acenapthylene would be treated by an appropriate in-plant control installed on the same waste streams for other toxic pollutants that have been determined to pass through. Table VI-14 presents the results of this analysis. Therefore, the Agency has decided to exclude three of these toxic pollutants from regulation under PSES and PSNS on the basis of Paragraph 8(a) (iii)(4) of the Settlement Agreement since they

TABLE VI-11.
FORTY-SEVEN TOXIC POLLUTANTS DETERMINED TO INTERFERE WITH, INHIBIT, OR PASS-THROUGH POTWS, AND REGULATED UNDER PSES AND PSNS BASED ON TABLE VII-7

Pollutant Name	Reason For Regulation
Acenaphthene	Pass-through Comparison @ 10 x MDL
Benzene	Pass-through Comparison @ 10 x MDL
Carbon Tetrachloride	Pass-through Comparison @ 10 x MDL
Chlorobenzene	Pass-through Comparison @ 10 x MDL
1,2,4-Trichlorobenzene	Pass-through Comparison @ 10 x MDL
Hexachlorobenzene	Volatilization
1,2-Dichloroethane	Pass-through Comparison @ 10 x MDL
1,1,1-Trichloroethane	Pass-through Comparison @ 10 x MDL
Hexachloroethane	Volatilization
1,1-Dichloroethane	Pass-through Comparison @ 20 ppb
1,1,2-Trichloroethane	Pass-through Comparison @ 20 ppb
Chloroethane	Pass-through Comparison @ 20 ppb
Chloroform	Pass-through Comparison @ 10 x MDL
1,2-Dichlorobenzene	Pass-through Comparison @ 10 x MDL
1,3-Dichlorobenzene	Pass-through Comparison @ 20 ppb
1,4-Dichlorobenzene	Pass-through Comparison @ 20 ppb
1,1-Dichloroethylene	Pass-through Comparison @ 10 x MDL
1,2-Trans-Dichloroethylene	Pass-through Comparison @ 20 ppb
1,2-Dichloropropane	Pass-through Comparison @ 10 x MDL
1,3-Dichloropropylene	Pass-through Comparison @ 20 ppb
2,4-Dimethylphenol	Pass-through Comparison @ 20 ppb
Ethylbenzene	Pass-through Comparison @ 10 x MDL
Fluoranthene	Pass-through Comparison @ 20 ppb
Methylene Chloride	Pass-through Comparison @ 10 x MDL
Methyl Chloride	Pass-through Comparison @ 20 ppb
Hexachlorobutadiene	Volatilization
Naphthalene	Pass-through Comparison @ 10 x MDL
Nitrobenzene	Pass-through Comparison @ 10 x MDL
2-Nitrophenol	Pass-through Comparison @ 20 ppb
4-Nitrophenol	Pass-through Comparison @ 20 ppb
4,6-Dinitro-O-Cresol	Pass-through Comparison @ 10 x MDL
Phenol	Pass-through Comparison @ 10 x MDL
Bis(2-Ethylhexyl)Phthalate	Pass-through Comparison @ 10 x MDL
Di-N-Butyl Phthalate	Pass-through Comparison @ 20 ppb
Diethyl Phthalate	Pass-through Comparison @ 20 ppb
Dimethyl Phthalate	Pass-through Comparison @ 20 ppb
Anthracene	Pass-through Comparison @ 10 x MDL
Fluorene	Pass-through Comparison @ 20 ppb
Phenanthrene	Pass-through Comparison @ 10 x MDL
Pyrene	Pass-through Comparison @ 10 x MDL
Tetrachloroethylene	Pass-through Comparison @ 10 x MDL
Toluene	Pass-through Comparison @ 10 x MDL
Trichloroethylene	Pass-through Comparison @ 10 x MDL
Vinyl Chloride	Pass-through Comparison @ 10 x MDL
Cyanide	Pass-through Comparison @ 10 x MDL
Lead	Pass-through Comparison @ 10 x MDL
Zinc	Pass-through Comparison @ 10 x MDL

TABLE VI-12.
SIX TOXIC POLLUTANTS DETERMINED NOT TO INTERFERE WITH, INHIBIT, OR PASS-THROUGH POTWs, AND EXCLUDED FROM REGULATION UNDER PSES AND PSNS

Benzo(A)Anthracene
Benzo(A)Pyrene
Chrysene
Chromium
Copper
Nickel

TABLE VI-13.
SIX TOXIC POLLUTANTS THAT DO NOT VOLATILIZE EXTENSIVELY AND DO NOT HAVE POTW PERCENT REMOVAL DATA

Acrylonitrile
Bis(2-Chloroisopropyl)Ether
2,4-Dinitrophenol
3,4-Benzofluoranthene
Benzo(K)Fluoranthene
Acenaphthylene

TABLE VI-14.
RESULTS OF PSES ANALYSIS TO DETERMINE IF TOXIC POLLUTANT REMOVALS WERE "... SUFFICIENTLY CONTROLLED BY EXISTING TECHNOLOGIES ..."

Pollutant Number	Pollutant Name	Percent of plants at which the pollutant is adequately treated or costed due to presence of another similarly treatable toxic pollutant
3	Acrylonitrile	39%
42	Bis(2-Chloroisopropyl)Ether	50%
59	2,4-Dinitrophenol	100%
74	3,4-Benzofluoranthene	*
75	Benzo(k)Fluoranthene	100%
77	Acenaphthylene	87%

* Analysis could not be performed

TABLE VI-15.
THREE TOXIC POLLUTANTS EXCLUDED FROM PSES AND PSNS REGULATION UNDER PARAGRAPH 8(a)(iii) OF THE SETTLEMENT AGREEMENT BECAUSE THEY WERE "... SUFFICIENTLY CONTROLLED BY EXISTING TECHNOLOGIES ..."

2,4-Dinitrophenol
Benzo(K)Fluoranthene
Acenaphthylene

TABLE VI-16.
THREE POLLUTANTS RESERVED FROM REGULATION UNDER PSES AND PSNS DUE TO LACK OF POTW PERCENT REMOVAL DATA

Acrylonitrile
Bis(2-Chloroisopropyl)Ether
3,4-Benzofluoranthene

will be "...sufficiently controlled by existing technologies." The Agency has also decided to reserve the three remaining toxic pollutants from regulation under PSES and PSNS in addition to the seven pollutants shown in Table VI-6 (see Tables VI-15 and VI-16, respectively).

SECTION VI

REFERENCES

6-1 APHA, AWWA AND WPCR, STANDARD METHODS FOR EXAMINATION OF WATER AND WASTEWATER, 4TH EDITION, WASHINGTON, DC, APHA, 19076, P. 549

6-2 Ibid., p. 94

6-3 Ibid., p. 516, 517, 519, 521.

6-4 Ibid., p. 554

6-5 Ibid., p. 534

VII. CONTROL AND TREATMENT TECHNOLOGIES

A. INTRODUCTION

This section identifies and describes the principal Best Management Practices (BMPs) and in-plant and end-of-pipe wastewater control and treatment technologies currently used or available for the reduction and removal of conventional, nonconventional, and priority pollutants discharged by the OCPSF industry. Many OCPSF plants have implemented programs that combine elements of BMPs, in-plant wastewater treatment, and end-of-pipe wastewater treatment to minimize pollutant discharges from their facilities. Due to the diversity of the OCPSF industry, the configuration of these controls and technologies differs widely from plant to plant.

BMPs are in-plant source controls and general operation and maintenance (O&M) practices that prevent or minimize the potential for the release of toxic pollutants or hazardous substances to surface waters or POTWs (7-1). The following pages describe these in-plant source controls (i.e., process modifications; instrumentation; solvent recovery; and water reuse, recycle, and recovery) and O&M practices that are employed, or could potentially be employed, at OCPSF plants.

Physical/chemical in-plant treatment technologies are used selectively in the OCPSF industry on certain process wastewaters to recover products or process solvents, to reduce loadings that may impair the operation of a biological treatment system, or to remove certain pollutants that are not sufficiently removed by biological treatment systems. The in-plant treatment technologies currently used or available to the OCPSF industry and available performance data for these technologies are described and presented in Part C of this section.

End-of-pipe treatment systems in the OCPSF industry employ physical, biological, and physical/chemical treatment, and often consist of a combination of primary (neutralization and settling), secondary (biological high rate aeration and clarification), polishing, and/or tertiary (ponds, filtration, or activated carbon adsorption) unit operations. The end-of-pipe treatment technologies currently used or available to the OCPSF industry and available performance data for these technologies are described and presented in Part D of this section.

The performance of selected BPT and BAT total treatment systems, including nonbiological treatment systems, are presented in Part E of this section. Wastewater discharge or disposal methods (other than direct to surface waters and indirect through POTWs) used by OCPSF plants, frequently called zero or alternate discharge methods, are presented in Part F. Part G presents treatment and disposal options for the sludges resulting from certain wastewater treatment operations. Finally, Part H presents the procedures used to develop the effluent limitations guidelines and standards for the OCPSF industry.

The Environmental Protection Agency (EPA) developed three technology options for promulgating BPT. BPT Option I consists of biological treatment, which usually involves either activated sludge or aerated lagoons, followed by clarification (and preceded by appropriate process controls and in-plant treatment to ensure that the biological system may be operated optimally). Many of the direct discharge facilities have installed this level of treatment. BPT Option II is based on Option I with the addition of a polishing pond to follow biological treatment. BPT Option III is based on multimedia filtration as an alternative basis (in lieu of BPT Option II polishing ponds) for additional total suspended solids (TSS) control after biological treatment.

EPA has selected BPT Option I--biological treatment with secondary clarification--as the technology basis for BPT limitations controlling BOD_5 and TSS for the OCPSF industry. This option has been previously described by EPA as "biological treatment." However, a properly designed biological treatment system includes "secondary clarification" which usually consists of a clarifier following the biological treatment step of activated sludge, aerated lagoons, etc. The rationale for the selection of BPT Option I as the basis for the final BPT effluent limitations is discussed in detail in Section IX.

EPA developed three final options for BAT effluent limitations. BAT Option I would establish concentration-based BAT effluent limitations for priority pollutants based on using BPT-level biological treatment for the end-of-pipe biological treatment subcategory. Since some plants do not have sufficient BOD_5 in their wastewater to support (or require) biological treatment, there is a non-end-of-pipe biological treatment subcategory. The plants in this subcategory do not use end-of-pipe biological treatment; their BAT Option I treatment involves in-plant controls that consist of physical/ chemical treatment and in-plant biological treatment to achieve toxic pollutant limitations, with end-of-pipe TSS control if necessary.

BAT Option II would establish concentration-based BAT effluent limitations based on the performance of the end-of-pipe treatment component (biological treatment for the end-of-pipe biological treatment subcategory and physical/chemical for the non-end-of-pipe biological treatment subcategory), plus in-plant control technologies that remove priority pollutants prior to discharge to the end-of-pipe treatment system. The in-plant technologies include steam stripping to remove selected volatile and semivolatile (as defined by the analytical methods) priority pollutants, activated carbon for various base/neutral priority pollutants, chemical precipitation for metals, alkaline chlorination for cyanide, and in-plant biological treatment for removal of selected priority pollutants, including several polynuclear aromatics (PNA), several phthalate esters, and phenol.

BAT Option III adds activated carbon to the end-of-pipe treatment to follow biological treatment or physical/chemical treatment in addition to the BAT Option II level of in-plant controls.

The Agency has selected Option II as the basis for BAT limits for both subcategories. The rationale for the selection of BAT Option II as the basis for the final BAT effluent limitations for both subcategories is discussed in detail in Section X.

The Agency is promulgating PSES for all indirect dischargers based on the same technology basis as the BAT non-end-of-pipe biological treatment subcategory. The rationale for selection of this technology basis for the final PSES effluent limitations guidelines is discussed in Section XII.

A review of waste management practices and well-designed and -operated wastewater treatment system configurations currently in use by the OCPSF manufacturing facilities, reveals that there are numerous approaches for implementing effective pollutant control practices. Since the Agency does not specify what technology must be used to achieve the promulgated numerical effluent limitations and standards, the following portions of this section describe the unit operations and treatment practices that provide the bases of the selected technical options, as well as alternative unit operations and treatment systems that may also be utilized to achieve pollutant reduction goals. As noted in Section VIII, the Agency's methodology for estimating the engineering costs of compliance for individual facilities is based on costing one or more of the treatment unit operations included in the selected technology option, depending on the difference between current effluent pollutant concentrations and target effluent concentrations that would be required to achieve compliance with regulatory requirements.

B. BEST MANAGEMENT PRACTICES

Best Management Practices (BMPs) consist of a variety of procedures to prevent or minimize the potential for the release of toxic pollutants or hazardous substances to surface waters or POTWs (7-1). Specific practices that limit the volume and/or contaminant concentration of polluted waste streams, such as solvent recovery, water reuse, and various pretreatment options, involve applying BMPs to facility design. O&M procedures such as preventive maintenance measures, monitoring of key parameters, and equipment inspections that minimize the potential for unit process failures and subsequent treatment plant upsets are also considered part of BMPs. The following discussion is divided into two parts: in-plant source controls (i.e., process modifications; instrumentation; solvent recovery; and water reuse, recycle, and recovery) and general O&M practices. Several specific examples of how wastewater treatment plants improved their performances through minor modifications are also included.

1. In-Plant Source Controls

In-plant source controls include processes or operations that reduce pollutant discharges within a plant. Some in-plant controls reduce or eliminate waste streams, while others recover valuable manufacturing by-products.

In-plant controls provide several advantages: income from the sale of recovered material, reduction of end-of-pipe treatment costs, and removal of pollutants that upset or inhibit end-of-pipe treatment processes (7-2).

While many newer chemical manufacturing plants were designed to reduce water use and pollutant generation, improvements can often be made in older plants to control pollution from their manufacturing activities. The major in-plant source controls that are effective in reducing pollutant loads in the OCPSF industry are described below.

a. Process Modifications

Most manufacturers within the OCPSF industry use one or more toxic priority pollutants in various stages of production. In some cases, problems pertaining to a difficult-to-treat pollutant can be solved by finding less toxic or easier to treat substitutes for that compound. In many cases, a suitable substitute can be found at no or minor additional cost.

In some situations, plants can improve their effluent quality by shifting from batch processes to continuous operations, thus eliminating the wastewaters generated between batches by cleanup with solvents or caustic. Such modifications increase production yields and reduce wastewater generation.

Effluent quality at a facility can sometimes be improved by taking advantage of unused equipment or by simply reconfiguring existing equipment and structures. Some plant-specific approaches are as follows:

- Floor drains likely to receive spills can be designed to flow into a collection sump instead of directly into an industrial sewer system. This allows concentrated wastes to be recovered, treated, or equalized prior to being pumped or transferred to the wastewater treatment plant.
- Highly acidic or basic waste streams can be neutralized or diluted by being mixed together upstream of the wastewater treatment plant.

- Unused tanks at a facility can be fitted to intercept shock loadings and allow concentrated pollutants to be gradually mixed in with process wastewater at a high dilution rate. Excess tank or lagoon capacity can also be used to increase detention times and improve equalization of wastewaters.
- An abandoned steam stripper from a closed process line can be converted for use in treating in-plant waste streams containing volatile organic chemical compounds.
- Preheating or cooling waste streams designated for biological treatment can also be a great asset as activated sludge systems generally perform better at optimum temperatures, provided that the temperature can be consistently maintained.

Two examples of process modifications from other industries may be applicable to the OCPSF industry. The first involves biological degradation. Although anaerobic digestion is common at the mesophilic temperature of 30°C, use of thermophilic digestion has gained popularity of late because of potentially increased solids destruction. New York City, in its wastewater treatment operation, conducted thermophilic digestion directly after mesophilic digestion. This has led to increased sludge solids destruction, and when employed with increased decanting, has led to a reduction in sludge volume and more efficient operation (7-3).

Another modification involves the use of a step-feed operating program. Having a variety of feed points enables the protection of effluent quality while steps are taken to correct malfunctions in the biological treatment process.

b. Instrumentation

Process upsets resulting in the discharge of products, raw materials, or by-products are important sources of pollution in the OCPSF industry. Well-designed monitoring, sensor, and alarm systems can enable compensatory action to be taken before an unstable condition results in such process upsets.

Some common parameters that can be monitored and controlled using various types of sensors and equipment include flow (both open channel and closed conduit), pump speed, valve position, and tank level. Analytical measurements such as pH, dissolved oxygen (DO), suspended solids, and chemical residuals can also be monitored and regulated using feedback control equipment. At many facilities, the overpressurization of reaction kettles, the bursting of rupture-disks, and the discharge of chemical pollutants could be controlled with a proper early warning system.

c. Solvent Recovery

The recovery of waste solvents has become a common practice among plants using solvents in their manufacturing processes. In some cases, solvents can be recovered in a sufficiently pure form to be used in the same manner as new solvents. Solvents of lesser quality may still be usable in other areas of manufacturing or be sold to another facility for use in applications not requiring a high level of purity. Also, many private companies exist that collect and reclaim spent solvents which are then sold back to the same or other OCPSF facilities.

Solvents that cannot be recovered or reused can be destroyed through incineration. Incineration may also be the best disposal method for used solvents that cannot be economically recovered and for wastes such as bottoms from solvent recovery units.

Solvent recovery, off-site reclaiming, reuse, and incineration are methods of removing solvents from waste streams before they arrive at an end-of-pipe treatment system or a POTW. Therefore, they contribute to protecting biological treatment units from toxic shocks which could cause poor effluent quality. In addition, as the cost for disposal of hazardous liquid waste increases, solvent recovery becomes more economical.

d. Water Reuse, Recycle, and Recovery

Water conservation through reuse, recycle, and recovery can result in more efficient manufacturing operations and a significant reduction in industrial effluent requiring treatment. Recycling cooling water through the use of cooling towers is a common industrial practice that dramatically decreases total discharge volume. While noncontact cooling water may require little or no treatment prior to recycling (other than reducing the water temperature in cooling towers and adding corrosion inhibitors), treatment of the wastewater prior to reuse is usually necessary to ensure a return stream of sufficient quality for use in the process. In some cases, the treatment required is simple, and facilities may already exist on-site (e.g., sedimentation).

By reducing the volume of wastewater discharged, recycling often allows the use of abatement practices that are uneconomical on the full waste stream. Further, by allowing concentrations to increase, the opportunities for recovery of waste components to offset treatment cost (or even achieve profitability) are substantially improved. In addition, pretreatment costs of process water (and in some cases, reagent use) may be reduced. For example, removal efficiencies for metals in chemical precipitation units are increased at higher raw waste concentrations and proper chemical coagulant dosage. More economical recovery of solvents is obtained from a properly designed steam stripper at elevated solvent feed levels. Recycling also enables many plants to achieve zero discharge, eliminating the need for ultimate disposal or surface discharge.

Recycling systems can achieve significant pollutant load reductions or zero discharge at relatively low cost. The systems are easily controlled by simple instrumentation, and relatively little operator attention is required. The most important design parameter is the recycle rate (rate of return) to the process stream or blowdown rate from closed loop recycle systems to avoid build-up of dissolved solids.

Recycling limitations include the potential for plugging and scaling of the process lines and excessive heat build-up in the recycled water which may require cooling prior to reuse. Chemical aids are often used in the recycle loops to inhibit scaling or corrosion.

Other approaches to reducing industrial discharge volumes include equipment modifications and separation of stormwater and process wastewater. The use of barometric condensers can result in significant water contamination, depending upon the nature of the materials entering the discharge water streams. As an alternative, several plants use surface condensers to reduce hydraulic or organic loads. Water-sealed vacuum pumps can also create water pollution problems. These problems can be minimized by using a water recirculation system to reduce the amount of water being discharged.

Separation of stormwater and process wastewater enables each waste stream to receive only the treatment required, and prevents problems caused by large volumes of stormwater being contaminated by process wastewater, which subsequently requires specialized treatment. If stormwater contains polluted runoff from contaminated areas of a site, it may be possible to collect the stormwater in retention basins and then gradually blend it in with process wastewater in an equalization basin at the beginning of the wastewater treatment cycle.

2. Operation and Maintenance (O&M) Practices

Many O&M practices minimize the potential for unit process failures and subsequent treatment plant upsets. Inspections of those aspects of site operation that have the highest potential for uncontrolled chemical releases should be conducted by qualified maintenance or environmental engineering staff members. Construction records should be reviewed to assure that underground tanks and pipes have coatings or cathodic protection to inhibit corrosion. Storage tanks and pipelines should be regularly inspected for leaks, corrosion, deterioration of foundation or supports, pitting, cracks, deformation, or any other abnormalities. Seams, rivets, nozzle connections, valve function and position, and any associated ancillary equipment should also be inspected regularly to check for deterioration as well as potential leaks from human error (e.g., valve not closed, loose pipe connections).

Training is important to assure that an operator reacts properly to upset conditions. Treatment plant personnel should receive on-the-job and classroom training covering the fundamental theories of wastewater treatment, specific information about the equipment in use at that facility, the nature of manufacturing processes and potential for upset, and prearranged procedures for responding to upset conditions. Plants with operational flexibility may be able to compensate to some degree for sudden changes in weather conditions or inflow volume and quality by adjusting factors such as hydraulic retention times and clarifier overflow rates through altering recycling rates, putting backup units on-line, or directing excess wastewater to a holding basin until flow rates return to normal. In addition, manufacturing personnel upstream of a treatment plant should be trained in the proper disposal of waste chemicals and the restrictions associated with disposal of wastes in industrial sewers or storm drains.

Facilities handling a wide range of chemicals should be particularly sensitive to potential problems arising from incompatible materials mixing in tanks or pipelines. Monitoring storm sewers and industrial sewers on a regular basis for toxic and hazardous pollutants is useful in identifying potential misuse of sewers or evidence of infiltration of industrial wastes. This type of internal housekeeping helps to reduce the potential for uncontrolled releases from a facility or shock loadings to an on-site treatment plant.

At some facilities, waste treatment operations can be improved by bringing in private contractors to handle some or all facets of operations. Contractors experienced in treatment plant operations may have greater available technical resources to draw from than typical plant personnel in the event of an operational problem. For example, a company specializing in sludge handling may be able to improve that aspect of treatment plant operations with a higher level of expertise and a lower cost than plant personnel. In addition, a contractor operating several treatment plants may be able to reduce costs for all facilities through bulk purchasing of chemicals and pooling parts inventories.

If properly applied, certain O&M practices can compensate for cold weather temperatures. Plants operating in cold weather conditions must recognize that unnecessary storage of wastewater prior to treatment may reduce the temperature of the biotreatment system. Cold weather operation may require insulation of treatment units, covering of open tanks, and/or tracing of chemical feed lines. Maintenance of higher mixed liquor suspended solids (MLSS) concentrations and a reduced food-to-microorganism (F/M) ratio may be necessary. Plant-specific techniques are presented in the summer/winter discussion in the secondary treatment technology section.

C. IN-PLANT TREATMENT TECHNOLOGIES

1. Introduction

In-plant treatment is directed toward removing certain pollutants from segregated product/process waste streams before these waste streams are combined with the plant's remaining wastewaters. In-plant technologies, usually designed to treat toxic or priority pollutants, could often be used for end-of-pipe treatment of the plant's combined waste streams. Using these technologies on segregated internal waste streams is usually more cost-effective, since treatment of low volume, concentrated, and homogenous waste streams generated by specific product/processes is more efficient.

In-plant treatment is frequently employed to protect the plant's end-of-pipe treatment by removing the following types of pollutants (7-2):

- Pollutants toxic or inhibitory to biological treatment systems
- Biologically refractive pollutants
- High concentrations of specific pollutants
- Pollutants that may offer an economic recovery potential (e.g., solvent recovery)
- Pollutants that are hazardous if combined with other chemicals downstream
- Pollutants generated in small volumes in remote areas of the plant
- Corrosive pollutants that are difficult to transport.

Many technologies have proven effective in removing specific pollutants from the wastewaters produced by OCPSF plants. The selection of a specific in-plant treatment scheme depends on the nature of the pollutant to be removed, and on engineering and cost considerations.

The frequency of in-plant treatment technologies in the OCPSF industry is presented in Table VII-1. This information was compiled from the 546 OCPSF manufacturers that responded to all three parts of the Section 308 Questionnaire and the 394 Part A plants that responded to only Part A of the Section 308 Questionnaire. OCPSF manufacturers are defined as "full-response" if

TABLE VII-1.
FREQUENCY OF IN-PLANT TREATMENT TECHNOLOGIES IN THE
OCPSF INDUSTRY LISTED BY MODE OF DISCHARGE AND
TYPE OF QUESTIONNAIRE RESPONSE

	Direct		Indirect		Other Discharge		Total
Treatment Technology	# of Full-Resp Plants With Tech.	# of Part A Plants With Tech.	# of Full-Resp Plants With Tech.	# of Part A Plants With Tech.	# of Full-Resp Plants With Tech.	# of Part A Plants With Tech.	# of Plants With Technology
Cyanide Destruction	2	3	2	3	0	1	11
Chemical Precipitation	19	13	6	12	0	0	50
Chromium Reduction	2	3	1	5	0	0	11
Air Stripping	3	1	4	0	0	0	8
Steam Stripping	50	12	17	2	1	0	82
Solvent Extraction	13	4	8	3	1	0	29
Ion Exchange	3	2	0	1	0	1	7
Carbon Adsorption[1]	7	4	5	1	1	0	18
Distillation	35	13	14	9	0	1	72
Chemical Oxidation[2]	7	2	6	3	0	1	19
Filtration[1]	17	11	16	9	0	1	54

[1]These technologies are also tertiary treatment technologies and are discussed further in Section D.

[2]Chemical oxidation is discussed in the section on cyanide destruction.

over 50 percent of their total plant production includes OCPSF products; if they treat their OCPSF wastewaters in a separate treatment system; or if only one treatment system is employed, the non-OCPSF wastewaters contribute less than 25 percent of the total process flow. Part A plants are those that meet the definition of being zero dischargers or do not meet the full-response requirements stated above as direct or indirect dischargers. The 1983 Section 308 Questionnaire requested information on the plant's general profile (Part I); detailed production information (Part II); and wastewater treatment technology, disposal techniques, and analytical data summaries (Part III). In-plant controls frequently used by OCPSF plants for the treatment of individual waste streams include steam stripping (82 plants), distillation (72), filtration (54), chemical precipitation (50), solvent extraction (29), and carbon adsorption (18).

This section presents a general description and performance data for selected in-plant treatment processes that are currently used or that may be applicable to treat wastewaters from the OCPSF industry. General descriptions of the treatment technologies are based largely upon material found in the EPA Treatability Manual, most recently revised in February 1983 (EPA-600/2-82-001a). Performance data specific to various technologies are derived from four sources. The first source is OCPSF data compiled from responses to the 1983 OCPSF Section 308 Questionnaire, responses to the Supplemental Questionnaire sent to 84 facilities, and data collected by EPA in several sampling studies previously detailed in Section V. The second source is data obtained from other point source categories found in EPA technical development documents and the Treatability Manual. The third source is data submitted as part of public comments on the proposal and NOAs. Technical literature serves as the final source of performance data.

2. Chemical Oxidation (Cyanide Destruction)

Oxidation is a chemical reaction process in which one or more electrons are transferred from the chemical being oxidized to the chemical initiating the transfer (the oxidizing agent). The primary function performed by oxidation is detoxification. For instance, oxidants are used to convert cyanide to the less toxic cyanate or completely to carbon dioxide and nitrogen. Oxidation has also been used for the removal of phenol and organic residues in wastewaters and potable water. Oxidation can also be used to assure complete precipitation, as in the oxidation of iron from the ferrous (Fe^{+2}) to the ferric (Fe^{+3}) form where the more oxidized material has a lower solubility under the reaction conditions. Cyanide destruction (the oxidation of cyanide to carbon dioxide and nitrogen) is a form of chemical oxidation and will be used to illustrate the oxidation process, which is discussed in detail below.

Cyanide Destruction. Chlorine in elemental or hypochlorite salt form is a strong oxidizing agent in aqueous solution, and is used in industrial waste treatment facilities primarily to oxidize cyanide. Chemical oxidation equipment often consists of an equalization tank followed by two reaction tanks, although the reaction can be carried out in a single tank. The cyanide alkaline chlorination process uses chlorine and a caustic to oxidize cyanides to cyanates and ultimately to carbon dioxide and nitrogen. The oxidation reaction between chlorine and cyanide is believed to proceed in two steps, as follows:

(1) $CN^- + Cl_2 = CNCl + Cl^-$

(2) $CNCl + 2OH^- = CNO^- + Cl^- + H_2O$

The cyanates can be further decomposed into nitrogen and carbon dioxide by excess chlorination:

(3) $2CNO^- + 4OH^- + 3Cl_2 = 6Cl^- + 2CO_2 + N_2 + 2H_2O$

According to the Section 308 Questionnaire data base, 30 OCPSF plants use chemical oxidation as an in-plant treatment technology; of these, 11 plants use chemical oxidation for cyanide destruction. Performance data for chemical oxidation are not available for the OCPSF industry. However, data for cyanide destruction from the metal finishing industry are available, and can be applied to the OCPSF industry as discussed in detail later in this section and in Tables VII-2 and VII-3.

TABLE VII-2.
OXIDATION OF CYANIDE WASTES WITH OZONE

Plant #30022 (mg/l)

	Day 1			Day 2			Day 3		
Parameter	In	Out	Removal Efficiency (%)	In	Out	Removal Efficiency (%)	In	Out	Removal Efficiency (%)
Cyanide, Total	1.4	.113	92	.30	.03	87	2.4	.096	96
Cyanide, Amenable	1.4	.110	92	.30	.039	87	2.389	.096	96

Source: Development Document for Effluent Limitations Guidelines New Source Performance Standards for the Metal Finishing Point Source Category, June 1983.

TABLE VII-3.

PERFORMANCE DATA FOR TOTAL CYANIDE OXIDATION USING CHLORINATION

Plant ID	Adjusted Average Total CN Effluent Concentration (mg/l)
12065	0.14
21051	0.0
38051	0.0
06075	0.039
36623	0.103
19050	0.031
20079	17.54
05021	0.035
20078	0.083
20080	0.949
15070	0.323
33073	0.707
09026	0.119
31021	0.708
33024	0.204

Source: Development Document for Effluent Limitations Guidelines New Source Performance Standards for the Metal Finishing Point Source Category, June 1983.

As shown in Table VII-2, removal efficiency for plant #30022 using ozone as an oxidant varies between 87 and 96 percent. The oxidation of cyanide using ozone results in high capital and energy costs, and its efficiency is limited when treating wastewaters containing more than one pollutant. Cyanide can also be destroyed using hydrogen peroxide, but this results in high energy costs because the wastewater must be heated prior to treatment. Furthermore, peroxide only partially oxidizes cyanide to cyanate, and the addition of a formaldehyde catalyst results in a higher strength (BOD_5 level) wastewater.

Results of cyanide oxidation using chlorination from a number of metal finishing plants can be seen in Table VII-3. Average effluent cyanide concentrations range from 0.0 (plant #21051) to 17.54 mg/l (plant #20079).

EPA indicated in its December 8, 1986, Notice that it was considering using the performance data for cyanide destruction from the metal finishing industry to develop cyanide limitations and standards. These data are based on alkaline chlorination (a type of chemical oxidation). Public comments on this notice suggested that EPA should transfer cyanide destruction performance data from the pharmaceutical manufacturing industry rather than from the metal finishing industry because of the similarity in wastewater characteristics shared by the OCPSF and pharmaceutical categories. EPA has evaluated the pharmaceutical cyanide destruction performance data and has rejected transfer of these data for use in the development of OCPSF cyanide limitations because the cyanide destruction performance data from the pharmaceutical industry are from a cyanide hydrolysis system that utilizes high temperatures and pressures to hydrolyze free cyanide; this particular type of cyanide destruction technology has not yet been demonstrated to be effective on OCPSF cyanide-bearing wastewater. EPA believes that the cyanide destruction by alkaline chlorination data from the metal finishing industry are more appropriate for transfer to the OCPSF industry since this technology is used on cyanide waste streams in the OCPSF industry.

Another significant issue raised concerning the use of alkaline chlorination technology in the OCPSF industry was the contention that while this technology may effectively reduce concentrations of free cyanide in OCPSF wastewaters, it cannot reduce concentrations of metal-complexed cyanides.

Industry commenters have stated that the limitations and standards should be for amenable cyanide only. EPA has evaluated the expected amount of cyanide complexing resulting from the presence of certain transition metals (i.e., nickel, copper, silver, and cobalt in OCPSF cyanide-bearing waste streams), and has concluded that only cyanide complexed by copper, silver, or nickel could present a problem for treatment by alkaline chlorination. However, silver is found at such low levels in the process wastewater of so few product/processes that cyanide complexing would not present a problem, and only a limited number of product/process waste streams would contain combinations of either copper and cyanide (four sources), or nickel and cyanide (two sources). For these six product/process sources, a potential for cyanide complexing is present. However, no data have been submitted to demonstrate that the actual levels of complexing interfere with the ability of the plant to meet the total cyanide limitations. Thus, EPA believes that limitations and standards controlling total cyanide are appropriate for all dischargers subject to this regulation. A discussion identifying the sources of cyanide and the product/processes with a potential for complex formation with nickel and copper are contained in Section V of this document.

3. Chemical Precipitation

Chemical precipitation is a principal technology used to remove metals from OCPSF wastewaters. Most metals are relatively insoluble as hydroxides, sulfides, or carbonates, and can be precipitated in one of these forms. The sludge formed is then separated from solution by physical means such as sedimentation or filtration. Hydroxide precipitation is the conventional method of removing metals from wastewater. Most commonly, caustic soda (NaOH) or lime ($Ca(OH)_2$) is added to the wastewater to adjust the pH to the point where metal hydroxides exhibit minimum solubilities and are thus precipitated. Sulfide precipitation has also been demonstrated to be an alternative to hydroxide precipitation for removing metals from certain wastewaters. Sulfide, in the form of hydrogen sulfide, sodium sulfide, or ferrous sulfide, is added to the wastewater to precipitate metal ions as insoluble metal sulfides. Carbonate precipitation, while not used as frequently as hydroxide or sulfide precipitation, is another method of removing metals from wastewater. A carbonate reagent such as calcium carbonate is added to the wastewater to precipitate metal carbonates. The solubility of metal hydroxides and sulfides as a function of pH is shown in Figure VII-1. The solubility of most metal carbonates is between hydroxide and sulfide solubilities.

Chemical precipitation has proven to be an effective technique for removing many industrial wastewater pollutants. It operates at ambient conditions and is well suited to automatic control. Hydroxide precipitation has been used to remove metal ions such as antimony, arsenic, chromium, copper, lead, mercury, nickel, and zinc. Sulfide precipitation has mainly been used to remove mercury, lead, and silver from wastewater, with less frequent use to remove other metal ions. Carbonate precipitation has been used to remove antimony and lead from wastewater. To achieve maximum pollutant removals, chemical precipitation should be 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 stirring to promote particle growth by various coagulation mechanisms (flocculation); and 4) clarification (or sedimentation or filtration) to remove the flocculated solid particles.

The use of chemical precipitation technology as well as the availability of performance data may be limited for several reasons. First, treatable raw waste concentrations of product/process sources of priority pollutant metals are not prevalent throughout the industry. Furthermore, plants that generate process sources of metals and plants that utilize in-plant chemical precipitation unit operations also tend to rely on co-dilution of metal-bearing wastestreams by non-metal-bearing process wastewater as well as incidental metal removals in end-of-pipe treatment systems. Fifty OCPSF plants in the Section 308 Questionnaire data base report using chemical precipitation as an in-plant treatment technology; however, very few facilities reported in-plant chemical precipitation performance data.

Second, sulfide precipitation technology may generate toxic hydrogen sulfide and may result in discharges of wastewaters containing residual levels of sulfide. The generation of toxic hydrogen sulfide can be controlled by

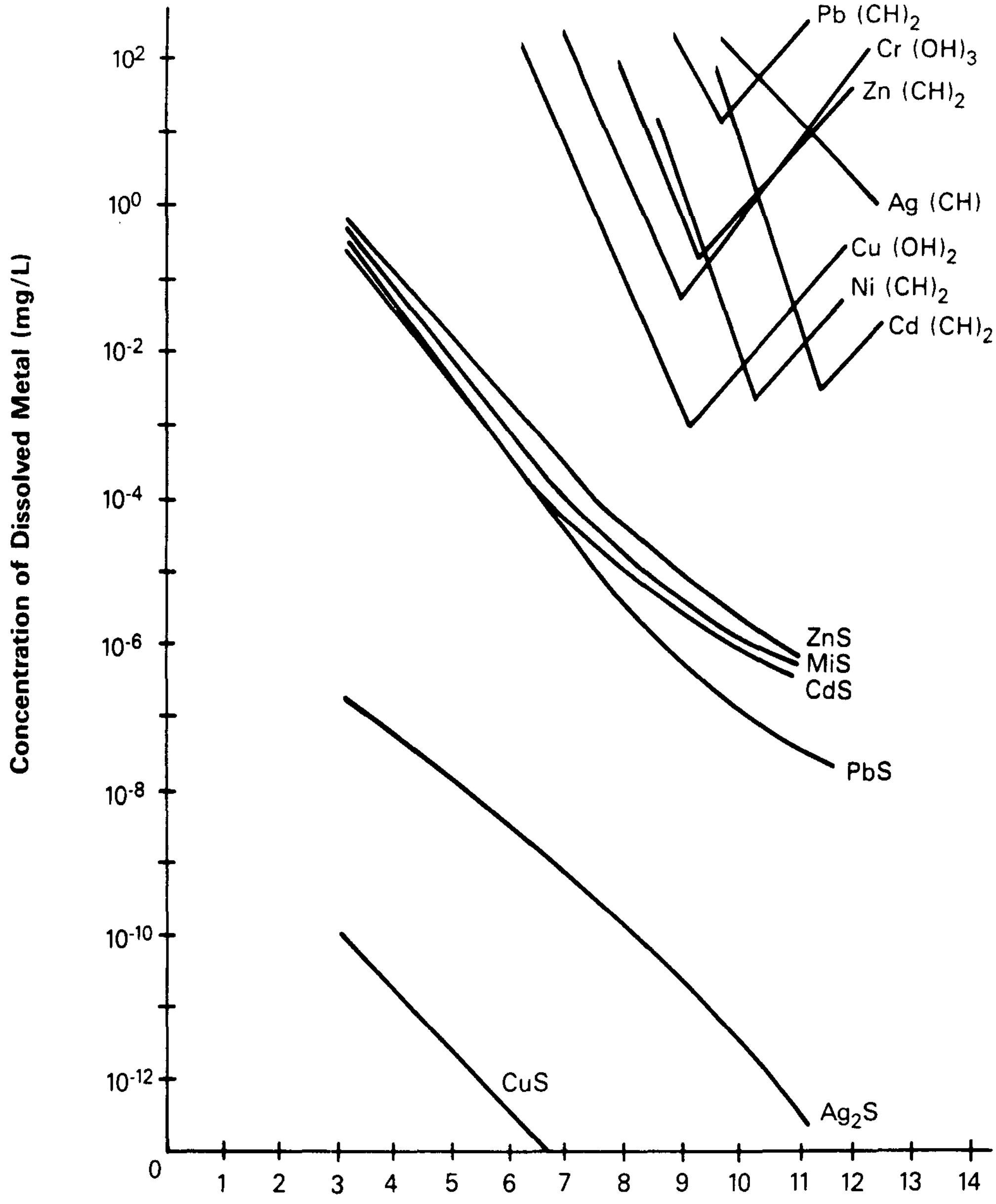

Figure VII-1: Solubility of Metal Hydroxides and Sulfides as a Function of pH

Source: Treatability Manual. 1981.

maintaining the pH of the solution between 8 and 9.5. The discharge of wastewaters containing sulfide can be controlled by carefully monitoring the amount of sulfide added.

Third, in some instances, chemical precipitation may be limited by interference of chelating agents and complexed metal ions. Because of the varying stabilities of metal complexes and the wide variety of organic ligands in OCPSF wastewaters, each plant with highly stable complexes has adapted or should adapt its treatment system to control the concentrations of the metals present in its process wastewater. Thus, control options for complexed metals, and the degree to which control is necessary or cost-effective, are unique to individual plants.

Several of the strategies employed by the OCPSF industry for treating complexed metals in process wastewater are as follows:

- Destabilize the complex by chemically reducing the metal's valence to zero. The released non-ionic metal is insoluble and can be captured via agglomeration with other solids that are being separated from the wastewater. Reductive destabilization is also effected by electroplating, in which case the metal is captured on the cathode.
- Destabilize the complex by degrading the organic ligand. The released metal is then captured as an insoluble salt by subsequent addition of a reagent (e.g., lime, caustic, or sodium sulfide). In special cases, ion exchange could be used to capture the metal ion.
- Capture the metal directly from the complex through the addition of a reagent (e.g., sodium sulfide to a copper complex) that forms an exceedingly insoluble salt of the metal.
- Concentrate the wastewater (e.g., in an evaporator) beyond the typically limited solubility of the metal-dye complex, so that it and other solids separate as a sludge.
- Use carbon adsorption technology to capture the complexed metal from the wastewater via the organic ligand, which will adsorb on the carbon as if it were not complexed.

Specific examples of the abovementioned precipitation technologies are detailed below:

- Plant 1647. Complexed copper (cuprous, +2) in a dyestuff process wastewater could not be precipitated effectively in a plant's combined wastewater by lime addition. The segregated wastewater from the dyestuff process was pretreated with sodium borohydride. Although relatively expensive, the pretreatment destabilized the complex by reducing the metal ion to copper (0), which was no longer amenable to complexation by the organic ligand. Since copper (0) is insoluble, the plant was then able to effectively remove the metal from the combined wastewater via agglomeration with other solids precipitated by the lime addition.

- Plant 1593. Copper (+2) and trivalent chromium (+3) are complexed with organic ligands in metallized dyes manufactured at the plant. The product is captured as a presscake on a plate-and-frame filter. The filtrate, together with wastewater from floor drains and other processes, is segregated into dilute and concentrated wastewater. Concentrated wastewater is concentrated still further in an evaporator, where most of the complexed metals separate as a residue which is sent to a surface impoundment. Condensed overhead from the evaporator and the dilute wastewater from a surge lagoon (flow equalization), neither of which now contains concentrations of complexed metals above their toxic thresholds, are combined as influent to a powdered activated carbon (PAC) biological treatment system.

  Prior to segregating the dilute and concentrated wastewaters, the combined process wastewater flow had to be pretreated with activated carbon columns to protect the biota from the toxic effects of metals released after complexing organic ligands had been biodegraded. Since most of the combined flow was dilute wastewater that did not contain complexed metals at toxic levels, the treatment system was modified to segregate the concentrated wastewater for pretreatment to eliminate the carbon column. Substantial operating cost savings were achieved by these modifications.

- Plant 1572. Cadmium (+2) chelated with an unknown organic ligand is used as a catalyst in a reactor. Reactor washout is treated with sodium hydrosulfide to form a cadmium sulfide precipitate directly from the complexed cadmium. The solids are captured by centrifugation, and the centrifugate is passed through a rapid sand filter to capture any fines. The solids from the centrifuge are saved and are available to the plant as a cadmium reclaiming option with the catalyst supplier.

- Plant 1769. Two organometallic products, tetraethyl lead (TEL) and tetramethyl lead (TML), are produced at this plant. Although the chemical bonding in organometallics differs from the metallized dye complexes discussed previously, the treatment technology is the same in principle. After adjusting the wastewater to a pH of 8 to 10 with dilute sulfuric acid, sodium borohydride is added to reduce the ethyl groups to ethane by hydride transfer. The released lead (+4) then reacts with water to precipitate lead dioxide, which is captured in a clarifier. The lead dioxide is recycled to refiners, which regenerate the lead for sale to the market.

- Plant 2447. This plant manufactures oil-soluble dialkyl dithiocarbamates and water-soluble dithiocarbamates of antimony, cadmium, nickel, lead, and zinc. The metals in this plant's wastewater are not present as stable complexes but as salts of organic acids. This example is given only to illustrate the wide variety of treatment strategies used by the OCPSF industry to control metals.

  Since metal dithiocarbamates have low solubility in water, a precipitating reagent is readily available that is effective for controlling these metals in the wastewater. The wastewater is generated in batches as washout from mixing tanks and reactors, and is collected in a storage tank. Depending on the characteristics of the batch, the plant will either incinerate the waste, or route it to the wastewater treatment system. Treatment consists of adding sodium dithiocarbamate to precipitate the metals, and a coagulant (ferrous sulfate) to aid settling of the solids in a clarifier.

Wastewaters from the OCPSF industries generally do not contain high concentrations of metal ions. Rayon and certain acrylic fibers manufacturing, however, generate elevated levels of zinc in wastewaters. Other industrial processes may also have metals in their wastewaters due to use of metals in chemical processing and as trace contaminants from raw materials and equipment.

In the December 8, 1986, Federal Register Notice of Availability, the Agency proposed to establish limitations for metals from OCPSF plants with and without end-of-pipe biological treatment in-place for BAT and PSES based upon the use of hydroxide precipitation data from several metals industries. For OCPSF waste streams with complexed metals, EPA proposed the use of sulfide precipitation to achieve the same limitations.

Industry commenters strongly criticized several aspects of EPA's proposed approach. First, they argued that most priority pollutant metals are not present in significant quantities in OCPSF wastewaters. They criticized the data base upon which EPA had estimated loadings for these pollutants. They argued that these pollutants resulted not from OCPSF processes, many of which do not use metals, but rather from non-process wastewaters (e.g., zinc and chromium used as corrosion inhibitors and often contained in cooling water blowdown) or due to their presence in intake waters. The commenters concluded that EPA should regulate only those metals present in OCPSF process wastewaters as a result of the process use of the metals, applying the limits to those wastewaters only.

To address these comments, EPA has conducted a detailed analysis of the process wastewater sources of metals in the OCPSF industry. In response to criticism that EPA has relied too heavily on limited Master Process File metals data, EPA reviewed the responses to the 1983 Section 308 Questionnaire to examine which metals were used as catalysts in particular OCPSF product/processes, or were for other reasons likely to be present in the effluent from these processes. When necessary, EPA contacted plant personnel for additional information. The results of EPA's analysis, together with supporting documentation, are set forth in Section V of this document.

Based upon this analysis, EPA has concluded that chromium, copper, lead, nickel, and zinc are discharged from OCPSF process wastewaters at frequencies and levels that warrant national control. However, EPA agrees that many OCPSF wastewaters do not contain these pollutants or contain them only at insignificant levels. At most plants, process wastewater flows containing these metals constitute only a small percentage of the total plant OCPSF process wastewater flow. As a result, end-of-pipe data obtained by EPA often do not reflect treatment but rather reflect the dilution of metal-bearing process wastewater by nonmetal-bearing wastewater. Thus, these data are unreliable for the purpose of setting effluent limitations reflecting the use of best available technology. Consistent with the comments, EPA has decided to focus its regulations on metal-bearing process wastewaters only.

The concentration limitations are based upon 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 are available, EPA has decided to transfer data for this technology from the metal finishing industry point source category. A comparison of the metals raw waste data from the metal finishing industry data base with the validated product/process OCPSF raw waste data indicates that the concentrations of the metals of concern are generally within an acceptable range of concentrations found at metal finishing plants, except for lead. Table VII-4 presents this comparison of available OCPSF and metal finishing raw waste metals concentrations. With respect to lead, some OCPSF plants' raw waste concentrations exceed the range of metal finishing raw waste

TABLE VII-4.
COMPARISON OF OCPSF AND METAL FINISHING
RAW WASTE METALS AND CYANIDE CONCENTRATIONS

Parameter	Range of OCPSF Raw Waste Concentrations[1] (mg/l)	Range of Metal Finishing Raw Waste Concentrations (mg/l)	Metal Finishing Effluent Long-Term Average Concentration (mg/l)
Total Chromium (119)	0.200-0.799	0.650-393.000	0.572
Total Copper (120)	0.100-14.500	0.880-108.000	0.815
Total Cyanide (121)	0.140- 5200.000	0.045-1680.000	0.180
Total Lead (122)	50.060-218.900[2]	0.052-9.701	0.197
Total Nickel (124)	0.270-4.000	1.070-167.000	0.942
Total Zinc (128)[3]	0.400-20.000	0.630-175.000	0.549

[1]OCPSF raw waste concentration data are limited to data from the Master Process File for only product/processes that are validated process sources of metals.

[2]OCPSF raw waste concentration data for lead are from two validated product/ processes that occur at the same plant. These values compare to the raw waste concentrations for a lead battery manufacturing facility (identified as plant #672 in the battery manufacturing industry study). The lead battery plant raw waste concentration range was 2.21 to 295 mg/l for lead; its effluent long-term average concentration (after lime/hydroxide precipitation) was 0.131 mg/l. The effluent data ranged from 0.01 to 0.81 mg/l.

[3]Excludes raw waste zinc concentrations from rayon and acrylic fiber manufacturers.

concentrations. A comparison was made between the available OCPSF raw waste concentrations and the data from the lead battery subcategory of the battery manufacturing point source category. This comparison, as noted in Table VII-4, shows that the battery manufacturing lead raw waste concentrations encompass the range of OCPSF raw waste concentrations. Since hydroxide precipitation achieves lead effluent concentrations at battery manufacturing facilities that are as good as or better than those demonstrated by metal finishing plants, EPA believes that transfer of metal finishing lead data is appropriate.

In addition, the metal finishing wastewater matrices contain organic compounds that are used as cleaning solvents and plating bath additives. Some of these compounds serve as complexing agents, and their presence is reflected in the metal finishing industry data base. This data base contains hydroxide precipitation performance results from plants with waste streams from certain operations (electroless plating, immersion plating, or printed circuit board manufacturing) containing complexing agents. This is important because the data base reflects both treatment of waste streams containing complexing agents and segregation of these waste streams prior to treatment.

The transfer of technology and limitations from the metal finishing industry is further supported by the theory of precipitation. Given sufficient retention time and the proper pH (which is frequently achieved by the addition of a lime hydroxide), and barring the binding up of metals in unusual organic complexes (see discussion below), a metal exceeding its solubility level in water can be removed to a particular concentration (i.e., the effluent can be treated to a level approaching solubility for each constituent metal). This is a physical/chemical phenomenon that is relatively independent of the type of wastewater, barring the presence of complexing agents.

Some product/processes do have wastewaters that contain organic compounds that bind up the metals in stable complexes that are not amenable to optimal settling through the use of lime. EPA asked for comments in the December 1986 Notice on the use of sulfide precipitation in these situations. Industry commenters argued that the effectiveness of this technology has not been demonstrated for highly stable, metallo-organic chemicals. EPA agrees.

Strongly complexed priority pollutant metals are used or created, for instance, in the manufacture of metal complexed dyestuffs (metallized dyes) or metallized organic pigments. The most common priority pollutant metals found in these products are trivalent chromium and copper. The degree of complexing of these metals may vary among different product/processes. Consequently, each plant may need to use a different set of unique technologies to remove these metals. Thus, metals limits are not set by this regulation and must be established by permit writers on a case-by-case basis for certain product/processes containing complexed metals. These product/processes are listed in Appendix B to the regulation and in Table X-5.

The list in Table X-5 has been compiled based upon the analysis summarized in Section V of this document. EPA has concluded that all other metal-bearing process wastewaters (whether listed in Table X-5 or established as metal-bearing by a permit writer) can be treated using hydroxide precipitation to the levels set forth in the regulation.

As noted previously, since certain manufacturers of rayon and acrylic fibers have significantly higher raw waste zinc concentrations than any other OCPSF process wastewaters, the lime precipitation performance data received from the subject facilities are only applicable to certain types of processes. Table VII-5 presents a summary of zinc raw waste concentration data and lime precipitation performance data from three rayon facilities, as well as one acrylic fibers plant that uses a zinc chloride/solvent process. Acrylic fibers facilities using the zinc chloride/solvent process have been combined with rayon facilities for the purpose of establishing BAT zinc limitations because of their high raw waste zinc concentrations. By comparing the raw waste concentrations and resulting effluent concentrations for zinc in Tables VII-4 and VII-5, the fairly distinct differences in the two data sets are obvious.

4. Chemical Reduction (Chromium Reduction)

Reduction is a chemical reaction process in which one or more electrons are transferred to the chemical being reduced from the chemical initiating the transfer (the reducing agent). The major application of chemical reduction

TABLE VII-5.
RAW WASTE AND TREATED EFFLUENT
ZINC CONCENTRATIONS FROM RAYON
AND ACRYLIC FIBERS MANUFACTURING

Plant No.	Plant Type	Average Influent Zinc Concentration (mg/l)	No. of of Influent Observations	Average Effluent Zinc Concentration (mg/l)	No. of Effluent Observations
63	Rayon	143.471	365	3.847	253
387	Rayon	135.257	354	2.198	258
1012	Acrylic Fibers	287.686	363	2.291	358
1774	Rayon	15.570	346	2.409	346

involves the treatment of chromium wastes. To illustrate the reduction process, the conversion of hexavalent chromium to trivalent chromium (chromium reduction) is discussed below.

Chromium Reduction. A common chemical used in industrial plants for the reduction of chromium is sulfur dioxide. Chemical reduction equipment usually consists of one reaction tank where gaseous sulfur dioxide is mixed with the wastewater. The reduction occurs when sulfurous acid, produced through the reaction of sulfur dioxide and water, reacts with chromic acid as follows:

(1) $3SO_2 + 3H_2O = 3H_2SO_3$

(2) $3H_2SO_3 + 2H_2CrO_4 = Cr_2(SO_4)_3 + 5H_2O$

According to the Section 308 Questionnaire data base, 11 OCPSF plants use chromium reduction as an in-plant treatment technology.

5. Gas Stripping (Air and Steam)

Stripping, in general, refers to the removal of relatively volatile components from a wastewater by the passage of air, steam, or other gas through the liquid. The stripped volatiles are usually processed further by recovery or incineration.

Stripping processes differ according to the stripping medium chosen for the treatment system. Air and steam are the most common media, with inert gases also used. Air and steam stripping are described below.

Air Stripping. Air stripping is essentially a gas transfer process in which a liquid containing dissolved gases is brought into contact with air and an exchange of gases takes place between the air and the solution. In general, the application of air stripping depends on the environmental impact of the resulting air emissions. If sufficiently low concentrations are involved, the gaseous compound can be emitted directly to the air. Otherwise, air pollution control devices may be necessary.

The exchange of gases takes place in the stripping tower. The tower consists of a vertical shell filled with packing material to increase the surface area for gas-liquid contact, and fans to draw air through the tower. The towers are of two basic types--countercurrent towers and crossflow towers. In countercurrent towers, the entire airflow enters at the bottom of the tower, while the water enters the top of the tower and falls to the bottom. In crossflow towers, the air is pulled through the sides of the tower along its entire height, while water flow proceeds down the tower.

The removal of pollutants by air stripping is adversely affected by low temperatures, because the solubility of gases in water increases as temperature decreases.

Steam stripping. 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. More recently, this unit operation has been applied to the removal of water immiscible compounds (chlorinated hydrocarbons), which must be reduced to trace levels because of their toxicity.

Steam stripping is usually conducted as a continuous operation in a packed tower or conventional fractionating distillation column (bubble cap or sieve tray) with more than one stage of vapor/liquid contact. The preheated wastewater from the last exchanger enters near the top of the distillation column and then flows by gravity countercurrent to superheated steam and organic vapors (or gas) rising up from the bottom of the column. As the wastewater passes down through the column, it contacts the vapors rising from the bottom of the column. This contact progressively reduces the concentrations of volatile organic compounds or gases in the wastewater as it approaches the bottom of the column. At the bottom of the column, the wastewater is heated by the incoming steam, which also reduces the concentrations of volatile components to their final level. Much of the heat in the wastewater discharged from the bottom of the column can then be recovered by preheating the feed to the column.

Reflux (condensing a portion of the vapors from the top of the column and returning it to the column) may be practiced if it is desired to alter the composition of the vapor stream that is derived from the stripping column (e.g., increase the concentration of the stripped material for recovery purposes). There also may be advantages to introducing the feed to a tray below the top tray when reflux is used. Introducing the feed at a lower tray (while still using the same number of trays in the stripper) will have the effect of either reducing steam requirements, as a result of the need for less reflux, or yielding a vapor stream richer in the volatile components. The combination of using reflux and introducing the feed at a lower tray will increase the concentration of the volatile organic components in the overhead (vapor phase) beyond that obtainable by reflux alone and increase the potential for recovery.

Stripping of the organic (volatiles) constituents of the wastewater stream occurs because the organic volatiles tend to vaporize into the steam until its concentration in the vapor and liquid phases (within the stripper) are in equilibrium. The height of the column and the amount of packing material and/or the number of metal trays along with steam pressure in the column generally determine the amounts of volatiles that can be removed and the effluent pollutant levels that can be attained by the stripper. After the volatile pollutant is extracted from the wastewater into the superheated steam, the steam is condensed to form two layers of generally immiscible liquids--the aqueous and volatile layers. The aqueous layer is generally recycled back to the steam stripper influent feed stream because it may still contain low levels of the volatile. The volatile layer may be recycled to the process, incinerated on-site, or contract hauled (for incineration, reclaiming, or further treatment off-site) depending on the specific plant's requirements.

Steam stripping is an energy-intensive technology in which heat energy (boiler capacity) is required to both preheat the wastewater and to generate the superheated steam needed to extract the volatiles from wastewater. In addition, some waste streams may require pretreatment such as solids removal (e.g., filtration) prior to stripping because accumulation of solids within the column will prevent efficient contact between the steam and wastewater phases. Periodic cleaning of the column and its packing materials or trays is a necessary part of routine steam stripper maintenance to assure that low effluent levels are consistently achieved.

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 and diameter, 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 (7-4). 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 are taken into account for the volatile compounds the Agency has evaluated.

Since Henry's Law Constants were such important design parameters, the Agency initially proposed that, for consolidation purposes, toxic pollutants could be grouped into three general ranges of Henry's Law Constants termed high, medium, and low; these groups are presented in Table VII-6. The pollutants in the low Henry's Law Constant group were determined to require treatment other than steam stripping (i.e., carbon adsorption or in-plant biological treatment). The remaining groups were then used in the development of steam stripping cost curves and in the transfer of steam stripping performance data to toxic pollutants without performance data, depending on whether they fell within the high or medium grouping. For the purposes of this document, these groupings are designated "strippability" groups.

According to the Section 308 Questionnaire data base, eight OCPSF plants report using air stripping and 82 report using steam stripping as an in-plant treatment technology. Steam stripping performance data collected during the EPA 12-Plant Study or submitted by industry for selected volatile organic compounds are presented in Table VII-7. The data indicate that high removal

TABLE VII-6.

HENRY'S LAW CONSTANT (H_i) GROUPINGS

High (H_i*)--2 x 10^2 to 10^{-1}	Medium (H_i*)--10^{-1} to 10^{-3}	Low (H_i*)--10^{-3} to 10^{-8}
Benzene (0.19)	Acenaphthene (0.0079)	Bis (2-Chloroethyl) Ether (5.4 x 10^{-4})
Carbon Tetrachloride (1.0)	Acrolein (0.004)	2-Chloroethyl Vinyl Ether (1.04 x 10^{-4})
Chlorobenzene (0.17)	Acrylonitrile (0.0026)	Bis (2-Chloroethoxy) Methane (1.17 x 10^{-5})
1,1,1-Trichloroethane (0.15)	1,2-Dichloroethane (0.046)	Nitrobenzene (5.46 x 10^{-4})
Chloroethane (0.21)	Hexachloroethane (0.046)	2,4-Dinitrotoluene (1.87 x 10^{-4})
1,1-Dichloroethane (0.62)	1,1,2-Trichloroethane (0.032)	2,6-Dinitrotoluene (3.29 x 10^{-4})
Chloroform (0.14)	1,1,2,2-Tetrachloroethane (0.017)	Phenol (1.89 x 10^{-5})
Chloromethane (1.67)	Methylene Chloride (0.085)	2-Chlorophenol (4.29 x 10^{-4})
Vinyl Chloride (3.4)	1,2-Dichloropropane (0.096)	2,4-Dichlorophenol (1.17 x 10^{-4})
1,1-Dichloroethene (7.92)	1,3-Dichloropropene (0.055)	2,4,6-Trichlorophenol (1.67 x 10^{-4})
1,2-Trans-Dichloroethene (2.79)	Dibromochloromethane (0.041)	Pentachlorophenol (1.17 x 10^{-4})
Trichloroethene (0.379)	Tribromomethane (0.023)	2-Nitrophenol (3.15 x 10^{-4})
Tetrachloroethene (0.638)	Bis(Chloromethyl)Ether (0.00875)	2,4-Dinitrophenol (2.69 x 10^{-8})
Hexachloro-1, 3-Butadiene (1.07)	Bis(2-Chloroisopropyl) Ether (0.00458)	2,4-Dimethylphenol (7.08 x 10^{-4})
Hexachlorocyclopentadiene (0.667)	4-Chlorophenyl Phenyl Ether (0.00912)	P-Chloro-M-Cresol (1.04 x 10^{-4})
Bromomethane (8.21)	4-Bromophenyl Phenyl Ether (0.00417)	Dimethyl Phthalate (8.96 x 10^{-5})
Bromodichloromethane (0.100)	1,2-Dichlorobenzene (0.080)	Diethyl Phthalate (5 x 10^{-5})
Dichlorodifluoromethane (124.2)	1,2,4-Trichlorobenzene (0.096)	Di-n-Butyl Phthalate (1.17 x 10^{-5})
Trichlorofluoromethane (4.58)	Hexachlorobenzene (0.028)	Di-n-Octyl Phthalate (7.08 x 10^{-4})
1,3-Dichlorobenzene (0.150)	4-Nitrophenol (0.0010)	Bis(2-Ethylhexyl) Phthalate (1.25 x 10^{-5})

TABLE VII-6.
HENRY'S LAW CONSTANT (H_i) GROUPINGS
(Continued)

High (H_i*)--2 x 10^{2} to 10^{-1}	Medium (H_i*)--10^{-1} to 10^{-3}	Low (H_i*)--10^{-3} to 10^{-8}
1,4-Dichlorobenzene (0.125)	4,6-Dinitro-o-Cresol (0.0017)	Butyl Benzyl Phthalate (3.46 x 10^{-4})
Ethylbenzene (0.275)	Acenaphthylene (0.0604)	Benzo (a) Anthracene (4.17 x 10^{-5})
Toluene (0.277)	Anthracene (0.0036)	Benzo (b) Fluoranthene (5.08 x 10^{-4})
	Benzo (k) Fluoranthene (0.0016)	Benzo (ghi) Perylene (6 x 10^{-6})
	Fluorene (0.00267)	Benzo (a) Pyrene (2.04 x 10^{-5})
	Naphthalene (0.0191)	Chrysene (4.38 x 10^{-5})
	Phenanthrene (0.0094)	Di-Benzo (a,h) Anthracene (3.04 x 10^{-6})
	Dimethyl Nitrosoamine (0.0014)	Fluoranthene (2.71 x 10^{-4})
	Diphenyl Nitrosoamine (0.0275)	Indeno(1,2,3-(d) Pyrene (2.89 x 10^{-6})
		Pyrene (2.12 x 10^{-4})
		Di-n-Propyl Nitrosoamine (2.62 x 10^{-4})
		Benzidine (1.25 x 10^{-5})
		3,3-Dichlorobenzidine (3.33 x 10^{-5})
		1,2-Diphenylhydrazine (1.41 x 10^{-7})

*H_i is expressed as the ratio of mass per unit volume in air to mass per unit volume in water ($mg/m^3/mg/m^3$).

TABLE VII-7.
STEAM STRIPPING PERFORMANCE DATA

Pollutant	Plant	Influent (ppb) Arithmetic Mean	Influent Min.	Influent Max.	Influent No. Points	Effluent (ppb) Arithmetic Mean	Effluent Min.	Effluent Max.	Effluent No. Points	AML+	Removal Efficiency (%)
Benzene (4)	0415*	35,200	22,300	48,100	2	38.8	10	80	4	10	>99
	0415**	321,667	274,000	412,000	3	200.3	134	329	3	10	>99
	2680	92,159	34,693	147,212	10	10	10	10	10	10	>99
	1494	819,905	239	2,008,310	14	44.8	10	171	13	10	>99
Chloroethane (16)	415T	20,393	690	42,000	15	50.0	50	50	15	50	>99
	913	18,292	50	47,700	6	50.0	50	50	14	50	>99
Chloroform (23)	415T	399,263	7,330	1,088,000	15	10.5	10	16	15	10	>99
	913	118,667	28,700	200,000	6	129.2	10	290	14	10	>99
Methyl Chloride(45)	725	103,209	9,440	1,290,000	15	923.1	50	6,070	13	50	>99
1,1-Dichloroethane (13)	913	8,483	3,400	13,900	6	10.0	10	10	14	10	>99
1,2-Dichloroethane (10)	415T	9,614,773	2,339,900	23,476,000	15	56.1	10	374	15	10	>99
	913	259,500	172,000	327,000	6	73.3	10	487	14	10	>99
1,1-Dichloroethylene (29)	415T	4,358	200	10,800	15	10.2	10	13	15	10	>99
	913	5,970	2,900	12,300	6	10.0	10	10	14	10	>99
Trans-1,2-Dichloro-	415T	13,684	4,860	43,000	15	14.1	10	57	15	10	>99
methylene (30)	913	36,917	14,100	70,300	6	10.0	10	10	14	10	>99
Methylene Chloride (44)	415T	2,107	198	12,100	15	10.5	10	18	15	10	>99
	913	3,398	200	10,400	6	10.0	10	10	14	10	>99
	725	1,306	10	5,100	15	217.3	10	1,120	13	10	>83
1,1,1-Trichloroethane (11)	913	18,417	11,900	35,000	6	10.0	10	10	14	10	>99
Toluene (86)	415*	3,400	2,570	4,230	2	22.3	10	47	4	10	99
	415**	22,600	19,300	29,000	3	12.0	10	16	3	10	>99
Tetrachloroethylene (85)	913	55,083	10,800	241,000	6	18.4	10	107	14	10	>99
1,1,2-Trichloroethane (14)	415T	6,811	220	14,500	8	10.0	10	10	15	10	>99
	913	18,686	416	26,400	6	11.2	10	26	14	10	>99
Trichloroethylene (87)	415	1,862	59	10,300	15	16.1	10	85	15	10	>99
	913	32,583	22,900	52,700	6	10.0	10	10	14	10	>99
Vinyl Chloride (88)	725	1,085,200	410,000	2,230,000	15	37,944.2	50	336,000	13	50	>96
	913	1,767	50	3,500	6	50.0	50	50	14	50	>97

*Steam Stripper No. 2 at Plant 415.
**Steam Stripper No. 3 at Plant 415.
+AML is the analytical minimum level.

efficiencies (e.g., most plant-pollutant combinations are over 99%) can be achieved for these volatile organic compounds. It should also be recognized that most treatment systems consist of several unit processes and that additional removal of organic compounds will likely occur, especially in systems with biological treatment units.

Nitrobenzene performance data from two plants in the OCPSF industry that employed steam stripping followed by activated carbon are presented in Table VII-8. The data indicate that a high removal efficiency (e.g., approximately 99%) can be obtained for this semi-volatile organic compound by using these two processes. However, the data shown in Table VII-9 also indicate that competitive adsorption may be occurring among nitrobenzene, the dinitrotoluenes (2,4- and 2,6-dinitrotoluene), and the nitrophenols (2- and 4-nitrophenol and 2,4-dinitrophenol) which seem to favor adsorption of nitrophenols over nitrobenzene because of their more attractive chemical affinity to the carbon. The nitrotoluene data are not available because matrix interferences prevented quantitation with the analytical methods that had been used.

6. 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 can be based either on physical differences that affect differential solubility between solvents or on 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 since the solute chemicals are generally recovered for reuse, resale, or further treatment and disposal. A process for extracting a solute from solution will typically include three basic steps: 1) the actual extraction, 2) solvent recovery from the treated stream, and 3) solute removal from the extracting solvent. The process may be operated continuously.

TABLE VII-8.
STEAM STRIPPING AND ACTIVATED CARBON PERFORMANCE DATA

Plant No.	Pollutant	Influent (ppb) Arithmetic Mean	Influent (ppb) Min.	Influent (ppb) Max.	Influent (ppb) No. Points	Effluent (ppb) Arithmetic Mean	Effluent (ppb) Min.	Effluent (ppb) Max.	Effluent (ppb) No. Points	Nominal Detection Limit	Removal Efficiency (%)
2680	Nitrobenzene	190,386	87,000	330,000	10	712.6	135	4900	10	14	>99
500	Nitrobenzene	2,848,229	14	5,460,000	35	520.3	14	9800	37	14	>99

TABLE VII-9.
DAILY ACTIVATED CARBON PERFORMANCE DATA
FOR NITROBENZENE, NITROPHENOLS, AND 4,6-DINITRO-O-CRESOL
PLANT NO. 2680T

Sampling	Nitrobenzene		2-Nitrophenol		4-Nitrophenol		2,4-Dinitrophenol		4,6-Dinitro-O-Cresol	
Date	Influent	Effluent	Influent	Effluent	Influent	Effluent	Influent	Effluent	Influent	Effluent
3/25/84	330,000	374	3,549	ND	6,603	ND	58,155	1,059	11,374	ND
3/26/84	190,000	150	2,900	ND	4,900	ND	29,500	ND	10,200	ND
3/27/84	267,160	143	2,400	-	5,000	-	28,700	-	10,400	-
3/28/84	309,920	330	1,400	ND	4,800	ND	30,700	1,761	9,600	ND
3/29/84	106,995	372	1,475	ND	6,350	ND	37,000	237	11,400	ND
4/01/84	144,860	140	1,740	ND	2,160	ND	56,517	ND	9,788	ND
4/02/84	139,530	4,900	3,719	ND	6,531	ND	30,000	ND	10,595	ND
4/03/84	87,000	135	2,408	ND	1,790	ND	20,000	ND	8,713	ND
4/04/84	139,340	331	2,663	ND	1,800	ND	27,000	ND	8,885	ND
4/05/84	189,054	251	2,363	ND	1,900	ND	30,900	ND	7,622	ND

Solvent extraction is presently applied in two main areas: 1) the recovery of phenol from aqueous wastes, and 2) the recovery of halogenated hydrocarbon solvents from organic solutions containing other water-soluble components.

Although effective in recovering solvents and other organic compounds for recycle and reuse, solvent extraction is not a widespread wastewater treatment technology because effluent concentration levels that are acceptable for recycle and reuse are generally too high for wastewater discharge. According to the Section 308 Questionnaire data base, 29 OCPSF plants use solvent extraction as an in-plant control or a raw material reclamation technology. Performance data are summarized for petroleum refining and organic chemical manufacturing plants in Volume III of the Treatability Manual. The data show a wide variation in removal efficiency, varying from 12 to 99 percent. Most volatile organics are removed with greater than 90 percent efficiency, but base/neutrals show removal efficiencies generally below 75 percent.

7. Ion Exchange

Ion exchange involves the process of removing anions and cations from wastewater. Wastewater is brought in contact with a resin that exchanges the ions in the wastewater with a set of substitute ions. The process has four operations carried out in a complete cycle: service, backwash, regeneration, and rinse. The wastewater is passed through the resin until the available exchange sites are filled and the contaminant appears in the effluent (breakthrough point). When this point is reached, the service cycle is stopped and the resin bed is backwashed with water in a reverse direction to that of the service cycle. Next, the exchanger is regenerated (converted to original form) by contacting the resin with a sufficiently concentrated solution of the substitute ion. Finally, the bed is rinsed to remove excess regeneration solution prior to the next service step.

Ion exchange is used in several ways. In industrial wastewaters, ion exchange may be used to remove ammonia, arsenic, chromium, and nickel. It is commonly used to recover rinse water and process chemicals, or to reduce salt concentrations in incoming water sources.

According to the Section 308 Questionnaire data base; only seven OCPSF plants use ion exchange as an in-plant treatment technology. Based on the limited number of OCPSF plants employing ion exchange and the absence of OCPSF ion exchange performance data, ion exchange was not considered as a BAT or PSES candidate technology. Performance data for ion exchange systems in the metal finishing industry are presented in Table VII-10. Although removal efficiencies are greater for the electroplating and printing circuit board plants (e.g., 91 to greater than 99%) than for plant #11065 (e.g., zero removal to greater than 99%), the influent pollutant concentrations are also much greater.

8. Carbon Adsorption

Activated carbon adsorption is a proven technology primarily used for the removal of organic chemical contaminants from individual process waste streams. Carbon has a very large surface area per unit mass and removes pollutants through adsorption and physical separation mechanisms. In addition to removal of many organic chemicals, activated carbon achieves limited removal of other pollutants such as BOD_5 and metals. Carbon used in a fixed column, as opposed to being directly applied in granular or powdered form to a waste stream, may also act as a filtration unit.

Activated carbon can be used as an in-plant treatment technology in order to protect downstream treatment units such as biological systems from high concentrations of toxic pollutants that could adversely affect system performance. In-plant activated carbon treatment also enables removal of pollutants from low volume waste streams before the waste streams mix with and contaminate much larger volumes of wastewater, which would be more difficult and costly to treat.

According to the Section 308 Questionnaire data base, 18 OCPSF plants are known to use activated carbon as an in-plant treatment technology. Although performance data for a specific individual in-plant carbon adsorption unit prior to biological treatment were not available, the Agency collected performance data from a carbon adsorption unit following steam stripping at an OCPSF facility for which the carbon adsorption unit treated a separate process

TABLE VII-10.
TYPICAL ION EXCHANGE PERFORMANCE DATA[1]

Parameter	Electroplating Plant Prior To Purification	After Purification	Removal Efficiency (%)	Printed Circuit Board Plant Prior To Purification	After Purification	Removal Efficiency (%)
Zinc (Zn)	14.8	0.40	97	-	-	
Cadmium (Cd)	5.7	0.00	100	-	-	
Chromium (Cr^{+3})	3.1	0.01	100	-	-	
Chromium (Cr^{+6})	7.1	0.01	100	-	-	
Copper (Cu)	4.5	0.09	98	43.0	0.10	100
Iron (Fe)	7.4	0.01	100	-	-	
Nickel (Ni)	6.2	0.00	100	1.60	0.01	99
Silver (Ag)	1.5	0.00	100	9.10	0.01	100
Tin (Sn)	1.7	0.00	100	1.10	0.10	91
Cyanide (CN)	9.8	0.04	100	3.40	0.09	97
Manganese (Mn)	4.4	0.00	100	-	-	
Aluminum (Al)	5.6	0.20	96	-	-	
Sulfate (SO4)	-	-		210.00	2.00	99
Lead (Pb)	-	-		1.70	0.01	99
Gold (Au)	-	-		2.30	0.10	96

Plant #11065, which was visited and sampled, employs an ion exchange unit to remove metals from rinsewater. The results of the sampling are displayed below.

POLLUTANT CONCENTRATION (mg/l)
Plant #11065

Parameter	Day 1 Input To Ion Exchange	Day 1 Effluent From Ion Exchange	Removal Efficiency (%)	Day 2 Input To Ion Exchange	Day 2 Effluent From Ion Exchange	Removal Efficiency (%)
TSS	6.0	4.0	33	1.0	1.0	0
Cu	52.080	0.118	100	189.3	0.20	100
Ni	0.095	0.003	97	0.017	0.003	82
Cr, Total	0.043	0.051	0	0.026	0.006	77
Cd	0.005	0.005	0	0.005	0.005	0
Pb	0.010	0.011	0	0.010	0.010	0

Source: Development Document for Effluent Limitations Guidelines New Source Performance Standards for the Metal Finishing Point Source Category, June 1983.

[1]Concentrations in mg/l.

waste stream prior to discharge. This unit was sampled during the EPA 12-Plant Study. This plant manufactures only interrelated products whose similar waste streams are combined and sent to a physical/chemical treatment system consisting of steam stripping followed by activated carbon. The toxic pollutants associated with these waste streams are removed by either steam stripping or activated carbon, or a combination of both.

The Agency has decided to use this available performance data from the end-of-pipe carbon adsorption unit as the basis for establishing BAT limits for four pollutants (2-nitrophenol, 4-nitrophenol, 2,4-dinitrophenol, and 4,6-dinitro-o-cresol), and the combination of steam stripping and activated carbon adsorption for nitrobenzene. Table VII-11 presents the performance data for the carbon adsorption unit at this plant. These data show very good removals (greater than 99%) for the carbon adsorption unit for 4,6-dinitro-o-cresol, 2-nitrophenol, 4-nitrophenol, and 2,4-dinitrophenol. However, the concentration data indicate that for 2,4-dinitrophenol and nitrobenzene the carbon adsorption unit is experiencing competitive adsorption phenomena. As shown in Table VII-9, this condition exists when a matrix contains adsorbable compounds in solution that are being selectively adsorbed and desorbed.

9. Distillation

Distillation is a unit process usually employed to separate volatile components of a waste stream or to purify liquid organic product streams. The process involves boiling a liquid solution and collecting and condensing the vapor, thus separating the components of the solution. The vapor is collected in a vessel where it is condensed, resulting in a separation of materials in the feed stream into two streams of different composition.

The distillation process is used to recover solvents and chemicals from industrial wastes that otherwise would be destroyed by waste treatment. Although effective in recovering solvents and other organic compounds for recycle and reuse, distillation is not a widespread wastewater treatment technology because effluent levels that are acceptable for recycle and reuse are generally too high for wastewater discharge. According to the Section 308 Questionnaire, 72 OCPSF plants use distillation as an in-plant control and/or secondary product or raw material reclamation technology.

TABLE VII-11.
CARBON ADSORPTION PERFORMANCE DATA
FROM PLANT #2680T

Pollutant (µg/l)	Influent Arithmetic Mean	Influent Min.	Influent Max.	Influent No. Points	Effluent Arithmetic Mean	Effluent Min.	Effluent Max.	Effluent No. Points	Det. Limits	Removal Efficiency (%)
2-Nitrophenol	2,462	1,400	3,719	10	20.0	20	20	9	20	> 99
4-Nitrophenol	4,183	1,790	6,603	10	50.0	50	50	9	50	> 98
2,4-Dinitrophenol	34,847	20,000	58,155	10	373.0	50	1,761	9	50	> 98
4,6-Dinitro-o-Cresol	9,858	7,622	11,400	10	24.0	24	24	9	24	> 99

No performance data are available for distillation as a wastewater control technology.

10. Filtration

Filtration is a proven technology for achieving the removal of suspended solids from wastewaters. The removal is accomplished by the passage of water through a physically restrictive medium (e.g., sand, coal, garnet, or diatomaceous earth) with resulting entrapment of suspended particulate matter by a complex process involving one or more removal mechanisms, such as straining, sedimentation, interception, impaction, and adsorption. In-plant filtration can serve to remove suspended solids and subsequently improve the performance of downstream treatment units that may be adversely affected by larger particles in the waste stream. In addition, filtration units can serve to collect solids with reclamation value from specific waste streams.

According to the Section 308 Questionnaire data base, 54 OCPSF plants use filtration as an in-plant treatment technology. Performance data for filtration as an in-plant technology were not available in the OCPSF industry; however, performance data for hydroxide precipitation plus in-plant filtration from the metal finishing point source category for TSS and selected metals are presented in Table VII-12, along with the hydroxide precipitation performance data from metal finishing for comparison purposes.

11. Reverse Osmosis

Reverse osmosis is a pressure-driven membrane process that separates a wastewater stream into a purified "permeate" stream and a residual "concentrate" stream by selective permeation of water through a semipermeable membrane. This occurs by developing a pressure gradient large enough to overcome the osmotic pressure of the ions within the waste stream. This process generates a permeate of relatively pure water, which can be recycled or disposed, and a concentrate stream containing most of the pollutants originally present, which can be treated further, reprocessed, or recycled. Reverse osmosis systems generally require extensive pretreatment (pH adjustment, filtration, chemical precipitation, activated carbon adsorption) of the wastewater stream to prevent rapid fouling or deterioration of the membrane surface.

TABLE VII-12.
PERFORMANCE DATA FROM HYDROXIDE PRECIPITATION AND HYDROXIDE PRECIPITATION PLUS FILTRATION FOR METAL FINISHING FACILITIES

Parameter	Hydroxide Precipitation only (mg/l)	Hydroxide Precipitation Plus Filtration (mg/l)
Total Suspended Solids	16.8	12.8
Chromium, Total	0.572	0.319
Copper	0.815	0.367
Lead	0.051	0.031
Nickel	0.942	0.459
Zinc	0.549	0.247

Source: Development Document for Effluent Limitations Guidelines New Source Performance Standards for the Metal Finishing Point Source Category, June 1983.

Reverse osmosis has been used in industry for the recovery and recycle of chemicals. Metals and other reusable materials can easily be separated from a waste stream. Although reverse osmosis is slightly more effective than chemical precipitation for metals removal, it is very expensive and appropriate only for low volume waste streams high in dissolved solids.

12. Ultrafiltration

Ultrafiltration is a physical unit process, similar to reverse osmosis, that is used to segregate dissolved or suspended solids from a liquid stream through the use of semipermeable polymeric membranes. The membrane of an ultrafilter forms a molecular screen that separates molecular particles based on their differences in size, shape, and chemical structure. A hydrostatic pressure is applied to the upstream side of a membrane unit, which acts as a filter, passing small particles such as salts while blocking larger emulsified and suspended matter. Ultrafiltration differs from reverse osmosis in the size of contaminants passed. Ultrafiltration generally retains particulates and materials with a molecular weight greater than 500, while reverse osmosis membranes generally pass only materials with a molecular weight below 100.

Ultrafiltration has been used in oil/water separation and for the removal of macromolecules such as proteins, enzymes, starches, and other organic polymers. Ultrafiltration is presently not a widely used process but has potential application to OCPSF wastewater treatment. Summary performance data are available from EPA's Volume III Treatability Manual for the aluminum forming, automobile and other laundries, rubber manufacturing, and timber products processing industries and are presented in Table VII-13. The data show a wide variation in removal efficiencies and effluent levels. An experimental combined ultrafiltration and carbon adsorption system does show promise. This system consists of powdered activated carbon suspended in wastewater. The mixture is then pumped through 20 ultrafilter modules arranged in two parallel trains. Heavy metal removal data for this system are presented in Table VII-13.

TABLE VII-13.
ULTRAFILTRATION PERFORMANCE DATA FOR METALS
IN LAUNDRY WASTEWATER-OPA LOCKA, FLORIDA

Parameter (mg/l)	Raw	Supernatant	Permeate
Zinc	0.52	<0.20	<0.20
Copper	0.51	0.14	0.06
Lead	0.4	0.1	0.01
Chromium (total)	0.1	<0.01	<0.01
Cadmium	0.03	<0.02	<0.02

Source: Van Gils, G. and M. Pirbazari. August 1986. Development of a Combined Ultrafiltration and Carbon Adsorption System for Industrial Wastewater Reuse and Priority Pollutant Removal. Environmental Progress 5(3):167-170.

13. Resin Adsorption

Resin adsorption is a process that may be used to extract and, in some cases, recover dissolved organic solutes from aqueous wastes. Waste treatment by resin adsorption involves two basic steps: 1) contacting the liquid waste stream with the resin, allowing the resin to adsorb the solutes from the solution, and 2) subsequently regenerating the resin by removing the adsorbed chemicals, often accomplished by simply washing with the proper solvent. Resin adsorption is similar in nature to activated carbon adsorption; the most significant difference being that resins are chemically regenerated while carbon is usually thermally regenerated, eliminating the possibility of material recovery. 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.

Current applications of resin adsorption include removal of copper and chromium both as salts and organic chelates, removal of color associated with metal complexes and organics, and the recovery of phenol from a waste stream. According to the Section 308 Questionnaire data base, no plants reported using resin adsorption. No data are available from other industries.

14. In-Plant Biological Treatment

For certain segregated waste streams and pollutants, in-plant biological treatment is an effective and less costly alternative to carbon adsorption for control of toxic organic pollutants, especially those which are effectively absorbed into the sludge and are relatively biodegradable. In-plant biological treatment may require longer detention times and certain species of acclimated biomass to be effective as compared to end-of-pipe biological treatment that is predominantly designated to treat BOD_5. EPA has determined that in-plant biological treatment with an acclimated biomass is as effective as activated carbon adsorption for removing priority pollutants such as polynuclear aromatics (PNAs) like naphthalene, anthracene, and pyrene; phenol; and 2,4-dimethylphenol as shown in the sampling data collected at plant #1293 of the 12-Plant Sampling Study, which are presented later in this section. Plant #1293 is a coal tar facility with flows of less than 50,000 gallons per day (gpd), which generates the highest raw waste concentrations of these toxic pollutants. Its treatment system consists of equalization, extended aboveground aerated lagoon, and secondary clarification prior to discharge to a POTW. This treatment system reduces the concentrations of all the abovementioned toxic pollutants to their respective analytical minimum levels.

After reviewing the performance data from this plant, the Agency determined that other relatively biodegradable toxic pollutants could also be controlled by this type of dedicated biological treatment system (i.e., with a minimum amount of dilution with other process wastewaters). This determination was made after review of performance data from selected end-of-pipe biological treatment systems (plant #948 and #2536) receiving wastewaters whose main toxic pollutant constituents included the following: acrylonitrile, bis (2-ethylhexyl) phthalate, di-N-butyl phthalate, diethyl phthalate, and dimethyl phthalate.

The Agency has determined that these data are appropriate for use in characterizing the performance of in-plant biological treatment based upon the waste stream characteristics of the influent to the treatment systems. The selected plants generate major sources of these pollutants.

According to the Section 308 Questionnaire data base, 33 OCPSF plants report using some form of biological treatment prior to discharge to an end-of-pipe treatment system (direct dischargers) or POTW (indirect dischargers). Table VII-14 presents the performance data for the three plants chosen by the Agency to represent the performance of in-plant biological treatment.

D. END-OF-PIPE TREATMENT TECHNOLOGIES

1. Introduction

End-of-pipe treatment systems in the OCPSF industry often consist of primary, secondary, and polishing or tertiary unit operations. In primary treatment, physical operations are used to remove floating and settleable solids found in wastewater. In secondary treatment, biological and chemical processes are used to remove most of the organic matter. In polishing or tertiary treatment, additional combinations of unit operations and processes

TABLE VII-14.
PERFORMANCE DATA BASIS FOR IN-PLANT BIOLOGICAL SYSTEMS

Pollutant	Plant Number	Influent (ppb) Arithmetic Mean	Influent (ppb) Min.	Influent (ppb) Max.	Influent (ppb) No. of Points	Effluent (ppb) Arithmetic Mean	Effluent (ppb) Min.	Effluent (ppb) Max.	Effluent (ppb) No. of Points	Analytical Minimum Level	Removal Efficiency
Acenaphtene	1293	876	513	1,516	13	10.0	10	10	15	10	> 98
Acrylonitrile	2536	209,882	43,496	414,785	15	50.0	50	50	15	50	> 99
2,4-Dimethylphenol	1293	29,868	16,216	73,537	14	10.0	10	10	15	10	> 99
Fluoranthene	1293	1,572	988	2,141	14	11.5	10	27	15	10	> 99
Naphthalene	1293	20,964	11,227	37,145	14	10.0	10	10	15	10	> 99
Phenol	1293	836,293	698,564	978,672	13	10.0	10	10	15	10	> 99
Bis(2-Ethyl Hexyl)Phthalate	948	1,097	11	11,740	34	43.3	10	185	33	10	> 96
Di-N-Butyl Phthalate	948	377	19	2,000	34	13.0	10	57	33	10	> 96
Diethyl Phthalate	948	1,220	14	15,000	34	23.5	10	175	33	10	> 98
Dimethyl Phthalate	948	134	10	625	25	10.0	10	10	22	10	> 92
Benzo(a)Anthracene	1293	308	10	614	13	10.0	10	10	15	10	> 96
Benzo(a)Pyrene	1293	166	10	426	13	10.3	10	15	15	10	> 93
3,4-Benzofluoranthene	1293	173	10	374	13	10.2	10	14	15	10	> 94
Benzo(k)Fluoranthene	1293	146	10	352	13	10.0	10	10	15	10	> 93
Chrysene	1293	266	10	677	13	10.0	10	10	15	10	> 96
Acenaphthylene	1293	472	191	699	13	10.0	10	10	15	10	> 97
Anthracene	1293	694	418	943	14	10.0	10	10	15	10	> 98
Fluorene	1293	1,232	678	1,873	13	10.0	10	10	15	10	> 99
Phenanthrene	1293	3,285	2,035	4,711	14	10.0	10	10	15	10	> 99
Pyrene	1293	1,023	641	1,438	14	10.3	10	15	15	10	> 98

are used to remove other constituents that are not removed by primary or secondary treatment. Many technologies have proven effective in removing specific pollutants from the wastewaters produced by OCPSF plants. The selection of a specific end-of-pipe treatment scheme depends on the nature of the pollutant to be removed and on engineering and cost considerations. Data on the frequency of application of specific primary, secondary, and polishing or tertiary end-of-pipe treatment technologies are presented in Tables VII-15, VII-16, and VII-17, respectively. Primary treatment technologies used by the OCPSF plants to remove floating and settleable solids, to protect the biological segment of the system from shock loadings, and to assure the efficiency of biological treatment include neutralization (365 plants), equalization (297), primary clarification (144), and nutrient addition (114). Secondary treatment technologies used by OCPSF plants to remove organic matter include secondary clarification (174 plants), activated sludge (143), and aerated lagoons (89). Polishing or tertiary treatment technologies used to remove certain constituents not sufficiently removed by the primary and secondary systems include polishing ponds (64 plants), filtration (41), and carbon adsorption (21).

2. Primary Treatment Technologies

Although the final BPT, BAT, and PSES effluent limitations guidelines are not based on these primary treatment technologies, many OCPSF facilities utilize one or some combination of these technologies to enhance the performance of subsequent treatment steps (e.g., biological). The Agency encourages the use of any of the primary treatment technologies discussed to improve the removal efficiency of the overall treatment system.

a. Equalization

Equalization involves the process of dampening flow and pollutant concentration variation of wastewater before 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 and that reduce effluent variability associated with slug

TABLE VII-15.
FREQUENCY OF PRIMARY TREATMENT TECHNOLOGIES
IN THE OCPSF INDUSTRY

	Direct		Indirect		Other Discharge		Total
Treatment Technology	# of Full-Resp Plants With Tech.	# of Part A Plants With Tech.	# of Full-Resp Plants With Tech.	# of Part A Plants With Tech.	# of Full-Resp Plants With Tech.	# of Part A Plants With Tech.	# of Plants With Technology
Equalization	147	30	87	27	4	2	297
Neutralization	144	36	134	41	5	5	365
Screening	19	9	12	8	0	1	49
Grit Removal	14	8	10	9	0	0	41
Oil Skimming	43	19	25	24	0	0	111
Oil Separation	38	13	22	11	1	1	86
API Separation	32	8	14	4	0	0	58
Dissolved Air Flotation (DAF)	14	5	5	6	0	1	31
Primary Clarification	60	18	52	10	2	2	144
Coagulation	21	6	10	5	0	0	42
Flocculation	27	11	15	11	1	1	66
Nutrient Addition[1]	83	20	6	3	1	1	114

[1]Nutrient addition is discussed with secondary treatment technologies.

TABLE VII-16.
FREQUENCY OF SECONDARY TREATMENT TECHNOLOGIES
IN THE OCPSF INDUSTRY

Treatment Technology	Direct: # of Full-Resp Plants With Tech.	Direct: # of Part A Plants With Tech.	Indirect: # of Full-Resp Plants With Tech.	Indirect: # of Part A Plants With Tech.	Other Discharge: # of Full-Resp Plants With Tech.	Other Discharge: # of Part A Plants With Tech.	Total: # of Plants With Technology
Activated Sludge	102	27	8	5	0	1	143
Aerated Lagoon	55	14	14	4	1	1	89
Aerobic Lagoon	13	4	3	4	0	0	24
Anaerobic Lagoon	7	1	4	0	0	0	12
Rotating Biological Contactors	7	1	0	0	0	0	8
Trickling Filters	7	2	1	2	0	0	12
Oxidation Ditch[1]	1	1	0	0	0	0	2
Pure Oxygen Activated[1] Sludge	7	0	0	1	0	0	8
Second Stage of an Indicated Biological System	12	5	1	2	0	1	21
Powdered Activated Carbon Addition[2]	7	0	0	0	0	0	7
Secondary Clarification	127	24	14	6	1	2	174

[1]These technologies are discussed with activated sludge.

[2]Powdered activated carbon addition discussed in section on Operating, Managing, and Upgrading Biological Treatment Systems.

TABLE VII-17.
FREQUENCY OF POLISHING/TERTIARY TREATMENT TECHNOLOGIES
IN THE OCPSF INDUSTRY

Treatment Technology	Direct		Indirect		Other Discharge		Total
	# of Full-Resp Plants With Tech.	# of Part A Plants With Tech.	# of Full-Resp Plants With Tech.	# of Part A Plants With Tech.	# of Full-Resp Plants With Tech.	# of Part A Plants With Tech.	# of Plants With Technology
Polishing Pond	47	12	2	2	0	1	64
Filtration	31	6	1	1	2	0	41
Carbon Adsorption	17	2	1	1	0	0	21
Second Stage of an Indicated Tertiary System	2	1	0	0	0	0	3

raw waste loadings. Equalization is accomplished in a holding tank manufactured from steel or concrete, or in an unlined or lined 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.

Equalization is reliable from both equipment and process standpoints, and is used to increase the reliability of the flow-sensitive treatment processes that follow by reducing the variability of flow and pollutant concentrations. Equalization is a common treatment technology to the OCPSF industry. According to the Section 308 Questionnaire data base, 297 OCPSF plants use equalization as a primary treatment technology.

b. Neutralization

Neutralization involves the process of adjusting either an acidic or a basic waste stream closer to a neutral pH. Neutralization may be accomplished in either a collection tank, rapid mix tank, or an equalization tank by mixing 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).

Neutralization of an excessively acidic or basic waste stream is necessary in a variety of situations, including 1) the precipitation of dissolved heavy metals; 2) the prevention of metal corrosion and damage to other construction materials; 3) preliminary treatment allowing effective operation of the biological treatment process; 4) the providing of neutral pH water for recycle uses; and 5) the reduction of detrimental effects in the receiving water.

Neutralization is highly reliable with proper monitoring, control, and proper pretreatment to control interfering substances. Neutralization is a common treatment technology to the OCPSF industry; according to the Section 308 Questionnaire data base, 365 OCPSF plants neutralize their wastewaters.

c. Screening

Screening is the process of removing coarse and/or gross solids from wastewater before subsequent downstream treatment, and is usually accomplished by passing wastewater through drum- or disk-type screens. Typically, coarse screens are stainless steel or nonferrous wire mesh with openings from 6 to 20 mm. Fine screens have openings that are less than 6 mm. Solids are raised above the liquid level by rotation of the screen and are backflushed into receiving troughs by high-pressure jets.

Screening has proven to be a very reliable process when properly designed and maintained. According to the Section 308 Questionnaire data base, 49 OCPSF plants use screening as a primary treatment technology.

d. Grit Removal

Grit removal is achieved in specially designed chambers. Grit consists of sand, gravel, cinders, or other heavy solid materials that have subsiding velocities or specific gravities substantially greater than those of the organic putrescible solids in wastewater. Grit chambers are used to protect moving mechanical equipment from abrasion; to reduce formation of heavy deposits in pipelines, channels, and conduits; and to reduce the frequency of digester cleaning that may be required as a result of excessive accumulations of grit in such units.

Normally, grit chambers are designed to remove all grit particles with a 0.21 mm diameter, although many chambers have been designed to remove grit particles with a 0.15 mm diameter. According to the Section 308 Questionnaire data base, 41 OCPSF plants use grit removal as a primary treatment process.

e. Oil Separation (Oil Skimming, API Separation)

Oil separation techniques are used to remove oils and grease from wastewater. Oil may exist as free or emulsified oil. The separation of free oils and grease is accomplished by gravity, and normally involves retaining the oily waste in a holding tank and allowing oils and other materials less dense than water to float to the surface. This oily top layer is skimmed off the wastewater surface by a mechanism such as a rotating drum-type or a belt-type skimmer. Emulsified oil, after it has gone through a "breaking" step involving chemical or thermal processes to generate free oil, can also be separated using a skimming system.

Oil separation is used throughout the OCPSF industry to recover oil for use as a fuel supplement or for recycle, or to reduce the concentration of oils, which reduces any deleterious effects on subsequent treatment or receiving waters. In the OCPSF industry, oil separation also removes many toxic organic chemicals (typically large non-polar molecules) that tend to concentrate in oils and grease. However, since the removal of these toxic pollutants is incidental to oil separation/removal, this treatment process was not used as the technology basis for this final regulation. Still, the Agency encourages its use to improve the performance of the overall treatment system for removing unwanted floating oils and greases.

According to the Section 308 Questionnaire data base, 86 OCPSF plants use oil separation; 58 use API separation (a common gravity oil separation based upon design standards published by the American Petroleum Institute); and 111 practice oil skimming as a preliminary treatment technology. No OCPSF performance data are available; however, data from the iron and steel manufacturing and electrical and electronic components industries are presented in Volume III of the EPA Treatability Manual. The data show generally high removal efficiencies for metals and toxic organics.

f. Flotation

Flotation is a process by which suspended solids, free and emulsified oils, and grease are separated from wastewater by releasing gas bubbles into the wastewater. The gas bubbles attach to the solids, increasing their buoyancy and causing them to float. A surface layer of sludge forms, and is usually continuously skimmed for disposal. Flotation may be performed in several ways, including foam (froth), dispersed air, dissolved air, vacuum flotation, and flotation with chemical addition. The principal difference between these variations is the method of gas bubbles generation.

Flotation is used primarily in the treatment of wastewater streams that carry heavy loads of finely divided suspended solids or oil. Solids having a specific gravity only slightly greater than water, which would require abnormally long sedimentation times, may be removed in much less time by flotation. Thus, it is often an integral part of standard clarification.

According to the Section 308 Questionnaire data base, 31 OCPSF plants used dissolved air flotation as a primary treatment technology. No OCPSF performance data are available. The Volume III EPA Treatability Manual presents performance data from textile mills, pulp and paper mills, auto and other laundries, and petroleum refineries. The data show a median removal efficiency of 61 percent for BOD_5 and a median effluent concentration of 250 mg/l. Toxic removal efficiencies show large variations.

g. Clarification (settling, sedimentation)

Clarification is a physical process used to remove suspended solids from wastewater by gravity settling. Settling tanks, clarifiers, and sedimentation ponds or basins are designed to let wastewater flow slowly and quiescently, providing an adequate retention time to permit most solids more dense than water to settle to the bottom. The settling solids form a sludge at the bottom of the tank or basin. This sludge is usually pumped out continuously or intermittently from settling tanks or clarifiers, or scraped out periodically from sedimentation ponds or basins.

Settling is used alone or as part of a more complex treatment process. It is usually the first process applied to wastewaters containing high concentrations of settleable suspended solids. Settling is also often used in conjunction with other treatment processes such as removal of biomass after biological treatment or removal of metal precipitates after chemical precipitation. Clarifiers, in conjunction with chemical addition, are used to remove materials such as dissolved solids that are not removed by simple sedimentation (chemically assisted clarifiers are discussed later in this section under polishing and tertiary treatment).

Clarification (or sedimentation or settling) is a common primary treatment technology in the OCPSF industry; according to the Section 308 Questionnaire data base, 144 OCPSF plants use primary clarification.

h. Coagulation and Flocculation

Chemical coagulation and flocculation are terms often used interchangeably to describe the physiochemical process of suspended particle aggregation resulting from chemical additions to wastewater. Technically, coagulation involves the reduction of electrostatic surface charges and the formation of complex hydrous oxides. Coagulation is essentially instantaneous in that the only time required is that necessary for dispersing the chemicals in solution. Flocculation is the time-dependent physical process of the aggregation of wastewater solids into particles large enough to be separated by sedimentation.

The purpose of coagulation is to overcome electrostatic repulsive surface forces and cause small particles to agglomerate into larger particles, so that gravitational and inertial forces will predominate and affect the settling of the particles. The process can be grouped into two sequential mechanisms:

- Chemically induced destabilization of the repulsive surface-related forces, thus allowing particles to stick together when contact between particles is made.
- Chemical bridging and physical enmeshment between the non-repelling particles, thus allowing for the formation of large particles.

There are three different types of coagulants: inorganic electrolytes, natural organic polymers, and synthetic polyelectrolytes.

Inorganic electrolytes are salts or multivalent ions such as alum (aluminum sulfate), lime, ferric chloride, and ferrous sulfate. The inorganic coagulants act by neutralizing the charged double layer of colloidal particles and by precipitation reactions. Alum is typically added to the waste stream as a solution. At an alkaline pH and upon mixing, the alum hydrolyzes and forms fluffy gelatinous precipitates of aluminum hydroxide. These precipitates, partially as a result of their large surface area, act to enmesh small particles and thereby create large particles. Lime and ion salts, as well as alum, are used as flocculants primarily because of this tendency to form large fluffy precipitates of "floc" particles.

Natural organic polymers derived from starch, vegetable materials, or monogalactose act to agglomerate colloidal particles through hydrogen bonding and electrostatic forces. These are often used as coagulant aids to enhance the efficiency of inorganic coagulants.

Synthetic polyelectrolytes are polymers that incorporate ionic or other functional groups along the carbon chain in the molecule. The functional groups can be either anionic (attract positively charged species), cationic (attract negatively charged species), or neutral. Polyelectrolytes function by electrostatic bonding and the formation of physical bridges between particles, thereby causing them to agglomerate. These are also most often used as coagulant aids to improve floc formation.

The coagulation/flocculation and sedimentation process entails the following steps:

- Addition of the coagulating agent to the liquid
- Rapid mixing to dispense the coagulating agent throughout the liquid
- Slow and gentle mixing to allow for contact between small particles and agglomeration into larger particles.

Coagulation and flocculation are used for the clarification of industrial wastes containing colloidal and suspended solids. Coagulants are most commonly added upstream of sedimentation ponds, clarifiers, or filter units to increase the efficiency of solids separation. This practice has also been shown to improve dissolved metal removal as a result of the formation of denser, rapidly settling flocs, which appear to be more effective in absorbing and adsorbing fine metal hydroxide precipitates. Coagulation may also be used to remove emulsified oil from industrial wastewaters. Emulsified oil and grease is aggregated by chemical addition through the processes of coagulation and/or acidification in conjunction with flocculation. Performance data for coagulation/flocculation units are presented in the context of TSS and metals removal in the section on chemical precipitation.

According to the Section 308 Questionnaire data base, 42 OCPSF plants utilize coagulation and 66 OCPSF plants utilize flocculation as part of their preliminary treatment systems.

3. Secondary Treatment Technologies

a. Activated Sludge

The activated sludge process is a biological treatment process primarily used 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 the turbulence induced by aeration. These microorganisms oxidize soluble organics and agglomerate colloidal and particulate solids in the presence of dissolved molecular oxygen. The process can be preceded by sedimentation to remove larger and heavier solid particles if needed. The mixture of microorganisms, agglomerated particles, and wastewaters (referred to as mixed liquor) is aerated in an aeration basin. The aeration step is followed by sedimentation to separate biological sludge from treated wastewater. The major portion of the microorganisms and solids removed by sedimentation are recycled to the aeration basins to be recombined with incoming wastewater, while the excess, which constitutes the waste sludge, is sent to sludge disposal facilities.

The activated sludge biomass is made up of bacteria, fungi, protozoa, and rotifers. The bacteria are the most important group of microorganisms as they are responsible for stabilization of the organic matter and formation of the biological floc. The function of the biomass is to convert the soluble organic compounds to cellular material. This conversion consists of transfer of organic matter (also referred to as substrate or food) through the cell wall into the cytoplasm, oxidation of substrate to produce energy, and synthesis of protein and other cellular components from the substrate. Some of the cellular material undergoes auto-oxidation (self-oxidation or endogenous respiration) in the aeration basin, the remainder forming net growth or excess sludge. In addition to the direct removal of dissolved organics by biosorption, the biomass can also remove suspended matter and colloidal matter. The suspended matter is removed by enmeshment in the biological floc. The colloidal material is removed by physiochemical adsorption on the biological floc. Volatile compounds may be driven off to a certain extent in the aeration process. Metals are also partially removed, and accumulate in the sludge.

The effectiveness of the activated sludge process is governed by several design and operation variables. The key variables are organic loading, sludge retention time, hydraulic or aeration detention time, oxygen requirements, and the biokinetic rate constant (K). The organic loading is described as the food-to-microorganism (F/M) ratio, or the kilograms of BOD_5 applied daily to the system per kilogram of mixed liquor suspended solids (MLSS). The MLSS in the aeration tank is determined by the rate and concentration of activated sludge returned to the tank. The organic loading (F/M ratio) affects the BOD_5 removal, oxygen requirements, biomass production, and the settleability of the biomass. The sludge retention time (SRT) or sludge age is a measure of the average retention time of solids in the activated sludge system. Sludge retention time is important in the operation of an activated sludge system as it must be maintained at a level that is greater than the maximum generation time of microorganisms in the system. If adequate sludge retention time is not maintained, the bacteria are washed from the system faster than they can reproduce themselves and the process fails. The SRT also affects the degree of treatment and production of waste sludge. A high SRT results in carrying a high quantity of solids in the system and obtaining a higher degree of treatment and also results in the production of less waste sludge. The hydraulic detention time is used to determine the size of the aeration tank and should be determined by use of F/M ratio, SRT, and MLSS. The biokinetic rate constant (or K-rate) determines the speed of the biochemical oxygen demand reaction and generally ranges from 0.1 to 0.5 $days^{-1}$ for municipal wastewaters. The value of K for any given organic compound is temperature-dependent; because microorganisms are more active at higher temperatures, the value of K increases with increasing temperatures (7-5). Oxygen requirements are based on the amount required for BOD_5 synthesis and the amount required for endogenous respiration. The design parameters will vary with the type of wastewater to be treated and are usually determined in a treatability study.

The oxygen requirement to satisfy BOD_5 synthesis is established by the characteristics of the wastewater. The oxygen requirement to satisfy endogenous respiration is established by the total solids maintained in the system and their characteristics. A detailed discussion of typical design parameters used in the OCPSF industry and how these parameters are used in the Agency's compliance cost estimates are presented in Section VIII.

Modifications of the activated sludge process are common, as the process is extremely versatile and can be adapted for a wide variety of organically contaminated wastewaters. The typical modification may represent a variation in one or more of the key design parameters, including the F/M loading, aeration location and type, sludge return, and contact basin configuration. The modifications in practice have been identified by the major characteristics that distinguish the particular configuration. The characteristic types and modifications are briefly described as follows:

- Conventional. The aeration tanks are long and narrow, with plug flow (i.e., little forward or backwards mixing).
- Complete Mix. The aeration tanks are shorter and wider, and the aerators, diffusers, and entry points of the influent and return sludge are arranged so that the wastewater mixes completely.
- Tapered Aeration. A modification of the conventional process in which the diffusers are arranged to supply more air to the influent end of the tank, where the oxygen demand is highest.
- Step Aeration. A modification of the conventional process in which the wastewater is introduced to the aeration tank at several points, lowering the peak oxygen demand.
- High Rate Activated Sludge. A modification of conventional or tapered aeration in which the aeration times are shorter, the pollutants loadings are higher per unit mass of microorganisms in the tank. The rate of BOD_5 removal for this process is higher than that of conventional activated sludge processes, but the total removals are lower.
- Pure Oxygen. An activated sludge variation in which pure oxygen instead of air is added to the aeration tanks, the tanks are covered, and the oxygen-containing off-gas is recycled. Compared to normal air aeration, pure oxygen aeration requires a smaller aeration tank volume and treats high-strength wastewaters and widely fluctuating organic loadings more effectively.
- Extended Aeration. A variation of complete mix in which low organic loadings and long aeration times permit more complete wastewater degradation and partial aerobic digestion of the microorganisms.

- Contact Stabilization. An activated sludge modification using two aeration stages. In the first, wastewater is aerated with the return sludge in the contact tank for 30 to 90 minutes, allowing finely suspended colloidal and dissolved organics to absorb to the activated sludge. The solids are settled out in a clarifier and then aerated in the sludge aeration (stabilization) tank for 3 to 6 hours before flowing into the first aeration tank.

- Oxidation Ditch Activated Sludge. An extended aeration process in which aeration and mixing are provided by brush rotors placed across a race track-shaped basin. Waste enters the ditch at one end, is aerated by the rotors, and circulates.

Activated sludge is the most common end-of-pipe biological treatment employed in the OCPSF industry. According to the Section 308 Questionnaire data base, 143 OCPSF plants reported using activated sludge, 2 plants reported using an oxidation ditch, and 8 plants reported using pure oxygen activated sludge. Performance data for BOD_5 and TSS removal are from the OCPSF Master Analysis File and are presented in Table VII-18. The data show that activated sludge treatment results in a median removal efficiency of 96 percent for BOD_5 and 81 percent for TSS. For those plants meeting the BPT performance edit of 95 percent removal of BOD_5 or having an effluent BOD_5 concentration no greater than 40 mg/l, the BOD_5 median removal efficiency is 98 percent and the TSS median removal efficiency is 82 percent. (A detailed discussion of EPA's BPT data editing criteria is presented later in this section.)

b. Lagoons

A body of wastewater contained in an earthen dike and designed for biological treatment is termed a lagoon or stabilization pond or oxidation pond. While in the lagoon, the 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 be either aerobic or anaerobic, depending on the design of the lagoon. Because of their low construction and operating costs, lagoons offer a financial advantage over other treatment methods and for this reason have become popular where sufficient land area is available at reasonable cost.

Lagoons are used in industrial wastewater treatment for stabilization of suspended, dissolved, and colloidal organics either as a main biological

TABLE VII-18.
ACTIVATED SLUDGE PERFORMANCE DATA FOR BOD_5 AND TSS

Statistics	Effluent Flow (mgd)	Influent BOD_5(mg/l)	Effluent BOD_5(mg/l)	% Removal BOD_5	Influent TSS(mg/l)	Effluent TSS(mg/l)	% Removal TSS
			Type = Activated Sludge Tech Edit = W/O Performance Edit*				
Mean	1.5400	1232	139	93.8	509	84	67.2
Median	0.7155	664	30	96.3	280	52	81.1
Minimum	0.0041	79	3	31.3	24	3	-29.3
Maximum	13.8000	9420	5303	99.8	3664	737	98.7
# OBS/Pairs	66	49	68	49	39	66	39
			Type = Activated Sludge Tech Edit = With Performance Edit*				
Mean	1.6841	970	22	96.5	429	37	72.0
Median	0.7640	510	21	97.5	214	33	82.2
Minimum	0.0099	79	3	84.8	24	9	-28.3
Maximum	13.8000	3176	65	99.8	3664	92	98.7
# OBS/Pairs	40	33	41	33	28	41	28

*Performance edit was either 95% BOD_5 removal or effluent BOD_5 concentration no greater than 40 mg/l and effluent TSS concentration no greater than 100 mg/l.

treatment process or as a polishing treatment process following other biological treatment systems. Aerobic, facultative, and aerated lagoons are generally used for industrial wastewater of low and medium organic strength. High strength wastewaters are often treated by a series of ponds; the first one will be virtually all anaerobic, the next facultative, and the last aerobic.

The performance of lagoons in removing degradable organics depends upon detention time, temperature, and the nature of waste. Aerated lagoons generally provide a high degree of BOD_5 reduction more consistently than the aerobic and facultative lagoons. Typical problems associated with lagoons are excessive algae growth, offensive odors from anaerobic ponds if sulfates are present and the pond is not covered, and seasonal variations of effluent quality.

There are four major classes of lagoons that are based on the nature of biological activity.

Aerobic Lagoons. Aerobic lagoons are shallow ponds that contain dissolved oxygen (DO) throughout their liquid volume at all times. These lagoons may be lined with concrete or an impervious flexible lining, depending on soil conditions and wastewater characteristics. Aerobic bacterial oxidation and algal photosynthesis are the principal biological processes. Aerobic lagoons are best suited to treating soluble organics in wastewater relatively free of suspended solids. Thus, they are often used to provide additional treatment of effluents from anaerobic ponds and other partial treatment processes.

Aerobic lagoons depend on algal photosynthesis, natural reaeration, adequate mixing, good inlet-outlet design, and a minimum annual air temperature above about 5°C (41°F), for a major portion of the required DO. Without any one of these conditions, an aerobic pond may develop anaerobic conditions or be ineffective or both. Because light penetration decreases rapidly with increasing depth, aerobic pond depths are restricted to 0.2 to 0.3 m (0.6 to 1.0 ft) to maintain active algae growth from top to bottom. In order to achieve effective pollutant removals with aerobic lagoons, some means of removing algae (coagulation, filtration, multiple-cell design) is sometimes necessary.

Anaerobic Lagoons. Anaerobic lagoons are relatively deep ponds (up to 6 meters) with steep sidewalls in which anaerobic conditions are maintained by keeping organic loading so high that complete deoxygenation is prevalent. Some oxygenation is possible in a shallow surface zone. If floating materials in the waste form an impervious surface layer, complete anaerobic conditions will develop. Treatment or stabilization results from anaerobic digestion of organic wastes by acid-forming bacteria that break down organics. The resultant acids are then converted to carbon dioxide, methane, and other end products. Anaerobic lagoons are capable of providing treatment of high strength wastewaters and are resistant to shock loads. These lagoons are sometimes used to digest the waste sludge from an activated sludge plant.

In the typical anaerobic lagoon, raw wastewater enters near the bottom of the pond (often at the center) and mixes with the active microbial mass in the sludge blanket, which can be as much as 2 meters (6 feet) deep. The discharge is located near one of the sides of the pond, submerged below the liquid surface. Excess sludge is washed out with the effluent and recirculation of waste sludge is not required.

Anaerobic lagoons are customarily contained within earthen dikes. Depending on soil and wastewater characteristics, lining with various impervious materials, such as rubber, plastic, or clay may be necessary. Pond geometry may vary, but surface area-to-volume ratios are minimized to enhance heat retention.

Facultative Lagoons. Facultative lagoons are intermediate depth ponds of 1 to 2.5 m (3 to 8 feet) in which the wastewater is stratified into three zones. These zones consist of an anaerobic bottom layer, an aerobic surface layer, and an intermediate zone. Stratification is a result of solids settling and temperature-water density variations. Oxygen in the surface stabilization zone is provided by reaeration and photosynthesis. The photosynthetic activity at the lagoon surface produces oxygen diurnally, increasing the DO content during daylight hours, and decreasing it during the night. In general, the aerobic surface layer serves to reduce odors while providing treatment of soluble organic by-products of the anaerobic processes operating at the bottom. Sludge at the bottom of facultative lagoons will undergo anaerobic digestion, producing carbon dioxide and methane.

Facultative lagoons are customarily contained within earthen dikes. Depending on soil and wastewater characteristics, lining the lagoon with various impervious materials, such as rubber, plastic, or clay, may be necessary.

Aerated Lagoons. Aerated lagoons are medium-depth basins of 2.5 to 5 m (8 to 15 ft) in which oxygenation is accomplished by mechanical or diffused aeration units and from induced surface aeration. Surface aerators may be high speed, small diameter or low speed, large diameter impeller devices, either fixed-mounted on piers or float-mounted on pontoons. Diffused aerators may be plastic pipe with regularly spaced holes, static mixers, helical diffusers, or other types. Aerated lagoons can be either aerobic or facultative. Aerobic ponds are designed to maintain complete mixing. Thus, all solids are in suspension and separate sludge settling and disposal facilities are required to separate the solids from the treated wastewater.

According to the Section 308 Questionnaire data base, lagoons are a common secondary treatment technology in the OCPSF industry; 89 plants reported using aerated lagoons, 24 plants reported using aerobic lagoons, and 12 plants reported using anaerobic lagoons. Performance data for BOD_5 and TSS removal from these lagoon systems were obtained from the OCPSF Master Analysis File and are presented in Table VII-19. The data show that lagoon treatment results in a median removal efficiency of 89 percent for BOD_5 and 66 percent for TSS, when all plants using only this secondary treatment process are considered. For those plants meeting the BPT performance edit, the median BOD_5 removal efficiency is 90 percent and the median TSS removal efficiency is 75 percent.

c. Attached Growth Biological Systems

Attached growth biological treatment systems are used to biodegrade the organic components of a wastewater. In these systems, the biomass adheres to

TABLE VII-19.
LAGOON PERFORMANCE DATA FOR BOD_5 AND TSS

Statistics	Effluent Flow (mgd)	Influent BOD_5(mg/l)	Effluent BOD_5(mg/l)	% Removal BOD_5	Influent TSS(mg/l)	Effluent TSS(mg/l)	% Removal TSS
			Type = Lagoons Tech Edit = W/O Performance Edit*				
Mean	1.9970	775	181	73.6	1565	164	16.9
Median	0.4915	447	27	89.2	237	58	66.4
Minimum	0.0058	71	5	-26.3	23	3	-456.1
Maximum	16.0624	2442	2940	99.0	6103	2051	98.2
# OBS/Pairs	30	16	29	16	13	29	13
			Type = Lagoons Tech Edit = With Performance Edit*				
Mean	2.5501	446	21	87.6	1100	38	51.5
Median	0.4915	193	22	89.9	165.	27	74.6
Minimum	0.0058	71	5	73.3	23	3	-30.4
Maximum	16.0624	1947	35	98.8	3549	97	97.9
# OBS/Pairs	18	8	18	8	6	18	6

*Performance edit was either 95% BOD_5 removal or effluent BOD_5 concentration no greater than 40 mg/l and effluent TSS concentration no greater than 100 mg/l.

the surfaces of rigid supporting media. As wastewater contacts the supporting medium, a thin-film biological slime develops and coats the surfaces. As this film (consisting primarily of bacteria, protozoa, and fungi) grows, the slime periodically breaks off the medium and is replaced with new growth. This phenomenon of losing the slime layer is called sloughing and is primarily a function of the organic and hydraulic loadings on the system. The effluent from the system is usually passed to a clarifier to settle and remove the agglomerated solids. Attached growth biological treatment systems are applicable to industrial wastewaters amenable to aerobic biological treatment in conjunction with suitable pre- and post-treatment. The process is effective for the removal of suspended or colloidal materials, but less effective for the removal of soluble organics. The two major types of attached growth biological treatment processes used in the OCPSF industry are trickling filters and rotating biologic contactors. These processes are described below:

Trickling Filters. The physical unit of a trickling filter consists of a suitable structure packed with an inert medium (usually rock, wood, or plastic) on which a biological mass is grown. The wastewater is distributed by either a fixed-spray nozzle system or a rotating distribution system over the upper surface of the medium and as it flows through the medium covered with biological slime, both dissolved and suspended organic matter are removed by adsorption. The adsorbed matter is oxidized by the organisms in the slime during their metabolic processes. Air flows through the filter by convection, thereby providing the oxygen needed to maintain aerobic conditions. Most trickling filters are classified as either low- or high-rate, depending on the organic and hydraulic loading. A low-rate filter generally has a media bed depth of 1.5 to 3 meters (5 to 10 feet) and does not use recirculation. High-rate filter media bed depths can vary from 1 to 9 meters (3 to 30 feet) and require recirculation. The recirculation of effluent in high-rate filters is necessary for effective sloughing control. Otherwise, media clogging and anaerobic conditions could develop as a consequence of the high organic loading rates employed.

Rotating Biological Contactors. The most common types of rotating biological contactors consist of a plastic disk or corrugated plastic medium mounted on horizontal shafts. The medium slowly rotates in wastewater (with 40 to 50% of its surface immersed) as the wastewater flows past. During rotation, the medium picks up a thin layer of wastewater, which flows over its surface absorbing oxygen from the air. A biological mass growing on the medium surface adsorbs and coagulates organic pollutants from the wastewater. The biological mass biodegrades the organic matter. Excess microorganisms and other solids are continuously removed from the film on the disk by shearing forces created by the rotation of the disk in the wastewater. This rotation also mixes the wastewater, keeping sloughed solids in suspension until they are removed by final clarification.

According to the Section 308 Questionnaire data base, 8 plants report using rotating biological contactors and 12 plants report using trickling filters as a secondary treatment technology. Performance data for BOD_5 and TSS removal are from the OCPSF Master Analysis File and are presented in Table VII-20. The data show that attached growth biological treatment results in a median removal efficiency of 92 percent for BOD_5 and 70 percent for TSS, when all plants using only this secondary treatment process are considered. For those plants meeting the BPT performance edits, the median BOD_5 removal efficiency is 92 percent and the median TSS removal efficiency is 70 percent.

d. Secondary Clarification

The function of secondary clarifiers varies with the method of biological treatment utilized. Clarifiers in an activated sludge system serve a dual purpose. In addition to providing a clarified effluent, they must also provide a concentrated source of return sludge for process control. Adequate area and depth must be provided to allow this compaction to occur while avoiding rejection of solids into the tank effluent (7-6). Secondary clarifiers in activated sludge systems are also sensitive to sudden changes in flow rates. Therefore, the use of multispeed pumps for in-plant wastewater lift stations is strongly recommended where adequate flow equalization is not provided (7-7).

Clarifiers in activated sludge systems must be designed not only for hydraulic overflow rates, but also for solids loading rates. This is due

TABLE VII-20.
ATTACHED GROWTH TREATMENT SYSTEMS PERFORMANCE DATA FOR BOD_5 AND TSS

Statistics	Effluent Flow (mgd)	Influent BOD_5(mg/l)	Effluent BOD_5(mg/l)	% Removal BOD_5	Influent TSS(mg/l)	Effluent TSS(mg/l)	% Removal TSS
			Type = Attached Growth Tech Edit = W/O Performance Edit*				
Mean	0.43069	395	254	92.2	767	49	70
Median	0.44250	167	42	92.2	767	33	70
Minimum	0.00365	145	12	91.7	50	15	70
Maximum	1.07300	872	921	92.8	1483	100	70
# OBS/Pairs	5	3	4	2	2	3	1
			Type = Attached Growth Tech Edit = With Performance Edit*				
Mean	0.826	145	16	91.7	50	15	70
Median	0.826	145	16	91.7	50	15	70
Minimum	0.579	145	12	91.7	50	15	70
Maximum	1.073	145	20	91.7	50	15	70
# OBS/Pairs	2	1	2	1	1	1	1

*Performance edit was either 95% BOD_5 removal or effluent BOD_5 concentration no greater than 40 mg/l and effluent TSS concentration no greater than 100 mg/l.

mainly to the need for both clarification and thickening in activated sludge clarifiers to provide both a well clarified effluent and a concentrated return sludge (7-6).

When the MLSS concentration is less than about 3,000 mg/l, the clarifier size will normally be governed by hydraulic overflow rates. At higher MLSS values, the ability of the clarifier to thicken solids becomes the governing factor. Therefore, solids loading rates become more critical in determining tank size. Design size should be computed for both average and peak conditions to ensure satisfactory effluent quality at all times (7-6).

Depth of clarifiers in activated sludge systems is extremely important. The depth must be sufficient to permit the development of a sludge blanket, especially under conditions when the sludge may be bulking. At the same time, the interface of the sludge blanket and the clarified wastewater should be well below the effluent weirs (7-6).

For long rectangular tanks, it is common practice to locate the sludge withdrawal hopper about 1/3 to 1/2 the distance to the end of the tank to reduce the effects of density currents (7-6, 7-7).

Typical design parameters for clarifiers in activated sludge systems treating typical domestic wastewaters are also presented in Table VII-21. The design of these clarifiers should be based upon an evaluation of average and peak overflow rates and solids loadings. That combination of parameters that yields the largest surface area should be used (7-6).

Clarifiers following trickling filters must effectively separate biological solids sloughed from the filter media. The design of clarifiers following trickling filters is based on hydraulic overflow rates similar to the method used for primary clarifiers. Design overflow rates must include recirculated flow where clarified secondary effluent is used for recirculation. Because the influent SS concentrations are low, tank solids loadings need not be considered. Typical design parameters for clarifiers following trickling filters are also presented in Table VII-21 (7-6).

TABLE VII-21.
TYPICAL DESIGN PARAMETERS FOR SECONDARY CLARIFIERS
TREATING DOMESTIC WASTEWATER

Type of Treatment	Overflow Rate (gpd/sq ft) Average	Overflow Rate (gpd/sq ft) Peak	Solids Loading[1] (lb solids/day/sq ft) Average	Solids Loading[1] (lb solids/day/sq ft) Peak	Depth ft
Settling Following Trickling Filtration	400-600	1,000-1,200	-	-	10-12
Settling Following Air-Activated Sludge (Excluding Extended Aeration)	400-800	1,000-1,200	20-30	<50	12-15
Settling Following Extended Aeration	200-400	800	20-30	<50	12-15
Settling Following Oxygen-Activated Sludge with Primary Settling	400-800	1,000-1,200	25-35	<50	12-15

[1]Allowable solids loadings are generally governed by sludge settling characteristics associated with cold weather operations.

Source: Process Design Manual for Upgrading Existing Wastewater Treatment Plants, EPA 625/1-71-004a, October 1974.

e. <u>Operating, Managing, and Upgrading Biological Treatment Systems</u>

This section identifies methods by which biological treatment systems in the OCPSF industry may modify their existing facilities in order to upgrade or improve performance. Most of the upgrades discussed pertain to activated sludge and aerated lagoon systems, since these are the biological treatment systems most commonly used in the OCPSF industry and the systems most amenable to operational and design modifications. Approaches to upgrading biological treatment units include adding unit treatment processes, modifying the design and operational parameters of existing units, acclimating existing bacteria to certain toxicants or using bioaugmentation (the addition of acclimated types of bacteria bred to remain active under a variety of adverse conditions), particle size reduction, nutrient addition, and the addition of powdered activated carbon (PAC) to aeration units.

In some cases, the only means of improving the performance of a biological treatment system is to add additional unit treatment processes. Aeration basins and clarifiers are sometimes added to accommodate higher waste loads or to address inadequacies in the original treatment plant design. The addition of primary unit treatment such as equalization improves system performance by diluting slugs of concentrated wastes, minimizing routine variations in influent wastewater flow and pollutant concentration, and removing suspended particles. Preaeration basins are often added to raise wastewater DO levels and improve the treatability and settling characteristics of the wastes. Postaeration basins are added to systems to raise the DO in treatment plant effluent before it flows into receiving streams. Microscreen and filtration units can be added to improve suspended solids removal prior to effluent discharge. In summary, there are a number of unit processes available that can be added to a facility, provided that land is available, to address specific treatment problems.

Upgrading existing bioreactor facilities can include adding chemical and physical treatments such as the addition of polyelectrolytes to clarifiers to improve solids settling or the installation of a surface skimmer to a pre-treatment unit to accomplish oil and scum removal. Operational changes affecting the quantity and species of microorganisms in a system, however, are often the most significant with regard to improving the removal of pollutants and increasing a treatment system's capacity to handle large raw waste loads. Experience at some facilities indicates that operation of an activated sludge plant to maintain a stable mixed liquor fauna (i.e., maintain a specific distribution of bacterial species), rather than operation based on a constant aeration rate or MLSS concentration, yields more consistent treatment of BOD_5 and priority pollutants (7-8). Thus, operational changes and unit treatment modifications should be planned giving appropriate consideration to this approach. Many of the concepts for improving the performance of biological units discussed below are presented in the context of activated sludge and aerated lagoon systems; however, in many cases they also apply to other types of biological units, such as fixed film reactors.

As previously discussed, flow equalization is important in improving the treatability of a waste stream by minimizing variations in wastewater characteristics, such as temperature, pH, and pollutant concentrations. One facility in the OCPSF industry improved the equalization of its wastewater by removing several feet of sedimentation from a primary clarifier, thus increasing the wastewater detention time. This plant also added heat exchangers upstream of the treatment units to lower the wastewater temperature and provide a more uniform wastewater temperature year round.

Modifications to the operations of activated sludge units include changing influent flow patterns; altering the division, mixing, and aeration characteristics of the tanks; and recycling sludge from the secondary clarifier to one or more locations in the treatment train. Step aeration, introducing primary effluent at several locations in the aeration basin, can be used to upgrade the performance of a plant with high pollutant loadings (7-9). Distribution of the waste equalizes the loading in the aeration basin and enables the microorganisms to function more efficiently.

In situations where a treatment system needs to be modified to handle an increased waste load, a conventional single tank activated sludge process can be converted into a two-stage contact stabilization process. The main advantage of contact stabilization is that it operates with a much shorter hydraulic retention time and hence enables the facility to treat a larger waste load. In other situations where oxygen requirements are not being met and the facility has extra capacity, oxygen supply can be improved by creating a complete mix activated sludge system from a contact stabilization or conventional activated sludge unit. Another approach to improving oxygen supply is to convert a standard air supplied aeration system to a pure oxygen system.

Pure oxygen systems are recommended for situations where wide fluctuations occur in the organic loading to a plant and for strong industrial wastewater. Since they are more efficient than conventional aeration systems, they can be used to increase the treatment capacity of existing plants. A means of further improving a pure oxygen or air supplied aeration system is to use diffusers that produce smaller diameter bubbles (and hence increase the surface area to bubble volume ratio), and to increase the contact time between the bubble and the wastewater.

In some treatment train configurations, it is possible to create a second biological treatment unit by recycling sludge from a secondary clarifier to a preaeration unit. As presented in the discussion of summer/winter issues, this was done by plant #2394 in the OCPSF industry to improve the performance of its treatment plant during cold weather. An additional benefit of recycling sludge in this manner is that there is usually a decrease in the total sludge volume generated. Plant #2394 used 100 percent recycle and hence had no waste sludge during winter months.

Fixed film biological treatment units sometimes have problems associated with waste distribution and waste loading. Low flows in trickling filter plants may result in poor distribution of wastewater over the filter media. Recirculation of part of the treatment plant effluent will increase the flow through the plant and improve the motion of the distribution arm. An approach to increasing the capacity or improving the performance of some trickling filter plants is to replace traditional filter media usually consisting of stones with synthetic media designed to have a much larger surface area.

Efficient operation of a bioreactor is dependent on maintaining viable populations of bacteria. Organic priority pollutant removal is often problematic as the pollutants often inhibit the growth of organisms responsible for their degradation (7-10). To efficiently degrade these organics, the inhibitory levels should be determined and should not be exceeded in plant operations. In addition, bacteria can be acclimated to certain toxicants by subjecting the activated sludge to an acclimation program or by using "pre-acclimated" bacteria, the latter process being called bioaugmentation. Bioaugmentation has also been used to supplement plants in cold weather with specialized bacteria that maintain high levels of biodegradation activity at wastewater temperatures as low as 40°F. In addition, bioaugmentation has been proven to improve oxygen transfer, reduce sludge generation, and improve sludge settling characteristics. Furthermore, bioaugmentation will greatly reduce the time needed for recovery from a shock loading. Preserved bacteria can be added to a biological treatment system as needed to maintain existing populations and to increase biodegradation capabilities in the event of a chemical upset.

The efficiency of a biological system can be improved by reducing the particle size of solids in the influent through pretreatment with coagulation/flocculation, sedimentation, or other processes. Rates of adsorption, diffusion, and biochemical reaction are all enhanced by smaller particle size. Particles smaller than 1×10^{-6} meter in diameter can be biochemically degraded at a much faster rate than larger particles (7-11). This is due to the increase in surface area to mass ratio as particle size decreases. Higher quality secondary effluent from the biological treatment unit will result in subsequent improvements in the performance of downstream units such as filtration and activated carbon units.

Secondary clarification systems can also be modified or operated differently in order to upgrade or improve TSS effluent performance. An Agency study of full-scale municipal treatment systems shows that rectangular clarifier modifications such as reaction baffles and other flow-modifying structures at clarifier inlets resulted in a 13.8 percent reduction in effluent TSS. Also, the additional installation of a stop-gate in a channel upstream of the aeration basins to reduce large flow transients to a rectangular secondary clarifier resulted in 31.5 percent lower effluent TSS levels than the unmodified clarifier without the stop-gate. In another case, this study also shows that slowing the rotational speed of hydraulic sludge removal mechanisms in circular clarifiers to 56 percent of its design speed reduced effluent TSS by 10.5 percent. Also, the additional installation of a cylindrical ring baffle/flocculation chamber in secondary clarifiers resulted in 38.5 percent lower effluent TSS levels than the unmodified secondary clarifier (7-7).

For a biological system to function properly, nutrients such as organic carbon, nitrogen, and phosphorus must be available in adequate amounts. While domestic wastewaters usually have an excess of nutrients, industrial wastewaters are sometimes deficient. If a deficiency is identified, the performance of an industrial wastewater treatment plant can be improved through nutrient addition. According to the Section 308 Questionnaire data base, 114 OCPSF plants utilize nutrient addition prior to biological treatment.

Removal of organics can be enhanced by mixing powdered activated carbon (PAC) in the aeration basin of a biological treatment system (7-12). PAC improves treatment in the activated sludge process because of its adsorptive and physical properties. Lighter weight organics, such as phenols, appear to adsorb reversibly on the carbon. Use of PAC can dampen the shock effects of concentrated slugs of inhibiting organics on the bacteria culture, as the organics will initially adsorb on the carbon. The PAC can be bioregenerated as these lighter weight organic species desorb from the PAC and are degraded. Heavier organics, such as the residual metabolic end products, appear to adsorb irreversibly on the PAC. PAC also helps to remove pollutants by extending the contact time between the pollutant and the biomass. When adsorbed by the carbon, pollutants settle into the sludge and contact time with the biomass is extended from hours to days. The waste sludge that contains powdered carbon is removed from the activated sludge system, dewatered, and either disposed of or regenerated. The regenerated carbon may require an acid wash to remove metals as well as other inorganic materials to improve the adsorption capacity.

e. Summer/Winter

In commenting on the 1983 proposal and subsequent notices, many commenters asserted that EPA incorrectly evaluated the effect of temperature on biological treatment systems and incorrectly concluded that temperature is not important in the context of effluent limitations guidelines. They claimed that one element of this incorrect analysis was EPA's deletion of nine plants from the data base simply because they had been issued "Best Professional Judgement" NPDES permits with separate compliance standards for summer and winter months. They claim that this is an arbitrary decision that virtually ensures that the effect of temperature will not be considered in estimating effluent variability.

EPA has studied the effects of temperature variations on biological treatment system performance in the OCPSF industry and disagrees with these comments. With regard to operations in warm climates, the Agency believes that warmer than average temperatures do not have any significant effect on biological treatment efficiency or variability. However, algae blooms in ponds can be a wastewater treatment problem in ponds located in warm climates. Nonetheless, polishing ponds are not part of the technology basis for BPT limitations. Also, EPA was not able to associate algae bloom problems with any elements of biological treatment (aerated lagoons, clarification, equalization basins, etc.). Consequently, EPA believes that algae growth problems in warm climates are not relevant to the promulgated BPT regulations.

In order to evaluate winter performance of biological treatment systems, EPA has analyzed BOD_5 removal efficiency, BOD_5 effluent concentration, and operational changes for 21 plants reporting daily data and other plants located in various parts of the country. These analyses indicated that there is a slight reduction in average BOD_5 removal efficiency and a small increase in average effluent BOD_5 concentrations during winter months for some plants. However, other plants were able to maintain a BOD_5 removal efficiency of 95 percent or greater and effluent BOD_5 concentrations characteristic of good operation during the entire year. The analysis also suggests that the plants with lower efficiencies are affected as much by inefficient operation practices as by winter temperature considerations. A discussion of inefficient operating practices used by some plants as well as practices employed by plants achieving superior all year performance is presented below. The adoption of practices used by plants with higher winter efficiencies should result in improved winter effluent quality.

EPA has determined that temperature effects can be mitigated by operational and technological changes so that compliance with BPT limitations using biological treatment is possible for all OCPSF plants with well-designed and well-operated biological systems. As also discussed below, the potential effects of winter operations are included in the plant-specific factors that affect derivation of the variability factors used to establish effluent limitations guidelines. In addition, EPA has developed costs for plants that need to upgrade their winter-time biological treatment operation to comply with the promulgated BPT limitations.

Regarding the deletion of nine summer/winter plants' data from the data base, the Agency notes that because these plants were subject to meeting two different sets of permit limits, they had no incentive to attempt to achieve uniform limitations throughout the year. Not suprisingly then, the daily data from these plants exhibit a two-tier pattern. These data can be characterized by two means, and the variability of these data over a 12-month period is fundamentally different from the data from plants required to meet only one set of permit limits. Consequently, the data generated during these periods are not representative of well-operated biological treatment, which as noted above, is capable of uniform treatment throughout the year as demonstrated by a number of plants. Another problem with daily data from these plants is that during certain periods of the spring and fall, these plants may be able to operate their treatment plants at less than full efficiency because they are required to meet the less stringent set of permit limits.

In summary, the Agency believes that it has accounted adequately for the effect of temperature changes on biological treatment performance in its variability analysis by including in the variability data base a number of well-designed and well-operated plants from climates with significant temperature variation. The inclusion of data from plants with summer/winter permits would result in an overestimate of the variability of biological treatment operations in the OCPSF categories.

The detailed analyses described below are based on two sets of data that were analyzed in order to determine the effect of temperature on the treatment of BOD_5 and TSS. The first set included the OCPSF daily data base, which contained daily data from 69 plants. Of these, 48 were excluded from the final BPT daily data base analysis for a variety of reasons, including greater than 25 percent non-process wastewater dilution, summer/winter NPDES permit limits, changes in treatment system during sampling, non-representative treatment, and effluent data after post-biological tertiary treatment. As a result, daily data from 21 plants formed the basis of the variability component of the BPT limits and were included in the summer/winter analysis. These 21 plants are #s 387, 444, 525, 682, 741, 908, 970, 1012, 1062, 1149, 1267, 1407, 1647, 1973, 1977, 2181, 2430, 2445, 2592, 2626, and 2695. The second data set includes 131 plant responses to a Section 308 Survey question regarding average winter and average summer performance and operating parameters that were gathered to highlight practices used to accommodate cold weather conditions.

The principal parameters evaluated for correlation with temperature were average effluent BOD_5 and TSS concentration, and BOD_5 removal efficiency. In addition, two plants that had made operational changes to increase winter efficiency were also evaluated.

$\underline{BOD_5}$ Removal Efficiency. Of the 21 plants with long-term daily data, 14 had sufficient BOD_5 influent and effluent data (total BOD_5 values were used) to enable the calculation of BOD_5 monthly removal efficiencies. Six plants (#s 387, 444, 1149, 1267, 2626, and 2695) were not used because they had no BOD_5 influent values, and plant #908 was eliminated because its geographic location in Puerto Rico made any seasonal distinctions meaningless.

The plants that were used had a minimum of three influent and effluent values each month; if there were time periods where fewer values were available, these specific time periods were excluded from the analysis (Plant 1062 had only one influent measurement between 1-1-79 and 7-31-79 and plant 2592 had no influent sampling between 12-1-79 and 7-9-80). For each plant where sampling occurred over a period exceeding 1 year, values for the same month but different years were averaged together.

The monthly efficiencies were derived by use of the formula

$$\text{Fraction removed} = 1 - \left[\frac{\text{average BOD effluent for the month}}{\text{average BOD influent for the month}}\right]^{1}.$$

The result of the efficiency analysis is presented in Table VII-22.

As can be seen, the annual average BOD_5 removal efficiency is 95 percent. Seven of the fourteen plants (#s 682, 970, 1062, 1647, 1977, 2181, and 2430) had greater than 95 percent removal of BOD_5 throughout the year. If the winter months are defined to be January-February-March and the summer months are defined to be June-July-August, two plants had removal efficiencies in the winter months that were greater than or equal to those in the summer months. Plant 1062 had 97 percent removal efficiency in both the winter and summer months, and Plant 2430 had 99 percent removal efficiency in the winter months and 98 percent removal efficiency in the summer. In addition, five plants (#s 682, 970, 1647, 1977 and 2181) had average winter removal efficiencies within 1 percent of their average summer removal efficiencies.

The 14 plants are located in three different geographical regions. Plant data were analyzed by region, with subset I including data from the five plants located in the north (WV, IL, RI, IA, IN), subset II including data from the six plants located in the south (TX, GA, LA, SC), and subset III including data from the three plants located in the middle-latitudes (VA, NC). These results are presented in Tables VII-23, VII-24, and VII-25. Monthly average removal efficiencies for each plant were obtained, and these were combined into an overall monthly average for each subset. Plants located in the northern region had the highest average removal efficiency (northern plants - 98 percent; southern plants - 95 percent; middle latitude - 89 percent). In the northern region, four of the five plants (682, 1062, 1647, and 2181) had removal efficiencies greater than 95 percent throughout the

[1] Although it was also possible to obtain monthly efficiencies by calculating daily efficiencies and averaging them for each month, such a method would have resulted in elimination of many data points when only influent or effluent values, not both, were available for a specific day. Also, because retention times are generally greater than 1 day, and because wastewaters are mixed during treatment, an effluent value cannot necessarily be correlated with an influent value for that same day or for any other particular time.

TABLE VII-22 : MONTHLY BOD5 REMOVAL EFFICIENCY

Month	Plant 525	682	741	970	1012	1062	1407	1647	1973	1977	2181	2430	2445	2592	Monthly Average
January	0.87	0.98	0.93	0.96	0.54	0.99	0.92	0.98	0.88	0.97	0.98	0.99	0.88	0.93	0.91
February	0.87	0.99	0.95	0.96	0.55	0.99	0.95	0.97	0.90	0.97	0.99	0.99	0.96	0.94	0.93
March	0.99	0.99	0.97	0.97	0.74	0.99	0.94	0.96	0.88	0.96	0.99	0.99	0.98	0.98	0.95
April	0.89	0.99	0.96	0.97	0.80	0.98	0.95	0.98	0.89	0.98	0.98	0.98	0.98	0.98	0.95
May	0.93	0.99	0.98	0.97	0.70	0.99	0.96	0.99	0.89	0.98	0.99	0.99	0.96	0.98	0.95
June	0.95	0.99	0.97	0.97	0.70		0.97	0.97	0.84	0.97	0.98	0.98	0.97	0.98	0.94
July	0.95	0.99	0.97	0.97	0.88	0.99	0.96	0.98	0.96	0.97	1.00	0.99	0.97	0.98	0.97
August	0.91	0.99	0.98	0.98	0.69	0.99	0.93	0.98	0.95	0.98	1.00	0.97	0.98	0.98	0.95
September	0.89	0.99	0.97	0.97	0.91	0.98	0.97	0.99	0.96	0.97	0.98	0.97	0.98	0.98	0.97
October	0.95	0.99	0.93	0.98	0.90	0.99	0.97	0.99	0.97	0.96	0.98	0.99	0.99	0.99	0.97
November	0.89	0.99	0.95	0.97	0.87	0.99	0.97	0.99	0.98	0.96	0.97	0.98	0.98	0.99	0.96
December	0.90	0.99	0.98	0.97	0.75	0.99	0.95	0.99	0.97	0.97	1.00	0.99	0.96		0.95
Plant Average	0.92	0.99	0.96	0.97	0.75	0.99	0.95	0.98	0.92	0.97	0.99	0.98	0.97	0.97	0.95

TABLE VII-23 : MONTHLY BOD5 EFFICIENCY BY REGION

Subset I (Northern--WV, IA, IL, IN, RI)

Month	plant 682	plant 1062	plant 1647	plant 2181	plant 2445	Monthly Average
January	0.98	0.99	0.98	0.98	0.88	0.96
February	0.99	0.99	0.97	0.99	0.96	0.98
March	0.99	0.99	0.96	0.99	0.98	0.98
April	0.99	0.98	0.98	0.98	0.98	0.98
May	0.99	0.99	0.99	0.99	0.96	0.98
June	0.99		0.97	0.98	0.97	0.98
July	0.99	0.99	0.98	1.00	0.97	0.99
August	0.99	0.99	0.98	1.00	0.98	0.99
September	0.99	0.98	0.99	0.98	0.98	0.98
October	0.99	0.99	0.99	0.98	0.99	0.99
November	0.99	0.99	0.99	0.97	0.98	0.98
December	0.99	0.99	0.99	1.00	0.96	0.99
Plant Average	0.99	0.99	0.98	0.99	0.97	0.98

TABLE VII-24 : MONTHLY BOD5 EFFICIENCY BY REGION
Subset II (Southern--GA, LA, SC, TX)

Month	plant						Monthly
	525	741	1973	1977	2430	2592	Average
January	0.87	0.93	0.88	0.97	0.99	0.93	0.93
February	0.87	0.95	0.90	0.97	0.99	0.94	0.94
March	0.99	0.97	0.88	0.96	0.99	0.98	0.96
April	0.89	0.96	0.89	0.98	0.98	0.98	0.95
May	0.93	0.98	0.89	0.98	0.99	0.98	0.96
June	0.95	0.97	0.84	0.97	0.98	0.98	0.95
July	0.95	0.97	0.96	0.97	0.99	0.98	0.97
August	0.91	0.98	0.95	0.98	0.97	0.98	0.96
September	0.89	0.97	0.96	0.97	0.97	0.98	0.96
October	0.95	0.93	0.97	0.96	0.99	0.99	0.96
November	0.89	0.95	0.98	0.96	0.98	0.99	0.96
December	0.90	0.98	0.97	0.97	0.99		0.96
Plant Average	0.92	0.96	0.92	0.97	0.98	0.97	0.95

TABLE VII-25 : MONTHLY BOD5 EFFICIENCY BY REGION
Subset III (Middle-latitude--VA, NC)

Month	plant 970	1012	1407	Monthly Average
January	0.96	0.54	0.92	0.81
February	0.96	0.55	0.95	0.82
March	0.97	0.74	0.94	0.88
April	0.97	0.80	0.95	0.91
May	0.97	0.70	0.96	0.88
June	0.97	0.70	0.97	0.88
July	0.97	0.88	0.96	0.94
August	0.98	0.69	0.93	0.86
September	0.97	0.91	0.97	0.95
October	0.98	0.90	0.97	0.95
November	0.97	0.87	0.97	0.93
December	0.97	0.75	0.95	0.89
Plant Average	0.97	0.75	0.95	0.89

year. In the southern region, only two of the six plants (1977 and 2430) had greater than 95 percent removal efficiencies throughout the year; in the middle latitudes, one out of the three plants (970) had greater than 95 percent removal efficiency. This analysis shows that removal efficiency was affected primarily by nonclimate-related factors.

A similar analysis was performed using the data base derived from plants that responded to the OCPSF 308 Questionnaire on summer/winter operations. Question C-12 of the questionnaire asked each respondent to select a 3-month period in the summer and a 3-month period in the winter of the same year. The summer period was generally selected as June-July-August or July-August-September, although a few respondents selected May-June-July. The winter period was generally selected as January-February-March, although some respondents selected various other 3-month periods from October through February. For these two periods, the respondent was to provide summary data for a variety of parameters, including average daily total BOD_5 influent and effluent concentrations, TSS influent and effluent concentrations, MLSS concentration, mixed liquor volatile suspended solids (MLVSS) concentration, and food to microorganism ratio (F/M). Plants were included in the analysis if there were both influent and effluent total BOD_5 values so that a BOD_5 removal efficiency could be calculated. Of all plants for which information was available from Question C-12, 131 had sufficient information to enable the calculation of BOD_5 removal efficiency. When estimated values were given, they were used. For the four plants using recycled waste streams (296, 2551, 1617, 2430), only the initial influent and final effluent values were used; although this might result in artificially high efficiencies, it represented the only logical approach. Two plants (1038 and 1389) had two different sets of values, so each set was used. Two plants (227 and 909) had influent data from one biological treatment system and effluent data from another, and were not used in the analysis.

The results of the analysis are as follows:

Plant Category	N	Summer Avg Efficiency	Summer Std Dev	Winter Avg Efficiency	Winter Std Dev
All Plants	131	0.89	0.31	0.86	0.25
Southern Plants	52	0.91	0.14	0.86	0.21
Northern Plants	46	0.86	0.48	0.85	0.32
Middle Latitude Plants	33	0.89	0.18	0.87	0.19

Southern plants were located in Alabama, Florida, Georgia, Louisiana, Mississippi, South Carolina, and Texas. Northern plants were located in Connecticut, Iowa, Illinois, Indiana, Michigan, New Jersey, New York, Ohio, Pennsylvania, Rhode Island, and West Virginia. Middle latitude plants were located in Arkansas, Delaware, Kentucky, Maryland, North Carolina, Oregon, Tennessee, Virginia, and Washington.

These results are consistent with the results of the 14-plant daily data analysis discussed previously. The BOD_5 removal efficiencies for all plants are 3 percent less during the winter period than the summer period (86% vs. 89%). The regional removal efficiencies are 1 to 5 percent less in the winter period than in the summer period. The greatest regional variation in efficiency occurs in the south. The standard deviation of the efficiency is large relative to the efficiency difference within each category, reflecting the large variations among plants within the same category. These results tend to indicate that while northern and middle latitude plants would have larger swings in temperature going from season to season, these swings have been compensated for through operation and process modifications as indicated by the similar summer and winter removal efficiencies (86% vs. 85%). The larger difference between summer and winter removal efficiencies for southern plants (91% vs. 86%) indicate that these facilities have not adequately addressed the smaller temperature swings by operational and process modifications.

These findings support several conclusions. There may be differences between efficiencies attainable in summer and in winter, but these differences are nonetheless small. The large standard deviations obtained reflect differences in operating practices among plants. Plants that operate efficiently do so year-round, and have been able to minimize or at least partially compensate for temperature effects through equipment and operational treatment system adjustments. In addition, plants located in the colder northern climate show minimal efficiency differences between winter and summer months, which provides further evidence that temperature effects are minimal. The daily data assessment also indicates minimal efficiency variations during the spring and autumn months, when temperature fluctuations would tend to be greatest; this result casts doubt on the theory that fluctuations, rather than continued cold, would reduce BOD_5 removal efficiency by preventing the formation of a stable microbial population.

Average Effluent BOD_5 and TSS

The effect of temperature on effluent BOD_5 and TSS levels was evaluated previously in the July 1985 document entitled "Selected Summary of Information in Support of the OCPSF Point Source Category Notice of Availability of New Information." EPA calculated rank correlation by subcategory for BOD_5 effluent and TSS effluent versus heating degree days, a measure typically used by power companies to estimate heating bills. The results of the analysis were consistent with the assumption that temperature is not a factor. With the exception of effluent TSS for specialty chemicals, all calculated rank correlations were not significant. In the case of specialty chemicals, the correlation was positive and significant. However, the positive correlation implies that TSS increases as temperature decreases. Since engineering considerations dictate that TSS should not decrease as temperature increases, this result is considered spurious.

A new analysis was conducted, employing data from 20 of the 21 plants in the data base used for the calculation of BPT variability factors. The only plant not used was #908, because of its location in Puerto Rico. BOD_5 and TSS effluent averages were compared to months rather than heating degree days (see Tables VII-26 and VII-27). The annual average BOD_5 and TSS effluent concentrations are 22 mg/l and 31 mg/l, respectively. Seven of the 20 plants (525,

TABLE VII-26 : AVERAGE EFFLUENT BOD BY MONTH

Month	387	444	525	682	741	970	1012	1062	1149	plant 1267	1407	1647	1973	1977	2181	2430	2445	2592	2626	2695	Monthly Average
January	22.77	23.73	9.58	16.80	206.43	17.04	35.02	9.61	29.14	37.69	30.85	15.05	10.00	61.498	8.909	4.229	93.176	78.275	13.632	24.907	37.42
February	13.83	38.50	7.39	13.88	105.83	17.19	31.83	7.81	36.25		18.27	28.65	8.25	75.154	5.071	4.800	28.718	58.583	8.997	23.610	28.03
March	13.42	11.25	10.67	12.37	80.08	13.35	19.94	8.56	38.96	25.31	24.93	43.57	8.93	75.913	4.000	5.826	16.661	19.147	9.861	25.755	23.42
April	6.93	9.07	10.62	11.62	83.85	11.21	12.40	9.58	22.22	22.40	17.92	14.33	7.92	37.503	8.667	9.870	12.477	23.027	8.653	22.456	18.14
May	28.31	20.90	5.51	7.56	49.00	13.96	19.20	9.51	35.47	20.39	13.92	8.42	6.92	48.430	4.111	5.464	22.138	20.619	11.517	15.838	18.36
June	15.00	10.42	6.51	5.47	67.92	13.24	26.47	11.95	41.86	15.33	13.39	28.64	7.43	47.453	4.538	6.483	17.510	15.714	8.566	8.713	18.63
July	11.13	12.13	5.03	7.33	90.57	10.44	12.90	11.77	52.70	17.14	15.15	11.55	4.58	50.094	1.000	4.481	15.777	19.200	8.474	6.676	18.41
August	18.67	8.00	5.47	9.79	63.92	11.62	24.74	12.87	30.19	27.81	28.50	13.58	5.86	42.551	1.000	6.390	16.687	16.103	8.700	38.219	19.53
September	12.09	14.00	3.41	7.62	57.14	12.42	7.00	8.00	49.77	21.13	14.23	10.90	4.00	52.213	1.250	12.193	20.913	16.333	10.583	12.308	17.38
October	6.27	14.77	5.73	6.76	212.23	12.44	10.94	7.74	20.25	24.41	13.00	14.45	3.00	78.644	4.200	5.645	7.810	16.107	12.248	18.324	24.75
November	8.33	11.17	16.13	8.18	115.46	13.44	12.13	9.36	28.82	26.26	16.00	11.76	3.87	85.987	4.625	6.290	10.300	15.857	22.490	18.495	22.25
December	9.50	13.50	13.81	8.08	30.69	13.00	26.61	6.29	30.45		20.08	10.94	3.62	56.445	2.000	4.252	19.474	39.143	14.410	11.113	17.55
Plant Average	13.85	15.62	8.32	9.62	96.93	13.28	19.93	9.42	34.67	23.79	18.85	17.65	6.20	59.32	4.11	6.33	23.47	28.18	11.51	18.87	21.99

TABLE VII-27 : AVERAGE EFFLUENT TSS BY MONTH

Month	plant 387	444	525	682	970	1012	1062	1149	1267	1407	1647	1973	1977	2181	2430	2445	2592	2626	2695	Monthly Average
January	22.31	55.07	19.77	58.81	41.08	8.19	57.91	61.75	34.43	15.31	36.89	11.50	49.18	33.74	4.19	91.58	67.87	18.32	13.92	36.94
February	23.75	16.47	22.92	53.74	43.41	6.86	26.38	61.30		9.82	171.44	13.37	70.89	12.07	3.79	71.86	68.88	14.00	16.30	39.29
March	29.50	11.08	39.62	45.77	55.23	5.81	17.77	47.82	24.39	21.21	228.16	10.78	49.90	14.42	4.39	48.74	34.91	14.45	11.38	37.65
April	2.46	21.92	56.69	37.34	53.40	6.60	14.14	38.24	24.08	21.25	30.43	9.48	40.86	10.20	8.50	35.27	56.94	14.60	10.49	26.99
May	34.08	22.36	18.69	28.29	51.37	9.55	26.11	52.30	16.39	7.25	37.45	7.37	45.24	12.55	9.97	42.71	72.60	20.94	6.38	27.45
June	21.33	20.08	24.39	22.45	35.90	11.90	18.67	72.27	27.23	10.69	91.77	9.90	15.58	23.80	7.00	51.67	67.32	14.93	12.63	29.45
July	12.67	30.43	16.31	25.43	24.87	6.71	10.18	69.59	22.23	12.31	23.52	9.81	20.93	15.42	4.52	44.81	58.36	12.00	6.90	22.47
August	9.92	24.77	20.21	38.57	17.72	12.81	10.87	87.71	22.92	14.10	23.55	8.00	13.67	22.61	9.87	66.77	32.61	16.13	15.58	24.65
September	25.77	34.23	25.15	26.56	16.57	6.63	16.50	80.72	25.92	10.39	25.03	6.60	32.21	49.70	9.23	119.30	24.00	18.47	35.76	30.99
October	14.69	33.69	22.39	25.71	18.31	5.45	20.74	57.23	23.77	13.58	36.07	10.30	126.38	33.81	6.42	41.10	49.23	22.39	26.26	30.92
November	8.69	22.31	34.25	27.25	40.27	5.70	10.36	57.80	18.33	13.67	20.37	11.67	79.73	32.97	13.63	77.27	27.29	34.67	6.00	28.54
December	21.00	18.69	64.77	29.92	28.18	6.65	3.86	57.72		19.54	30.00	12.43	22.61	27.97	6.90	100.74	110.15	20.84	5.90	32.66
Plant Average	20.51	25.93	30.43	34.99	35.53	7.74	19.46	62.04	23.97	14.09	62.89	10.10	47.26	24.10	7.37	65.98	55.85	18.48	13.96	30.67

682, 970, 1062, 1973, 2181, and 2430) have monthly average BOD_5 effluent concentrations less than 22 mg/l throughout the year, while four of the 20 plants (387, 1012, 1407, and 2626) have monthly average BOD_5 effluent concentrations less than 37 mg/l throughout the year. Also, if winter months are defined as January-February-March and summer months are defined as June-July-August, three plants (1062, 1149, and 2430) have lower average BOD_5 effluent concentrations for the winter months than for the summer months. In addition, two plants (387 and 2626) have average BOD_5 effluent concentrations for the winter within 3 mg/l of the summer average BOD_5 effluent concentrations, while four plants (444, 1973, 2626, and 2695) have average TSS effluent concentrations for the winter months within 3 mg/l of the summer average TSS effluent concentrations.

Another analysis was performed comparing each plant's average BOD_5 and TSS effluent concentrations in the winter and summer months to its annual average BOD_5 and TSS effluent targets that provide the basis for BPT effluent limitations. These annual compliance targets are presented in Appendix VII-A of this document. Eight of the 20 plants (525, 682, 1062, 1407, 1647, 1973, 2181, and 2430) had both winter and summer average BOD_5 effluent concentrations below their annual average BOD_5 effluent compliance targets, while eight plants (387, 444, 525, 1012, 1407, 1973, 2181, and 2626) had both summer and winter average TSS effluent concentrations below their annual average TSS effluent compliance targets.

The plants were then divided into geographical regions and the same analyses performed. Subset I consisted of six northern plants from West Virginia, Illinois, Rhode Island, Iowa, and Indiana; subset II consisted of 10 southern plants from Texas, Georgia, Louisiana, and South Carolina; and subset III consisted of four middle latitude plants from Virginia and North Carolina (see Tables VII-28, VII-29, VII-30, VII-31, VII-32, and VII-33). The annual average BOD_5 effluent concentrations were 13 mg/l, 30 mg/l, and 16 mg/l for the northern, southern, and middle latitude plants, respectively; annual average TSS effluent concentrations were 38 mg/l, 31 mg/l, and 19 mg/l for the northern, southern, and middle latitude plants, respectively. Approximately 66 percent, 70 percent, and 50 percent of the plants in the northern, southern, and middle latitude regions, respectively, have annual average BOD_5

TABLE VII-28 : MONTHLY EFFLUENT BOD5 BY REGION
Subset I (Northern--WV, IL, RI, IA, IN)

Month	Plant 682	1062	1647	2181	2445	2626	Monthly Average
January	16.80	9.61	15.05	8.91	93.18	13.63	26.20
February	13.88	7.81	28.65	5.07	28.72	9.00	15.52
March	12.37	8.56	43.57	4.00	16.66	9.86	15.84
April	11.62	9.58	14.33	8.67	12.48	8.65	10.89
May	7.56	9.51	8.42	4.11	22.14	11.52	10.54
June	5.47	11.95	28.64	4.54	17.51	8.57	12.78
July	7.33	11.77	11.55	1.00	15.78	8.47	9.32
August	9.79	12.87	13.58	1.00	16.69	8.70	10.44
September	7.62	8.00	10.90	1.25	20.91	10.58	9.88
October	6.76	7.74	14.45	4.20	7.81	12.25	8.87
November	8.18	9.36	11.76	4.63	10.30	22.49	11.12
December	8.08	6.29	10.94	2.00	19.47	14.41	10.20
Plant Average	9.62	9.42	17.65	4.11	23.47	11.51	12.63

TABLE VII-29 : MONTHLY EFFLUENT BOD5 BY REGION
Subset II (Southern--TX, GA, LA, SC)

Month	Plant 444	525	741	1149	1267	1973	1977	2430	2592	2695	Monthly Average
January	23.73	9.58	206.43	29.14	37.69	10.00	61.50	4.23	78.28	24.91	48.55
February	38.50	7.39	105.83	36.25		8.25	75.15	4.80	58.58	23.61	39.82
March	11.25	10.67	80.08	38.96	25.31	8.93	75.91	5.83	19.15	25.76	30.18
April	9.07	10.62	83.85	22.22	22.40	7.92	37.50	9.87	23.03	22.46	24.89
May	20.90	5.51	49.00	35.47	20.39	6.92	48.43	5.46	20.62	15.84	22.85
June	10.42	6.51	67.92	41.86	15.33	7.43	47.45	6.48	15.71	8.71	22.78
July	12.13	5.03	90.57	52.70	17.14	4.58	50.09	4.48	19.20	6.68	26.26
August	8.00	5.47	63.92	30.19	27.81	5.86	42.55	6.39	16.10	38.22	24.45
September	14.00	3.41	57.14	49.77	21.13	4.00	52.21	12.19	16.33	12.31	24.25
October	14.77	5.73	212.23	20.25	24.41	3.00	78.64	5.65	16.11	18.32	39.91
November	11.17	16.13	115.46	28.82	26.26	3.87	85.99	6.29	15.86	18.50	32.83
December	13.50	13.81	30.69	30.45		3.62	56.45	4.25	39.14	11.11	22.56
Plant Average	15.62	8.32	96.93	34.67	23.79	6.20	59.32	6.33	28.18	18.87	29.95

TABLE VII-30 : MONTHLY EFFLUENT BOD5 BY REGION

Subset III (Middle_latitude--VA, NC)

Month	Plant 387	970	1012	1407	Monthly Average
January	22.77	17.04	35.02	30.85	26.42
February	13.83	17.19	31.83	18.27	20.28
March	13.42	13.35	19.94	24.93	17.91
April	6.93	11.21	12.40	17.92	12.11
May	28.31	13.96	19.20	13.92	18.85
June	15.00	13.24	26.47	13.39	17.02
July	11.13	10.44	12.90	15.15	12.41
August	18.67	11.62	24.74	28.50	20.88
September	12.09	12.42	7.00	14.23	11.43
October	6.27	12.44	10.94	13.00	10.66
November	8.33	13.44	12.13	16.00	12.48
December	9.50	13.00	26.61	20.08	17.30
Plant Average	13.85	13.28	19.93	18.85	16.48

TABLE VII-31 : MONTHLY EFFLUENT TSS BY REGION
Subset I (Northern--WV, IL, RI, IA, IN)

Month	Plant 682	1062	1647	2181	2445	2626	Monthly Average
January	58.81	57.91	36.89	33.74	91.58	18.32	49.54
February	53.74	26.38	171.44	12.07	71.86	14.00	58.25
March	45.77	17.77	228.16	14.42	48.74	14.45	61.55
April	37.34	14.14	30.43	10.20	35.27	14.60	23.66
May	28.29	26.11	37.45	12.55	42.71	20.94	28.01
June	22.45	18.67	91.77	23.80	51.67	14.93	37.21
July	25.43	10.18	23.52	15.42	44.81	12.00	21.89
August	38.57	10.87	23.55	22.61	66.77	16.13	29.75
September	26.56	16.50	25.03	49.70	119.30	18.47	42.59
October	25.71	20.74	36.07	33.81	41.10	22.39	29.97
November	27.25	10.36	20.37	32.97	77.27	34.67	33.81
December	29.92	3.86	30.00	27.97	100.74	20.84	35.55
Plant Average	34.99	19.46	62.89	24.10	65.98	18.48	37.65

TABLE VII-32 : MONTHLY EFFLUENT TSS BY REGION
Subset II (Southern--TX, GA, LA, SC)

Month	plant 444	525	1149	1267	1973	1977	2430	2592	2695	Monthly Average
January	55.07	19.77	61.75	34.43	11.50	49.18	4.19	67.87	13.92	35.30
February	16.47	22.92	61.30		13.37	70.89	3.79	68.88	16.30	34.24
March	11.08	39.62	47.82	24.39	10.78	49.90	4.39	34.91	11.38	26.03
April	21.92	56.69	38.24	24.08	9.48	40.86	8.50	56.94	10.49	29.69
May	22.36	18.69	52.30	16.39	7.37	45.24	9.97	72.60	6.38	27.92
June	20.08	24.39	72.27	27.23	9.90	15.58	7.00	67.32	12.63	28.49
July	30.43	16.31	69.59	22.23	9.81	20.93	4.52	58.36	6.90	26.56
August	24.77	20.21	87.71	22.92	8.00	13.67	9.87	32.61	15.58	26.15
September	34.23	25.15	80.72	25.92	6.60	32.21	9.23	24.00	35.76	30.43
October	33.69	22.39	57.23	23.77	10.30	126.38	6.42	49.23	26.26	39.52
November	22.31	34.25	57.80	18.33	11.67	79.73	13.63	27.29	6.00	30.11
December	18.69	64.77	57.72		12.43	22.61	6.90	110.15	5.90	37.40
Plant Average	25.93	30.43	62.04	23.97	10.10	47.26	7.37	55.85	13.96	30.99

TABLE VII-33 : MONTHLY EFFLUENT TSS BY REGION
Subset III (Middle_latitude--VA, NC)

Month	Plant 387	970	1012	1407	Monthly Average
January	22.31	41.08	8.19	15.31	21.72
February	23.75	43.41	6.86	9.82	20.96
March	29.50	55.23	5.81	21.21	27.94
April	22.46	53.40	6.60	21.25	25.93
May	34.08	51.37	9.55	7.25	25.56
June	21.33	35.90	11.90	10.69	19.96
July	12.67	24.87	6.71	12.31	14.14
August	9.92	17.72	12.81	14.10	13.64
September	25.77	16.57	6.63	10.39	14.84
October	14.69	18.31	5.45	13.58	13.01
November	8.69	40.27	5.70	13.67	17.08
December	21.00	28.18	6.65	19.54	18.84
Plant Average	20.51	35.53	7.74	14.09	19.47

concentrations less than the regional annual average BOD_5 effluent concentration; approximately 66 percent, 66 percent, and 50 percent of the plants in the northern, southern, and middle latitude regions, respectively, have annual average TSS effluent concentrations below the regional annual average TSS effluent concentrations.

Additional Parameters

Evaluating other parameters using the 21-plant daily data base was not possible since BOD_5, TSS, and flow were the only parameters monitored. The Question C-12 data base provides average summer and winter values for MLSS, MLVSS, and F/M. For all plants used in the previous C-12 data analysis for BOD_5 efficiency and for which values for MLSS, MLVSS, or F/M were available for both summer and winter periods, average values for MLSS, MLVSS, and F/M were determined.

Several editing rules were used. If estimates were given, they were used. For Plant #1340, two different biological treatment processes had the same BOD_5 values, but had two different sets of MLSS, MLVSS, and F/M values. Both sets were used. For Plant #296, which recycled waste streams, the MLSS, MLVSS, and F/M values for each recycled stream were used. For Plants #1389 and #1038, where two sets of BOD_5 values were used, two sets of MLSS, MLVSS, and F/M values were also used.

Based on these rules, average MLSS, MLVSS, and F/M values are as follows:

MLSS (mg/l)		MLVSS (mg/l)		F/M	
Summer	Winter	Summer	Winter	Summer	Winter
4634	4950	3003	3444	1.024	0.863

An attempt was made to correlate the summer and winter values for MLSS, MLVSS, and F/M to the summer and winter values for BOD_5 removal efficiency. This exercise yielded no conclusive results; the analysis found some plants with poor winter performance to have higher MLSS concentrations and lower F/M ratios (which should help to compensate for lower temperatures), while other poor winter performers had the opposite trend in operating conditions. There also appeared to be no correlation between plant location (northern or southern) and seasonal operating parameters. This exercise also found plants in northern climates achieving high year-round performance with very little variation in seasonal MLSS, MLVSS, and F/M values. Therefore, it seems that good plant performance is a function of a combination of factors (including system design, operating parameters, and operating procedures) whose separate contributions cannot be readily determined based on the level of information gathered in this segment of the Section 308 Questionnaire.

Operational Changes

Two plants (948 and 2394) were identified as having made operational or process changes in an effort to improve efficiency and provide at least partial compensation for temperature.

Plant #948, which has a warm process effluent, has instituted several operational changes in winter months to improve the performance of its biological treatment system. First, it turns off some of its cooling towers to compensate for greater heat loss during winter months. The facility also decreases the number of aerators by 5 percent since there is significant heat loss during the aeration process. The MLSS level and sludge age are increased by decreasing the sludge wastage rate. These measures increase the sludge's capacity to oxidize and metabolically assimilate organic material. A disadvantage of the increased sludge age is that sludge settling characteristics are adversely affected. The plant largely compensates for this by increasing the polyelectrolyte dosage to the influent to the clarifier in the winter.

A second facility, Plant #2394, has also instituted process modifications to improve the performance of its activated sludge system in the winter. In the summer, the plant uses a preaeration basin followed by a single stage activated sludge unit and secondary clarifiers. In the summer, sludge from the clarifiers is recycled to the activated sludge unit. In the winter, sludge from the clarifiers is recycled to the preaeration unit, thus converting it into a second biological unit. In summary, the installation of additional piping to allow flexibility in the sludge recycle point allows the plant to have a one-stage biological treatment system in the summer and a two-stage system in the winter.

Data are not available for Plant #948 to correlate its operational changes with removal efficiency. Monthly monitoring data are available for Plant #2394, although the plant was excluded from the 21-plant data base for calculating BPT variability factors because the treatment system was modified during the period of record and the effluent data were collected after tertiary treatment. Monthly BOD_5 influent and effluent levels ($IBOD_5$ and $EBOD_5$), TSS effluent levels (ETSS), and removal efficiencies for Plant #2394 are presented in Table VII-34 for the period December 1981 to March 1984. The results are inconclusive. They show reduced efficiency during the months of January and February. They also show an efficiency increase of 19 percent between January 1982 and January 1983, and an increase of 13 percent between February 1982 and February 1983. The efficiency for January 1984 then drops by 7 percent from the preceding January, but the February 1984 efficiency of 95 percent is the same as the efficiency of the preceding February. The sharp efficiency increase between winter 1982 and winter 1983 suggests the effectiveness of the operational changes, but the reasons for the decrease between January 1983 and January 1984 cannot be determined from the available data. It is not known if production changes occurred during that period.

Conclusion

Results of the BOD_5 removal efficiency, BOD_5 effluent, and operational changes analyses performed above show a slight reduction in efficiency at some plants during the months of January and February. Efficiencies vary widely among plants, and many plants have attained efficiencies of 95 percent or greater for all months of the year. This suggests that the plants with lower efficiencies are affected as much by inefficient operating practices as by winter temperature considerations. Adoption of certain practices used by plants with higher winter efficiencies by these plants should result in improved winter efficiency.

Technologies and operating techniques exist that, if properly applied, can compensate for temperature. Plants operating in cold weather conditions should recognize that excessive storage prior to treatment may reduce the temperature of the biotreatment system. Cold weather operation may require insulation of treatment units, covering of open tanks, and tracing of chemical

TABLE VII-34.
MONTHLY DATA FOR PLANT #2394

		Average Influent BOD_5 (mg/l)	Average Effluent BOD_5 (mg/l)	Average Effluent TSS (mg/l)	BOD_5 Removal Efficiency (%)
1981	December	396	59	26	0.85
1982	January	311	76	20	0.76
	February	475	84	20	0.82
	March	484	38	22	0.92
	April	468	9	24	0.98
	May	364	5	14	0.99
	June	416	5	19	0.99
	July	350	2	13	0.99
	August	608	2	8	1.00
	September	427	3	7	0.99
	October	570	9	8	0.98
	November	530	9	10	0.98
	December	521	14	15	0.97
1983	January	377	20	15	0.95
	February	457	21	14	0.95
	March	420	13	14	0.97
	April	387	8	22	0.98
	May	404	5	17	0.99
	June	436	4	17	0.99
	July	332	3	13	0.99
	August	474	3	8	0.99
	September	364	3	10	0.99
	October	415	4	13	0.99
	November	388	8	21	0.98
	December	351	11	15	0.97
1984	January	295	35	24	0.88
	February	397	21	25	0.95
	March	354	15	26	0.96

feed lines. Insulation may include installing tanks in the ground rather than aboveground, using soil around the walls of aboveground units, or enclosing treatment units. During colder periods, maintenance of higher MLSS concentrations and suitable, reduced F/M may be necessary. Plant-specific techniques, such as those used at Plants #948 and #2394, should also be applied.

Another case study, cited in vendor literature, discusses cold weather modifications for a biological treatment system at a West Virginia polyester resin manufacturer. During the winter, the plant uses its equalization basin for biological contact stabilization before the wastewater enters the biological aeration basin. The plant replaced some of its aerators with mechanical aerators especially designed for cold weather operation and added similar aerators to the equalization basin for winter use. The new aerators designed specifically for winter conditions provide "aeration, mixing, and O_2 transfer without the temperature loss of conventional aerators during cold weather." The West Virginia facility now achieves "a 99 percent BOD removal, with influent BOD at 2,500 mg/l and effluent at 20 mg/l--even in the winter." Part of the improvement in effluent quality was attributed to warmer basin temperature (7-13).

Two other points should be made. First, temperature is only one of many factors that impacts wastewater treatment performance. Waste load variations, biomass acclimation, flow variations, waste treatability, and temperature of the wastewater as well as adequacy of treatment system design and operation must all be considered. The interaction among these factors makes it difficult to isolate any one factor separately. Temperature considerations must be viewed as specific to a given site in the context of these factors, rather than as specific to a given geographic area.

Secondly, EPA has taken the cost of improving winter efficiency into account by using the minimum State temperature in the K-rate equation for estimating costs for full-scale and second-stage biological systems and by adding a cost factor for biological upgrades. The cost factor ranges from 1.0 to 2.0 and is also based upon a State's minimum average ambient temperature. Both State minimum temperature and the biological upgrade cost factor are discussed in more detail in Section VIII.

4. Polishing and Tertiary Treatment Technologies

Polishing technologies consist of polishing ponds, filtration, and chemically assisted clarification (CAC). Tertiary treatment includes only activated carbon treatment.

a. Polishing Ponds

Polishing ponds are bodies of wastewater, generally limited to 2 to 3 feet in depth, used for the removal of residual suspended solids by sedimentation. They are usually used as a tertiary treatment step following biological treatment. Depending on the nature of the pollutant to be removed and the degree of removal required, the polishing treatment system can consist of one unit operation or multiple unit operations in series.

According to the Section 308 Questionnaire data base, 64 OCPSF plants reported using polishing ponds as an end-of-pipe treatment. Originally, 18 of these 64 plants were used to establish treatment performance limits for BPT Option II. However, following the December 9, 1986, Federal Register Notice of Availability, the Agency carefully reviewed the BPT data base identifying plants that reported having polishing ponds, and evaluated the data that they provided. The 18 plants used to calculate BPT Option II effluent limitations met the preliminary BPT effluent criteria, which was 95 percent removal of BOD_5 across the treatment system or an effluent BOD_5 concentration equal to or less than 50 mg/l and an effluent TSS concentration equal to or less than 100 mg/l.

The Agency reviewed the information provided in response to the Section 308 Questionnaires and contacted permit writers in the Regions and/or States in which the facilities were located. The results of this effort identified 16 of the 18 plants as not containing BPT Option II treatment systems. Only two plants are actually using their ponds as a final polishing step to remove suspended solids and BOD_5 from the effluent produced by a biological system operating at a BPT Option I level. A summary of the results of this evaluation is given in Table VII-35. A description of the 16 plants without the BPT Option II technology follows. Seven of the 16 plants combine treated wastewater from the biological treatment system with other wastewaters in a

TABLE VII-35.
MATRIX OF 18 PLANTS WITH POLISHING
PONDS USED AS BASIS FOR BPT OPTION II LIMITATIONS

Plant ID	Pond Serves as Equalization Basin	Pond Serves as Secondary Clarifier	Pond Serves as Reaeration Basin	Pond Known to Have Algae Problem	Pond Serves as a Final Polish
157	X				
267	X				
284		X			
384	X				
500	X				
811		X			
866					X
948			X		
990					X
1020		X			
1061		X			
1438	X				
1695	X				
1698		X			
1717				X	
2471		X			
2528		X			
4017	X				
TOTAL	7	7	1	1	2

final pond. Since these ponds mix different wastewaters, they achieve some dilution of treated process wastewater prior to discharge. Because the actual removal of the pollutants through biodegradation or settling cannot be demonstrated, these ponds cannot be characterized as polishing ponds. Another plant uses a "polishing pond" as a reaeration basin to increase the level of dissolved oxygen (DO) in its effluent and to prevent a depressed oxygen level from occurring in the receiving stream. Finally, one plant is known to have an algae problem associated with its pond operation during the summer months, that indicates that this plant may not be meeting the BPT Option II criteria during part of the year.

As for the remaining 30 plants that reported having polishing ponds that were not used to form the basis for the BPT Option II limits, four plants that reported effluent BOD_5, TSS, and flow data did not meet the BPT Option II criteria. Fifteen plants did not report any BOD_5 or TSS data; seven of these 15 plants use their ponds as a secondary clarification step, and six plants use their ponds as a final mixing step. The remaining 11 plants were not used because three plants have BPT Option III treatment (filtration); one plant recycles water back to its production processes from the pond; one plant is an indirect discharger; two plants discharge from their polishing ponds into subsequent treatment stages; and four plants do not use biological treatment. Based on the above information, the Agency concluded that the use of polishing ponds to provide additional removal of conventional pollutants (BOD_5 and TSS) beyond that achievable by well-designed and well-operated biological treatment (Option I) is not successfully demonstrated in the OCPSF industry.

b. Filtration

Filtration is an established unit operation for achieving the removal of suspended solids from wastewaters. The removal is accomplished by the passage of water through a physically restrictive medium (e.g., sand, coal, garnet, or diatomaceous earth) with resulting entrapment of suspended particulate matter by a complex process involving one or more removal mechanisms, such as straining, sedimentation, interception, impaction, and adsorption. Continued filtration reduces the porosity of the bed as particulate matter removed from the wastewater accumulates on the surface of the grains of the media and in the pore spaces between grains. This reduces the filtration rate and increases the head loss across the filter bed. The solids must be removed by "backwashing" when the head loss increases to a limiting value. Backwashing involves forcing wash water through the filter bed in the reverse direction of the original fluid flow so that the solids are dislodged from the granular particles and are discharged in the spent wash water. When backwashing is completed, the filter is returned to service.

Filtration is an established wastewater treatment technology currently in full-scale use for industrial waste treatment. Filtration has several applications: 1) pretreatment to remove suspended solids prior to processes such as activated carbon adsorption, steam stripping, ion exchange, and chemical oxidation; 2) removal of residual biological floc from settled treatment process effluents; 3) removal of residual chemically coagulated floc from physical/chemical treatment process effluents; and 4) removal of oil from oil separation and dissolved air flotation effluents.

According to the Section 308 Questionnaire data base, 41 OCPSF plants use filtration as a polishing technology. EPA evaluated BPT Option III (biological treatment plus multimedia filtration) technology to determine if this option could achieve, in a practicable manner, additional conventional pollutant removal beyond that achievable by well-designed, well-operated biological treatment with secondary clarification. Eleven plants in the BPT data base use BPT Option III technology and meet the final BPT editing criteria. Thus, this option would require EPA to regulate all seven subcategories based upon a very small data set. As shown in Table VII-36, the median effluent TSS concentration value for these plants is 32 mg/l. Even if three additional plants are included in this data base because they use Option I treatment plus either ponds or activated carbon followed by filters, the resulting median TSS value is 34 mg/l. These results, when compared to the performance of clarification only following biological treatment (median value of 30 mg/l), clearly show that the efficiency of filtration following good biological treatment and clarification is not demonstrated for this industry. Moreover, on the average, OCPSF plants with more than Option I treatment in EPA's data base (biological treatment plus filtration) have not demonstrated significant BOD_5 removal beyond that achievable by Option I treatment alone. The median

TABLE VII-36.
OPTION III OCPSF PLANTS WITH BIOLOGICAL TREATMENT
PLUS FILTRATION TECHNOLOGY THAT PASS THE BPT EDITING CRITERIA

Plant ID	Effluent TSS (mg/l)	Effluent BOD_5 (mg/l)
2551	9	11
1943	16	22
102	18	7
2536	18	3
883	27	20
2376	32	27
1343	36	8
2328	37	19
909	41	21
1148	46	37
844	54	5
Median value	32	19

BOD_5 concentration value for these plants is 19 mg/l compared to a median value of 23 mg/l BOD_5 for the plants with Option I technology in place which meet the 95 percent/40 mg/l BOD_5 editing criteria. Therefore, EPA does not believe that the data support any firm estimate of incremental pollutant removal benefits and incremental costs for BPT Option III.

One commenter suggested that, in light of the apparent poor incremental performance of filters in the OCPSF industry, EPA should transfer data from non-OCPSF filtration operations, specifically from domestic sewage treatment. EPA has evaluated the additional removal achievable by multimedia filtration on the effluent from the biological treatment of domestic sewage. Data found in EPA's "Process Design Manual for Suspended Solids Removal" (EPA 625/1-75-003, January 1975) indicates that multimedia filtration achieves a median of 62 percent removal of TSS from biological treatment effluent TSS levels of 25 mg/l or less.

The Agency also considered transferring multimedia filtration performance data from the pharmaceutical manufacturing point source category for use in the development of BPT Option III (biological treatment plus filtration) limitations. Daily data across multimedia filtration systems at three pharmaceutical plants demonstrated that effluent concentrations of TSS from advanced biological treatment in that industry could be reduced by 50 percent over a 15 to 100 mg/l influent concentration range by multimedia filtration (no removal of BOD_5 across multimedia filtration was demonstrated). This concentration range covers the range of performance of OCPSF plants that meet the Agency's Option I 95 percent/40 mg/l (BOD_5) and 100 mg/l (TSS) editing criteria to define well-designed and well-operated biological treatment.

However, the OCPSF industry filtration data do not indicate any substantial TSS or BOD_5 removal beyond that achieved by Option I technology. This indicates that differences in the biological solids in the OCPSF industry may be responsible for the lack of filtration effectiveness. For example, if the OCPSF biological floc (solids) were to break into smaller sized or colloidal particles, they could pass through the filter substantially untreated. While EPA cannot be certain whether this occurs, the data indicate that filters in this industry are not as effective in removing OCPSF wastewater solids as they may be for domestic sewage or certain other industry wastewater solids. EPA does not believe that the appropriateness of transferring data from these other wastewaters to the OCPSF industry is demonstrated.

c. Chemically Assisted Clarification (CAC)

Coagulants are added to clarifiers (chemically assisted clarifiers) to enhance liquid-solid separation, permitting solids denser than water to settle to the bottom and materials less dense than water (including oil and grease) to flow to the surface. Settled solids form a sludge at the bottom of the clarifier, which can be pumped out continuously or intermittently. Oil and grease and other floating materials may be skimmed off the surface.

Chemically assisted clarification may be used alone or as part of a more complex treatment process. It may also be used as:

- The first process applied to wastewater containing high levels of settleable suspended solids.
- The second stage of most biological treatment processes to remove the settleable materials, including microorganisms, from the wastewater; the microorganisms can then be either recycled to the biological reactor or discharged to the plant's sludge handling facilities.
- The final stage of most chemical precipitation (coagulation/flocculation) processes to remove the inorganic flocs from the wastewater.

As discussed in Section VIII, chemically assisted clarification was a component of the model wastewater treatment technology for estimating the BPT engineering costs of compliance. First, when biological treatment was in place (with or without secondary clarification), an additional chemically assisted clarification unit operation was costed if the reported TSS effluent concentration was more than 3 mg/l above the plant's long-term average compliance target. Second, for plants that do not need biological treatment to comply with their BOD_5 compliance targets, chemically assisted clarification unit operations were costed if the reported TSS effluent concentrations were more than 3 mg/l above the long-term average compliance target.

Although chemical addition was not frequently reported by plants in the OCPSF industry, chemically assisted clarification is a proven technology for the removal of BOD_5 and TSS in a variety of industrial categories, particularly in the pulp and paper industry. Case studies of full-, pilot-, and laboratory-scale chemically assisted clarification systems in the pulp and paper industry as well as other industrial point source categories are discussed in the following sections.

Full-Scale Systems

Several full-scale, chemically assisted clarification systems have been constructed in the pulp, paper, and paperboard industry and in other industrial point source categories. Data on the capability of full-scale systems to remove conventional pollutants are presented below.

Recent experience with full-scale, alum-assisted clarification of biologically treated kraft mill effluent suggests that final effluent levels of 15 mg/l each of BOD_5 and TSS can be achieved. The desired alum dosage to attain these levels can be expected to vary depending on the chemistry of the wastewater to be treated. The optimum chemical dosage is dependent on pH.

Chemical clarification following activated sludge treatment is currently being employed at a groundwood (chemi-mechanical) mill. According to data provided by mill personnel, alum is added at a dosage of about 150 mg/l to bring the pH to an optimum level of 6.1. Polyelectrolyte is also added at a rate of 0.9 to 1.0 mg/l to improve flocculation.

Neutralization using NaOH is practiced prior to final discharge to bring the pH within acceptable discharge limits. The chemical/biological solids are recycled through the activated sludge system with no observed adverse effects on biological organisms. Average reported results for 12 months of sampling data (as supplied by mill personnel) show a raw wastewater to final effluent BOD_5 reduction of 426 to 12 mg/l, and TSS reduction of 186 to 12 mg/l.

Treatment system performance at the mill was evaluated as part of a study conducted for the EPA (7-14). Data obtained over 22 months show average final effluent BOD_5 and TSS concentrations of 13 and 11 mg/l, respectively. As part of this study, four full-scale chemically assisted clarification systems in other industries were evaluated. Alum coagulation at a canned soup and juice plant reduced final effluent BOD_5 concentrations from 20 to 11 mg/l, and TSS levels from 65 to 22 mg/l. Twenty-five mg/l of alum plus 0.5 mg/l of polyelectrolyte are added to the biologically treated wastewater to achieve these final effluent levels. Treatment plant performance was evaluated at a winery where biological treatment followed by chemically assisted clarification was installed. Final effluent levels of 39.6 mg/l BOD_5 and 15.2 mg/l TSS from a raw wastewater of 2,368 mg/l BOD_5 and 4,069 mg/l TSS were achieved. The influent wastewater concentrations to the clarification process were not reported. The chemical dosage was 10 to 15 mg/l of polymer (7-14). A detailed summary of the results of the study of full-scale systems is presented in Table VII-37 (7-14).

In October 1979, operation of a full-scale chemically assisted clarification system treating effluent from an aerated stabilization basin at a northeastern bleached kraft mill began. This plant was designed and constructed after completion of extensive pilot-scale studies. The purpose of the pilot plant was to demonstrate that proposed water quality limitations could be met through the use of chemically assisted clarification. After demonstrating that it was possible to meet the proposed levels, studies were conducted to optimize chemical dosages. The testing conducted showed that the alum dosage could be reduced significantly by the addition of acid for pH control, while still attaining substantial TSS removal. In the pilot-scale study, it was shown that total alkalinity, a measure of a system's buffering capacity, was a reliable indicator of wastewater variations and treatability. Through this study, a direct relationship between total alkalinity and alum demand was shown. High alkalinity (up to 500 mg/l) caused by the discharge of black liquor or lime mud results in high alum demands. Therefore, a substantial portion of alum dosage can be used as an expensive and ineffective means of reducing alkalinity (pH) to the effective pH point (5 to 6) for optimum coagulation. The use of acid to assist in pH optimization can mean substantial cost savings and reduction in the alum dosage rate required to

Table VII-37.
Summary of Chemically Assisted Clarification Technology Performance Data

Major Industrial Category	Industrial Plant and Location	Sub category or Products	Description of Biological Treatment	Average of Period – Clarifier Influent BOD$_5$	Average of Period – Clarifier Influent TSS	Average of Period – Clarifier Effluent BOD$_5$	Average of Period – Clarifier Effluent TSS	Maximum Day Clarifier Effluent BOD$_5$	Maximum Day Clarifier Effluent TSS	Maximum 30 Consecutive Days Average Clarifier Effluent BOD$_5$	Maximum 30 Consecutive Days Average Clarifier Effluent TSS	Recent Removals Across Clarifier BOD$_5$	Recent Removals Across Clarifier TSS	Surface Over flow Rates and Detention Time	Chemicals Added and Dosage Rate Average	NPDES Permit Average Maximum Day BOD$_5$	NPDES Permit Average Maximum Day TSS	Average of Period Plant Influent Flow	Average of Period Plant Influent BOD$_5$	Average of Period Plant Influent TSS
F ’ı ;nd Paper	B 12	Groundwood Chemi Mech	Aerated Stablization Basin 2 lb BOD$_5$ 1000 cu ft D Hydraulic detention time 8 days at 2 25 MGD Nitrogen and phosphorous added	Average of 12 months of daily data N D	Average of 12 months of daily data 1295 7 lb/day	Average of 12 months of daily data 140 7 lb/day	Average of 12 months of daily data 172 8 lb/day	504 4 lb/day	1502 6 lb day	Based on 12 months of daily data 201 3 lb/day	Based on 12 months of daily data 250 5 lb/day	Based on annual average Based on mean of 30 consecutive day averages N D	87%	For annual ave flow of 1 6 MGD 369 gal day/sq ft For max day flow of 2 8 MGD 641 gal/day/sq ft	Alum Silica	30 Day average 275 lb D Order No 74 69 NPDES No CA0004821 effective 1 July 75		1 95 MGD average of 12 months of daily data	475 7 mg l average of 12 months of daily data	1 6 lbs 1000 gal average of 12 months of daily data
				Average of 10 months of daily data 315 5 lb day	Average of 10 months of daily data 737 7 lb/day	Average of 10 months of daily data 198 2 lb day	Average of 10 months of daily data 177 2 lb/day	473 3 lb/day	1400 2 lb/day	Based on 10 months of daily data 239 7 lb day	Based on 10 months of daily data 257 9 lb/day	Based on annual average (10 months) 29% Based on mean of 30 consecutive day averages 35%	76% 76%	For annual average flow of 1 9 MGD 432 gal/day/sq ft For max day flow of 2 5 MGD - 564 gal/day/sq ft	Alum 150 mg l average Polymer 0 5 mg/l average	Average max flow of 2 2 mgd Max day 550 lb D 30 mg l	Max Day 800 lb D 40 mg l	1 9 MGD Average of 10 months of daily data	N D	1 7 lbs 1000 gal Average of 10 months of daily data
Synthetic Fiber Manufacturer	B 11	Dacron and ethlyene glycol	Activated sludge (extended aeration) F M 0 05 to 0 1 lb BOD$_5$ applied lb MLSS MLSS 2000 2500 mg/l	Data not provided		Average of 4 quarterly averages with chemicals 113 3 lb D	Average of 4 quarterly averages with chemicals 203 8lb D	Data not provided		Data not provided		Data not available for calculations		For average period flow 2 097 MGD 220 gal D/sq ft 7 hours detention	Polymer only cationic 0 10 mg l Average 8 mg l	Daily average 750 lb D NPDES No NC0000663 31 Dec 73 to 31 Dec 76 Ave max flow 2 5 MGD	Daily average 1040 lb D	Data not provided		
For Site (System)			Hydraulic detention time 30 hours at 2 MGD Nitrogen and phosphorous added	Data not provided		Average of 4 quarterly averages without chemicals 151 lb D	Average of 4 quarterly averages without chemicals 665 3 lb D	Data not provided		Data not provided		Data not available for calculations		For average period flow 1 67 MGD 176 gal/D/sq ft 7 hours detention	None added	Daily maximum 100 lb D	Daily maximum 2000 lb D	Data not provided		
Canned Foods	B 10	Canned soup juices	2 stage trickling filter, filter followed by aerated lagoon with 5 days detention with sub surface static aeration 18" diameter x 12 feet long	Annual average June '75 to May '76 20 mg/l No back up data provided	Annual average June '75 to May '76 65 mg/l No back up data provided	Figures provided without back up data 11 mg/l Annual average June 75 to May 76	22 mg l Annual average June 75 to May 76	Data not provided		Data not provided		No back up data provided for calculation		558 gal day sq ft @ 4 3 MGD 3 5 hours detention time	Campbell soup had no record of when chemicals were added or not added Alum can be added at lagoon effluent weir @ 25 mg/l Polymer added at flow splitting box before clarifiers 0 5 mg/l	Daily average 45 mg/l TSS Daily maximum - 90 mg l TSS Daily average 30 mg/l BOD$_5$ Daily maximum 75 mg/l BOD$_5$ No H221 AD		4 3 MGD average Number provided, no back up data provided	473 mg l average Number provided no backup data provided	364 mg l average Number provided no backup data provided
Wine Making	B 11	Wine	Activated sludge 18 6 lb BOD 1000 cu ft F M = 0 07 MLSS = 4069 mg l Detention Time = 8 days at 0 176 MGD Phosphorous and nitrogen added	Average of period from April 26, 1976 to July 31, 1976 2368 mg l	Average of period from April 26 1976 to July 31 1976 4069 mg l	Average of period from April 26, 1976 to July 31 1976 39 6 mg l Data after post aeration and chlorination	15 2 mg l	Data after post aeration and chlorination 70 mg/l for period April 26 1976 to July 31, 1976	36 mg l	Data not available		Average of period from April 26 1976 to July 31 1976 N A	99 6%	At average flow 0 17 MGD 140 gal D shift 11 5 hoursurs	Polymer at 10 15 mg l Testing period for proper dosage	Process Season Daily average 30 mg l BOD$_5$ Daily maximum 50 mg l BOD$_5$ Daily average 20 mg l TSS Daily maximum 50 mg l TSS		0 177 MGD Average of period April 26 1976 to July 31 1976 Caution - does not include the pressing season which is the season of highest loading	2368 mg l	215 5 mg l

effect coagulation. In one instance, use of concentrated sulfuric acid for pH reduction decreased alum demand by 45 percent. Acid addition was also effective in reducing alum dosage for wastewaters with low alkalinity (approximately 175 mg/l) (7-15).

Table VII-38 summarizes effluent quality of the full-scale system since startup; this system has been operated at an approximate alum dosage rate of 350 mg/l without acid addition. Recent correspondence with a mill representative indicated that, with acid addition, this dosage rate could be reduced to 150 mg/l (7-16). However, this lower dosage rate has not been confirmed by long-term operation.

Scott et al. (7-17) reported on a cellulose mill located on the shore of Lake Baikal in the USSR. The mill currently produces 200,000 kkg (220,000 tons) of tire cord cellulose and 11,000 kkg (12,100 tons) of kraft pulp per year. Average water usage is 1,000 kl/kkg (240 kgal/t). The mill has strong and weak wastewater collection and treatment systems. The average BOD_5 for the weak wastewater system is 100 mg/l, while the strong wastewater BOD_5 is 400 mg/l. Only 20 percent of the total wastewater flow is included in the strong wastewater system. Each stream receives preliminary treatment consisting of neutralization of pH to 7.0, nutrient addition, and aerated equalization. Effluent from equalization is discharged to separate aeration and clarification basins. These basins provide biological treatment using a conventional activated sludge operation. Aeration is followed by secondary clarification. Suspended solids are settled, and 50 percent of the sludge is returned to the aeration process. Waste sludge is discharged to lagoons. The separate streams are combined after clarification and are treated for color and suspended solids removal in reactor clarifiers with 250 to 300 mg/l of alum and 1 to 2 mg/l of polyacrylamide flocculant, a nonionic polymer. The clarifiers have an overflow rate of approximately 20.4 m^3 per day/m^2 (500 gpd/ft^2).

Chemical clarification overflow is discharged to a sand filtration system. The sand beds are 2.9 m (9.6 ft) deep with the media arranged in five layers (7-18). The sand size varies from 1.3 mm (0.05 in) at the top to 33 mm (1.3 in) at the bottom. The filter is loaded at 0.11 m^3 per minute/m^2

TABLE VII-38.
FINAL EFFLUENT QUALITY OF A CHEMICALLY ASSISTED
CLARIFICATION SYSTEM TREATING BLEACHED KRAFT WASTEWATER

Date	BOD_5 (mg/l)		TSS (mg/l)	
	Average for Month	Maximum Day	Average for Month	Maximum Day
September 1979	11	21	87	254
October 1979	8	12	40	92
November 1979	9	18	28	47
December 1979	21	83	21	56
January 1980	8	16	28	36
February 1980	7	14	31	68
March 1980	13	46	44	113
April 1980	9	16	32	96
May 1980	11	22	38	80

(2.7 gpm/ft^2). Effluent from sand filtration flows to a settling basin and then to an aeration basin; both basins are operated in series and provide a 7-hour detention time.

The effluent quality attained is as follows:

Parameter	Raw Waste	Final Effluent
BOD_5 (mg/l)	300	2
Suspended Solids (mg/l)	60	5
pH	--	6.8 - 7.0

Individual treatment units are not monitored for specific pollutant parameters.

Pilot- and Laboratory-Scale Systems

Several laboratory- and pilot-scale studies of the application of chemically assisted clarification have been conducted. Available data on this technology to remove conventional pollutants based on laboratory- and pilot-scale studies are presented below.

As part of a study of various solids reduction techniques, Great Southern Paper Co. supported a pilot-scale study of chemically assisted clarification (7-19). Great Southern operates an integrated unbleached kraft mill. Treatment consists of primary clarification and aerated stabilization followed by a holding pond. The average suspended solids in the discharge from the holding pond were 65 mg/l for the period January 1, 1973, to December 31, 1974. In tests on this wastewater, 70 to 100 mg/l of alum at a pH of 4.5 provided optimum dosages; the removals after 24 hours of settling ranged from 83 to 86 percent. Influent TSS of the sample tested was 78 mg/l. Effluent TSS concentrations ranged from 11 to 13 mg/l.

In a recent EPA-sponsored laboratory study, alum, ferric chloride, and lime in combination with five polymers were evaluated in further treatment of biological effluents from four pulp and paper mills (7-20). Of the three chemical coagulants, alum provided the most consistent flocculation at minimum dosages, while lime was the least effective of the three. However, the study provides the optimum chemical dosage for removal of TSS from biologically treated effluents. These inconclusive findings are the result of a number of factors, including the lack of determination of optimum pH to effect removal of TSS; the lack of consideration of higher chemical dosages when performing laboratory tests even though data for some mills indicated that better removal of TSS was possible with higher chemical dosage (a dosage of 240 mg/l was the maximum considered for alum and ferric chloride, while 200 mg/l was the maximum dosage used for lime); the testing of effluent from one mill where the TSS concentration was 4 mg/l prior to the addition of chemicals; and the elimination of data based simply on a visual determination of proper flocculation characteristics.

Laboratory data on alum dosage rates for chemically assisted clarification have been submitted to the Agency in comments on the pulp, paper, and paperboard contractor's draft report (7-21). Data submitted for bleached and unbleached kraft pulp and paper wastewaters indicate that significant removals of suspended solids occur at alum dosages in the range of 100 to 350 mg/l (7-22, 7-23, 7-24). For wastewaters resulting from the manufacture of dissolving sulfite pulp, effluent BOD_5 and TSS data were submitted for dosage rates of 250 mg/l; however, it was stated that dosages required to achieve an effluent TSS concentration on the order of 15 mg/l would be in the range of 250 to 500 mg/l (7-25). During the pulp, paper, and paperboard rulemaking, NCASI assembled jar test data for several process types and submitted it to the Agency (7-26). Data for chemical pulping subcategories indicated that alum dosages in the range of 50 to 700 mg/l will effect significant removals of TSS. The average dosage rate for all chemical pulping wastewaters was 282 mg/l. Data submitted for the groundwood, deink, and nonintegrated-fine papers subcategories indicate that dosages in the range of 100 to 200 mg/l will significantly reduce effluent TSS.

Data on the frequency of this technology are not available for the OCPSF industry although data on the frequency of other similar technologies (coagulation, flocculation, clarification, chemical precipitation) have been previously presented. However, based upon the above information and upon the general performance of clarifiers in treating TSS, EPA has concluded that chemically assisted clarification can treat TSS in non-end-of-pipe biological plants to meet the BPT TSS limits.

d. Activated Carbon Adsorption

Activated carbon adsorption is a physical separation process in which organic and inorganic materials are removed from wastewater by sorption or the attraction and accumulation of one substance on the surface of another. There are essentially three consecutive steps in the sorption of dissolved materials in wastewater by activated carbon. The first step is the transport of the solute through a surface film to the exterior of the carbon. The second step is the diffusion of solute within the pores of the activated carbon. The third and final step is sorption of the solute on the interior surface bounding the pore and capillary spaces of the activated carbon. While the primary removal mechanism is adsorption, biological degradation and filtration also may reduce the organics in the solution.

Activated carbon is considered to be a non-polar sorbent and tends to sorb the least polar and least soluble organic compounds; it will sorb most, but not all, organic compounds. As activated carbon adsorbs organics from wastewater, the carbon pores eventually become saturated and the exhausted carbon must be regenerated for reuse or replaced with fresh carbon. The adsorptive capacity of the carbon can be restored by chemical or thermal regeneration.

There are two forms of activated carbon in common use--granular and powdered. Granular carbon is generally preferred for most wastewater applications because it can be readily regenerated. The two forms of carbon used and different process configurations are described below.

Granular Activated Carbon. Granular carbon is about 0.1 to 1 mm in diameter and is contacted with wastewater in columns or beds. The water to be treated is either filtered down (downflow) or forced up (upflow) through the carbon column or bed. Additional design configurations of carbon contact columns include gravity or pressure flow, fixed or moving beds, and single (parallel) or multi-stage (series) arrangements. In a typical downflow countercurrent operation, two columns are operated in series with a common spare column. When breakthrough occurs for the second column (i.e., the concentration of a target pollutant in the effluent is higher than the desired concentration), the exhausted column is removed from service for regeneration of the carbon. The partially exhausted second column becomes the lead column, and the fresh spare column is added as a second column in the series. When breakthrough is again reached, the cycle is repeated. The fixed bed downflow operation, in addition to adsorption, provides filtration but may require frequent backwashing. In an upflow configuration, the exhausted carbon is removed at the bottom of the column, and virgin or regenerated carbon is added at the top, thereby providing countercurrent contact in a single vessel.

Powdered Activated Carbon. Powdered carbon is about 50 to 70 microns in diameter and is usually mixed with the wastewater to be treated. This "slurry" of carbon and wastewater is then agitated to allow proper contact. Finally, the spent carbon carrying the adsorbed impurities is settled out or filtered. In practice, a multi-stage, countercurrent process is commonly used to make the most efficient use of the carbon's capacity.

Carbon adsorption systems have been demonstrated as practical and economical for the reduction of dissolved organic and toxic pollutants from industrial wastewaters. Activated carbon can be used to remove chemical oxygen demand (COD), biochemical oxygen demand (BOD), and related parameters; to remove toxic and refractory organics; to remove and recover certain organics; and to remove selected inorganic chemicals from industrial wastewater. Compounds that are readily removed by activated carbon include aromatics, phenolics, chlorinated hydrocarbons, surfactants, organic dyes, organic acids, higher molecular weight alcohols, and amines. Activated carbon can also be used to remove selected inorganic chemicals, such as cyanide, chromium, and mercury. A summary of classes of organic compounds adsorbed on carbon are presented in Table VII-39, and a summary of carbon adsorption capacities (the milligram of compound adsorbed per gram of carbon) is presented for powdered carbon in Table VII-40.

The major benefits of carbon treatment involve its applicability to a wide variety of organics and its high removal efficiencies. The system is compact, and recovery of adsorbed materials is sometimes practical. The limitations of the process include ineffective removal of low molecular weight

TABLE VII-39.
CLASSES OF ORGANIC COMPOUNDS ADSORBED ON CARBON

Organic Chemical Class	Examples of Chemical Class
Aromatic Hydrocarbons	benzene, toluene, xylene
Polynuclear Aromatics	naphthalene, anthracenes , biphenyls
Chlorinated Aromatics	chlorobenzene, polychlorinated biphenyls, aldrin, endrin, toxaphene, DDT
Phenolics	phenol, cresol, resorcenol, and polyphenyls
Chlorinated Phenolics	trichlorophenol, pentachlorophenol
High Molecular Weight Aliphatic and Branch Chain Hydrocarbons*	gasoline, kerosene
Chlorinated Aliphatic Hydrocarbons	1,1,1-trichloroethane, trichloroethylene, carbon tetrachloride, perchloroethylene
High Molecular Weight Aliphatic Acids and Aromatic Acids*	tar acids, benzoic acid
High Molecular Weight Aliphatic Amines and Aromatic Amines*	aniline, toluene diamine
High Molecular Weight Ketones, Esters, Ethers, and Alcohols*	hydroquinone, polyethylene glycol
Surfactants	alkyl benzene sulfonates
Soluble Organic Dyes	methylene blue, Indigo carmine

*High Molecular Weight includes compounds in the range of 4 to 20 carbon atoms

TABLE VII-40.
SUMMARY OF CARBON ADSORPTION CAPACITIES

Compound	Adsorption[a] Capacity (mg/g)	Compound	Adsorption[a] Capacity (mg/g)
bis(2-Ethylhexyl) phthalate	11,300	Phenanthrene	215
Butylbenzyl phthalate	1,520	Dimethylphenylcarbinol*	210
Heptachlor	1,220	4-Aminobiphenyl	200
Heptachlor epoxide	1,038	beta-Naphthol*	200
Endosulfan sulfate	686	alpha-Endosulfan	194
		Acenaphthene	190
Endrin	666	4,4′ Methylene-bis-(2-chloroaniline)	190
Fluoranthene	664		
Aldrin	651	Benzo(k)fluoranthene	181
PCB-1232	630	Acridine orange	180
beta-Endosulfan	615	alpha-Naphthol	180
Dieldrin	606	4,6-Dinitro-o-cresol	169
Hexachlorobenzene	450	alpha-Naphthylamine	160
Anthracene	376	2,4-Dichlorophenol	157
4-Nitrobiphenyl	370	1,2,4-Trichlorobenzene	157
		2,4,6-Trichlorophenol	155
Fluorene	330		
DDT	322	beta-Naphthylamine	150
2-Acetylaminofluorene	318	Pentachlorophenol	150
alpha-BHC	303	2,4-Dinitrotoluene	146
Anethole*	300	2,6-Dinitrotoluene	145
		4-Bromophenyl phenyl ether	144
3,3-Dichlorobenzidine	300		
2-Chloronaphthalene	280	p-Nitroaniline*	140
Phenylmercuric Acetate	270	1,1-Diphenylhydrazine	135
Hexachlorobutadiene	258	Naphthalene	132
gamma-BHC (lindane)	256	1-Chloro-2-nitrobenzene	130
		1,2-Dichlorobenzene	129
p-Nonylphenol	250		
4-Dimethylaminoazobenzene	249	p-Chlorometacresol	124
Chlordane	245	1,4-Dichlorobenzene	121
PCB-1221	242	Benzothiazole*	120
DDE	232	Diphenylamine	120
		Guanine*	120
Acridine yellow*	230		
Benzidine dihydrochloride	220	Styrene	120
beta-BHC	220	1,3-Dichlorobenzene	118
N-Butylphthalate	220	Acenaphthylene	115
N-Nitrosodiphenylamine	220	4-Chlorophenyl phenyl ether	111
		Diethyl phthalate	110

TABLE VII-40.
SUMMARY OF CARBON ADSORPTION CAPACITIES (Continued)

Compound	Adsorption[a] Capacity (mg/g)
2-Nitrophenol	99
Dimethyl phthalate	97
Hexachloroethane	97
Chlorobenzene	91
p-Xylene	85
2,4-Dimethylphenol	78
4-Nitrophenol	76
Acetophenone	74
1,2,3,4-Tetrahydro- naphthalene	74
Adenine*	71
Dibenzo(a,h)anthracene	69
Nitrobenzene	68
3,4-Benzofluoranthene	57
1,2-Dibromo-3-chloro- propane	53
Ethylbenzene	53
2-Chlorophenol	51
Tetrachloroethene	51
o-Anisidine*	50
5 Bromouracil	44
Benzo(a)pyrene	34
2,4-Dinitrophenol	33
Isophorone	32
Trichloroethene	28
Thymine*	27
Toluene	26
5-Chlorouracil*	25
N-Nitrosodi-n-propylamine	24
bis(2-Chloroisopropyl) ether	24
Phenol	21
Bromoform	20
Carbon tetrachloride	11
bis(2-Chloroethoxy) methane	11
Uracil*	11
Benzo(ghi)perylene	11
1,1,2,2-Tetrachloroethane	11
1,2-Dichloropropene	8.2
Dichlorobromomethane	7.9
Cyclohexanone*	6.2
1,2-Dichloropropane	5.9
1,1,2-Trichloroethane	5.8
Trichlorofluoromethane	5.6
5-Fluorouracil*	5.5
1,1-Dichloroethylene	4.9
Dibromochloromethane	4.8
2-Chloroethyl vinyl ether	3.9
1,2-Dichloroethane	3.6
1,2-trans-Dichloroethene	3.1
Chloroform	2.6
1,1,1-Trichloroethane	2.5
1,1-Dichloroethane	1.8
Acrylonitrile	1.4
Methylene chloride	1.3
Acrolein	1.2
Cytosine*	1.1
Benzene	1.0
Ethylenediaminetetra- acetic acid	0.86
Benzoic acid	0.76
Chloroethane	0.59
N-Dimethylnitrosamine	6.8×10^{-5}

TABLE VII-40.
SUMMARY OF CARBON ADSORPTION CAPACITIES (Continued)

NOT ADSORBED	
Acetone cyanohydrin	Adipic acid
Butylamine	Choline chloride
Cyclohexylamine	Diethylene glycol
Ethanol	Hexamethylenediamine
Hydroquinone	Morpholine
Triethanolamine	

*Compounds prepared in "mineralized" distilled water containing the following composition:

Ion	Conc. (mg/l)	Ion	Conc. (mg/l)
Na+	92	PO4	10
K+	12.6	SO4	100
Ca++	100	Cl-	177
Mg++	25.3	Alkalinity	200

[a]Adsorption capacities are calculated for an equilibrium concentration of 1.0 mg/l at neutral pH.

Source: "Carbon Adsorption Isotherms for Toxic Organics." MERL, April 1980. PB 80 197 320.

or highly soluble organics, low tolerance for suspended solids in the wastewater, and relatively high capital and operating costs. Preliminary treatment to reduce suspended solids and to remove oil and grease will often improve the effectiveness of the activated carbon system.

Treatability tests should be performed on specific waste streams to determine actual performance of an activated carbon unit. The degree of removal of different organic compounds varies depending on the nature of the adsorbate, the pH of the solution, the temperature of the solution, and the wastewater characteristics. If the wastewater contains more than one organic compound, these compounds may mutually enhance adsorption, may act relatively independently, or may interfere with one another.

According to the Section 308 Questionnaire data base, 21 OCPSF plants reported using carbon adsorption as a tertiary treatment technology. Table VII-41 presents tertiary activated carbon performance data for an OCPSF plant sampled during the EPA 12-Plant Study.

E. Total Treatment System Performance

1. Introduction

The last two sections presented descriptions and performance data for those in-plant and end-of-pipe treatment technologies currently used or available for the reduction and removal of conventional, nonconventional, and priority pollutants discharged by the OCPSF industry. The performance data presented were primarily for those pollutants that the technologies were primarily designed to remove. For example, BOD_5 and TSS data were presented for activated sludge; metals data were presented for chemical precipitation; and volatile priority pollutant data were presented for steam stripping.

This section discusses the removal of pollutants from all treatment technologies by presenting the performance of total treatment systems. The treatment systems studied are those used to promulgate the BPT and BAT effluent limitations. In addition, the performances of those treatment systems within the OCPSF industry that do not use biological treatment are also presented.

TABLE VII-41.
END-OF-PIPE CARBON ADSORPTION PERFORMANCE
DATA FROM PLANT NO. 3033

Pollutant Name	Average Influent Concentration to Activated Carbon (ug/l)	Average Effluent Concentration from Activated Carbon (ug/l)
Bis(2-chloroethyl)ether (18)	13.64	10.00 (ND)
1,2-Dichloropropane (32)	10.46	10.00 (ND)
2,4-Dimethylphenol (34)	13.92	10.00 (ND)
Methylene Chloride (44)	12.21	11.46
Phenol (65)	11.42	10.00 (ND)
Bis(2-ethylexyl)Phthalate (66)	14.31	13.00

2. BPT Treatment Systems

EPA has promulgated concentration-based BPT effluent limitations based on selected biological end-of-pipe technologies that are designed primarily to address the conventional pollutants BOD_5 and TSS. These are supplemented by those in-plant controls and technologies that are commonly used to assure the proper and efficient operation of the end-of-pipe technologies, such as steam stripping, activated carbon, chemical precipitation, cyanide destruction, and in-plant biological treatment. Activated sludge and aerated lagoons are the primary examples of such biological treatment.

The performance of BPT treatment systems is represented by the long-term BOD_5 and TSS averages for each subcategory and the overall maximum monthly and daily maximum variability factors presented in the limitations development part of this section.

3. Nonbiological Treatment Systems

Approximately 84 plants rely exclusively upon end-of-pipe physical/ chemical treatment or did not report any in-place treatment at all. These facilities must comply with the BPT effluent limitations guidelines based on biological treatment system performance. Some of these plants generate low levels of BOD_5, thus finding physical/chemical treatment more effective in reducing TSS loadings. Without nutrient addition, biological systems generally cannot function unless influent BOD_5 is high enough to sustain their biota. Other plants have determined, based on an analysis of the types and volumes of pollutants that they discharge, that physical/chemical treatment is more economical, easier to operate, or otherwise more appropriate. Some of these plants can control conventional pollutants effectively without using the biological component of the BPT Option I technologies. However, other plants seem to rely on dilution of process wastewater prior to discharge rather than the appropriate Option I treatment. A listing of available BOD_5 and TSS effluent data and in-place controls reported by those plants with nonbiological treatment systems is presented in Table VII-42. Forty-one of the physical/chemical treatment only plants reported discharge BOD_5 concentration data, and 46 provided TSS concentration data. After adjusting the reported wastewater concentration data for non-process wastewater dilution, 29 percent

TABLE VII-42.
TREATMENT TECHNOLOGIES FOR DIRECT NONBIOLOGICAL PLANTS*

Plant ID	Effluent BOD_5 (mg/l)	Effluent TSS (mg/l)	Type of Controls Reported
76	-	-	Neutralization
87	929	44	Equalization, neutralization, primary clarification, carbon adsorption
105	-	-	Stream stripping, neutralization, primary clarification
114	15	89	Filtration
155	-	282	Neutralization, API separation, dissolved air flotation
159	429	-	Filtration, chemical precipitation, steam stripping, equalization, coagulation, neutralization, oil separation, primary clarification, filtration, carbon adsorption, second stage of an indicated treatment unit
225	96	46	Steam stripping, distillation, equalization, settling pond, neutralization, screening, oil skimming
259	350	-	Filtration, coagulation, API separation, surface impoundment
260	20	8	Cooling tower, API separation
294	57	119	Reuse for steam, coagulation, flocculation, neutralization, oil separation, primary clarification
373	62	155	Neutralization, oil separation, oil skimming
447	23,628	22,898	Neutralization, filtration
451	-	-	Chemical precipitation, primary clarification, flocculation
502	93	38	Water scrub, neutralization
536	31	1	Neutralization

TABLE VII-42.
TREATMENT TECHNOLOGIES FOR DIRECT NONBIOLOGICAL PLANTS*
(Continued)

Plant ID	Effluent BOD_5 (mg/l)	Effluent TSS (mg/l)	Type of Controls Reported
569	-	-	Steam stripping, primary clarification
614	-	-	Distillation, equalization, acidification/aeration, neutralization, filtration, equalization
657	16	17	Collection basin, neutralization, oil separation
663	7	47	Equalization, flocculation, neutralization, dissolved air flotation, mechanical skimming, spray cooling, polishing pond
669	56	42	Filtration, steam stripping, neutralization, oil skimming, dissolved air flotation, air stripping
709	91	98	Settling pond, neutralization, API separation, filtration, carbon adsorption
727	84	108	Equalization, flocculation, chemical precipitation, grit removal, oil skimming, clarification, air stripping, neutralization, polishing pond
775	-	6	Chemical precipitation, neutralization, primary clarification
814	-	-	Carbon adsorption, neutralization, oil skimming, oil separation, API separation, coagulation, flocculation
819	-	128	Chemical precipitation, equalization, neutralization, oil separation, carbon adsorption
859	225	4,369	Equalization, neutralization, primary clarification
876	90	76	Formaldehyde treatment, carbon absorption, equalization, neutralization, primary clarification

TABLE VII-42.
TREATMENT TECHNOLOGIES FOR DIRECT NONBIOLOGICAL PLANTS*
(Continued)

Plant ID	Effluent BOD_5 (mg/l)	Effluent TSS (mg/l)	Type of Controls Reported
877	-	-	Dissolved air flotation
913	4	54	Chemical oxidation, steam stripping, equalization, phase separation, neutralization
938	-	27	Steam stripping, equalization, flocculation, hypochlorite addition, filtration, neutralization, primary clarification, settling pond
942	71	66	Steam stripping, neutralization, oil skimming, primary clarification
962	17	25	Equalization, primary clarification
991	-	-	Solvent decantation
992	-	-	Distillation, equalization, neutralization
1249	-	-	Equalization, neutralization
1439	302	1,463	Settling, solvent extraction, equalization, neutralization, steam stripping
1532	110	-	Steam stripping, mercury treatment, neutralization, carbon adsorption
1569	18	44	Distillation, equalization, neutralization, primary clarification, blending and air stripping, filtration
1618	4	11	Oil skimming
1688	142	46	Steam stripping, equalization, flocculation, neutralization, primary clarification
1774	8	5	Equalization, flocculation, neutralization, primary clarification, filtration

TABLE VII-42.
TREATMENT TECHNOLOGIES FOR DIRECT NONBIOLOGICAL PLANTS*
(Continued)

Plant ID	Effluent BOD_5 (mg/l)	Effluent TSS (mg/l)	Type of Controls Reported
1776	-	100	Steam stripping, grit removal, oil skimming, neutralization
1785	-	-	Chemical precipitation, chromium reduction, steam stripping, ion exchange, carbon adsorption, equalization, neutralization
1794	-	-	Oil skimming, API separation
1839	-	-	Steam stripping, gravity settling
2030	-	-	Chemical precipitation, chromium reduction, air stripping, neutralization, flocculation
2055	168	-	Steam stripping, coagulation, flocculation, recycle basin, clarification, polishing pond
2062	-	-	Chemical precipitation, steam stripping, carbon adsorption, coagulation, flocculation, neutralization, pH adjustment
2073	6	40	HDPE skimmer, polishing pond, pH adjustment
2090	862	50	Distillation, equalization, neutralization, grit removal
2206	-	-	Oil skimming, oil separation
2268	-	264	Equalization, sedimentation, neutralization, filtration
2345	50	29	Steam stripping, solvent extraction, flocculation, redox reactor, redox towers, neutralization, polishing pond, noncontact coolers
2400	5,640	1,175	Solvent extraction, distillation
2419	-	-	Equalization, neutralization, oil skimming, dissolved air flotation
2527	-	-	Oil skimming, aerobic spray field

TABLE VII-42.
TREATMENT TECHNOLOGIES FOR DIRECT NONBIOLOGICAL PLANTS*
(Continued)

Plant ID	Effluent BOD_5 (mg/l)	Effluent TSS (mg/l)	Type of Controls Reported
2531	639	145	Equalization, flocculation, neutralization, primary clarification, carbon adsorption
2533	-	31	Equalization, screening
2590	16	13	Sulfur recovery, single stage flash, equalization, stormwater impoundment, neutralization, oil separation, filtration, carbon adsorption
2606	-	-	Neutralization
2647	47	51	Filtration, distillation
2668	939	5,866	Steam stripping, distillation
2680	48	26	Decant sump, equalization, steam stripping, neutralization, carbon adsorption
2735	8	21	Pellet skimming, neutralization, oil skimming, dissolved air flotation, clarification
2767	16	31	Neutralization
2770	140	17	Distillation, equalization, neutralization, oil skimming, primary clarification
2771	-	13	Equalization, neutralization, primary clarification
2786	80	55	Filtration, chemical precipitation, air stripping, steam stripping, equalization, neutralization, oil skimming, oil separation, API separation, dissolved air flotation, polishing pond, (nutrient addition prior to a septic tank for part of the plant flow)
4010	-	176	Depolymerization, distillation, pH adjustment, neutralization, centrifugation

*Plants 33, 180, 412, 446, 601, 611, 664, 956, 1033, 1327, 1593, 1670, 1986, 2047, and 2660 report no in-place treatment technology.

of the physical/chemical treatment plants were determined to require no further treatment to comply with the individual plant BPT Option I BOD_5 long-term average effluent compliance targets (discussed later in this section and in Section VIII). For another 69 percent of the plants, the engineering costs of compliance were based on activated sludge treatment systems because their discharge BOD_5 concentrations (after correction for non-process wastewater dilution) ranged from 15 to 23,600 mg/l above their individual plant BPT Option I BOD_5 long-term average effluent compliance targets. The remaining 2 percent of the plants were costed for contract hauling because their wastewater flows were less than 500 gallons per day (gpd).

In the case of TSS, 38 percent of the 46 physical/chemical treatment only plants that reported TSS data were determined to require no further treatment to comply with the individual plant BPT Option I TSS long-term average effluent compliance targets. For 49 percent of the plants, the engineering costs of TSS compliance were associated with the activated sludge treatment system costed for BOD_5 control. For another 7 percent of the plants, the engineering costs of TSS compliance were based on chemically assisted clarification treatment systems; for 4 percent of the plants, costs were based on copper sulfate addition to polishing ponds; and for 2 percent, on contract hauling because the wastewater flows were less than 500 gpd.

Currently, 14 plants do not report any in-place treatment at all; of these, two plants reported BOD_5 and TSS concentrations. One plant would require no treatment and the other plant would require biological treatment to comply with their respective BPT compliance targets.

The Agency did not establish alternative limitations for facilities that do not utilize or install biological treatment systems to comply with the BPT effluent limitations. Some industry commenters criticized the Agency for not exempting or establishing alternative BOD_5 limitations for stand-alone "chlorosolvent" manufactures. They claim that "chlorosolvent" wastewaters cannot sustain a biomass and should not be subject to limitations based on biological treatment, but did not provide supporting data. The Agency identified only three stand-alone "chlorosolvent" facilities (plants 569, 913, and 2062) using the commenters definition of "chlorosolvents" as chlorinated

C1 and C2 hydrocarbons. These three plants use only physical/chemical controls to achieve their current discharge levels. However, of these three plants, only plant 913 reported BOD_5 data that provided a long-term average of 4 mg/l BOD_5. Since this is significantly below the plant's BPT long-term effluent compliance target of 21 mg/l BOD_5, the Agency concluded that plant 913 would comply with the BOD_5 effluent limitations without the use of biological treatment. The only other identified stand-alone chlorinated organics plant that did not use biological treatment was plant 1569, a manufacturer of chlorinated benzenes. This plant reported a long-term average BOD_5 discharge concentration of 18 mg/l, a level already below its BPT long-term effluent compliance target of 27 mg/l BOD_5. The Agency also identified three other manufacturers that produced "chlorosolvents" along with other products (plants 1532, 2770, and 2786); they reported long-term average BOD_5 discharge concentrations of 110, 140, and 80 mg/l, respectively--sufficient levels to sustain biota. In fact, the Agency identified 13 OCPSF plants that utilize biological treatment systems with reported influent BOD_5 concentration less than 125 mg/l. The influent concentrations for seven of these plants range from 60 to 80 mg/l BOD_5. Furthermore, another plant (725) sampled by EPA has an activated sludge system that treats wastewater with a 37 mg/l BOD_5 average influent concentration. The product mix at this facility included tetrachloroethylene and chlorinated paraffins.

The nonbiological wastewater treatment performance information for OCPSF plants that reported influent and effluent BOD_5 and/or TSS data is listed in Table VII-43. As shown, the ranges of BOD_5 and TSS percent removals are 27 to 98 percent and 0 to 91 percent, respectively. Some of these systems include clarification treatment, but in combination with other physical/chemical wastewater treatment unit operations.

In an effort to identify performance data for physical/chemical clarification treatment systems treating BOD_5 and TSS, the Agency was able to obtain influent and effluent BOD_5 and TSS data for clarification systems at pulp, paper, and paperboard mills. Table VII-44 presents performance data for clarification systems at 27 mills, and the data show that clarification systems can obtain significant removals of both TSS and BOD_5 as well as reducing TSS levels in raw wastewaters to levels comparable to BPT Option I

TABLE VII-43.
PERFORMANCE OF OCPSF NONBIOLOGICAL WASTEWATER TREATMENT SYSTEMS

Plant ID	Pollutant Parameter	Reported Influent (mg/l)	Reported Effluent (mg/l)	% Removal	In-Place Treatment*
657	BOD_5	22	16	27	Collection basin, neutralization, oil separation
	TSS	47	17	64	
669	BOD_5	2804	56	98	Filtration, steam stripping, neutralization, oil skimming, dissolved air flotation, air stripping
	TSS	451	42	91	
938	BOD_5	--	--	--	Steam stripping, equalization, flocculation, hypochlorite addition, filtration, neutralization, primary clarification, settling pond
	TSS	226	27	88	
1688	BOD_5	--	142	--	Steam stripping, equalization, flocculation, neutralization, primary clarification
	TSS	235	46	80	
1776	BOD_5	--	--	--	Steam stripping, grit removal, oil skimming, neutralization
	TSS	100	100	0	
2055	BOD_5	237	168	29	Steam stripping, coagulation, flocculation, recycle basin, secondary clarification, polishing pond
	TSS	--	--	--	

*Individual plants may treat all process wastewater or a portion of the process wastewater by the reported treatment unit operations. Reported influent data may not precede all listed unit operations.

TABLE VII-44.
BOD_5 AND TSS REDUCTIONS BY CLARIFICATION
AT SELECTED PULP, PAPER, AND PAPERBOARD MILLS

Mill No.	Subcategory	Type Clarification	BOD_5 Influent Concentration (mg/l)	BOD_5 Effluent Concentration (mg/l)	BOD_5 % Reduction	TSS Influent Concentration (mg/l)	TSS Effluent Concentration (mg/l)	TSS % Reduction	Data Source
140026	SF-Misc.	Primary	416	275	34	1,149	188	84	1977 308 Survey
140027	SF-Misc.	Primary	515	317	38	1,865	114	94	1977 308 Survey
14008	Deink-F	Primary	634	405	36	1,645	378	77	1977 308 Survey
140021	Deink-T	Primary	747	286	62	1,937	67	97	1981 Long-Term Sampling
140025	Deink-T	Primary	575	260	55	2,583	224	91	1977 308 Survey
080041	NI-Fine	Primary	137	36.9	73	344	51.5	85	Supplemental Data
100005	Tis fwp	Primary	305	171	44	2,313	173	92	Supplemental Data
		Secondary	120	73	39	171	45.7	73	Supplemental Data
030044	Int. Misc.	Primary	327	200	39	641	162	75	Supplemental Data
080046	NI-Fine	Primary	222	116	48	521	43.7	92	Supplemental Data
040009	PG-S	Primary	675	530	21	358	112	69	Supplemental Data
030051	Alk-F	Primary	658	525	20	348	124	64	Supplemental Data
030027	Alk-F	Primary	355	255	28	531	146	73	Supplemental Data
080027	NI-F	Primary	379	155	59	1,062	175	84	Supplemental Data
		Secondary	54	31	42	193	17.2	91	Supplemental Data
040010	PG-S	Primary	104	29.8	71	253	20.4	92	Supplemental Data
090008	NI-T	Primary	142	39.5	72	613	13	98	Supplemental Data
090022	NI-T	Primary	188	45.7	76	510	42	92	Supplemental Data
140019	Deink-F	Primary	648	403	38	3,753	391	90	Supplemental Data
030005	Mkt-BK	Primary	315	344	0	431	76.1	82	Supplemental Data
015001	UBK&SC	Primary	224	203.9	9	499	104.7	79	Supplemental Data
105024	NI-Misc.	Primary	34.2	7.4	78	169	10.7	94	Verification Study
105067	NI-Misc.	Primary	31.9	12.3	61	903	5.3	99	Verification Study
040013	PG-S	Primary	222	156	30	468	93.4	80	Verification Study
		Secondary	170	154	9	119	86	28	Verification Study
105055	NI-F&NW	Primary	37.9	24.2	36	145	60.4	58	Verification Study
090022	NI-T	Primary	182	49.5	73	464	37.3	92	Verification Study
100005	TFWP	Primary	336	174	48	3,785	366	90	Verification Study
110043	PBFWP	Primary	914	594	35	3,198	131	96	Verification Study
030047	BCT BK	Primary	479	295	38	1,160	138	88	Verification Study
		Secondary	61.6	41.1	33	78.7	38.8	51	Verification Study

long-term average levels in a wastewater matrix containing low BOD_5 levels. In addition, for these plants BOD_5 effluent values are also comparable to BPT Option I long-term average levels.

Based on the discussion and the performance data presented above, the Agency concludes that:

- There are a limited number of OCPSF plants with either no treatment or physical/chemical treatment in-place (which have BOD_5 and TSS effluent data) that are not in compliance with the BOD_5 and TSS BPT long-term average effluent compliance targets and have not had BPT compliance costs estimated based on biological treatment.

- There are a limited number of OCPSF plants with either no treatment or physical/chemical treatment in-place (which have BOD_5 and TSS effluent data) that are in compliance with BOD_5 but not in compliance with TSS BPT Option I long-term average effluent compliance targets.

- BPT Option I long-term averages for BOD_5 and TSS, which are based on the performance of biological treatment, can be attained by physical/chemical treatment systems either in-place or used by the Agency to estimate BPT compliance costs (i.e., chemically assisted clarification).

Furthermore, compliance with BAT toxic pollutant effluent limitations guidelines based on installation of physical/chemical or biological treatment or improvements in the design and operation of in-place treatment would also result in incidental reductions of conventional pollutants.

For these reasons, the Agency has decided not to establish a separate set of BPT effluent limitations for OCPSF plants that do not require biological treatment to comply with BPT.

4. BAT Treatment Systems

The Agency promulgated BAT limitations for two subcategories that were largely determined by raw waste characteristics. First, the end-of-pipe biological treatment subcategory includes plants that have or will install biological treatment to comply with BPT limits. Second, the non-end-of-pipe biological treatment subcategory includes plants that either generate such low levels of BOD_5 that they do not need biological treatment or choose to use physical/chemical treatment alone to comply with the BPT limitations for BOD_5. The BAT limitations are based on the performance of the biological treatment component plus in-plant control technologies that remove priority pollutants prior to discharge to the end-of-pipe treatment system. These in-plant technologies include steam stripping to remove volatile and semivolatile priority pollutants, activated carbon for various base/neutral priority pollutants, chemical precipitation for metals, cyanide destruction for cyanide, and in-plant biological treatment for removal of polynuclear aromatic (PNA) and other biodegradable priority pollutants. Table VII-45 presents a list of the regulated BAT toxic pollutants and the technology basis for the final BAT Subcategory One and Two effluent limitations for each. Tables VII-46 and VII-47 present a summary of the long-term weighted average effluent concentrations for the final BAT toxic pollutant data base for BAT Subcategory One and Subcategory Two. The minimum, maximum, and median of the plant's weighted average effluent concentrations were calculated for each pollutant to display the performance of well-operated treatment systems in the OCPSF industry.

F. WASTEWATER DISPOSAL

1. Introduction

The method of treatment for direct and indirect dischargers was discussed in Sections C and D. In this section the treatment processes and disposal methods associated with zero or alternate discharge in the OCPSF industry are described. Zero or alternate discharge at the OCPSF plant is defined as no discharge of contaminated process wastewater to either surface water bodies or to POTWs. Table VII-48 presents the frequency of waste stream final discharge and disposal techniques. This section describes deep well injection (56 OCPSF plants), contract hauling (128 plants), incineration (93 plants), evaporation (29 plants), surface impoundment (25 plants), and land application (19 plants).

2. Deep Well Injection

Deep well injection is a process used for the ultimate disposal of wastes. The wastes are disposed by injecting them into wells at depths of up to 12,000 ft. The wastes must be placed in a geological formation that prevents the migration of the wastes to the surface or to groundwater

TABLE VII-45.
LIST OF REGULATED TOXIC POLLUTANTS AND THE TECHNOLOGY BASIS
FOR BAT SUBCATEGORY ONE AND TWO EFFLUENT LIMITATIONS

Poll't. No.	Pollutant Name	BAT Subcategory One End-of-Pipe Biological Treatment Plus	BAT Subcategory Two
1	Acenaphthene	In-Plant Biological	In-Plant Biological
3	Acrylonitrile	In-Plant Biological	In-Plant Biological
4	Benzene	Steam Stripping	Steam Stripping
6	Carbon Tetrachloride	Steam Stripping	Steam Stripping*
7	Chlorobenzene	Steam Stripping	Steam Stripping*
8	1,2,4-Trichlorobenzene	Steam Stripping	Steam Stripping*
9	Hexachlorobenzene	Steam Stripping	Steam Stripping
10	1,2-Dichloroethane	Steam Stripping	Steam Stripping*
11	1,1,1-Trichloroethane	Steam Stripping	Steam Stripping
12	Hexachloroethane	Steam Stripping	Steam Stripping*
13	1,1-Dichloroethane	Steam Stripping**	Steam Stripping
14	1,1,2-Trichloroethane	Steam Stripping	Steam Stripping
16	Chloroethane	Steam Stripping	Steam Stripping
23	Chloroform	Steam Stripping	Steam Stripping
24	2-Chlorophenol	(Biological Only)	Reserved
25	1,2-Dichlorobenzene	Steam Stripping	Steam Stripping*
26	1,3-Dichlorobenzene	Steam Stripping	Steam Stripping*
27	1,4-Dichlorobenzene	Steam Stripping	Steam Stripping*
29	1,1-Dichloroethylene	Steam Stripping	Steam Stripping
30	1,2-Trans-Dichloroethylene	Steam Stripping	Steam Stripping
31	2,4-Dichlorophenol	(Biological Only)	Reserved
32	1,2-Dichloropropane	Steam Stripping	Steam Stripping*
33	1,3-Dichloropropene	Steam Stripping	Steam Stripping*
34	2,4-Dimethylphenol	In-Plant Biological	In-Plant Biological
35	2,4-Dinitrotoluene	(Biological Only)	Reserved
36	2,6-Dinitrotoluene	(Biological Only)	Reserved
38	Ethylbenzene	Steam Stripping	Steam Stripping*

TABLE VII-45.
LIST OF REGULATED TOXIC POLLUTANTS AND THE TECHNOLOGY BASIS
FOR BAT SUBCATEGORY ONE AND TWO EFFLUENT LIMITATIONS
(Continued)

Poll't. No.	Pollutant Name	BAT Subcategory One End-of-Pipe Biological Treatment Plus	BAT Subcategory Two
39	Fluoranthene	In-Plant Biological	In-Plant Biological
42	Bis(2-Chloroisopropyl)Ether	Steam Stripping	Steam Stripping*
44	Methylene Chloride	Steam Stripping	Steam Stripping
45	Methyl Chloride	Steam Stripping	Steam Stripping
52	Hexachlorobutadiene	Steam Stripping	Steam Stripping*
55	Naphthalene	In-Plant Biological	In-Plant Biological
56	Nitrobenzene	Steam Stripping and Activated Carbon	Steam Stripping and Activated Carbon
57	2-Nitrophenol	Activated Carbon	Activated Carbon
58	4-Nitrophenol	Activated Carbon	Activated Carbon
59	2,4-Dinitrophenol	Activated Carbon	Activated Carbon
60	4,6-Dinitro-o-Cresol	Activated Carbon**	Activated Carbon
65	Phenol	In-Plant Biological	In-Plant Biological
66	Bis(2-Ethylhexyl)Phthalate	In-Plant Biological	In-Plant Biological
68	Di-N-butyl Phthalate	In-Plant Biological	In-Plant Biological
70	Diethyl Phthalate	In-Plant Biological	In-Plant Biological
71	Dimethyl Phthalate	In-Plant Biological	In-Plant Biological
72	Benzo(a)Anthrancene	In-Plant Biological	In-Plant Biological
73	Benzo(a)Pyrene	In-Plant Biological	In-Plant Biological
74	3,4-Benzofluoranthene	In-Plant Biological	In-Plant Biological
75	Benzo(k)Fluoranthene	In-Plant Biological	In-Plant Biological
76	Chrysene	In-Plant Biological	In-Plant Biological
77	Acenaphthylene	In-Plant Biological	In-Plant Biological
78	Anthracene	In-Plant Biological	In-Plant Biological
80	Fluorene	In-Plant Biological	In-Plant Biological
81	Phenanthrene	In-Plant Biological	In-Plant Biological

TABLE VII-45.
LIST OF REGULATED TOXIC POLLUTANTS AND THE TECHNOLOGY BASIS FOR BAT SUBCATEGORY ONE AND TWO EFFLUENT LIMITATIONS
(Continued)

Poll't. No.	Pollutant Name	BAT Subcategory One End-of-Pipe Biological Treatment Plus	BAT Subcategory Two
84	Pyrene	In-Plant Biological	In-Plant Biological
85	Tetrachloroethylene	Steam Stripping	Steam Stripping
86	Toluene	Steam Stripping	Steam Stripping
87	Trichloroethylene	Steam Stripping	Steam Stripping
88	Vinyl Chloride	Steam Stripping	Steam Stripping
119	Total Chromium	Hydroxide Precipitation***	Hydroxide Precipitation***
120	Total Copper	Hydroxide Precipitation***	Hydroxide Precipitation***
121	Total Cyanide	Alkaline Chlorination***	Alkaline Chlorination***
122	Total Lead	Hydroxide Precipitation***	Hydroxide Precipitation***
124	Total Nickel	Hydroxide Precipitation***	Hydroxide Precipitation***
128	Total Zinc	Hydroxide Precipitation***	Hydroxide Precipitation***

*Steam stripping performance data transferred based on Henry's Law Constant groupings.

**Transferred from Subcategory Two.

***Metals and cyanide limitations based on hydroxide precipitation and alkaline chlorination, respectively, only apply at the process source.

TABLE VII-46.
SUMMARY OF THE LONG-TERM WEIGHTED AVERAGE EFFLUENT CONCENTRATIONS FOR THE FINAL BAT TOXIC POLLUTANT DATA BASE FOR BAT SUBCATEGORY ONE

Pollutant Number	Pollutant Name	Number of Plants	Median of Est. Long-Term Means (ppb)	Minimum of Est. Long-Term Means (ppb)	Maximum of Est. Long-Term Means (ppb)
1	Acenaphthene	3	10.000	10.000	13.00
3	Acrylonitrile	5	50.000	50.000	122.67
4	Benzene	17	10.000	10.00	16.62
6	Carbon Tetrachloride	3	10.000	10.00	10.00
7	Chlorobenzene	2	10.000	10.00	10.00
8	1,2,4-Trichlorobenzene	3	42.909	10.00	69.46
9	Hexachlorobenzene	1	10.000	10.00	10.00
10	1,2-Dichloroethane	9	25.625	10.00	1228.33
11	1,1,1-Trichloroethane	2	10.000	10.00	10.00
12	Hexachloroethane	2	10.000	10.00	10.00
14	1,1,2-Trichloroethane	3	10.000	10.00	10.00
16	Chloroethane	4	50.000	50.00	50.00
23	Chloroform	8	12.208	10.00	43.00
24	2-Chlorophenol	3	10.000	10.00	93.30
25	1,2-Dichlorobenzene	7	47.946	10.00	88.20
26	1,3-Dichlorobenzene	1	24.800	24.80	24.80
27	1,4-Dichlorobenzene	1	10.000	10.00	10.00
29	1,1-Dichloroethylene	5	10.000	10.00	11.60
30	1,2-Trans-dichloroethylene	3	10.000	10.00	77.67
31	2,4-Dichlorophenol	3	17.429	10.00	21.62
32	1,2-Dichloropropropane	6	121.500	13.19	923.00
33	1,3-Dichloropropene	3	23.000	10.25	63.33
34	2,4-Dimethylphenol	4	10.794	10.00	13.47
35	2,4-Dinitrotoluene	2	58.833	10.00	107.67
36	2,6-Dinitrotoluene	2	132.667	10.00	255.33
38	Ethylbenzene	14	10.000	10.00	10.00
39	Fluoranthene	3	11.533	10.13	12.27
42	Bis(2-Chloroisopropyl)Ether	1	156.667	156.67	156.67
44	Methylene Chloride	8	22.956	10.00	206.67
45	Methyl Chloride	1	50.000	50.00	50.00
52	Hexachlorobutadiene	2	10.000	10.00	10.00

TABLE VII-46.
SUMMARY OF THE LONG-TERM WEIGHTED AVERAGE EFFLUENT CONCENTRATIONS FOR THE FINAL BAT TOXIC POLLUTANT DATA BASE FOR BAT SUBCATEGORY ONE
(Continued)

Pollutant Number	Pollutant Name	Number of Plants	Median of Est. Long-Term Means (ppb)	Minimum of Est. Long-Term Means (ppb)	Maximum of Est. Long-Term Means (ppb)
55	Naphthalene	10	10.000	10.00	10.21
56	Nitrobenzene	4	14.000	14.00	149.67
57	2-Nitrophenol	2	27.525	20.00	35.05
58	4-Nitrophenol	3	50.000	50.00	145.00
59	2,4-Dinitrophenol	3	50.000	50.00	105.35
65	Phenol	22	10.363	10.00	120.00
66	Bis(2-Ethylhexyl)Phthalate	2	47.133	43.45	50.81
68	Di-N-Butyl Phthalate	2	17.606	13.09	22.12
70	Diethyl Phthalate	2	42.500	23.67	61.33
71	Dimethyl Phthalate	2	10.000	10.00	10.00
72	Benzo(a)Anthracene	2	10.000	10.00	10.00
73	Benzo(a)Pyrene	1	10.333	10.33	10.33
74	3,4-Benzofluoranthene	1	10.267	10.27	10.27
75	Benzo(K)Fluoranthene	1	10.000	10.00	10.00
76	Chrysene	3	10.000	10.00	10.00
77	Acenaphthylene	3	10.000	10.00	13.00
78	Anthracene	3	10.000	10.00	10.00
80	Fluorene	3	10.000	10.00	10.00
81	Phenanthrene	6	10.000	10.00	17.92
84	Pyrene	3	11.333	10.33	16.00
85	Tetrachloroethylene	3	10.423	10.00	227.00
86	Toluene	24	10.000	10.00	102.67
87	Trichloroethylene	4	10.000	10.00	16.00
88	Vinyl Chloride	3	50.000	50.00	174.00

TABLE VII-47.
SUMMARY OF THE LONG-TERM WEIGHTED AVERAGE EFFLUENT CONCENTRATIONS FOR THE FINAL BAT TOXIC POLLUTANT DATA BASE FOR BAT SUBCATEGORY TWO

Pollutant Number	Pollutant Name	Number of Plants	Median of Est. Long-Term Means (ppb)	Minimum of Est. Long-Term Means (ppb)	Maximum of Est. Long-Term Means (ppb)
1	Acenaphthene	1	10.000	10.000	10.00
3	Acrylonitrile	1	50.000	50.000	50.00
4	Benzene	4	28.576	10.00	200.33
6	Carbon Tetrachloride	-	64.500	64.50	64.50
7	Chlorobenzene	-	64.500	64.50	64.50
8	1,2,4-Trichlorobenzene	-	64.722	64.72	64.72
9	Hexachlorobenzene	-	64.722	64.72	64.72
10	1,2-Dichloroethane	2	64.722	62.77	66.67
11	1,1,1-Trichloroethane	1	10.000	10.00	10.00
12	Hexachloroethane	-	64.722	64.72	64.72
13	1,1-Dichloroethane	1	10.000	10.00	10.00
14	1,1,2-Trichloroethane	2	10.293	10.00	10.59
16	Chloroethane	2	50.000	50.00	50.00
23	Chloroform	2	44.108	11.81	76.41
25	1,2-Dichlorobenzene	-	64.722	64.72	64.72
26	1,3-Dichlorobenzene	-	64.500	64.50	64.50
27	1,4-Dichlorobenzene	-	64.500	64.50	64.50
29	1,1-Dichloroethylene	2	10.052	10.00	10.10
30	1,2-Trans-dichloroethylene	2	11.052	10.00	12.10
32	1,2-Dichloropropane	-	64.722	64.72	64.72
33	1,3-Dichloropropene	-	64.722	64.72	64.72
34	2,4-Dimethylphenol	1	10.000	10.00	10.00
38	Ethylbenzene	-	64.500	64.50	64.50
39	Fluoranthene	1	11.533	11.53	11.53
42	Bis(2-Chloroisopropyl)Ether	-	64.722	64.72	64.72
44	Methylene Chloride	3	10.800	10.00	30.33
45	Methyl Chloride	1	50.000	50.00	50.00
52	Hexachlorobutadiene	-	64.500	64.50	64.50

TABLE VII-47.
SUMMARY OF THE LONG-TERM WEIGHTED AVERAGE EFFLUENT CONCENTRATIONS FOR THE FINAL BAT TOXIC POLLUTANT DATA BASE FOR BAT SUBCATEGORY TWO
(Continued)

Pollutant Number	Pollutant Name	Number of Plants	Median of Est. Long-Term Means (ppb)	Minimum of Est. Long-Term Means (ppb)	Maximum of Est. Long-Term Means (ppb)
55	Naphthalene	1	10.000	10.00	10.00
56	Nitrobenzene	2	948.675	712.60	1184.75
57	2-Nitrophenol	1	20.000	20.00	20.00
58	4-Nitrophenol	1	50.000	50.00	50.00
59	2,4-Dinitrophenol	1	373.000	373.00	373.00
60	4,6-Dinitro-O-Cresol	1	24.000	24.00	24.00
65	Phenol	1	10.000	10.00	10.00
66	Bis(2-Ethylhexyl)Phthalate	1	43.455	43.45	43.45
68	Di-N-Butyl Phthalate	1	13.091	13.09	13.09
70	Diethyl Phthalate	1	23.667	23.67	23.67
71	Dimethyl Phthalate	1	10.000	10.00	10.00
72	Benzo(a)Anthracene	1	10.000	10.00	10.00
73	Benzo(a)Pyrene	1	10.333	10.33	10.33
74	3,4-Benzofluoranthene	1	10.267	10.27	10.27
75	Benzo(k)Fluoranthene	1	10.000	10.00	10.00
76	Chrysene	1	10.000	10.00	10.00
77	Acenaphthylene	1	10.000	10.00	10.00
78	Anthracene	1	10.000	10.00	10.00
80	Fluorene	1	10.000	10.00	10.00
81	Phenanthrene	1	10.000	10.00	10.00
84	Pyrene	1	10.333	10.33	10.33
85	Tetrachloroethylene	1	18.429	18.43	18.43
86	Toluene	2	12.418	10.951	13.88
87	Trichloroethylene	2	11.586	10.00	13.17
88	Vinyl Chloride	2	64.500	50.00	79.00

TABLE VII-48.
FREQUENCY OF WASTE STREAM FINAL DISCHARGE
AND DISPOSAL TECHNIQUES

Disposal Technique	No. of Plants (Full Response)	No. of Plants (Part A)	Total No. of Plants
Direct Discharge to Surface Water	250	54	304
Discharge to Publicly Owned Treatment Works	287	106	393
Discharge to Privately Owned Off-Site Treatment Facilities	6	35	41
Deep Well Injection	32	24	56
Contract Hauling	82	46	128
Incineration	63	30	93
Land Application	0	19	19
Evaporation	13	16	29
Surface Impoundment	8	17	25
Recycle	36	0	36

NOTE: Combined direct and indirect discharges have been counted with the direct dischargers; otherwise, remaining disposal techniques can be double-counted for applicable plants.

supplies. The most suitable site for deep well injection is a porous zone of relatively low to moderate pressure that is sealed above and below by unbroken impermeable strata. Limestones, sandstones, and dolomites are among the rock types most frequently used because of their relatively high porosity. The formation chosen must have sufficient volume to contain the waste without resulting in an increase in the hydraulic pressure, which could lead to a crack in the confining rock layers.

The most significant hindrance to the application of deep well injection is the potential for groundwater and surface water contamination. Careful control of the process is necessary to prevent any contamination, and injection should only be used in certain geographically acceptable areas. The process is also limited to waste streams with low levels of suspended solids to prevent plugging of the well screen which can cause unstable operation. Pretreatment such as filtration can prevent clogging of the screen and the disposal aquifer. Another practical limitation is that waste streams to be injected should have a pH value between 6.5 and 8.0 to prevent equipment corrosion. In general, all streams subject to deep well injection are treated through equalization, neutralization, and filtration before disposal. Deep well injection may be particularly attractive for disposal of inhibitory or toxic organic waste streams.

According to the Section 308 Questionnaire data base, 56 OCPSF plants use deep well injection as a means for ultimate disposal for all or a portion of their wastes.

3. Off-Site Treatment/Contract Hauling

Off-site treatment refers to wastewater treatment at a site other than the generation site. Off-site treatment may occur at a cooperative or privately owned centralized facility. Often a contract hauler/disposer is paid to pick up the wastes at the generation site and to haul them to the treatment facility. The hauling may be accomplished by truck, rail, or barge.

Off-site treatment/contract hauling is usually limited to low volume wastes, many of which may require specialized treatment technologies for proper disposal. Generators of these wastes often find it more economical to treat the wastes at off-site facilities than to install their own treatment system. Sometimes, adjacent plants find it more feasible to install a centralized facility to handle all wastes from their sites. The costs usually are shared by the participants on a prorated basis.

According to the Section 308 Questionnaire data base, 128 plants use contract hauling and off-site treatment as a final disposal technique for part or all of their wastes.

4. Incineration

Incineration is a frequently used zero discharge method in the OCPSF industry. The process involves the oxidation of solid, liquid, or gaseous combustible wastes primarily to carbon dioxide, water, and ash. Depending upon the heat value of the material being incinerated, incinerators may or may not require auxiliary fuel. The gaseous combustion or composition products may require scrubbing, particulate removal, or another treatment to capture materials that cannot be discharged to the atmosphere. This treatment may generate a waste stream that ultimately will require some degree of treatment. Residue left after oxidation will also require some means of disposal.

Incineration is usually used for the ultimate disposal of flammable liquids, tars, solids, and hazardous waste materials of low volume that are not amenable to the usual end-of-pipe treatment technologies. To achieve efficient destruction of the waste materials by incineration, accurate and reliable information on the physical and chemical characteristics of the waste must be acquired in order to determine appropriate operating conditions for the process (e.g., feed rates, residence time, and temperature) and the required destruction efficiency.

According to the Section 308 Questionnaire data base, 93 OCPSF plants use incineration as an ultimate disposal technique.

5. Evaporation

Evaporation is a concentration process involving removal of water from a solution by vaporization to produce a concentrated residual solution. The energy source may be synthetic (steam, hot gases, and electricity) or natural (solar and geothermal). Evaporation equipment can range from simple open tanks or impoundments to sophisticated multi-effect evaporators capable of handling large volumes of liquid. The evaporation process is designed on the basis of the quantity of water to be evaporated, the quantity of heat required to evaporate water from solution, and the heat transfer rate. The process offers the possibility of total wastewater elimination with only the remaining concentrated solution requiring disposal and also offers the possibility of recovery and recycle of useful chemicals from wastewater.

According to the Section 308 Questionnaire date base, 29 OCPSF plants use evaporation as a final disposal technique.

6. Surface Impoundment

Impoundment generally refers to wastewater storage in large ponds. Alternate or zero discharge from these facilities relies on the natural losses by evaporation, percolation into the ground, or a combination thereof. Evaporation is generally feasible if precipitation, temperature, humidity, and wind velocity combine to cause a net loss of liquid in the pond. Surface impoundments are usually of shallow depth and large surface area to encourage evaporation. If a net loss does not exist, recirculating sprays, heat, or aeration can be used to enhance the evaporation rate to provide a net loss. The rate of percolation of water into the ground is dependent on the subsoil conditions of the area of pond construction. Since there is a great potential for contamination of the shallow aquifer from percolation, impoundment ponds are frequently lined or sealed to avoid percolation and thereby make the basins into evaporation ponds. Solids that accumulate over a period of time in these sealed ponds will eventually require removal. Land area requirements are a major factor limiting the amount of wastewater disposed of by this method.

According to the Section 308 Questionnaire data base, 25 OCPSF plants report using surface impoundments as a final disposal technique.

7. Land Application

Land treatment is the direct application of wastewater onto land with treatment being provided by natural processes (chemical, physical, and biological) as the effluent moves through a vegetative cover or the soil. Land application greatly reduces or eliminates BOD_5 and suspended solids, results in some nutrient removal, may result in some heavy metal removal, and can recharge groundwater. A portion of the wastewater is lost to the atmosphere through evapotranspiration, part to surface water by overland flow, and the remainder percolates to the groundwater system.

Land disposal of industrial wastewaters must be compatible with land use and take into consideration the potential for environmental pollution, damage to crops, and entrance into the human food chain. To protect soil fertility and the food chain during land disposal, it is necessary to determine the capacity of soils to remove nitrogen, the potential toxicity of organic and inorganic contaminants to plant life and soil, and the deleterious effects of dissolved salts, including sodium, on plants and soil.

According to the Section 308 Questionnaire data base, 19 OCPSF plants report using land application as a final disposal technique.

G. SLUDGE TREATMENT AND DISPOSAL

Solid residues (sludge) are generated by many wastewater treatment processes discussed in previous sections of this chapter. Sludge is generated primarily in biological treatment, chemical precipitation (coagulation/flocculation), and chemically assisted clarifiers. Sludge must be treated to reduce its volume and to render it inoffensive before it can be disposed. Sludge treatment alternatives include thickening, stabilization, conditioning, and dewatering. Disposal options include combustion and disposal to land. The frequency of these treatment and disposal alternatives, according to the Section 308 Quesionnaire data base, is presented in Table VII-49.

TABLE VII-49.
FREQUENCY OF SLUDGE HANDLING, TREATMENT, AND DISPOSAL TECHNIQUES

	Direct		Indirect		Other Discharge		Total
Treatment Technology	# of Full-Resp Plants With Tech.	# of Part A Plants With Tech.	# of Full-Resp Plants With Tech.	# of Part A Plants With Tech.	# of Full-Resp Plants With Tech.	# of Part A Plants With Tech.	# of Plants With Technology
Thickening	0	23	1	10	0	2	36
Centrifugation	2	1	0	1	0	0	4
Filtration	1	2	0	1	0	0	4
Digestion	0	13	0	8	0	1	22
On-Site Landfill	8	11	1	1	0	0	21
Incineration	2	12	1	0	0	0	15
Contract Hauling	6	6	4	2	0	0	18
Off-Site Landfill	5	12	4	25	0	4	50
Dissolved Air Flotation (DAF) Thickening	0	18	0	30	0	2	50

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. The principal purposes of stabilization are to make the sludge less odorous and putrescible, and to reduce 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 two most common methods used to condition sludge are thermal and chemical conditioning. Dewatering, the removal of water from solids to achieve a volume reduction greater than that achieved by thickening, is desirable to prepare sludge for disposal and to reduce the sludge volume and mass to achieve lower transportation and disposal costs. Some common dewatering methods include vacuum filtration, filter press, belt filter, centrifuge, thermal, drying beds, and lagoons. 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 may include discharges to the atmosphere (particles and other toxic or noxious emissions), surface waters (scrubbing water), and land (ash). Disposal of sludge to land may include the application of the sludge (usually biological treatment sludge) on land as a soil conditioner and as a source of fertilizer for plants, or the stockpiling of sludge 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.

According to the Section 308 Questionnaire data base, 116 plants report treating their sludge by thickening or dewatering (26 by thickening, 4 by centrifugation, 4 by filtration, 22 by digestion, and 50 by dissolved air flotation). Of the 104 plants reporting sludge disposal methods, 21 use on-site landfills, 15 employ incineration, 18 use contract hauling, and 50 dispose of sludge at off-site landfills.

H. LIMITATIONS DEVELOPMENT

This section describes the methodology used to develop BPT, BAT, and PSES effluent limitations and standards and includes discussions of data editing criteria, derivation of long-term averages, and derivation of "Maximum for Monthly Average" and "Maximum for Any One Day" variability factors.

1. BPT Effluent Limitations

As discussed in Section VI, the Agency decided to control BOD_5 and TSS under BPT. This section discusses the data editing rules and methodology used to derive the final BPT effluent limitations guidelines for BOD_5 and TSS.

a. Data Editing Criteria

Two sets of data editing rules were developed for BPT; one set was used to edit the data base, which was utilized to calculate the long-term averages (LTA) BOD_5 and TSS values for each subcategory, while the second set was used to edit the BPT daily data base, which was utilized to derive variability factors.

b. LTA Data Editing

The two major forms of data editing performed on the LTA data base obtained through the 1983 Section 308 Questionnaire were the dilution adjustment assessments made for each full-response, direct discharge OCPSF facility which submitted BOD_5 or TSS influent and/or effluent data and a BPT performance edit.

Dilution Adjustment - Since the limitations apply to all process wastewater as defined in Section V, the Agency grouped all volumes of process and non-process wastewater for the purpose of adjusting reported plant-level BOD_5 and TSS concentrations for dilution by nonprocess wastewater. This also permitted the Agency to estimate engineering costs of compliance based on the proper process wastewater flows and conventional pollutant concentrations. For example, if BOD_5 was reported as 28 mg/l at the final effluent sampling location with 1 MGD of process wastewater flow that was combined with 9 MGD of uncontaminated nonprocess cooling water flow, then the BOD_5 concentration in the process wastewater alone was actually 280 mg/l before dilution. This conservatively assumes that the cooling water flow is free of BOD_5 and TSS.

However, in the Agency's judgment, many of the sources and flows reported as nonprocess wastewater by plants in their respective Section 308 Questionnaires are contaminated by process sources of BOD_5 and TSS. Table VII-50 presents a list of the miscellaneous wastewaters reported in the Section 308 Questionnaires as nonprocess, which EPA has determined to be either contaminated (and therefore process wastewater) or uncontaminated with conventional pollutants. The Agency reviewed this list after receiving public comments on both NOAs criticizing some of its assignments and determined that, in general, its assignments were correct.

Since the limitations apply to process wastewater (which includes "contaminated nonprocess" wastewater) only, the relative contributions of process wastewater versus "uncontaminated nonprocess" wastewater were determined at the influent and effluent sample sites. These data were used to calculate plant-by-plant "dilution factors" for use in adjusting pollutant concentrations at influent and effluent sampling locations as appropriate.

The general procedure for determining sample-site dilution factors and adjusting BOD_5 and TSS values was as follows:

- Sum uncontaminated nonprocess wastewater flows for an individual plant (e.g., Plant No. 61 uncontaminated nonprocess wastewater flow = 0.280 MGD)

- Sum process wastewater flow for an individual plant (e.g., Plant No. 61 process wastewater flow = 0.02 MGD)

- Divide the sum of uncontaminated nonprocess wastewater flows by the total process wastewater flow to determine dilution factor (e.g., for Plant No. 61, 0.280 MGD/ 0.02 MGD = 14.0)

- Apply the sample-site dilution factor (plus 1) by multiplying by the reported BOD_5 or TSS value to be adjusted (e.g., for Plant No. 61, 196 mg/l effluent BOD_5 x (14.0 + 1) = 2,940 mg/l effluent BOD_5.

TABLE VII-50.
CONTAMINATED AND UNCONTAMINATED MISCELLANEOUS "NONPROCESS" WASTEWATERS REPORTED IN THE 1983 SECTION 308 QUESTIONNAIRE

Contaminated "Nonprocess" Wastewaters (therefore designated as process wastewater)	Uncontaminated Nonprocess Wastewaters
Air Pollution Control Wastewater (B5)	Non-Contact Cooling Water (B1)
Sanitary (receiving biological treatment) (B4)	Sanitary (no biological treatment, direct discharge) (B4)
Boiler Blowdown	Cooling Tower Blowdown (B2)
Sanitary (indirect discharge)	Stormwater Site Runoff (B3)
Steam Condensate	Deionized Water Regeneration
Vacuum Pump Seal Water	Miscellaneous Wastewater (conditional)
Wastewater Stripper Discharge	Softening Regeneration
Bi from Vertac	Ion Exchange Regeneration
Boiler Feedwater Lime	River Water intake
Softener Blowdown	Make-up Water
Contaminated Water Offsite	Fire Water Make-up
Condensate	Tank Dike Water
Storage, Lans, Shops	Demineralizer Regenerant
Laboratory Waste	Dilution Water
Steam Jet Condensate	Condensate Losses
Water Softener Backwashing	Shipping Drains
Miscellaneous Lab Wastewater	Water Treatment Blowdown
Raw Water Clarification	Cooling Tower Overflow
Landfill Leachate	Chilled Water Sump Overflow
Water Treatment	Air Compressor and Conditioning Blow
Technical Center	Firewall Drainings
Scrubber Water	Other Non-contact Cooling
Utility Streams	Miscellaneous Leaks and Drains
Washdown N-P Equipment	Boiler House Softeners
Contact Cooling Water	Fire Pond Overflow
Vacuum Steam Jet Blowdown	Boiler Regeneration Backwash
Densator Blowdown	Groundwater (Purge)
Bottom Ash-Quench Water	Firewater Discharge
Demineralizer Washwater	Freeze Protection Water

TABLE VII-50.
CONTAMINATED AND UNCONTAMINATED MISCELLANEOUS "NONPROCESS" WASTEWATERS
REPORTED IN THE 1983 SECTION 308 QUESTIONNAIRE
(Continued)

Contaminated "Nonprocess" Wastewaters (therefore designated as process wastewater)	Uncontaminated Nonprocess Wastewaters
Water Softening Backwash	H_2 and CO Generation
Lab Drains	Demineralizer Spent Regenerants
Closed Loop Equipment Overflow	Lime Softening of Process
Filter Backwash	Miscellaneous Service Water
Demineralizer Wastewater	Recirculating Cooling System
Laboratory Offices	HVAC Blowdown Lab Utility
Demineralizer Blowdown	Condenser Water Backwash
Utility Clarifier Blowdown	Deonfler Regenerant
Steam Generation	Raw Water Filter Backwash
RO Rejection Water	Distribution
Power House Blowdown	
Inert Gas Gen. Blowdown	
Contaminated Groundwater	
Potable Water Treatment	
Unit Washes	
Non-Contact Floor Cleaning	
Slop Water from Dist. Facilities	
Laboratory and Vacuum Truck	
Ion Bed Regeneration	
Tankcar Washing (HCN)	
Film Wastewater	
Generator Blowdown	
Air Sluice Water	
Research and Development	
Quality Control	
Steam Desuperheating	
Pilot Plant	
Other Company Off-site Waste	
Ion Exchange Resin Rinse	

TABLE VII-50.
CONTAMINATED AND UNCONTAMINATED MISCELLANEOUS "NONPROCESS" WASTEWATERS
REPORTED IN THE 1983 SECTION 308 QUESTIONNAIRE
(Continued)

Contaminated "Nonprocess" Wastewaters (therefore designated as process wastewater)	Uncontaminated Nonprocess Wastewaters
Iron Filter Backwash	
Area Washdown	
Vacuum Pump Wastewater	
Garment Laundry	
Hydraulic Leaks	
Grinder Lubricant	
Utility Area Process	
Contact Rainwater	
Alum Water Treatment	
Incinerator H_2O	
Product Wash	
Backflush from Demineralizer	
Water Clarifier Blowdown	
Water Treatment Filter Wash	
Equipment Cooling H_2O	
Belt Filter Wash	
Ejector	
OCPSF Flow from Another Plant	

Plant-specific dilution factor calculations and adjustments are summarized in Appendix VII-B.

BPT Performance Edits - As stated earlier in Section VII, the Agency has chosen BPT Option I (which is based on the performance of biological treatment only) as the technology basis for the final BPT effluent limitations. After selecting the technology basis, the Agency developed the associated limitations based on the "average-of-the-best" plants that use the BPT Option I technology. A performance criterion was developed to segregate the better designed and operated plants from the inadequate performers. This was done to ensure that the plant data relied upon to develop BPT limitations reflected the average of the best existing performers. Since the data base also included plants that are inadequate performers, it is necessary to develop appropriate criteria for differentiating poor from good plant performance. The BOD_5 criteria used for the March 21, 1983 Proposal, the July 17, 1985 and the December 8, 1986 Federal Register NOAs was to include in the data base any plants with a biological treatment system that, on the average 1) discharged 50 mg/l or less BOD_5 after treatment, or 2) removed 95 percent or more of the BOD_5 that entered the end-of-pipe treatment system.

The Agency has received two diametrically opposed sets of comments on the proposed data editing criteria used to develop BPT limitations. EPA proposed to select plants for analysis in developing limitations only if the plants achieve at least a 95 percent removal efficiency for BOD_5 or a long-term average effluent BOD_5 concentration below 50 mg/l. On one hand, many industry commenters argued that these criteria were too stringent, were based upon data collected after 1977 from plants that had already achieved compliance with BPT permits and thus raised the standard of performance above what it would have been had the regulation been promulgated in a timely manner, and had the effect of excluding from the BPT data base some well-designed, well-operated plants. An environmental interest group argued, in contrast, that the criteria were not stringent enough, in that they resulted in the inclusion of the majority of plants in the data base used to develop effluent limitations.

The data collected by EPA for the BPT regulation were indeed, as industry commenters have noted, based largely on post-1977 data. EPA had originally collected data in the early and mid-1970s that reflected OCPSF pollutant control practices at that time. As a result of industry challenges to EPA's ensuing promulgation of BPT (and other) limitations for the OCPSF industry, EPA began a new regulatory development program, which included a new series of data-gathering efforts (see Section I of this document). Industry commenters are correct in noting that the data are thus taken to a large extent from OCPSF plants that had already been issued BPT permits that required compliance by July 1977 with BPT limitations established by the permit writers on a case-by-case basis. It is thus fair to conclude that the performance of at least some of these plants was better when EPA collected the data for the new rulemaking effort than it had been in the mid-1970s when the original BPT regulations were promulgated.

EPA does not believe that the use of post-1977 data is improper. First, the Clean Water Act provides for the periodic revision of BPT regulations when appropriate. Thus it is within EPA's authority to write BPT regulations after 1977 and to base them on the best information available at the time. Moreover, it is not unfair to the industry. The final BPT regulations are based on the same technology that was used to effectively control BOD_5 and TSS in the 1970s--biological treatment preceded by appropriate process controls and in-plant treatment to ensure effective, consistent control in the biological system, and followed by secondary clarification as necessary to ensure adequate control of solids. The resulting effluent limitations are not necessarily more (or less) stringent than they would have been if based on pre-1977 data. Many of the plants that satisfy the final data editing criteria discussed below, and thus are included in the BPT data base, would not have satisfied those criteria in the mid-1970s. The improved performance wrought by the issuance of and compliance with BPT permits in the 1970's has resulted in EPA's ability in 1987 to use data from a larger number of plants to develop the BPT limitations. Approximately 72 percent of the plants for which data were obtained pass the final BOD_5 editing criteria (95 percent/40 mg/l for biological only treatment); the editing criteria have excluded other plants that, despite having BPT-type technology in-place, were determined not to meet the performance criteria used to establish the data base for support of BPT limitations. EPA concludes that the use of post-1977 data has resulted in a good quality but not unrealistic BPT data base.

EPA has modified the BOD_5 editing criteria to make them slightly more stringent. However, it must be noted that EPA does not consider the selection of editing criteria to be a strict numerical exercise based upon exclusion of data greater than a median or any other such measure. EPA specifically disagrees with the comment that data reflecting BPT performance must necessarily constitute performance levels better than a median. The criteria represent in numerical terms what is essentially an exercise of the Agency's judgment, informed in part by industry data, as to the general range of performance that should be attained by the range of diverse OCPSF plants operating well-designed biological systems properly. The numerical analyses discussed below should thus be regarded as an analytical tool that assisted EPA in exercising its judgment.

The data to which the criteria have been applied reflect the performance of plants that have been issued BPT permits requiring compliance with BPT permit limits. It is not unreasonable to expect, therefore, that the class of facilities identified as the "best" performers in the industry is considerably larger than it would have been had the data been collected in the mid-1970s. This result is consistent with the purpose and intent of the NPDES program: to require those plants performing below the level of the best performers to improve their performance. Moreover, it should be noted that while the majority of OCPSF plants pass the initial screening criteria, a majority of OCPSF plants (approximately 70 percent) will nonetheless need to upgrade their treatment systems' performance to comply with the BPT effluent limitations guidelines, based upon the reported effluent data (for 1980), and the long-term average targets for BOD_5 and TSS. The fact that a majority of plants will need to upgrade years after they received their initial BPT permits indicates that the result of the adoption of the data base used to develop the limitations is appropriately judged the best practicable treatment.

The editing criteria were applied to the "308" survey data, composed of annual average BOD_5 and TSS data from plants in the OCPSF industry. The purpose of the editing criteria was to establish a minimum level of treatment performance acceptable for admission of a plant's data into the data base that would be used to determine BPT limitations. First, only data from plants with suitable treatment (i.e., biological treatment) were considered for inclusion in the data base. For these plants, the use of both a percent removal criterion and an average effluent concentration criterion for BOD_5 is appropriate, since well-operated treatment can achieve either substantial removals and/or low effluent levels. In addition, use of only a percent removal criterion would exclude data from plants that submitted usable data but did not report influent data. The use of an effluent level criterion allowed the use of data from such plants in estimating the regression equation.

Following review of the data base, EPA continues to believe that 95 percent BOD_5 removal is an appropriate editing criterion. Over half the plants in the "308" survey data that reported both influent and effluent BOD_5 achieve better than 95 percent removal. The median removal for these plants is 95.8 percent, which reflects good removal from an engineering point of view.

The Agency also continues to believe that a cut-off for average effluent BOD_5 concentration is necessary to establish an acceptable standard of performance in addition to percent removal. In order to establish a cutoff value for the final regulation and respond to various comments, the Agency re-examined the "308" survey data. There are data from a total of 99 full response direct discharging plants with end-of-pipe biological treatment only (the selected BPT technology, as discussed below) that reported average effluent BOD_5 and a full range of information regarding production at the plant. All of these data were used in the evaluation of the BOD_5 cutoff, even in cases of plants that did not report influent values and for which removal efficiencies could therefore not be estimated. The median BOD_5 average effluent for these 99 plants is 29 mg/l. There is no engineering or statistical theory that would support the use of the median effluent concentration as a cutoff for developing a regulatory data base. In fact, there are many plants that, in the Agency's best judgment, achieve excellent treatment and have average effluent values greater than the overall median of 29. There are many reasonable explanations for differences in average effluent levels at well operated plants. Differences in a plant's BPT permit limitations coupled with individual company waste management practices and wastewater treatment system design and operation practices, in addition to the type of products and processes at each plant, contribute to differences in average effluent levels achieved. To obtain insight into differences in BOD_5 values among different subcategories, the data were grouped into different subsets based on subcategory production at each plant. The results of this analysis are summarized in Parts A and B of Table VII-51.

The Agency grouped the data two different ways for analysis. Thus, the data were assigned by plant into two different groupings, each with different subgroups, and the medians of the average BOD_5 effluent values in each subgroup were determined. The first grouping placed plants into three subgroups (plastics, organics, and mixed) and the second into five subgroups (fibers/rayon, thermoplastics, thermosets, organics, and mixed). All plants considered in the analysis had biological treatment only in place. The assignment of a plant to a subgroup was determined by the predominant production at the plant (i.e., whether a plant had 95% or more of its production in the subgroup). For instance, if a plant has 95 percent or more plastics production, it was placed in the plastics subgroup. Those plants not containing 95 percent or more of a subgroup production were classified as mixed.

The largest subset median average effluent BOD_5 in both groupings is 42.5 mg/l, which suggests that the proposed 50 mg/l criterion is high.

In the absence of a theoretical engineering or statistical solution that would determine what value should be used in a regulatory context, the Agency examined some reasonable alternatives suggested by the results displayed in Parts A and B of Table VII-51. The Agency considered using different editing criteria for different product subgroups, such as those listed in Part A of Table VII-51, but decided to use a single criterion to define the final data base.

TABLE VII-51.
SUMMARY STATISTICS FOR DETERMINATION
OF BPT BOD_5 EDITING CRITERIA BY GROUPS

Subset	Number of Plant Averages	Median of Plant Average Effluent BOD_5 (mg/l)
A. Summary of Groups for Three Groupings		
Plastics	30	20.5
Organics	42	42.5
Mixed (all remaining plants)	27	35
All Plants	99	29
B. Summary of Groups for the Five Groupings		
Rayon/Fibers	7	14
Thermoplastics	17	18
Thermosets	3	32
Organics	42	42.5
Mixed (all remaining plants)	30	35.5
All plants	99	29

An important reason for using a single edit criterion for all subcategories is that this facilitates setting an edit criterion for the group of plants that do not fall primarily into a single subcategory. These mixed plants comprise a significant segment of the industry; thus, regulations must be based on data from this segment as well. Editing criteria that are subcategory-specific cannot be applied to mixed plants. The Agency did, however, examine BOD_5 levels by subgroups to gain insight into what uniform editing criterion would be appropriate.

For the subgroups exhibiting relatively high BOD_5 levels (organics and mixed plants), EPA determined that a 40 mg/l BOD_5 edit would be appropriate. This value is between the median for these two subgroups. Given the fact that plants with substantial organics production tend to have fairly high influent BOD_5 levels or complex, sometimes difficult to biodegrade wastewaters, EPA believes that a more stringent edit would not be appropriate for these two groups. However, EPA believes that a less stringent edit would be inappropriate, since many plants in these subgroups meet the 40 mg/l criterion.

The other subgroups have median values below 40 mg/l, and EPA examined them closely to determine whether they should be subject to more stringent edits than the organics and mixed subgroups. EPA concluded that they should not for the reasons discussed below.

The thermosets subgroup contains three plants, whose average effluent BOD_5 levels are approximately 15, 32, and 34 mg/l, respectively. EPA believes all three should be retained in the data base. This is particularly important because a major source of wastewater at the plant with the lowest value is only melamine resin production; several other types of resins fall under the thermoset classification. Thus, including all three plants' data provides improved coverage of thermoset operations in the data base. An edit of 30 mg/l arbitrarily excludes data from the two plants whose performance slightly exceeds 30 mg/l and would result in melamine resin production being the predominant thermoset production represented in the data base.

The average BOD_5 effluent values for rayon/fibers and thermoplastics are lower than the average values for thermosets, organics, and mixed. The Agency evaluated the effects of these subgroups by uniformly editing the industry data base at 30, 35, 40, and 50 mg/l, using the BPT regression approach to calculating subcategory long-term average values. The long-term averages calculated for rayon/fibers and thermoplastics are relatively insensitive to the use of the 30, 35, 40, and 50 mg/l edited data bases. That is, the long-term averages are roughly the same regardless of which of these edits is used.

After considering the effect of the various editing criteria on the different subgroups discussed above, EPA has concluded that a 95 percent/ 40 mg/l BOD_5 editing criterion is most appropriate. Moreover, in defining BPT-level performance, this criterion results in a data base that provides adequate coverage of the industry.

As discussed previously, the Agency also saw a need to edit the data base for TSS performance. Some commenters recommended additional editing for TSS, and the Agency agrees that this is justified. The Agency is using two edits for the TSS data. The primary edit is that the data must be from a plant that meets the BOD_5 edit (i.e., achieves either 95 percent removal of BOD_5 or 40 mg/l). Second is an additional requirement that the average effluent TSS must be 100 mg/l or less. As a result of this edit, TSS data from 61 plants are retained for analysis.

In a well-designed, well-operated biological treatment system, achievable effluent TSS concentration levels are related to achievable effluent BOD_5 levels and, in fact, often are approximately proportional to BOD_5. This is reflected in the OCPSF data base for those plants that meet the BOD_5 performance editing criteria (provided that they also exhibit proper clarifier performance, as discussed below). By using TSS data only from plants that have good BOD_5 treatment, the Agency is thus establishing an effective initial edit for TSS removal by the biological system. However, as BOD_5 is treated through biological treatment, additional TSS may be generated in the form of biological solids. Thus, some plants may need to add post-biological secondary clarifiers to ensure that such biological solids are appropriately treated.

Thus, while the 95/40 BOD_5 editing ensures good BOD_5 treatment and a basic level of TSS removal, plants meeting this BOD_5 editing level will not necessarily meet a TSS level suitable for inclusion in the data base used to set TSS limitations. To ensure that the TSS data base for setting limitations reflects proper control, EPA proposed in the December 8, 1986, Notice to include only data reflecting a long-term average TSS concentration of less than or equal to 100 mg/l.

The December 1986 Notice requested comment on the use of the 100 mg/l TSS editing criterion and, as an alternative, use of 55 mg/l TSS concentration as the editing criterion along with setting the TSS limitations based upon the relationship between BOD_5 and TSS. Some commenters criticized both the 100 mg/l and 55 mg/l as overly stringent, and asserted that such additional TSS edits were unnecessary since the BOD_5 edit was sufficient to assure that TSS was adequately controlled. These commenters, while agreeing that there was a relationship between BOD_5 and TSS, also recommended a slightly different methodological approach for analyzing the BOD_5/TSS relationship.

The Agency disagrees with the commenters who argued in effect that all TSS data from plants that meet the BOD_5 criteria be included in the data base for setting TSS limitations. The Agency has examined the data and has concluded that an additional TSS edit is required at a level of 100 mg/l. Support for this is evident in the reasonably consistent BOD_5 and TSS relationship for plants in the data set that results from the 95/40 BOD_5 edit, for TSS values of 100 mg/l or less. For TSS values above 100 mg/l, there is a marked change in the pattern of the BOD_5/TSS relationship. Below 100 mg/l TSS, the pattern in the BOD_5/TSS data shown in Figure VII-2 is characterized by a homoscedastic or reasonably constant dispersion pattern along the range of the data. Above the 100 mg/l TSS value, there is a marked spread in the dispersion pattern of the TSS data. The Agency believes that this change in dispersion (referred to as heteroscedastic) reflects insufficient control of TSS in some of the treatment systems. The Agency has concluded that the 100 mg/l TSS edit provides a reasonable measure of additional control of TSS required in good biological treatment systems that have met the BOD_5 edit criterion.

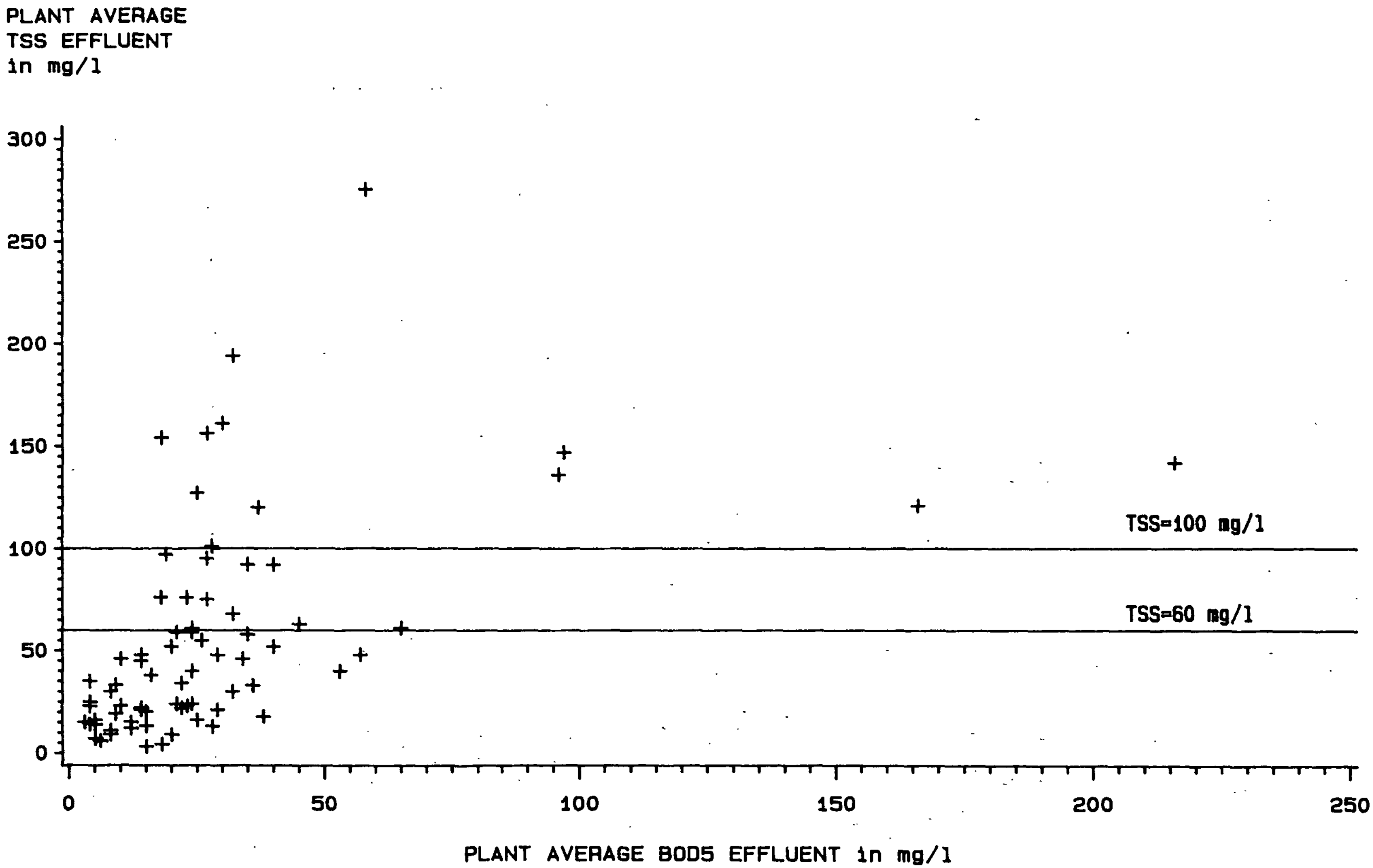

Figure VII-2
Plot of Average TSS Effluent Versus BOD_5 Effluent for Plants With Biological Only Treatment with $\geq$ 95% BOD_5 Removal or BOD_5 Effluent $\leq$ 40 mg/l

The Agency considered a more stringent TSS editing criterion of 60 mg/l, rather than 100 mg/l. The Agency's analysis demonstrated that this is not appropriate. Most fundamentally, this criterion would result in the exclusion of plants that EPA believes are well-designed and well-operated plants. Moreover, the relationship between BOD_5 and TSS is well defined for plants with TSS less than 100 mg/l and BOD_5 meeting the 95%/40 mg/l criteria.

The Agency gave serious consideration to the statistical method recommended by a commenter for the analysis of the BOD_5/TSS relationship. This commenter recommended a linear regression relationship between the untransformed (not converted to logarithms) BOD_5 and TSS data. The Agency has retained the use of a linear regression relationship between the natural logarithms of the BOD_5 and TSS data. The logarithmic appproach is similar to that recommended by the commenter, but resulted in a somewhat better fit to the data.

In response to comments, the Agency also considered an editing criterion based on secondary clarifier design criteria (i.e., clarifier overflow rates and solids loadings rates). While the Agency agrees that using these design criteria, if available, may have provided an appropriate editing criterion, very little data were supplied by industry in response to the Agency's request for data regarding these design criteria or were otherwise contained in the record.

Daily Data Base Editing

Prior to the calculation of BPT variability factors, the BPT daily data base was reviewed to determine if each plant's BOD_5 and TSS data were representative of the BPT technology performance.

The BPT daily data base contains daily data from 69 plants. The sources of the data were the Supplemental Questionnaire, public comment data from plants and the State of South Carolina, and data obtained during the EPA 12-Plant Study. The daily data, which included flow, BOD_5, and TSS, were entered on a computer data base. The sampling site for each parameter was identified by a treatment code that was entered along with the data. The treatment code allowed specific identification of the sampling site within the treatment plant. For example, effluent data were identified as sampled after the secondary clarifier, after a polishing pond, after tertiary filtration, at final discharge, etc.

After the data base was established, the data at each sampling site were compared with the treatment system diagrams obtained in the 1983 Section 308 Questionnaire. The comparison served to verify that the data corresponded to the sampling sites indicated on the diagrams, and to determine if the data were representative of the performance of OCPSF waste treatment systems. Non-representative data were those data from effluent sampling sites where the treatment plant effluent was diluted (>25 percent) with uncontaminated non-process waste streams prior to sampling; treatment systems where a significant portion of the wastewater treated by the treatment system (>25 percent) was uncontaminated non-process or non-OCPSF wastewater; treatment systems where side streams of wastewaters entered the treatment system midway through the process, and no data were available for these waste streams; and treatment systems where the influent sampling site did not include all wastewaters entering the head of the treatment system (e.g., data for a single process waste stream rather than all of the influent waste streams).

Examination of the data available for each plant and the treatment system diagrams provided the basis for exclusion of some of the plants from further analysis. The criteria used were:

- Performance based on more than BPT Option I controls
- Data not representative of the performance of the plant's treatment system
- Treatment systems not representative of the treatment technology normally used in the OCPSF industry (e.g., effluent data did not represent one wastewater treatment system, such as multiple end-of-pipe treatment systems)
- Insufficient data due to infrequent sampling (less than once per week while operating) or omission of one or more parameters from testing (BOD_5, TSS, or flow)
- Treatment plant performance below that expected from the treatment technology in operation (i.e., fail to meet the editing criteria of 95/40 for BOD_5 and 100 mg/l for TSS).

Of the plants excluded from the data base, most were excluded for two or more reasons. Other editing rules for plants retained in the data base included:

- Use of the most recent 12 months of all reported daily data when more than 1 year of data was available. This allowed the Agency to use the data from treatment systems with the most recent treatment system improvements.
- When historical reported long-term average and Section 308 Supplemental Questionnaire daily data were both available for a plant, the Supplemental daily data were used to calculate the long-term average because they provided a reproducible basis for calculating the averages.
- When daily BOD_5 or TSS values were received or calculated [concentration = C*(mass ÷ flow)] in decimal form, they were rounded to the nearest milligram per liter.

Plots of concentration versus time and other analyses revealed that most observations clustered around the mean with excursions far above or below the mean. In the case of influent data, the excursions were believed to be related to production factors such as processing unit startups and shutdowns, accidental spills, etc. Effluent excursions, particularly those of several days duration, were believed to be related to seasonal trends, upsets of the treatment system, and production factors. Verification of the cause of the excursions and of the apparent outliers in the data bases was deemed necessary in order to supplement the analysis of the data with engineering judgment and plant performance information. Each plant was contacted and asked to respond to a series of questions regarding their treatment system, its performance, and the data submitted. The plants were asked about seasonal effects on treatment system performance and compensatory operational adjustments, winter and summer NPDES permit limits, operation problems (slug loads, sludge bulking, plant upsets, etc.), production changes and time of operation, plant shutdowns, and flow metering locations. Data observations that were two standard deviations above and below the mean were identified, and the plants were asked to provide the cause of each excursion. The results of this effort are described below.

The plant contacts and analysis of the data that were identified as being more than two standard deviations above and below the mean revealed some of the strengths and weaknesses of treatment in the industry. Plants within the OCPSF industry, regardless of products manufactured at an individual plant, experience common treatment system problems. Daily data compiled over at least a year show operational trends and problems, plant upsets, and seasonal trends that would not be apparent for plants sampled less than daily. Equalization and diversion basins are commonly used to reduce the effects of slug loads on the treatment system and to prevent upsets. Influent data obtained before equalization or diversion may show high strength wastes, but the effluent may not because of equalization and diversion. Seasonal effects tend to be more pronounced in southern climates because treatment systems there generally may not be designed for cold weather. Operational techniques to compensate for reduced efficiency are similar and should be practiced industry-wide whenever needed or if possible with the existing treatment system.

While common operational problems appear to be consistent across the industry, responsive treatment system design and operation changes are not fully documented within the data base. For example, some treatment systems incorporating similar unit operations produced substantially different effluent quality. The reasons for this may include strength and type of raw wastes, capacity of the treatment system (under- or overloaded), knowledge and skill of operating personnel, and design factors. While the raw waste type can be categorized somewhat by dividing the OCPSF industry into subcategories, the degree to which the other factors affect plant performance may not be readily apparent in the data. For example, the daily data may not show seasonal trends because of plant design or operational adjustments which adequately compensate for cold weather.

Sampling and analytical techniques are another potential problem area of the data base, particularly for the BOD_5 data. The OCPSF industry manufactures and uses a multitude of toxic substances that can affect a bioassay such as the BOD_5 test. Also, certain facilities sometimes collect unrefrigerated BOD_5 composite samples which will affect the results of the analysis. However, since the majority of the effluent data were collected for NPDES permit compliance and approved analytical methodologies (such as standard methods or EPA's test method) and QA/QC procedures are stipulated in each facility's NPDES permit, it was assumed that the effluent data utilized were collected and analyzed in an acceptable manner.

Table VII-52 presents a summary of the plants that were excluded from the BPT daily data base and the reasons for the exclusion. Appendix VII-C presents a plant-by-plant accounting of all 69 BPT daily data plants and provides detailed explanations of each plant's inclusion or exclusion.

Based on the BPT daily data base editing, daily data from a total of 21 plants remain to calculate BOD_5 variability factors and 20 plants remain to calculate TSS variability factors (one plant does not meet the TSS editing criterion). For these plants, all reported daily data from the most recent 12 months of sampling were included in the calculation of variability factors because the Agency could not obtain sufficient information through plant contacts and followup efforts to provide an adequate basis for deleting any specific daily data points.

Derivation of Subcategory BOD_5 and TSS Long-Term Averages (LTAs)

As presented previously in Section IV, the Agency's final revised subcategorization approach also included a methodology for calculation of BPT BOD_5 and TSS LTAs for each subcategory, which are used together with variability factors to derive facility subcategorical daily and monthly maximum limitations. Recall from Section IV that the final subcategorization model is given by:

$$\ln(BOD_i) = a + \sum_{j=1}^{7} w_{ij}T_j + B\cdot I4_i + D\cdot Ib_i + e_i.$$

To estimate the average $\ln(BOD_i)$ corresponding to a set of the independent variables w_{ij}, $I4_i$, and Ib_i, the random error term e_i is deleted. The estimates of the coefficients a, T_j, B, and D are used with the values of the independent variables to obtain the estimate.

Table VII-52. Rationale for Exclusion of Daily Data Plants from Data Base

Plant Number	>25% Non-process Wastewater Dilution	Infrequent Sampling or <1 Year of Data	Summer/ Winter NPDES Permit Limits	Change in Treatment System During Period of Record	Combined Sampling Data from Parallel Treatment Systems	Missing Influent or Effluent Data (BOD, TSS, or Flow)	Non-representative Treatment System	Effluent Data After Tertiary Treatment	Periods of Production Shutdown or Cutbacks	Insufficient Information for Technical Assessment of Treatment System	Did Not Meet the 95/40/100 BPT Editing Rule
83				•							
296											•
659			•								
662			•								
866		•									
871			•								
1148								•			
1343							•				
1438	•										
1446								•			
1494									•		
1609									•		
1617			•					•			
1753			•								
2222	•										
2227			•								
2242				•			•		•		
2260										•	
2313			•								
2376								•			
2394				•				•			
2528								•			
2536			•					•			
2631	•										
2693			•								
2816	•							•			
3033			•					•			
63	•				•		•				
93		•									
683	•										
851	•										
913	•				•		•				
909						•	•				
942	•					•					
1323	•					•					
1522						•	•				
1650						•	•				
1769	•							•			
2110	•					•					
500					•	•	•	•			
2315	•										
2474	•										
2531	•					•	•				
2680	•						•				
2770						•	•				
1349		•						•			
1695				•				•	•		
1766							•				

The LTA BOD_5 for subcategory k is based on a plant that has 100 percent of its OCPSF production in subcategory k. Therefore, to obtain the LTA BOD_5 for subcategory k, set

$$w_{ij} = \begin{cases} 1, & j=k \\ 0, & j \neq k. \end{cases}$$

Also, because the subcategorical LTA BOD_5 is based on a plant that satisfies the BOD_5 95/40 criterion (set $I4_i=1$) and that has biological only treatment (set $Ib_i=1$), it follows that the BOD_5 LTA for subcategory k is given by

$$BOD_5 \ LTA_k = \exp [\hat{a} + \hat{T}_k + \hat{B} + \hat{D}],$$

where $\hat{a}$, $\hat{T}_k$, $\hat{B}$, and $\hat{D}$ are estimates of the model parameters given in Appendix IV-A, Exhibit 1. The estimates are derived from the data base of 157 full-response, direct discharge OCPSF facilities that have at least biological treatment in place, and that provided BOD_5 effluent and subcategorical production data. The parameter estimates are restated below and the subcategorical LTAs for BOD_5 are given in Table VII-53.

Parameter		Estimate
a+T1:	Thermoplastics	4.27270510
a+T2:	Thermosets	5.22885710
a+T3:	Rayon	4.32746980
a+T4:	Other Fibers	4.03782486
a+T5:	Commodity Organics	4.49784137
a+T6:	Bulk Organics	4.66262711
a+T7:	Specialty Organics	4.92138427
B:	Performance Shift	-1.94453768
C:	Treatment Shift	0.41834828

The subcategory LTAs for TSS are based on the final subcategorization regression model for TSS, which was presented in Section IV as:

$$\ln (TSS_i) = a + b [\ln(BOD_i)] + e_i.$$

The estimates of the regression parameters a and b are derived from the 61 OCPSF plants that have at least biological treatment in place, meet the 95/40 editing criteria for BOD_5, and have TSS effluent concentrations of at most 100 mg/l. The estimates of parameters a and b are presented in Appendix IV-A, Exhibit 2, and they are:

$$\hat{a} = 1.84996248$$

and

$$\hat{b} = 0.52810227.$$

Now, this model is used to provide subcategorical TSS LTAs corresponding to the subcategorical BOD_5 LTAs. Again, e_i is set to zero in the model, and

$$\text{TSS LTA}_k = \exp\ (\hat{a} + \hat{b}\ [\ln(\text{BOD}_5\ \text{LTA}_k)]$$

for k=1, 2, ..., 7. The calculated TSS LTA values are given in Table VII-54.

These subcategorical BOD_5 and TSS LTAs allow the determination of plant-specific BOD_5 and TSS LTAs, even for a plant that has production in more than one subcategory. These plant-specific LTAs are then used with variability factors to derive the effluent limitations guidelines presented in Section IX.

In particular, for a specific plant, let w_j be the proportion of that plant's production in subcategory j. The plant-specific LTAs are given by:

$$\text{Plant BOD}_5\ \text{LTA} = \sum_{j=1}^{7} w_j(\text{BOD}_5\ \text{LTA}_j)$$

and

$$\text{Plant TSS LTA} = \sum_{j=1}^{7} w_j(\text{TSS LTA}_j),$$

where BOD_5 LTA_j and TSS LTA_j are the BOD_5 and TSS long-term averages presented in Tables VII-53 and VII-54, respectively. This approach is analogous to the building-block approach typically used by permit writers.

TABLE VII-53.
BPT SUBCATEGORY LONG-TERM AVERAGES (LTAs) FOR BOD_5

Subcategory	BOD_5 LTA (mg/l)
Thermoplastics	16
Thermosets	41
Rayon	16
Other Fibers	12
Commodity Organics	20
Bulk Organics	23
Specialty Organics	30

TABLE VII-54.
BPT SUBCATEGORY LONG-TERM AVERAGES (LTAs) FOR TSS

Subcategory	TSS LTA (mg/l)
Thermoplastics	27
Thermosets	45
Rayon	27
Other Fibers	24
Commodity Organics	31
Bulk Organics	33
Specialty Organics	38

Calculation of BPT Variability Factors

After establishing a final BPT daily data base, data from 21 plants for BOD_5 and 20 plants for TSS were retained to calculate variability factors using the statistical methodology shown in Appendix VII-D. These statistical methods assume a lognormal distribution; hypothesis tests investigating this assumption are discussed in Appendix VII-E. The Agency has been using the 95th percentile average "Maximum for Monthly Average" and the 99th percentile average "Maximum for Any One Day" variability factors for BOD_5 and TSS, regardless of the subcategory mix of each plant. However, many industry commenters argued that effluent variability was subcategory-specific and should be taken into account in variability factor calculations. In response to these comments, the Agency performed an alternative variability factor analysis which calculated production proportion-weighted variability factors by category (plastics or organics) and subcategory for the 21 daily data plants for BOD_5 and the 20 plants for TSS. Table VII-55 presents the results of this analysis which compares overall average variability factors with the subcategory production proportion-weighted variability factors. This comparison shows that subcategory-specific variability factors are not substantially different from the overall average variability factors. This would be expected since subcategory differences would be reflected more in the long-term average values, while variability factors are dependent on treatment system performance which is fairly consistent given that all plants use biological treatment and perform well (i.e., after the 95/40/100 editing rule). Based on the results of this alternative subcategory weighted variability factor analysis, the Agency has decided to retain its approach of calculating overall average variability factors and applying them to all OCPSF facilities.

Individual plant variability factors are listed in Tables VII-56 and VII-57 for BOD_5 and TSS, respectively. As shown in the tables, the average BOD_5 Maximum for Monthly Average and Maximum for Any One Day variability factors are 1.47 and 3.97, respectively. The average TSS Maximum for Monthly Average and Maximum for Any One Day variability factors are 1.48 and 4.79, respectively.

TABLE VII-55.
OVERALL AVERAGE VERSUS PRODUCTION-
PROPORTION-WEIGHTED VARIABILITY FACTORS

Subcategory	Daily BOD_5 VF	Daily TSS VF	Monthly BOD_5 VF	Monthly TSS VF	BOD_5 Sum of Production Weights	TSS Sum of Production Weights
Thermoplastics	3.823	5.017	1.422	1.486	6.172	6.172
Thermosets	3.891	4.145	1.578	1.447	0.504	0.504
Rayon	4.143	4.373	1.536	1.426	1.000	1.000
Other Fibers	3.899	3.680	1.473	1.371	3.025	3.025
Commodity Organics	3.935	4.750	1.421	1.492	3.269	3.269
Bulk Organics	4.331	4.599	1.531	1.453	3.741	2.741
Specialty Organics	3.890	5.827	1.496	1.601	3.290	3.290
Plastics	3.878	4.538	1.455	1.446	10.701	10.701
Organics	4.064	5.086	1.485	1.519	10.299	9.299
Overall	3.969	4.793	1.469	1.480	21	20

TABLE VII-56.
BOD_5 VARIABILITY FACTORS FOR BIOLOGICAL ONLY SYSTEMS
(EFFLUENT BOD_5 $\leq$ 40 MG/L OR BOD_5 PERCENT REMOVAL $\geq$ 95%)

Plant Number	BOD_5 Percent Removal	BOD_5 Mean Effluent Concentration (mg/l)	BOD_5 Median Effluent Concentration (mg/l)	Number of Observations	Daily Variability Factor	Monthly Variability Factor
387	-	14	12	160	4.14	1.54
444	-	16	12	154	3.90	1.44
525	95	8	6	203	3.51	1.49
682	99	9	7	207	3.34	1.43
741	96	98	77	156	4.50	1.65
908	98	53	26	96	6.55	1.73
970	97	13	13	155	3.11	1.23
1012	77	20	14	357	4.35	1.62
1062	99	9	8	261	3.29	1.31
1149	-	32	30	160	2.89	1.22
1267	-	24	22	84	3.04	1.33
1407	97	13	12	48	3.76	1.41
1647	98	21	13	359	4.30	1.61

TABLE VII-56.
BOD_5 VARIABILITY FACTORS FOR BIOLOGICAL ONLY SYSTEMS
(EFFLUENT $BOD_5 \leq 40$ MG/L OR BOD_5 PERCENT REMOVAL $\geq 95\%$)
(Continued)

Plant Number	BOD_5 Percent Removal	BOD_5 Mean Effluent Concentration (mg/L)	BOD_5 Median Effluent Concentration (mg/l)	Number of Observations	Daily Variability Factor	Monthly Variability Factor
1973	93	6	5	157	2.97	1.48
1977	99	13	11	153	3.12	1.29
2181	99	4	2	124	6.12	1.68
2430	98	6	5	366	3.04	1.28
2445	96	24	16	347	4.43	1.72
2592	98	23	16	154	4.25	1.57
2626	-	12	10	363	4.25	1.34
2695	-	19	16	143	4.48	1.50
		Average BOD_5 Variability Factors:			3.97	1.47

TABLE VII-57.
TSS VARIABILITY FACTORS FOR BIOLOGICAL ONLY SYSTEMS
(EFFLUENT $BOD_5 \leq$ 40 MG/L OR BOD_5 PERCENT REMOVAL $\geq$ 95% AND TSS $\leq$ 100 MG/L)

Plant Number	TSS Percent Removal	TSS Mean Effluent Concentration (mg/l)	TSS Median Effluent Concentration (mg/l)	Number of Observations	Daily Variability Factor	Monthly Variability Factor
387	-	20	17	158	4.37	1.43
444	-	26	20	159	4.98	1.49
525	-	30	25	155	4.97	1.48
682	45	28	24	361	3.95	1.38
908	87	43	31	99	4.75	1.46
970	-	30	26	362	2.79	1.40
1012	-	8	7	366	3.35	1.31
1062	99.6	14	6	260	6.95	1.63
1149	-	60	56	363	2.67	1.21
1267	-	24	20	130	2.70	1.25
1407	(-2)	18	13	48	5.66	1.55
1647	84	86	28	366	7.43	1.84
1973	76	10	8	347	5.15	1.40

TABLE VII-57.
TSS VARIABILITY FACTORS FOR BIOLOGICAL ONLY SYSTEMS
(EFFLUENT $BOD_5 \leq 40$ MG/L OR BOD_5 PERCENT REMOVAL $\geq 95\%$ AND TSS ≤ 100 MG/L)
(Continued)

Plant Number	TSS Percent Removal	TSS Mean Effluent Concentration (mg/l)	TSS Median Effluent Concentration (mg/l)	Number of Observations	Daily Variability Factor	Monthly Variability Factor
1977	-	26	9	154	8.48	2.04
2181	92	24	15	366	5.07	1.56
2430	92	7	6	366	4.80	1.46
2445	29	66	49	365	4.08	1.49
2592	82	52	36	135	4.89	1.41
2626	99	18	16	366	3.93	1.35
2695	97	14	10	146	4.87	1.47
		Average TSS Variability Factors:			4.79	1.48

2. BAT Effluent Limitations

As discussed in Section VI, the Agency has decided to control 63 toxic pollutants under BAT Subcategory One (End-of-Pipe Biological Plants) and 59 toxic pollutants under BAT Subcategory Two (non-End-of-Pipe Biological Plants). This section discusses the data editing rules and methodology used to derive the toxic pollutant long-term averages and variability factors that provide the basis of the final BAT effluent limitations guidelines for both subcategories.

a. BAT Data Editing Rules

The BAT toxic pollutant data base has basically two sources of data: 1) data collected during EPA sampling studies, and 2) data submitted by industry either in response to Section 308 Questionnaire requests or as a result of submissions during the public comment periods for the March 21, 1983, Proposal, the July 17, 1985, Federal Register Notice of Availability, or the December 8, 1986, Federal Register Notice of Availability. Table VII-58 presents a summary of the BAT toxic pollutant data sources as organized into four sets for review and editing purposes.

In general, the Agency's BAT toxic pollutant data base editing criteria were as follows:

- Analytical methodology had to be EPA-approved (or equivalent) and have adequate supporting QA/QC documentation.
- It was not necessary to have influent-effluent data pairs for the same day, because many treatment systems have a wastewater retention time of more than 24 hours.
- Since most of the effluent data have values of ND, the average influent concentration for a compound had to be at least 10 times the analytical minimum level (ML) for the difference to be meaningful and qualify effluent concentrations for calculation of effluent limits. For in-plant control effluent data for steam stripping and activated carbon, the average influent concentration for a compound had to be at least 1.0 ppm.
- Exclude data for effluent that has been diluted more than 25 percent after treatment, but before final discharge. NPDES monitoring data often reflects such dilution, which may be discerned by reference to the wastewater flow diagram in a plant's response to the 1983 Section 308 Questionnaire. Appendix VII-G characterizes the problems associated with dilution of NPDES application Form 2C data.

TABLE VII-58.
PRIORITY POLLUTANT (PRIPOL) DATA SOURCES FOR THE FINAL OCPSF RULE

EPA Sampling Programs	
1.1 37 Plant Verification Study, 1978-80 1.2 Five Plant Study, 1980-81 (EPA/CMA Study)	Data Set 1
2.0 Twelve Plant Study, 1983-84	Data Set 2
OCPSF Proposal, 48 FR 11828 (March 21, 1983)	Data Set 3
3.1 Data attached to 28 public comments	
1983 Supplemental "308" Questionnaire* (sent to selected plants only)	
3.2 Data submitted by 74 selected plants	
NOA (Proposal Revision 1), 50 FR 29068 (July 17, 1985)	Data Set 4
4.1 Data attached to comments, or requested by EPA as an extension of the attached data**	
4.2 Requested from commenters, because the comment implied that supporting data were available**	
NOA (Proposal Revision 2), 51 FR 44082 (Dec. 8, 1986)	
4.3 Data attached to comments from 5 commenters	

*1983 308 Questionnaire - Priority pollutant data submitted in response to questions C13-C16 of the general questionnaire were average concentration values instead of daily concentration values. This precluded the use of the data for statistical calculation of effluent limitations.

**Data from a total of 21 plants were reviewed for data sets 4.1 and 4.2.

- Cyanide should be considered as having an analytical minimum level of 0.02 mg/l, and subject to the four criteria listed above.

- For data submitted by industry, exclude total phenols data, which become meaningless with the specific measurement of phenol (priority pollutant 65). The total phenol parameter represents a colorometric response to the 4-Aminoantipyrine (4-AAP) reagent, which is non-specific and characteristic of a host of both phenolic and non-phenolic organic chemicals.

- Data not representative of BAT technology performance were eliminated from the data base. Examples of reasons for not being representative of BAT technology performance include process spills; treatment system upsets; equipment malfunctions; performance not up to design specifications; past historical performance; or performance exhibited by other plants in the data base with BAT technology in place.

- Exclude data for pollutants that could not be validated as present based on the product/processes and the related process chemistry associated with each product/process. Examples include phthalate esters found because of sample contamination by the automatic sampler tubing and methylene chloride found because of sample contamination in the laboratory (methylene chloride is a common extraction solvent used in GC/MS methods).

- Data for pollutants that do not satisfy the 10 times ML editing criteria at the influent to the end-of-pipe treatment sampling site, because their original raw waste concentrations had been reduced previously by an in-plant control technology, were retained when sufficient information (i.e., verification, 12-Plant Sampling Reports, or Section 308 Questionnaire) was available to validate the in-plant control's presence.

In addition to the detailed editing criteria presented above, more general editing criteria involved:

- Deletion of presampling grab samples collected prior to the EPA 12 Plant Sampling Study

- Choosing the appropriate sampling sites for the treatment system of interest(e.g., influent to and effluent from steam stripper for BAT Subcategory Two data base)

- Deletion of not quantifiable (NQ) values discussed above

- Averaging of replicate and duplicate samples or analyses at a sampling site by day and, if appropriate, then across multiple laboratories. All data points in decimal form as a result of replicate and duplicate averaging were rounded to the nearest whole number (in ppb)

- Deletion of zero dischargers and plants without appropriate BAT or PSES treatment systems (e.g., indirect dischargers without appropriate in-plant controls such as steam stripping, and direct dischargers without end-of-pipe biological treatment or in-plant controls). [Plants 1904V; 2680V/2680T from the BAT Subcategory One data base; 722V, 1194V, 2474V, 2327V, 2666V]

- Deletion of plants with more than the recommended BAT treatment technology. [Plant 2680V from the BAT Subcategory Two data base]

- Deletion of plants without a combined raw waste sampling point, or if only product/process sampling data were collected at a plant. [Plants 430V, 1563V]

- Deletion of organic toxic pollutant data from six plants for which blind spike GC/CD analytical methods were utilized. [Plants 1869V, 250V, 387V, 2666V, 1569V, 1904V]

- Deletion of plant/pollutant combinations for which no effluent data exist [1785V]

- Deletion of plant/pollutant combinations when all influent values were not detected (ND) (except for the overrides discussed above for pollutants that do not satisfy the 10 times ML editing criteria)

- All values reported by the analytical laboratory at less than the analytical minimum level were set equal to the analytical minimum level

- Deletion of combined pollutant analytical results (e.g., anthracene and phenanthrene reported as a combined total concentration)

- Use of only laboratory-composited volatile grab samples as required by the analytical protocols instead of individual grab or automatic composite sample analyses

- Deletion of plant/pollutant combinations based on BAT Option III technology (i.e., in-plant controls, end-of-pipe biological treatment, and end-of-pipe activated carbon). [Plant 1494V, benzene]

- Deletion of plants which will be regulated under another point source category. [Plant 1099V under the Petroleum Refining Point Source Category].

In addition to the editing criteria mentioned above, the Agency also established another set of editing criteria in reviewing priority pollutant metals data:

- Excluded data on priority pollutant metals from non-process sources, such as non-contact cooling water blowdown and ancillary sources. An example of an ancillary source is caustic, which commonly assays for low levels of Cr(119), Cu(120), Ni(124), and sometimes Hg(123).

- Excluded end-of-pipe (NPDES) data, as well as data from other sampling points, that do not represent the direct effluent from technology that is specifically for the control of metals. In general, NPDES monitoring data do not directly reflect the reduction of priority pollutant metal concentrations by such technology. Rather, the data reflect dilution (by process wastewater and non-contact cooling water) and/or absorption into biomass (if biological treatment of the process wastewater is employed). Both dilution and biomass absorption of priority pollutant metals are plant-specific factors that vary widely throughout OCPSF wastewater collection and treatment systems.

- Exclude complexed priority pollutant metal data, unless it is the direct effluent from technology that is specifically for the control of complexed priority pollutant metals. This edit is generally applicable to priority pollutant metals (e.g., chromium+3 and copper+2) that have been very strongly complexed with organic dyes or chelating compounds, so that the metal remains in solution and is unresponsive to precipitation with usual reagents (lime or caustic).

- Exclude data that represent the direct effluent from technology specifically for the control of metals, if there is no corresponding influent data with which to evaluate the effectiveness of the technology.

The Agency's editing procedure differed somewhat for each data source. The data from the EPA sampling programs were edited using a combination of computer analysis and manual analysis by Agency personnel. This was done because all sampling data had previously been encoded. Data submitted by industry were first reviewed to determine if the data submitted warranted encoding for further study, lending itself to manual editing rather than computer analysis. However, all manual editing that could be validated by computer analysis (e.g., the 10 x ML/1.0 ppm edit) was performed. Based on this analysis, data from industry sources for a total of 17 plants were retained for use in calculation of final BAT effluent limitations. Table VII-59 presents a summary of the data retained for each plant and how it was utilized.

Table VII-60 presents a detailed explanation of the data excluded from the limitations analysis based on the BAT performance editing criterion. Based on this analysis, data from a total of 36 plants (plus six plant overlaps due to resampling) for Subcategory One and 10 plants for Subcategory Two (with nine plant overlaps with Subcategory One) from Agency studies and public comments were retained for the limitations analysis and are presented in Table VII-61 for BAT Subcategory One and Table VII-62 for BAT Subcategory Two.

TABLE VII-59.
DATA RETAINED FROM DATA SETS 3 AND 4 FOLLOWING
BAT TOXIC POLLUTANT EDITING CRITERIA

Plant ID	Pollutants	Data Set	BAT Subcategory Data Base
63	Zinc	3	One and Two
387	Zinc	3	One and Two
500	Nitrobenzene	3	Two Only
682	Toluene	3	One Only
1012	Zinc	3	One and Two
1650	Benzene, Naphthalene, Phenanthrene, Toluene	3	One Only
1753	Ethylbenzene	3	One Only
2227	1,2-4-Trichlorobenzene, 1,2-Dichlorobenzene, Nitrobenzene	3	One Only
1617	Toluene	3	One Only
2445	Methylene Chloride, Phenol	3	One Only
2693	Chloroform, Methylene Chloride	3	One Only
267	Methylene Chloride	4	One Only
399	Zinc	4	One and Two
415	Benzene, Toluene	4	Two Only
913	1,2-Dichloroethane, 1,1,1-Trichloroethane, 1,1,2-Trichlorethane, Chloroethane, Chloroform, 1,1-Dichloroethane, 1,2-Trans-Dichloroethylene, 1,1-Dichloroethylene, Methylene Chloride, Tetrachloroethylene, Trichloroethylene, Vinyl Chloride	4	Two Only
1769	Chlorobenzene, Chloroethane, 1,2-Dichlorobenzene, 2,4-Dinitrotoluene, 2,6-Dinitrotoluene, Nitrobenzene, Phenol	4	One Only
1774	Zinc	4	One and Two

TABLE VII-60.
EXPLANATION OF BAT TOXIC POLLUTANT DATA
BASE PERFORMANCE EDITS

Plant ID	Pollutant Name	Explanation
267F	2,4,6-Trichlorophenol	This pollutant should be treated in-plant with activated carbon prior to discharge to the end-of-pipe biological system. This plant pretreats its phenolic wastewaters with a trickling filter that is adequate for phenol but not for 2,4,6-trichlorophenol.
525V	Chlorobenzene	This pollutant should be (but was not) treated in-plant with steam stripping prior to discharge to the end-of-pipe biological system; also, compared to data from plants retained in the data base treating chlorobenzene with only biological treatment and having similar raw waste concentrations, this plant's treatment system performance for this pollutant was considered inadequate.
1494T	Benzene (only Subcategory 1 data), Chlorobenzene, 1,2-Dichlorobenzene, 2,4-Dinitrotoluene, 2,6-Dinitrotoluene, Methylene Chloride, Nitrobenzene, 2-Nitrophenol, Phenol, Toluene	This plant experienced a polyols spill during the sampling period which saturated the end-of-pipe activated carbon columns. These columns are used as an integral segment of the treatment system rather than a polishing step. Therefore, because the listed pollutants were basically passing through the activated carbon system untreated, this plant's treatment system performance was considered inadequate.
415T	Bis(2-chloroisopropyl)Ether	This pollutant should be treated in-plant with steam stripping prior to discharge to the end-of-pipe biological system; also, compared to data from plants retained in the data base treating bis(2-chloroisopropyl) ether with only biological treatment and having similar raw waste concentrations, this plant's treatment system performance for this pollutant was considered inadequate.

TABLE VII-60.
EXPLANATION OF BAT TOXIC POLLUTANT DATA
BASE PERFORMANCE EDITS
(Continued)

Plant ID	Pollutant Name	Explanation
2313T	Benzene, Chlorobenzene, 1,2-Dichloroethane; 2,4,6-Trichlorophenol, Chloroform, 3,3'-Dichlorobenzidine, Toluene	This plant experienced a malfunction of its in-plant chemical oxidation unit during the sampling period which caused high concentrations of 3,3'-dichlorobenzidine to be discharged to the end-of-pipe biological system; this may have caused an upset of biological activity which was evidenced by the low removals of the listed pollutants through biological treatment, or compared to other biological treatment systems treating similar raw waste concentrations. Also, certain pollutants (2,4,6-trichlorophenol, 3,3'-dichlorobenzidine) must be treated in-plant prior to discharge to an end-of-pipe biological system to obtain adequate treatment. Therefore, the Agency considers this plant's treatment system performance for the listed pollutants to be inadequate.
725T	Methylene Chloride, Methyl Chloride and Vinyl Chloride (Subcategory Two Steam Stripper Data for 5/29/83, 6/02/83)	Data for these pollutants from this plant were deleted because steam stripper performance for these 2 days was considered inadequate; the maximum design effluent concentration for this steam stripper should be 10 mg/l for vinyl chloride which is based on a NIOSH air regulation. This maximum was exceeded on both these days; therefore, the Agency considers this plant's steam stripper performance for the listed pollutants to be inadequate for these 2 days.

Note: Plants with V-suffix are verification study plants, plants with F-suffix are EPA/CMA 5-Plant Study plants, and plants with T-suffix are EPA 12-Plant Study plants.

TABLE VII-61.
PLANT AND POLLUTANT DATA RETAINED IN BAT ORGANIC TOXIC POLLUTANT
DATA BASE FOR BAT SUBCATEGORY ONE LIMITATIONS

Plant ID	Data Set	Pollutant #	Pollutant Name
2394	1	7	Chlorobenzene
		25	1,2-Dichlorobenzene
		27	1,4-Dichlorobenzene
		38	Ethylbenzene
		57	2-Nitrophenol
		58	4-Nitrophenol
		59	2,4-Dinitrophenol
		65	Phenol
		86	Toluene
2536	1	3	Acrylonitrile
		38	Ethylbenzene
		65	Phenol
725	1	6	Carbon Tetrachloride
		9	Hexachlorobenzene
		12	Hexachloroethane
		23	Chloroform
		44	Methylene Chloride
		45	Chloromethane
		52	Hexachlorobutadiene
		85	Tetrachloroethylene
		88	Vinyl Chloride
3033	1	10	1,2-Dichloroethane
		32	1,2-Dichloropropane
		34	2,4-Dimethylphenol
		55	Naphthalene
		65	Phenol
		85	Tetrachloroethylene
384	1	4	Benzene
		38	Ethylbenzene
		55	Naphthalene
		65	Phenol
		76	Chrysene
		86	Toluene
415	1	10	1,2-Dichloroethane
		14	1,1,2-Trichloroethane
		16	Chloroethane
		23	Chloroform
		29	1,1,-Dichloroethylene
		30	1,2-Trans-dichloroethylene
		32	1,2-Dichloropropane
		44	Methylene Chloride
		87	Trichloroethylene

TABLE VII-61.
PLANT AND POLLUTANT DATA RETAINED IN BAT ORGANIC TOXIC POLLUTANT
DATA BASE FOR BAT SUBCATEGORY ONE LIMITATIONS
(Continued)

Plant ID	Data Set	Pollutant #	Pollutant Name
1293	1	1	Acenaphthene
		4	Benzene
		34	2,4-Dimethylphenol
		39	Fluoranthene
		55	Naphthalene
		65	Phenol
		72	Benzo(a)Anthracene
		73	Benzo(a)Pyrene
		74	3,4-Benzofluoranthene
		75	Benzo(k)Fluoranthene
		76	Chrysene
		77	Acenaphthylene
		78	Anthracene
		80	Fluorene
		81	Phenanthrene
		84	Pyrene
		86	Toluene
2313	1	8	1,2,4-Trichlorobenzene
		24	2-Chlorophenol
		25	1,2-Dichlorobenzene
		26	1,3-Dichlorobenzene
		31	2,4-Dichlorophenol
		58	4-Nitrophenol
		81	Phenanthrene
2631	2	4	Benzene
		10	1,2-Dichloroethane
		14	1,1,2-Trichloroethane
		16	Chloroethane
		23	Chloroform
		29	1,1-Dichloroethylene
		30	1,2-Trans-dichloroethylene
		32	1,2-Dichloropropane
		33	1,3-Dichloropropene
		38	Ethylbenzene
		44	Methylene Chloride
		86	Toluene
		87	Trichloroethylene
2481	2	4	Benzene
		56	Nitrobenzene
		59	2,4-Dinitrophenol

TABLE VII-61.
PLANT AND POLLUTANT DATA RETAINED IN BAT ORGANIC TOXIC POLLUTANT DATA BASE FOR BAT SUBCATEGORY ONE LIMITATIONS
(Continued)

Plant ID	Data Set	Pollutant #	Pollutant Name
948	2	3	Acrylonitrile
		4	Benzene
		10	1,2-Dichloroethane
		29	1,1-Dichloroethylene
		38	Ethylbenzene
		65	Phenol
		66	Bis-(2-Ethylhexyl)Phthalate
		68	Di-N-Butyl Phthalate
		70	Diethyl Phthalate
		71	Dimethyl Phthalate
		86	Toluene
267	2	8	1,2-4-Trichlorobenzene
		25	1,2-Dichlorobenzene
		31	2,4-Dichlorophenol
		65	Phenol
12	2	1	Acenaphthene
		4	Benzene
		34	2,4-Dimethylphenol
		38	Ethylbenzene
		55	Naphthalene
		65	Phenol
		86	Toluene
2221	3	38	Ethylbenzene
		65	Phenol
		86	Toluene
2711	3	65	Phenol
		86	Toluene
725	3	6	Carbon Tetrachloride
		10	1,2-Dichloroethane
		12	Hexachloroethane
		23	Chloroform
		30	1,2-Trans-dichloroethylene
		52	Hexachchlorobutadiene
		85	Tetrachloroethylene
		88	Vinyl Chloride
444	3	4	Benzene
		86	Toluene

TABLE VII-61.
PLANT AND POLLUTANT DATA RETAINED IN BAT ORGANIC TOXIC POLLUTANT
DATA BASE FOR BAT SUBCATEGORY ONE LIMITATIONS
(Continued)

Plant ID	Data Set	Pollutant #	Pollutant Name
695	3	4	Benzene
		6	Carbon Tetrachloride
		10	1,2-Dichloroethane
		23	Choloroform
		24	2-Chlorophenol
		25	1,2-Dichlorobenzene
		29	1,1-Dichloroethylene
		32	1,2-Dichloropropane
		38	Ethylbenzene
		42	Bis-(2-Chloroisopropyl) Ether
		44	Methylene Chloride
		55	Naphthalene
		65	Phenol
		86	Toluene
1650	3	4	Benzene
		38	Ethylbenzene
		55	Naphthalene
		65	Phenol
		77	Acenaphthylene
		80	Fluorene
		81	Phenanthrene
		86	Toluene
948	3	3	Acrylonitrile
		65	Phenol
		66	Bis-(2-Ethylhexyl) Phthalate
		68	Di-N-Butyl Phthalate
		70	Diethyl Phthalate
		71	Dimethyl Phthalate
2430	3	4	Benzene
		55	Naphthalene
		65	Phenol
		86	Toluene
1349	3	3	Acrylonitrile
		88	Vinyl Chloride

TABLE VII-61.
PLANT AND POLLUTANT DATA RETAINED IN BAT ORGANIC TOXIC POLLUTANT DATA BASE FOR BAT SUBCATEGORY ONE LIMITATIONS
(Continued)

Plant ID	Data Set	Pollutant #	Pollutant Name
1494	3	25	1,2-Dichlorobenzene
		35	2,4-Dinitrotoluene
		36	2,6-Dinitrotoluene
		44	Methylene Chloride
		56	Nitrobenzene
		57	2-Nitrophenol
		58	4-Nitrophenol
		59	2,4-Dinitrophenol
		65	Phenol
		86	Toluene
883	3	3	Acrylonitrile
		38	Ethylbenzene
659	3	38	Ethylbenzene
1609	3	4	Benzene
		23	Chloroform
		24	2-Chlorophenol
		31	2,4-Dichlorophenol
		65	Phenol
		86	Toluene
		87	Trichloroethylene
851	3	4	Benzene
		38	Ethylbenzene
		39	Fluoranthene
		55	Naphthalene
		78	Anthracene
		80	Fluorene
		81	Phenanthrene
		84	Pyrene
		86	Toluene
1890	3	86	Toluene
1890*	3	65	Phenol
		86	Toluene

TABLE VII-61.
PLANT AND POLLUTANT DATA RETAINED IN BAT ORGANIC TOXIC POLLUTANT DATA BASE FOR BAT SUBCATEGORY ONE LIMITATIONS
(Continued)

Plant ID	Data Set	Pollutant #	Pollutant Name
2631	3	4	Benzene
		10	1,2-Dichloroethane
		11	1,1,1-Trichloroethane
		14	1,1,2-Trichloroethane
		16	Chloroethane
		23	Chloroform
		29	1,1-Dichloroethylene
		32	1,2-Dichloropropane
		33	1,3-Dichloropropene
		38	Ethylbenzene
		55	Naphthalene
		65	Phenol
		86	Toluene
4051	3	4	Benzene
		10	1,2-Dichloroethane
		32	1,2-Dichloropropane
		33	1,3-Dichloropropene
		86	Toluene
		87	Trichloroethylene
296	3	4	Benzene
		10	1,2-Dichloroethane
		11	1,1,1-Trichloroethane
		65	Phenol
		86	Toluene
306	3	1	Acenaphthene
		4	Benzene
		34	2,4-Dimethylphenol
		39	Fluoranthene
		65	Phenol
		72	Benzo(a)Anthracene
		76	Chrysene
		77	Acenaphthylene
		78	Anthracene
		81	Phenanthrene
		84	Pyrene
		86	Toluene
267	4	44	Methylene Chloride
682	4	86	Toluene

TABLE VII-61.
PLANT AND POLLUTANT DATA RETAINED IN BAT ORGANIC TOXIC POLLUTANT
DATA BASE FOR BAT SUBCATEGORY ONE LIMITATIONS
(Continued)

Plant ID	Data Set	Pollutant #	Pollutant Name
1617	4	86	Toluene
1650	4	4	Benzene
		55	Naphthalene
		81	Phenanthrene
		86	Toluene
1753	4	38	Ethylbenzene
1769	4	7	Chlorobenzene
		16	Chloroethane
		25	1,2-Dichlorobenzene
		35	2,4-Dinitrotoluene
		36	2,6-Dinitrotoluene
		56	Nitrobenzene
		65	Phenol
2227	4	8	1,2-4-Trichlorobenzene
		25	1,2-Dichlorobenzene
		56	Nitrobenzene
2445	4	44	Methylene Chloride
		65	Phenol
2693	4	23	Chloroform
		44	Methylene Cloride

Note: * denotes a plant which had two different treatment systems in the data base
Data Set 1 denotes 12-Plant Study.
Data Set 2 denotes 5-Plant Study.
Data Set 3 denotes Verification Study.
Data Set 4 denotes public comments and supplemental questionnaire data.

TABLE VII-62.
PLANT AND POLLUTANT DATA RETAINED IN BAT ORGANIC TOXIC POLLUTANT DATA BASE FOR BAT SUBCATEGORY TWO LIMITATIONS

Plant ID	Data Set	Pollutant #	Pollutant Name
725	1	44	Methylene Chloride
		45	Chloromethane
		88	Vinyl Chloride
1494	1	4	Benzene
415	1	10	1,2-Dichloroetheane
		14	1,12-Trichloroethane
		16	Chloroethane
		23	Chloroform
		29	1,1-Dichloroethylene
		30	1,2-Trans-Dichloroethylene
		44	Methylene Chloride
		87	Trichloroethylene
2680	1	4	Benzene
415	3	4	Benzene
		86	Toluene
913	3	10	1,2-Dichloroethane
		11	1,1,1-Trichloroethane
		13	1,1-Dichloroethane
		14	1,1,2-Trichloroethane
		16	Chloroethane
		23	Chloroform
		29	1,1-Dichloroethylene
		30	1,2-Trans-Dichloroethylene
		44	Methylene Chloride
		85	Tetrachloroethylene
		87	Trichloroethylene
		88	Vinyl Chloride
2680	1	56	Nitrobenzene
		57	2-Nitrophenol
		58	4-Nitrophenol
		59	2,4-Dinitrophenol
		60	4,6-Dinitro-o-Cresol
500	3	56	Nitrobenzene
948	2	66	Bis-(2-Ethylhexyl) Phthalate
		68	Di-n-Butyl Phthalate
		70	Diethyl Phthalate
		71	Dimethyl Phthalate

TABLE VII-62.
PLANT AND POLLUTANT DATA RETAINED IN BAT ORGANIC TOXIC POLLUTANT DATA BASE FOR BAT SUBCATEGORY TWO LIMITATIONS
(Continued)

Plant ID	Data Set	Pollutant #	Pollutant Name
2536	1	3	Acrylonitrile
1293	1	1	Acenaphthene
		34	2,4-Dimethylphenol
		39	Fluoranthene
		55	Naphthalene
		65	Phenol
		72	Benzo(a)Anthracene
		73	Benzo(a)Pyrene
		74	3,4-Benzofluoranthene
		75	Benzo(k)Fluoranthene
		76	Chrysene
		77	Acenaphthylene
		78	Anthracene
		80	Fluorene
		81	Phenanthrene
		84	Pyrene

Note: Data Set 1 denotes 12-Plant Study.
Data Set 2 denotes 5-Plant Study.
Data Set 3 denotes public comments and supplemental questionnaire data.

One industry commenter questioned the validity of treating pollutant data from one plant in two different sampling projects independently. It should be noted that the six plant overlaps occur because these plants were either sampled in separate Agency studies or the Agency received data submitted by commenters in addition to its sampling studies. EPA has treated these overlapping plant data sets separately for limitations calculations purposes because of general changes in a plant's production levels and product mix, and changes in a plant's treatment system or treatment system operation in the time period between sampling studies. Using the plant data in this manner did not significantly affect most of the pollutants being regulated.

EPA reviewed its files on these six plants relating to circumstances at the plants during the sampling episodes. Plant 725 upgraded a steam bath to a steam stripper by adding trays between sampling episodes. Plant 2631 had two processes in operation during the first sampling event and three on the second. EPA, accordingly, maintains that the 4 data sets associated with these 2 plants be treated separately because of the referent known changes.

For the remaining four plants, EPA combined the corresponding eight data subsets into four to yield a single data set for each of the four plants. EPA then recomputed all of the end-of-pipe BAT toxic limitations to perform a comparative analysis of these results to those for the EPA methodology for calculating daily maximum limitations for all of the 55 organic pollutants derived by this analysis.

The findings were that 11 of the 55 daily limitations changed value, but for seven of the 11 changes the shifts were only 5 percent or less. For the four limitations that showed larger changes, two increased and two decreased.

EPA maintains that the general rationale for treating these six plants as 12 separate entities is appropriate and that there is no bias introduced by this approach.

b. Derivation of BAT Toxic Pollutant LTAs

Table VII-63 presents a summary of the plants retained in the BAT toxic pollutant data base for BAT Subcategory One and Two, and the in-plant and end-of-pipe technologies in-place at each plant based on the 1983 Section 308 Questionnaire for industry-supplied data and on field sampling reports for EPA data. The table shows that the technology basis for the data to be used for BAT Subcategory One is mainly end-of-pipe biological treatment (in the form of activated sludge) preceded in many cases by some form of in-plant control. These in-plant controls are sometimes in the form of highly efficient technologies such as activated carbon or steam stripping, or are a more gross form of control used more for product recovery (e.g., distillation), but nonetheless contributing to a reduction or equalization of raw waste concentrations discharged to the end-of-pipe biological treatment system. The technology basis for the BAT Subcategory Two toxic pollutant data base is based on performance data from in-plant controls such as steam stripping, activated carbon, and in-plant biological treatment.

For each pollutant at each plant from each of the four data sets, an estimated long-term average (LTA) effluent concentration was calculated. The nondetected values at a plant were assigned an analytical minimum level value using the minimum levels associated with EPA analytical methods 1624 and 1625. The estimated long-term average was computed using a method that assigned nondetected values a relative weight in accordance with the frequency with which nondetected values for the pollutant were found in the daily data plants as defined in Appendix VIII-C.

The estimated long-term average, m, for a plant-pollutant combination is as follows:

$$M_j = pD + (1 - p)\frac{\sum_{i=1}^{n} X_i}{n}$$

TABLE VII-63.
TREATMENT TECHNOLOGIES FOR PLANTS IN THE
FINAL BAT TOXIC POLLUTANT DATA BASE

Plant I.D.	Treatment Technology
2394	Steam stripping, distillation, chemical oxidation, thiosulfate waste reuse, sewer segregation, phase separation, EQ, NEU, GRSP, ASL, SCLAR, POL, PAER
2536	Gravity separation, EQ, NEU, SCR, CLAR, ASL, SCLAR, FILT
725	Steam stripping, API separator, EQ, NEU, FLOCC, CLAR, ASL, SCLAR, FILT, CHLOR, SLDTH, SLDFILT
3033	NEU, SCSP, NUDADD, ALA, SSIBS, SETTLING LAGOON, POL, FILT, CAD, SSITS, POLISH BAGFILTERS
384	EQ, NEU, API, ASL, SCLAR, POL
415	Air stripping, steam stripping, carbon adsorption, distillation, retention impoundment, oil separation, API separation, EQ, NEU, CLAR, NUDADD, MULTISTAGE POASL, SCLAR
1293	Primary settling, oil removal, EQ, BIOLOGICAL DIGESTION, CLAR
2313	Chemical precipitation, steam stripping, solvent extraction, distillation, chemical oxidation, filtration, equalization, EQ, NEU, CLAR, NUDADD, ASL, PACA, SCLAR
2680	Decant sump, EQ, NEU, SS, CAD
2481	Carbon adsorption, EQ, NE, SCR, CLAR, FLOCC, ASL, SCLAR
948	NEU, ASL, SCLAR, POL
267	Steam stripping, NEU, SCR, OLSK, OLS, CLAR, NUDADD, TF, ASL, SCLAR, POL
12	Solvent extraction, decantation, EQ, NEU, OLS, API, NUDADD, ASL, SCLAR
2221	Solvent extraction, carbon adsorption, distillation, EQ, GR, ASL, SCLAR
2711	EQ, ARL, ANL, SCLAR
444	EQ, NEU, ASL, SCLAR, DAF

TABLE VII-63.
TREATMENT TECHNOLOGIES FOR PLANTS IN THE
FINAL BAT TOXIC POLLUTANT DATA BASE
(Continued)

Plant I.D.	Treatment Technology
695	Chemical precipitation, steam stripping, chemical oxidation, filtration, separation, catalyst recovery, EQ, NEU, OLSK, OLS, DAF, CLAR, FLOCC, NUDADD, ALA, SCLAR
2430	EQ, NEU, OLS, DAF, FLOCC, NUDADD, TF, POASL, SCLAR
1349	Steam stripping, EQ, NEU, CLAR, COAG, FLOCC, NUDADD, ASL, SCLAR, POL
1494	Steam stripping, solvent extraction, EQ, NEU, CLAR, ASL, SCLAR, CAD
883	EQ, ASL, SCLAR, POL, FILT
659	EQ, NEU, SCR, DAF, COAG, FLOCC, ALA, SCLAR
1609	EQ, NEU, CLAR, ASL, SCLAR
851	EQ, API, NUDADD, ASL, TF, SCLAR
1890	Septic tank, API separator, gravity separation, ion exchange, steam stripping, GR, API, EQ, NEU, API, NUDADD, ALA, TF, FSA, SCLAR, FILT, CHLORINE ADDITION
1890*	Septic tank, API separator, EQ, NEU, NUDADD, ASL, SCLAR, FILT, AERATION
2631	Steam stripping, solvent extraction, EQ, NEU, API, CLAR, ASL, SCLAR
4051	API, ALA, DAF
296	Steam stripping, ion exchange, distillation, decantation, org. recovery, EQ, NEU, GR, OLSK, CLAR, ALA, POASL, SCLAR
306	Steam stripping, EQ, NEU, OLS, FLOCC, NUDADD, ASL, SCLAR, FILT
63	Distillation, chemical precipitation, evaporation, EQ, CLAR, ARL, ASL, SCLAR, CHLOR
387	Filtration, crystallization, evaporation, EQ, NEU, SCR, CLAR, NUDADD, POLISHING BASIN, ASL, SCLAR

TABLE VII-63.
TREATMENT TECHNOLOGIES FOR PLANTS IN THE
FINAL BAT TOXIC POLLUTANT DATA BASE
(Continued)

Plant I.D.	Treatment Technology
500	Steam stripping, carbon adsorption, spill containment, NEU, CLAR, ASL, SCLAR, POL, pH ADJUSTMENT
682	Settling, flotation, EQ, NEU, SCR, CLAR, COAG, SETTLING, FLOTATION, MIXING, SURFACE BAFFLES, ASL, SCLAR, DEAERATION
913	Steam stripping, chemical oxidation, phase separation, EQ, NEU
1012	EQ, SEDIM, CP, RBC, TF, SCLAR, SEDIM
1617	Distillation, EQ, COAG, SAND BED FILTRATION, TF, SCLAR, POL
1650	NEU, SCR, OLSK, OLS, API, ARL1, ARL2, ARL3, ARL4, ARL5, ARL6, ANL
1753	EQ, NEU, CLAR, NUDADD, POLADD, CP, POASL, SCLAR
1769	Chemical precipitation, NEU, CLAR, NUDADD, FLOCC, ASL, PACA, SCLAR, POL
1774	EQ, NEU, CLAR, FLOCC, FILT
2227	EQ, NEU, CLAR, FLOCC, NUDADD, ASL, SCLAR
2445	Dissolved air flotation, EQ, NEU, SCR, API, CLAR, NUDADD, POASL, SCLAR
2693	Chemical precipitation, steam stripping filtration, EQ, NEU, NUDADD, ASL, SCLAR

Note: The order in which these treatment technologies are listed does not necessarily indicate that they are in series, since certain plants employ multiple treatment systems to treat segregated waste streams.

*Two separate treatment systems were sampled at the same plant during the same sampling study.

TABLE VII-63.
TREATMENT TECHNOLOGIES FOR PLANTS IN THE
FINAL BAT TOXIC POLLUTANT DATA BASE
(Continued)

Key:

CND - Cyanide Destruction
CP - Chemical Precipitation
CHRRED - Chromium Reduction
AS - Air Stripping
SS - Steam Stripping
DISTL - Distillation
EQ - Equalization
NEU - Neutralization
SCR - Screening
GR - Grit Removal
OLSK - Oil Skimming
OLS - Oil Separation
API - API Separation
DAF - Dissolved Air Flotation
CLAR - Primary Clarification
COAG - Coagulation
FLOCC - Flocculation
NUDADD - Nutrient Addition
ASL - Activated Sludge
ALA - Aerated Lagoon
ARL - Aerobic Lagoon
ANL - Anaerobic Lagoon
RBC - Rotating Biological Contractor
TF - Trickling Filters
POASL - Pure Oxygen Activated Sludge
SSIBS - Second Stage of Indicated Biological System
PACA - Powdered Activated Carbon Addition
SCLAR - Secondary Clarification
POL - Polishing Pond
FILT - Filtration
CAD - Carbon Adsorption
SSITS - Second Stage of Indicated Tertiary System
GRSP - Gravity Separation
PAER - Post Aeration
CHLOR - Chlorination
FSA - Ferrus Sulfide Addition
SLDTH - Sludge Thickening
SLDFILT - Sludge Filtering
AER - Aeration
SEDIM - Sedimentation
POLADD - Polymer Addition

Notes:
Upper Case: End-of-Pipe Treatment
Lower Case: In-Plant Control

where M_j is the estimated long-term average at plant j; D is the analytical minimum level; n is the number of concentration values where X_i is detected at or above the minimum level at plant j; and p is the proportion of nondetected values reported from all the daily data base plants. That is, p equals the total number of reported nondetected values from all daily data plants for a particular pollutant divided by the total number of values reported from all daily data plants for a particular pollutant. For plant-pollutant combinations with all nondetected values, the long-term average, m, equals the analytical minimum level. For plant-pollutant combinations where all values are detected, the long-term average is the arithmetic mean of all values. Pollutant group values for p were used when pollutant-specific estimates were not available.

c. Steam Stripping Long-Term Averages

EPA is regulating 28 volatile organic pollutants based on steam stripping technology. EPA had data on 15 of these pollutants, which were used to determine limitations using the same methodology used to determine other BAT organic pollutant limitations. For 13 volatile organic pollutants controlled by steam stripping, EPA lacked sufficient data to calculate estimated long-term averages directly from data relating to these pollutants. Instead, EPA concluded that these pollutants may be treated to levels equivalent, based upon Henry's Law Constants, to those achieved for the 15 pollutants for which there were data. Dividing the 15 pollutants into "high" and "medium" strippability subgroups, EPA developed a long-term average for each subgroup and applied these to the 13 pollutants for which data were lacking (six pollutants in the high subgroup and seven in the medium subgroup). The long-term average for pollutants with no data in each subgroup was determined by the highest of the long-term averages within each subgroup based upon the 15 pollutants for which the Agency had data. This approach tends to be somewhat conservative but in the Agency's judgment not unreasonable in light of the uncertainty that would be associated with achieving a lower long-term average for the pollutants for which data are unavailable. The high strippability long-term average thus derived is 64.5 µg/l, while the medium strippability long-term average is slightly higher, 64.7 µg/l.

While it may appear anomalous that the high strippable subgroup yields just a slightly lower long-term average effluent concentration, EPA believes that this is not the case. First, in the context of the maximum levels entering the steam strippers within the two subgroups (12,000 µg/l to over 23 million µg/l), the differences between these two long-term averages is negligible and essentially reflect the same level of long-term control from an engineering viewpoint. Second, the "high" and "medium" strippable compounds behave comparably in steam strippers, in the sense that roughly the same low effluent levels can be achieved with properly designed and operated steam strippers. In other words, it is possible to mitigate small differences in theoretical strippability among compounds in these groups with different design and operating techniques. The small differences in long-term average performance seen in the data reflect, in EPA's judgment, no real differences in strippability among pollutants but rather the difference in steam stripper operations among the plants from which the data were taken. Indeed, one could reasonably collapse the two subgroups into one group and develop a single long-term average for the 13 pollutants for which EPA lacks data. While such an approach might be technically defensible, EPA decided it would be most reasonable to retain the distinction between "high" and "medium" subgroups, which remains a valid and important distinction for the purpose of transferring variability factors, as discussed below.

Table VII-64 presents the long-term average values for each organic pollutant, calculated by taking the median of the plant estimated averages for those pollutants regulated under BAT Subcategory One and Two. The BAT Subcategory One median of long-term average values for 1,1-dichloroethane and 4,6-dinitro-o-cresol have been transferred from BAT Subcategory Two. Since the in-plant steam stripping and activated carbon units attain effluent levels equal to the analytical minimum level, the addition of end-of-pipe biological treatment for BAT Subcategory Two will not produce a measurable lower effluent concentration.

d. Calculation of Daily Maximum and Maximum Monthly Average Variability Factors

After determining estimated long-term average values for each pollutant, EPA developed two variability factors for each pollutant--a 99th percentile

TABLE VII-64.
BAT TOXIC POLLUTANT MEDIAN OF ESTIMATED LONG-TERM
AVERAGES FOR BAT SUBCATEGORY ONE AND TWO

			Subcategory One		Subcategory Two	
Pollutant Number	Pollutant Name	Minimum Level	Number of Plants	Median of Estimated Long-Term Means	Number of Plants	Median of Estimated Long-Term Means
1	Acenaphthene	10	3	10.0	1	10.00
3	Acrylonitrile	50	5	50.0	1	50.00
4	Benzene	10	17	10.0	4	28.5761
6	Carbon Tetrachloride	10	3	10.0	-	64.5000*
7	Chlorobenzene	10	2	10.0	-	64.5000*
8	1,2,4-Trichlorobenzene	10	3	42.909	-	64.7218*
9	Hexachlorobenzene	10	1	10.0	-	64.7218*
10	1,2-Dichloroethane	10	9	25.625	2	64.7218
11	1,1,1-Trichloroethane	10	2	10.0	1	10.0
12	Hexachloroethane	10	2	10.0	-	64.7218*
13	1,1-Dichloroethane	10	-	(10.0)**	1	10.00
14	1,1,2-Trichloroethane	10	3	10.0	2	10.2931
16	Chloroethane	50	4	50.0	2	50.00
23	Chloroform	10	8	12.208	2	44.1081
24	2-Chlorophenol	10	3	10.0	-	-
25	1,2-Dichlorobenzene	10	7	47.946	-	64.7218*
26	1,3-Dichlorobenzene	10	1	24.80	-	64.5000*
27	1,4-Dichlorobenzene	10	1	10.0	-	64.5000*
29	1,1-Dichloroethylene	10	5	10.0	2	10.0517
30	Trans-1,2-Dichloroethylene	10	3	10.0	2	11.0517
31	2,4-Dichlorophenol	10	3	17.429	-	-
32	1,2-Dichloropropane	10	6	121.50	-	64.7218*
33	1,3-Dichloropropene	10	3	23.00	-	64.7218*
34	2,4-Dimethyl Phenol	10	4	10.794	1	10.00
35	2,4-Dinitrotoluene	10	2	58.833	-	-
36	2,6-Dinitrotoluene	10	2	132.667	-	-

TABLE VII-64.
BAT TOXIC POLLUTANT MEDIAN OF ESTIMATED LONG-TERM
AVERAGES FOR BAT SUBCATEGORY ONE AND TWO
(Continued)

			Subcategory One		Subcategory Two	
Pollutant Number	Pollutant Name	Minimum Level	Number of Plants	Median of Estimated Long-Term Means	Number of Plants	Median of Estimated Long-Term Means
38	Ethyl benzene	10	14	10.0	-	64.5000*
39	Fluoranthene	10	3	11.533	1	11.5333
42	Bis-(2-Chloroisopropyl) Ether	10	1	156.667	-	64.7218*
44	Methylene Chloride	10	8	22.956	3	10.800
45	Methyl Chloride	50	1	50.0	1	50.00
52	Hexachlorobutadiene	10	2	10.0	-	64.5000*
55	Naphthalene	10	10	10.0	1	10.0
56	Nitrobenzene	14	4	14.0	2	948.675
57	2-Nitrophenol	20	2	27.525	1	20.00
58	4-Nitrophenol	50	3	50.00	1	50.00
59	2,4-Dinitrophenol	50	3	50.0	1	373.00
60	4,6-Dinitro-O-Cresol	24	-	(24.0)**	1	24.00
65	Phenol	10	22	10.363	1	10.0
66	Bis(2-Ethylhexyl)Phthalate	10	2	47.133	1	43.4545
68	Di-n-Butyl Phthalate	10	2	17.606	1	13.0909
70	Diethyl Phthalate	10	2	42.50	1	23.6667
71	Dimethyl Phthalate	10	2	10.0	1	10.00
72	Benzo(a)Anthracene	10	2	10.0	1	10.00
73	Benzo(a)Pyrene	10	1	10.333	1	10.333
74	3,4-Benzofluoranthene	10	1	10.267	1	10.2667
75	Benzo (k) Fluoranthene	10	1	10.00	1	10.00
76	Chyrsene	10	3	10.0	1	10.00
77	Acenaphthylene	10	3	10.0	1	10.00
78	Anthracene	10	3	10.0	1	10.00
80	Fluorene	10	3	10.0	1	10.00
81	Phenanthrene	10	6	10.0	1	10.00

TABLE VII-64.
BAT TOXIC POLLUTANT MEDIAN OF ESTIMATED LONG-TERM
AVERAGES FOR BAT SUBCATEGORY ONE AND TWO
(Continued)

			Subcategory One		Subcategory Two	
Pollutant Number	Pollutant Name	Minimum Level	Number of Plants	Median of Estimated Long-Term Means	Number of Plants	Median of Estimated Long-Term Means
84	Pyrene	10	3	11.333	1	10.3333
85	Tetrachloroethylene	10	3	10.4231	1	18.4286
86	Toluene	10	24	10.00	2	12.4177
87	Trichloroethylene	10	4	10.00	2	11.5862
88	Vinyl Chloride	50	3	50.0	2	64.5000

Note: All units in µg/l or ppb.

*Transferred median of long-term means by strippability groupings.

**Transferred from BAT Subcategory Two.

Maximum for Any One Day variability factor (VF1) and a 95th percentile Maximum for Monthly Average variability factor (VF4). These were developed by fitting a statistical distribution to the daily data for each pollutant at each plant; estimating a 99th percentile and a mean of the daily data distributions for each pollutant at each plant; estimating a 95th percentile and a mean of the distribution of 4-day monthly averages for each pollutant at each plant; dividing the 99th and 95th percentiles by the respective means of daily and 4-day average distributions to determine plant-specific variability factors; and averaging variability factors across all plants to determine a VF1 and VF4 for each pollutant. All plant-pollutant combinations for which variability factors were calculated have at least seven effluent concentration values (including NDs) with at least three values at or above the minimum level.

For certain pollutants, the amount of daily data was limited and individual pollutant variability factors could not be calculated. For such pollutants regulated in BAT Subcategory One, variability factors were imputed from the variability factors for groups of pollutants expected to exhibit comparable treatment variability based upon comparison of chemical structure and characteristics. The priority pollutants were grouped, as shown in Table VII-65, by generic classification based on a similarity of functional group or structure (isomers, homologs, analogs, etc.). As a consequence of these similarities, members of each group share precursors, and/or have a common response to generic process chemistry (7-27) and, in the Agency's judgment, would be expected to exhibit similar characteristics in wastewater treatment unit operations. Each pollutant in each chemical group without a variability factor was then assigned a VF1 and VF4 equal to the average of the VF1s and VF4s of any pollutants in the same group. However, there are six pollutants without individual variability factors that are also in pollutant variability groups without an average variability factor. An overall average variability factor based on all individual pollutant variability factors was transferred to these pollutants [acrylonitrile, 2,4-dinitrotoluene, 2,6-dinitrotoluene, bis(2-chloroisopropyl) ether, hexachlorobutadiene, and nitrobenzene]. In the case of acrylonitrile and hexachlorobutadiene, the reason for not having individual variability factors was not lack of sufficient daily data but that all or nearly all values for these pollutants were not detected.

TABLE VII-65.
PRIORITY POLLUTANTS BY CHEMICAL GROUPS

1. Halogenated Methanes (Cls)

46	Methyl bromide
45	Methyl chloride
44	Methylene chloride (dichloromethane)
47	Bromoform (tribromomethane)
23	Chloroform (trichloromethane)
48	Bromodichloromethane
51	Dibromochloromethane
50	Dichlorodifluoromethane
49	Trichlorofluormethane
6	Carbon tetrachloride (tetrachloromethane)

2. Chlorinated C2s

16	Chloroethane (ethyl chloride)
88	Chloroethylene (vinyl chloride)
10	1,2-Dichloroethane (ethylene dichloride)
13	1,1-Dichloroethane
30	1,2-trans-Dichloroethylene
29	1,1-Dichloroehtylene (vinylidene chloride)
14	1,1,2-Trichloroethane
11	1,1,1-Trichlorethane (methyl chloroform)
87	Trichloroethylene
85	Tetrachloroethylene
15	1,1,2,2-Tetrachloroethane
12	Hexachloroethane

3. Chlorinated C3s

32	1,2-Dichloropropane
33	1,3-Dichloropropylene

4. Chlorinated C4

52	Hexachlorobutadiene

5. Chlorinated C5

53	Hexachlorocylopentadiene

6. Chloroalkyl Ethers

17	bis(chloromethyl)ether
18	bis(2-chloroethyl)ether
42	bis(2-chloroisopropyl)ether
19	2-chloroethylvinyl ether
43	bis(2-chloroethoxy) methane

TABLE VII-65.
PRIORITY POLLUTANTS BY CHEMICAL GROUPS
(Continued)

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7. Metals

114	Antimony
115	Arsenic
117	Beryllium
118	Cadmium
119	Chromium
120	Copper
122	Lead
123	Mercury
124	Nickel
125	Selenium
126	Silver
127	Thallium
128	Zinc

8. Pesticides

89	Aldrin
90	Dieldrin
91	Chlordane
95	alpha-Endosulfan
98	Endrin
99	Endrin aldehyde
100	Heptachlor
101	Heptachlor epoxide
102	alpha-BHC
103	beta-BHC
104	gamma-BHC (Lindane)
105	delta-BHC
92	4,4'-DDT
93	4,4'-DDE (p,p'-DDx)
94	4,4'-DDD (p,p'-TDE)
113	Toxaphene

9. Nitrosamines

61	N-Nitrosodimethyl amine
62	N-Nitrosodiphenyl amine
63	N-Nitrosodi-n-propyl amine

10. Miscellaneous

2	Acrolein
3	Acrylonitrile
54	Isophorone
121	Cyanide

TABLE VII-65.
PRIORITY POLLUTANTs BY CHEMICAL GROUPS
(Continued)

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11. Aromatics

4 Benzene
86 Toluene
38 Ethylbenzene

12. Polyaromatics

55 Naphthalene
1 Acenanaphthene
77 Acenaphthylene
78 Anthracene
72 Benzo(a)anthracene (1,2-benzantharacene)
73 Benzo(a)pyrene (e,4-benzopyrene)
74 3,4-Benzofluorantehne
75 Benzo(k)fluorantehene (11,12-benzofluoranthene)
76 Chrysene
79 Benzo(ghi)perylene (1,1,2-benzoperylene)
82 Dibenzo(a,h)anthracene (1,2,5,6-dibenzanthracene)
80 Fluorene
39 Fluoranthene
83 Indeno(1,2,3-cd)pyrene (2,3-o-Phenylene pyrene)
81 Phenanthrene
84 Pyrene

13. Chloroaromatics

7 Chlorobenzene
25 o-Dichlorobenzene
27 p-Dichlorobenzene
26 m-Dichlorobenzene
8 1,2,4-Trichlorobenzene
9 Hexachlorobenzene

14. Chlorinated Polyaromatic

20 2-Chloronaphthalene

15. Polychlorinated Biphenyls

106-112 Seven listed

16. Phthalate Esters

66 bis(2-Ethylhexyl)
67 Butylbenzyl
68 Di-n-butyl
69 Di-n-octyl
70 Diethyl
71 Dimethyl

TABLE VII-65.
PRIORITY POLLUTANTS BY CHEMICAL GROUPS
(Continued)

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17. Nitroaromatics

    56 Nitrobenzene
    35 2,4-Dinitrotoluene
    36 2,6-Dinitrotoluene

18. Benzidines

    5 Benzidine
    28 3,3'-Dichlorobenzidine
    37 1,2-Diphenylhydrazine

19. Phenols

    65 Phenol
    34 2,4-Dimethylphenol

20. Nitrophenols

    57 2-Nitrophenol
    58 4-Nitrophenol
    59 2,4-Dinitrophenol
    60 4,6-Dinitro-o-cresol

21. Chlorophenols

    24 2-Chlorophenol
    22 4-Chloro-m-cresol
    31 2,4-Dichlorophenol
    21 2,4,6-Trichlorophenol
    64 Pentachlorophenol

22. 144 TCDD (2,3,7,8-Tetrachloro-dibenzo-p-dioxin)

23. Haloaryl Ethers

    40 4-Chlorophenylphenyl ether
    41 4-Bromophynylphynyl ether

Priority pollutant numbers refer to a published alphabetical listing of the priority pollutants.

Source: Wise, H.E., and P.O. Fahrenthold (1981). Occurrence and Predictability of Priority Pollutants in Wastewaters of the Organic Chemicals and Plastics/Synthetic Fibers Industrial Categories, USEPA 1981.

For pollutants regulated in Subcategory Two (non-end-of-pipe biological), a different methodology was employed to transfer variability factors to pollutants without individual variability factors. In this case, transfer was accomplished not by pollutant group, but instead by the in-plant control technology. Therefore, variability factors were transferred among the pollutants treated by steam stripping, activated carbon, and in-plant biological treatment. The Agency further subdivided the pollutants controlled by steam stripping into high and medium strippability groups (based on Henry's Law Constants). As discussed previously in this section, Henry's Law Constant is an important criterion in the design of steam strippers and is therefore an appropriate factor for the transfer of variability factors. Further sub-division of the pollutants controlled by in-plant biological treatment was not considered necessary since all pollutants were determined to be effectively biodegraded; transfer of variability factors by adsorpability groups for pollutants controlled by activated carbon was based on using the variability factor for 2,4-dinitrophenol (low adsorpability) for the other three pollutants controlled by activated carbon.

For certain pollutants controlled by in-plant biological treatment, the transferred variability factors for in-plant biological treatment systems are lower than the variability factors used for end-of-pipe BAT Subcategory One. This results because BAT Subcategory One variability factors are: 1) in general, calculated using a different data base; and 2) transferred using the pollutant variability groups (presented in Table VII-65) rather than across the technology (as BAT Subcategory Two variability factors are transferred). Based on these differences, pollutants controlled by in-plant biological systems which require transferred variability factors will receive variability factors based on data from three phthalate esters [bis(2-ethylhexyl) phthalate, di-n-butyl phthalate, and diethylphthalate]; this occurs because all other pollutants controlled by in-plant biological systems have all daily data equal to the analytical minimum level. The Agency believes that, in addition to the reasons mentioned above, the larger end-of-pipe biological systems have higher variability factors because they receive more commingled waste streams with a larger number of organic pollutants; thus, they may be more susceptible to daily fluctuations in performance.

Based on the reasons mentioned above, the Agency has decided to retain the methodology used to transfer in-plant biological system variability factors. EPA feels that it would be inconsistent to transfer a higher variability factor to pollutants whose in-plant biological system reduces high raw waste concentrations (higher than end-of-pipe biological raw waste concentrations) to the analytical minimum level solely on the basis of chemical structure. (It should be noted that the transferred end-of-pipe biological system variability factor for all polynuclear aromatics would be based on one plant-pollutant combination.)

In response to comments on the statistical aspects of the proposed limitations development, several statistical techniques were investigated for deriving limitations. This investigation found that a modification of the delta-lognormal procedures provides a reasonable approximation of the underlying empirical toxic pollutant data. The delta-lognormal distribution assumes that data are a mixture of positive lognormally distributed values and zero values. Consequently, zero concentration values are modeled by a point distribution; positive concentration values follow a lognormal distribution; and the mixture of these values forms the delta-lognormal distribution. The statistical methodology used for testing the assumption of lognormality is found in Appendix VII-E, previously referenced in the BPT Section; the results of these hypothesis tests are also included in this Appendix.

This method provides a reasonable approach for combining quantitative concentration values with information expressed only as a nondetect, which is more qualitative in nature. For the determination of variability factors, the delta-lognormal procedure was modified by placing the point distribution at the analytical minimum level. The details of this modification of the delta distribution are presented in Appendix VII-F. This approach is somewhat conservative since values reported as nondetect may actually be any value between zero and the minimum level. The detection limit used for each pollutant was the analytical minimum level in EPA analytical methods 1624 and 1625. Assigning a minimum level to nondetected values in calculating both variability factors and long-term averages for this data base tends to result in slightly higher limitations than would be derived if lower values were assumed. If the point distribution were set to a value below the analytical minimum level, then the variability component of the limitation would increase and the component corresponding to the mean would decrease. The net effect (mean times variability factor) would generally result in lower limitations. In the absence of establishing a firm estimate of the distribution of data below the analytical minimum levels, the Agency concluded that it would be more equitable to use the analytical minimum level to model the point distribution in the modification to the delta-lognormal statistical procedures.

Comments were also received regarding the use of the average variability factor for transfer to pollutants without individual variability factors for BAT Subcategory One within each of the 23 pollutant groups. Commenters stated that the source of data for many of the pollutants was the 3-day Verification sampling program, and that transfer of an average variability factor to an LTA based only on data from a 3-day sampling program did not adequately address the effluent variability of a pollutant. To address this comment, the Agency examined its edited BAT toxic pollutant data base and determined that the predominant reason for a pollutant not having an individual variability factor was not lack of sufficient daily data but that all or nearly all values for that pollutant were not detected. Therefore, the Agency has decided to retain the use of an overall average variability factor for each pollutant group to transfer variability factors to all pollutants within the group without an individual variability factor.

The Agency also notes the exclusion of two plants (2227P and 500P) from the variability factor calculations even though they were retained for calculation of long-term averages. For plant 2227P, EPA examined the end-of-pipe biological treatment performance data submitted by the plant (which consisted of data for 1,2,4-trichlorobenzene, 1,2-dichlorobenzene, and nitrobenzene over a 1-year period) and observed a 2-month period when effluent concentrations of these pollutants were considerably higher than the remaining 10-month period; during this period of higher effluent concentrations, the corresponding raw waste concentrations were consistent with the remaining 10 months of raw waste concentration data. Based on this inconsistent performance, the Agency has concluded that this plant did not have good enough control of variability to be used to develop variability factors. Thus, the Agency has excluded this plant from variability factor calculations. However, the overall long-term performance is good and consistent with that achieved by other good performers. Therefore, this plant's data has been retained for long-term average calculations.

For plant 500P, the Agency examined the steam stripping and carbon adsorption performance data submitted by the plant (which consisted of data for nitrobenzene over a 3-month period) and believes the data exhibit both competitive adsorption effects and column breakthrough. Competitive adsorption exists when a matrix contains adsorbable compounds in solution which are being selectively adsorbed and desorbed. A review of the data indicates that while the plant's long-term performance demonstrates significant removals of pollutants, it is not consistent, thus much more variable than that of another plant using similar treatment and achieving comparable long-term average concentrations. Therefore, the Agency has excluded this plant from variability factor calculations but has retained the data for long-term average calculations.

Table VII-66 presents the individual pollutant variability factors for BAT Subcategory One summarized by pollutant group including the pollutants for which the overall average variability factor has been transferred. Table VII-67 presents the individual pollutant variability factors for BAT Subcategory Two summarized by in-plant control technology and strippability and adsorpability groups for steam stripping and activated carbon, respectively.

3. BAT and PSES Metals and Cyanide Limitations

Raw wastewaters generated by certain OCPSF facilities contain relatively high concentrations of metals and total cyanide. Based on a detailed analysis (as discussed in Sections V and VI of this document), the Agency has decided to regulate the following six pollutants under BAT and PSES:

- Total chromium
- Total copper
- Total lead
- Total nickel
- Total zinc
- Total cyanide.

TABLE VII-66.
INDIVIDUAL TOXIC POLLUTANT VARIABILITY FACTORS
FOR BAT SUBCATEGORY ONE

Pollutant Number	Pollutant Name	Daily VF	Monthly VF	Imputed Variability Factor?
	Pollutant Class = 1			
6	Carbon Tetrachloride	3.79125	1.71212	Yes
23	Chloroform	3.71334	1.69050	
44	Methylene Chloride	3.86915	1.73374	
45	Methyl Chloride	3.79125	1.71212	Yes
	Pollutant Class = 2			
10	1,2-Dichloroethane	8.22387	2.61524	
11	1,1,1-Trichloroethane	5.34808	2.07532	Yes
12	Hexachloroethane	5.34808	2.07532	Yes
14	1,1,2-Trichloroethane	5.34808	2.07532	Yes
16	Chloroethane	5.34808	2.07532	Yes
29	1,1-Dichloroethylene	2.47230	1.53541	
30	1,2-Trans-dichloroethylene	5.34808	2.07532	Yes
85	Tetrachloroethylene	5.34808	2.07532	Yes
87	Trichloroethylene	5.34808	2.07532	Yes
88	Vinyl Chloride	5.34808	2.07532	Yes
	Pollutant Class = 3			
32	1,2-Dichloropropane	1.88783	1.25869	
33	1,3-Dichloropropene	1.88783	1.25869	Yes
	Pollutant Class = 4			
52	Hexachlorobutadiene	4.83045	1.91724	Yes
	Pollutant Class = 6			
42	Bis-(2-Chloroisopropyl) Ether	4.83045	1.91724	Yes
	Pollutant Class = 10			
3	Acrylonitrile	4.83045	1.91724	Yes
	Pollutant Class = 11			
4	Benzene	13.5252	3.63645	
38	Ethylbenzene	10.7379	3.10513	Yes
86	Toluene	7.9506	2.57382	

TABLE VII-66.
INDIVIDUAL TOXIC POLLUTANT VARIABILITY FACTORS
FOR BAT SUBCATEGORY ONE
(Continued)

Pollutant Number	Pollutant Name	Daily VF	Monthly VF	Imputed Variability Factor?
	Pollutant Class = 12			
1	Acenaphthene	5.89125	2.1563	Yes
39	Fluoranthene	5.89125	2.1563	Yes
55	Naphthalene	5.89125	2.1563	Yes
72	Benzo(a)Anthracene	5.89125	2.1563	Yes
73	Benzo(a)Pyrene	5.89125	2.1563	Yes
74	3,4-Benzofluoranthene	5.89125	2.1563	Yes
75	Benzo(k)Fluoranthene	5.89125	2.1563	Yes
76	Chrysene	5.89125	2.1563	Yes
77	Acenaphthylene	5.89125	2.1563	Yes
78	Anthracene	5.89125	2.1563	Yes
80	Fluorene	5.89125	2.1563	Yes
81	Phenanthrene	5.89125	2.1563	
84	Pyrene	5.89125	2.1563	Yes
	Pollutant Class = 13			
7	Chlorobenzene	2.79155	1.46787	Yes
8	1,2,4-Trichlorobenzene	3.25317	1.58318	
9	Hexachlorobenzene	2.79155	1.46787	Yes
25	1,2-Dichlorobenzene	3.38091	1.59720	
26	1,3-Dichlorobenzene	1.74057	1.22323	
27	1,4-Dichlorobenzene	2.79155	1.46787	Yes
	Pollutant Class = 16			
66	Bis-(2-Ethylhexyl) Phthalate	5.91768	2.17027	
68	Di-n-Butyl Phthalate	3.23768	1.51824	
70	Diethyl Phthalate	4.75961	1.89895	
71	Dimethyl Phthalate	4.63833	1.86249	Yes
	Pollutant Class = 17			
35	2,4-Dinitrotoluene	4.83045	1.91724	Yes
36	2,6-Dinitrotoluene	4.83045	1.91724	Yes
56	Nitrobenzene	4.83045	1.91724	Yes

TABLE VII-66.
INDIVIDUAL TOXIC POLLUTANT VARIABILITY FACTORS
FOR BAT SUBCATEGORY ONE
(Continued)

Pollutant Number	Pollutant Name	Daily VF	Monthly VF	Imputed Variability Factor?
		Pollutant Class = 19		
34	2,4-Dimethylphenol	3.25650	1.59976	
65	Phenol	2.49705	1.40602	
		Pollutant Class = 20		
57	2-Nitrophenol	2.49725	1.4643	
58	4-Nitrophenol	2.47783	1.4331	Yes
59	2,4-Dinitrophenol	2.45842	1.4019	
		Pollutant Class = 21		
24	2-Chlorophenol	9.70575	3.05490	
31	2,4-Dichlorophenol	6.37097	2.22674	

Note: Average pollutant class variability factors used (except overall average variability factor used for pollutants 3, 35, 36, 42, 52, and 56) for imputations when no pollutant class variability factors are available.

TABLE VII-67.
INDIVIDUAL TOXIC POLLUTANT VARIABILITY FACTORS
FOR BAT SUBCATEGORY TWO

Pollutant Number	Pollutant Name	Daily VF	Monthly VF	Imputed Variability Factor?
4	Benzene	4.65485	1.97430	
11	1,1,1-Trichloroethane	5.88383	2.18759	Yes
13	1,1-Dichloroethane	5.88383	2.18759	Yes
16	Chloroethane	5.88383	2.18759	Yes
23	Chloroform	7.36230	2.49394	
29	1,1-Dichloroethylene	5.88383	2.18759	Yes
30	1,2-Trans-dichloroethylene	5.88383	2.18759	Yes
45	Methyl Chloride	5.88383	2.18759	Yes
85	Tetrachloroethylene	8.85657	2.78458	
86	Toluene	5.88383	2.18759	Yes
87	Trichloroethylene	5.88383	2.18759	Yes
88	Vinyl Chloride	2.66160	1.49754	
10	1,2-Dichloroethane	8.8604	2.77681	
14	1,1,2-Trichloroethane	12.2662	3.02524	Yes
44	Methylene Chloride	15.6720	3.27366	

Note: Pollutant variability factors sorted by strippability group--mean of average variability factors within a strippability group used to impute variability factors when no variability factors available.

Pollutant Number	Pollutant Name	Daily VF	Monthly VF	Imputed Variability Factor?
56	Nitrobezene	6.7477	2.35797	
57	2-Nitrophenol	11.5023	3.23479	Yes
58	4-Nitrophenol	11.5023	3.23479	Yes
59	2,4-Dinitrophenol	11.5023	3.23479	
60	4,6-Dinitro-o-Cresol	11.5023	3.23479	Yes

Note: Pollutant variability factors--variability factors for pollutant 59 used to impute variability factors for 57, 58, and 60.

TABLE VII-67.
INDIVIDUAL TOXIC POLLUTANT VARIABILITY FACTORS
FOR BAT SUBCATEGORY TWO
(Continued)

Pollutant Number	Pollutant Name	Daily VF	Monthly VF	Imputed Variability Factor?
1	Acenaphthene	4.63833	1.86249	Yes
3	Acrylonitrile	4.63833	1.86249	Yes
34	2,4-Dimethylphenol	4.63833	1.86249	Yes
39	Fluorantehene	4.63833	1.86249	Yes
55	Naphthalene	4.63833	1.86249	Yes
65	Phenol	4.63833	1.86249	Yes
66	Bis-(2-Ethylhexyl) Phthalate	5.91768	2.17027	
68	Di-n-Butyl Phthalate	3.23768	1.51824	
70	Diethyl Phthalate	4.75961	1.89895	
71	Dimethyl Phthalate	4.63833	1.86249	Yes
72	Benzo(a)Anthracene	4.63833	1.86249	Yes
73	Benzo(a)Pyrene	4.63833	1.86249	Yes
74	3,4-Benzofluoranthene	4.63833	1.86249	Yes
75	Benzo(k)Fluoranthene	4.63833	1.86249	Yes
76	Chrysene	4.63833	1.86249	Yes
77	Acenaphthylene	4.63833	1.86249	Yes
78	Anthracene	4.63833	1.86249	Yes
80	Fluorene	4.63833	1.86249	Yes
81	Phenanthrene	4.63833	1.86249	Yes
84	Pyrene	4.63833	1.86249	Yes

Note: Pollutant variability factors--overall average variability factors used to impute variability factors when no variability factors available.

The technology basis for control of these pollutants is hydroxide precipitation for the metals and alkaline chlorination for cyanide. Although sulfide precipitation was the basis for BAT and PSES compliance cost estimates, it was not used as the technology basis for the limitations because the Agency's final regulation does not include control of complexed sources of these metals. This results in a slight overestimation of costs for compliance with the metals limits for BAT and PSES levels of control.

Although the concentrations of these pollutants in certain samples of untreated OCPSF wastewater are relatively high, the metals fall within the range of concentrations found in untreated wastewaters from metal processing and finishing, such as those for the metal finishing and battery manufacturing industries. Because no metals treatment performance data for OCPSF wastewaters generated by the validated product/processes listed in Section V were available, the Agency decided to transfer limitations from the metal finishing point source category. Cyanide is found at levels in certain OCPSF waste streams at higher concentrations than in metal finishing. Destruction of cyanide by alkaline chlorination is demonstrated in the OCPSF industry; this technology uses excess oxidizer (chlorine) and excess alkaline conditions, and should be able to treat cyanide by adding sufficient detention time which has been costed. Table VII-68 presents the long-term averages and daily and monthly maximum variability factors for each pollutant.

The monthly maximum limitations for the metal finishing industry are based on an assumed monitoring requirement of 10 samples per month and employ the 99th percentile as a basis for the monthly maximum standard. For the OCPSF standard, however, the monthly maximum standards are based on an assumed monitoring requirement of four samples per month and they use the 95 percentile as a basis. The above limitations have been adjusted accordingly to be consistent with the other OCPSF BAT limitations by deriving 4-day variability factors from the distributional parameters determined from the 10-day metal finishing variability factors (see Appendix VII-F). The OCPSF daily and monthly maximum limitations for each pollutant is the product of the respective long-term averages and respective 1-day and 4-day variability factors.

TABLE VII-68.
BAT SUBCATEGORY ONE AND TWO LONG-TERM AVERAGES AND VARIABILITY FACTORS FOR METALS AND TOTAL CYANIDE

Pollutant Number	Pollutant Name	Long-Term Average (mg/l)	Maximum Monthly Average VF	Maximum Daily VF
119	Total Chromium	0.572	1.934	4.85
120	Total Copper	0.815	1.781	4.15
121	Total Cyanide	0.180	2.343	6.68
122	Total Lead	0.197	1.642	3.52
124	Total Nickel	0.942	1.796	4.22
128	Total Zinc	0.549	1.912	4.75

4. <u>BAT Zinc Limitations for Plants Manufacturing Rayon by the Viscose Process and Acrylic Fibers by the Zinc Chloride/Solvent Process</u>

Raw wastewaters generated by the manufacture of rayon by the viscose process and acrylic fibers by the zinc chloride/solvent process exhibit high concentrations of zinc with levels generally exceeding 100 mg/l. Accordingly, the Agency has decided to control zinc in the process wastewaters from these product/processes by establishing separate BAT effluent limitations. Since these wastewaters do not contain complexed sources of zinc that could inhibit treatment by conventional methods, the Agency has selected hydroxide precipitation as the basis for these process-specific BAT effluent limitations.

During the public comment periods on the March 21, 1983, proposal and July 17, 1985, NOA, industry commenters submitted hydroxide precipitation performance data for four rayon plants and one acrylic fibers plant. These data sets contained influent and effluent data for four plants (three rayon, one acrylic fiber) with over 200 influent/effluent data pairs for each data set. One rayon plant (399) was eliminated because only effluent data were submitted. Following a quality assurance review, the effluent concentrations that exceeded 10 mg/l or that exhibited less than 90 percent removal of zinc were deleted from these three data sets. For the performance data from the acrylic fibers plant (1012), 1.4 percent of the effluent zinc concentrations were deleted, while for the three remaining rayon plants (63, 387, and 1774), 5.9, 0.8, and 63.6 percent of the respective effluent zinc concentrations were deleted.

The Agency then investigated the data set for plant 1774 because of the failure of 63.6 percent of the data to pass the editing criteria. Analysis of the data revealed that the majority of the data failed the 90 percent removal criteria. Further investigation revealed that the failure to achieve 90 percent removal was not because of high effluent zinc concentrations but due to low influent concentrations that are the result of a zinc recovery unit upstream of the influent sampling point. Based on these findings, the entire performance data set for plant 1774 was deleted from further limitations calculations.

The data sets for the two remaining rayon plants and the one acrylic fibers plant were analyzed according to the methodology for deriving BAT effluent limitations described in Appendix VII-F. Table VII-69 presents the resulting long-term averages and variability factors for the remaining plants.

5. PSES Effluent Limitations

As presented earlier in Section VI, the Agency has determined that 47 toxic pollutants pass through POTWs and will be controlled by PSES effluent limitations. For these 47 toxic pollutants, PSES effluent limitations are equal to BAT Subcategory Two effluent limitations.

TABLE VII-69.
BAT ZINC LONG-TERM AVERAGES AND VARIABILITY FACTORS FOR RAYON (VISCOSE PROCESS) AND ACRYLIC (ZINC CHLORIDE/SOLVENT PROCESS) FIBERS PLANTS

Plant Number	Long-Term Average (mg/l)	Maximum Monthly VF	Maximum Daily VF
63	1.739	1.79	4.19
387	2.114	1.41	2.50
1012	2.190	1.52	2.95
Median of LTA	2.114	----	----
Average VF	----	1.572	3.214

SECTION VII

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