United States
Environmental Protection
Agency

Effluent Guidelines Division
WH-552
Washington, DC 20460

EPA 440/1-81/023
January 1981

Water and Waste Management

EPA

Development Document for Effluent Limitations Guidelines and Standards for the

Final

Timber Products

Point Source Category

DEVELOPMENT DOCUMENT

for

EFFLUENT LIMITATIONS GUIDELINES NEW SOURCE PERFORMANCE STANDARDS

and

PRETREATMENT STANDARDS

for the

TIMBER PRODUCTS PROCESSING POINT SOURCE CATEGORY

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January, 1981

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ABSTRACT

This document presents the findings of a study of the wood preserving, insulation board, and wet process hardboard segments of the Timber Products Processing point source category for the purpose of developing effluent limitations and guidelines for existing point sources and standards of performance and pretreatment standards for new and existing point sources to implement Sections 301, 304, 306, 307, 308, and 501 of the Clean Water Act (the Federal Water Pollution Control Act Amendments of 1972, 33 USC 1251 et. seq., as amended by the Clean Water Act of 1977, P.L. 95-217) (the "Act"). This document was also prepared in response to the Settlement Agreement in _Natural Resources Defense Council, Inc._ v. _Train_, 8 ERC 2120 (D.D.C. 1976), modified March 9, 1979.

The information presented in this document supports regulations promulgated in January 1981 for the Timber Products Processing Point Source Category. Information is presented to support new source performance standards (NSPS) and pretreatment standards for new and existing sources (PSNS and PSES) for two subcategories in the wood preserving segment. Information is presented to support best practicable control technology (BPT), best conventional pollutant control technology (BCT), new source performance standards (NSPS), and pretreatment standards for new and existing sources (PSNS and PSES) for the two parts of the wet process hardboard subcategory and the insulation board subcategory. Best available technology (BAT) and BCT limitations are not proposed for the wood preserving segment because only one direct discharger of process wastewater has been identified. BAT limitations are not proposed for the hardboard subcategory and the insulation board subcategory because of the low level of toxic pollutants present in raw wastewaters generated by these subcategories. The guidelines and standards promulgated by the Agency and presented in this document are based on the performance of technology currently being practiced in the industry segments for which regulations are promulgated. Descriptions of the treatment technologies appropriate for achieving the limitations contained herein, as well as supporting data, cost estimates, and rationale for the development of the proposed effluent limitations, guidelines, and standards of performance are contained in this report.

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SECTION I

EXECUTIVE SUMMARY

SUMMARY AND CONCLUSIONS

Coverage

The technical study of the timber products processing industry, the findings of which are presented in this document, is limited to the wood preserving, insulation board, and wet process hardboard portions of the industry. New regulations are promulgated for these portions. In addition, previously promulgated regulations for the hydraulic barking portion of the barking subcategory, the veneer subcategory, and the log washing subcategory were reconsidered.

Wood Preserving

There are more than 415 wood preserving plants operated by more than 300 companies in the United States. The plants are concentrated in two areas, the Southeast from east Texas to Maryland and along the Northern Pacific coast. These areas correspond to the natural ranges of the southern pine and Douglas fir - western red cedar, respectively.

Toxic pollutants in wastewaters from plants that treat with organic preservatives are principally volatile organic solvents such as benzene and toluene, and the polynuclear aromatic components (PNAs) of creosote, including anthracene, pyrene and phenanthrene, that are contained in the entrained oils. Both phenol and phenol derivatives have been identified in these wastewaters; pentachlorophenol (PCP) is predominant when it is used as a preservative. Heavy metals are also found. The conventional pollutants found in the wastewaters include TSS, Oil and Grease, and pH. COD is the only nonconventional pollutant that has been identified.

The following toxic pollutants were found in treated effluents at two or more plants above the nominal detection limit of ten micrograms per liter, organics, and less than 2 micrograms per liter, metals.

fluoranthene
3,4-benzofluoranthene
benzo(k)fluoranthene
pyrene
benzo(a)pyrene
indeno(1,2,3-cd)pyrene
benzo(ghi)perylene
naphthalene
acenaphthylene
fluorene
chrysene
bis(2-ethylhexyl)phthalate
phenol
pentachlorophenol
arsenic
copper
chromium
nickel
zinc

The Agency is retaining the previously promulgated subcategorization scheme for the wood preserving segment except for the title of the Wood Preserving subcategory, which has been changed for descriptive purposes.

The Agency is withdrawing the existing best available technology economically achievable (BAT) regulation for the Wood Preserving-Steam subcategory because there is only one known direct discharging plant in the subcategory. The Agency does not believe it is necessary to develop national effluent limitations for this one plant.

The Agency is promulgating new source performance standards (NSPS) and pretreatment standards for new sources (PSNS) which prohibit discharge of process wastewater pollutants. Over eighty percent of all existing wood preserving plants have demonstrated that no discharge of process wastewater pollutants can be attained.

The Agency is not promulgating the proposed pretreatment standard for existing sources (PSES) that would have required no discharge of pentachlorophenol (PCP). The no discharge PCP limitation was based on the application of evaporative technology. Instead, the Agency has decided to retain the existing PSES for the Wood Preserving-Boulton and-Steam subcategories that were promulgated in December 1976. This existing standard, based on gravity oil-water separation technology, requires a limitation of 100 mg/l on Oil and Grease, as well as limitations of 5 mg/l for copper, 4 mg/l for chromium, and 4 mg/l for arsenic. This is being done out of economic and other considerations.

The Agency's decision to retain existing PSES for the Wood Preserving-Steam and -Boulton subcategories will result in no pollution control costs above and beyond those imposed by the existing standard.

Insulation Board/Wet Process Hardboard

There are 26 plants in the insulation board/wet process hardboard segment. Ten plants produce only insulation board, 11 plants produce only wet process hardboard, and five plants produce both insulation board and wet process hardboard. Nine plants are located in the South, seven in the Midwest, six in the Pacific Northwest, three in the Mid-Atlantic region, and one in the Northeast.

The pollutants present in the process wastewater are mainly water soluble wood constituents high in BOD and TSS, the result of the leaching of wood constituents into the process water. Additives also contribute to the waste load. These may include wax emulsion, paraffin, starch, polyelectrolytes, aluminum sulfate, vegetable oils, ferric sulfate, and thermoplastic and thermosetting resins. Wastewater flows from discharging plants range from 0.05 to 4 MGD. Data obtained from the sampling and analysis program conducted during the BAT review study show that the only toxic pollutants present in raw or treated wastewaters from this segment are very low concentrations of heavy metals, and the organics-benzene, toluene, and phenol. There is no treatment technology, except perhaps a no discharge technology, currently available to further reduce the low concentrations of these pollutants, and none of these pollutants are present at levels high enough to interfere with the operation of a POTW.

The following toxic pollutants were found in treated effluents at two or more plants above the nominal detection limit but below the limit of additional treatability.

benzene
toluene
copper
zinc
phenol
beryllium
nickel

The Agency is dividing the existing wet process hardboard subcategory of the industry into two parts, smooth-one-side and smooth-two-sides, S1S and S2S, respectively. Raw waste loads generated by plants producing S2S hardboard were found to be significantly higher than those generated by S1S plants. Therefore, application of comparable treatment to these wastewaters will result in a different treated effluent level.

The Agency is promulgating for this subcategory best practicable control technology (BPT), and best conventional pollutant control technology (BCT) limits for BOD, TSS and pH. It is also promulgating new source performance standards (NSPS) which require no discharge of process wastewater pollutants and pretreatment standards for new sources (PSNS), and pretreatment standards for existing sources (PSES) which require that dischargers meet the general pretreatment standards of 40 CFR Part 403. BAT limitations are not being promulgated because toxic pollutants were identified at only trace levels in effluents from this industry and treatment of these pollutants is not economically or technologically feasible.

The Agency is merging the insulation board subcategories into one subcategory. BPT, BCT, NSPS, PSNS and PSES effluent limitation guidelines and standards are being promulgated for this subcategory. BAT limitations are not being promulgated because toxic pollutants are present in only trace amounts in wastewaters generated by this industry and treatment of these pollutants is not economically or technologically feasible. The BPT and BCT numerical limitations are different than those for wet process hardboard because insulation board raw wastewaters are of lower strength and are more easily treated than wet process hardboard wastewaters. The Agency is promulgating PSNS and PSES which require that dischargers meet the general pretreatment standards of 40 CFR Part 403 because the pollutants present in insulation board wastewaters are compatible with POTW. The Agency is promulgating a NSPS which requires no discharge of process wastewater, based on the demonstrated feasibility of land application technology.

The cost of compliance for the hardboard subcategory to achieve the BPT level of control is estimated to be $9,556,000 capital, and $3,679,000 annual operating costs. A total of three plants might incur costs to achieve this level of control.

For the BCT level of control, seven plants could incur a total of $20,345,000 capital and $6,296,000 operating costs.

No plants in the insulation board subcategory will incur costs to achieve the promulgated BPT and BCT limitations.

EFFLUENT STANDARDS

Wood Preserving

The Agency is not changing the best practicable control technology currently available (BPT) limitations previously promulgated for the wood preserving segment in 40 CFR Part 429, (subparts F, G, and H)* (39 FR 13942, April 18, 1974). That rulemaking established a no discharge of process wastewater pollutants limitation for subparts F and H, and established numerical limits on the discharge of COD, total phenols (as measured by Standard Methods), Oil and Grease, and pH for subpart G.

The Agency is also retaining the previously promulgated best available technology economically achievable (BAT) limitations for subparts F and H, which established a no discharge of process wastewater pollutants limitation. BAT for subpart G is being withdrawn because there is only one plant in this subcategory that is known to be discharging process wastewater.

The Agency is promulgating new source performance standards (NSPS) that require no discharge of process wastewater pollutants. The rationale for this decision is that more than 80 percent of existing wood preserving plants are achieving no discharge of process wastewater pollutants and that new sources can achieve this status without severe economic consequences.

The Agency proposed a PSES standard requiring no discharge of PCP in order to eliminate PCP from passing through POTW. The Agency

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*Subpart F - Wood Preserving

Subpart G - Wood Preserving-Steam

Subpart H - Wood Preserving-Boulton

decided not to promulgate this proposed no discharge of PCP standard because the cost of attaining this level of control was too high and for other reasons.

Instead, it has decided to retain the previously promulgated pretreatment standards for existing sources (PSES) for subparts G and H, which require a 100 mg/l limitation on Oil and Grease, a 5 mg/l limitation on copper, and a 4 mg/l limitation on chromium and arsenic (41 FR 53930, Dec. 9, 1976). Control of Oil and Grease will control polynuclear aromatics and pentachlorophenol (PCP) to levels which insure minimal pass through of these toxics through POTW.

The Agency is retaining PSES for subpart F which require no discharge of process wastewater pollutants (40 CFR Part 429.164) (41 FR 53935). It is common practice for plants in this subcategory to recycle and reuse all process wastewater. The Agency is promulgating pretreatment standards for new sources (PSNS) that require no discharge of process wastewater pollutants. This standard will prevent PCP, heavy metals and PNAs from passing through POTW. New source indirect dischargers, unlike some of the existing sources, are fully capable of meeting this no discharge requirement without severe economic consequences. No hindrance to the addition of new capacity is expected.

Section 304(e) of the Act directs the Administrator "to control plant site runoff, spillage or leaks, sludge or waste disposal and drainage from raw material storage . . ." The technical/economic studies upon which these regulations are based did not include a detailed study of these factors. The Agency is conducting a separate study of these aspects (Best Management Practices, BMP) of pollution control to be addressed in future rulemaking.

Insulation Board/Wet Process Hardboard

BPT, BAT, NSPS and PSNS for the wet process hardboard subcategory were promulgated April 18, 1974 (39 FR 13942). These regulations established numerical limits on BOD, TSS, and pH. PSES for the subcategory were promulgated December 9, 1976 (41 FR 53930) and required compliance with general pretreatment standards. BPT, BAT and NSPS for the wet process hardboard subcategory were withdrawn by the Agency on September 27, 1977, because further information obtained indicated the need to revise the regulation.

BPT, BAT, NSPS and PSNS for the insulation board subcategory were proposed August 26, 1974 (39 FR 30892) but were never promulgated. Numerical limits on BOD,TSS and pH were proposed and the PSNS required compliance with general pretreatment standards. The PSES for the subcategory was promulgated on December 9, 1976, and requires compliance with the general pretreatment standards.

The Agency has changed the subcategorization scheme in the present round of rulemaking. In the insulation board subcategory, although the waste loads from the two pulp preparation processes are slightly different, there is only one "mechanical refining" plant which is a direct discharger, and this plant has a raw waste load equivalent to the average thermomechanical refining plant. Therefore, these two subcategories have been combined into one, "Insulation Board." Secondly, the Agency found that plants which produce S2S hardboard exhibit significantly greater raw waste loads than do S1S hardboard plants because S2S hardboard manufacture requires more cooking and refining of the wood chips. For this reason, the Agency divided the wet process hardboard subcategory into two parts, S1S Hardboard and S2S Hardboard.

Because BPT had been withdrawn in the wet process hardboard subcategory and never promulgated in the insulation board subcategory, it was necessary to designate a BPT treatment level in this round of rulemaking, as a minimum level of control applicable to all direct dischargers. BPT is also used as a baseline against which to compare the costs of achieving the BCT level of control.

The wet process hardboard subcategory has two parts, smooth-one-side (S1S) and smooth-two-sides (S2S). For the S1S part, BPT is based on the performance of a plant producing only S1S hardboard. In the S2S part, EPA has promulgated a limit which can be achieved if the treatment used at the S1S BPT plant is applied to the higher raw waste load at the S2S plant. This approach was elected because the sole plant producing only S2S hardboard demonstrates a performance well above that usually associated with BPT in terms of percent removal of BOD and TSS. Therefore, it is deemed an appropriate plant for BCT, but not BPT. In the absence of an appropriate model plant for BPT, this approach is the most rational; furthermore 7 out of 14 direct dischargers are already meeting the limit.

In the insulation board subcategory the Agency has promulgated BPT numerical limits on BOD, TSS and pH. These limits are based on the performance of one of the two direct discharging plants producing insulation board only.

To set BCT limits for the S1S and S2S parts of the wet process hardboard subcategory, the Agency identified only one treatment and control option technically and economically feasible for providing pollutant removal beyond that required by BPT limitations. This option is to provide additional detention time, aeration and settling capacity. The characteristics of the upgraded biological systems are based on documented performance of existing systems treating S1S hardboard wastewaters and S2S hardboard wastewaters. Although there are five plants producing hardboard that are currently achieving no discharge of process wastewater, the Agency did not select a no discharge of process wastewater option for BCT because this level of control would fail the "cost reasonableness" test.

BCT for the insulation board subcategory was proposed as the same limits as BPT because no existing plant demonstrated an intermediate, upgraded treatment level. The next step for this subcategory would be no discharge of all process wastewater, and this requirement would not pass the "cost-reasonableness" test.

The promulgated effluent limitations contain several changes from the proposed BPT and BCT limits for both the wet process hardboard and insulation board subcategories. In developing the final rule, the Agency collected a year's worth or more of additional data on treatment system performance, and revised its statistical methodology in order to account for both seasonality and autocorrelation of the data. The Agency re-analyzed all the data using the improved methodology, with the result that the daily limits became slightly more restrictive, and the 30-day limits became slightly more lenient.

The Agency did not propose BAT limits for the insulation board/wet process hardboard segment because review of the information available to the Agency indicated that such toxic pollutants as do occur in the segment are present in such low concentration levels that they cannot be effectively reduced by any of the technologies known to EPA, except a no discharge technology which is not considered to be technologically or economically feasible for many existing plants.

New source performance standards for both wet process hardboard and insulation board were proposed as no discharge of process wastewater pollutants. Five of the existing twenty-six plants in the two subcategories are achieving no discharge of process wastewater. The Agency believes that new sources, which have more flexibility to plan as necessary to achieve no discharge, are capable of meeting the standard. A no discharge limitation can be achieved by a number of methods, including recycle and reuse of treated wastewater, spray irrigation of treated process wastewater and in-plant controls designed to minimize the wastewater generated.

In establishing pretreatment standards for both new and existing facilities, the Agency recognized that process wastewaters generated by the insulation board/wet process hardboard segment of the industry do not contain toxic pollutants at treatable levels. Conventional pollutants present in these wastewaters, primarily BOD and TSS, are treatable by a POTW. Because of these facts, the Agency is promulgating pretreatment standards for new and existing sources in the insulation board/wet process hardboard segment that do not establish numerical limitations on the introduction of process wastewater to a POTW.

Section 304(e) of the Act directs the Administrator "to control plant site runoff, spillage or leaks, sludge or waste disposal and drainage from raw material storage . . ." The technical/economic study upon which these regulations are based did not include a detailed study of these factors. The Agency is conducting a separate study of these aspects (Best Management Practices, BMP) of pollution control to be addressed in future rulemaking.

SECTION II

INTRODUCTION

PURPOSE AND AUTHORITY

The regulations described in this notice are promulgated under authority of sections 301, 304, 306, 307, and 501 of the Clean Water Act (the Federal Water Pollution Control Act Amendments of 1972, 33 USC 1251 et seq., as amended by the Clean Water Act of 1977, P.L. 95-217) (the "Act"). These regulations are also promulgated in response to the Settlement Agreement in Natural Resources Defense Council, Inc. v. Train, 8 ERC 2120 (D.D.C. 1976), modified March 9, 1979.

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)). By July 1, 1977, existing industrial dischargers were required to achieve "effluent limitations requiring the application of the best practicable control technology currently available" ("BPT") (section 301(b)(1)(A)); and by July 1, 1983, these dischargers were required to achieve "effluent limitations requiring the application of the best available technology economically achievable (BAT) which will result in reasonable further progress toward the national goal of eliminating the discharge of all pollutants" (section 301(b)(2)(A)). New industrial direct discharges were required to comply with section 306, new source performance standards ("NSPS"), based on best available demonstrated technology (BADT); and new and existing dischargers to publicly owned treatment works ("POTW") were subject to pretreatment standards under sections 307(b) and (c) of the Act. While the requirements for direct dischargers were to be incorporated into National Pollutant Discharge Elimination System (NPDES) permits issued under section 402 of the Act, pretreatment standards were to be enforceable directly against dischargers to POTW (indirect dischargers).

Although section 402(a)(1) of the 1972 Act authorized the setting of requirements for direct dischargers on a case-by-case basis, Congress intended that, for the most part, control requirements would be based on regulations promulgated by the Administrator of EPA. Section 304(b) of the Act required the Administrator to promulgate regulations providing guidelines for effluent limitations setting forth the degree of effluent reduction attainable through the application of BPT and BAT. Moreover, sections 304(c) and 306 of the Act required promulgation of NSPS, and sections 304(f), 307(b), and 307(c) required promulgation of pretreatment standards. In addition to these regulations for designated industry categories, section 307(a) of the Act required the Administrator to promulgate effluent standards applicable to all dischargers of toxic pollutants. Finally, section 501(a) of the Act authorized the Administrator to prescribe any additional regulations "necessary to carry out his functions" under the Act.

The EPA was unable to promulgate many of these guidelines and standards by the dates contained in the Act. In 1976, EPA was sued by several environmental groups and in settlement of this lawsuit, EPA and the plaintiffs executed a "Settlement Agreement," which was approved by the Court. This Agreement required EPA to develop a program and adhere to a schedule for promulgation for 21 major industries BAT effluent limitations guidelines, pretreatment standards and new source performance standards for 65 "toxic" pollutants and classes of pollutants. See Natural Resources Defense Council, Inc. v. Train, 8 ERC 2120 (D.D.C. 1976), modified March 9, 1979.

On December 27, 1977, the President signed into law the Clean Water Act of 1977. Although this law makes several important changes in the Federal water pollution control program, its most significant feature is its incorporation of many of the basic elements of the Settlement Agreement program for toxic pollutant control. Sections 301(b)(2)(A) and 301(b)(2)(C) of the Act now require the achievement by July 1, 1984, of effluent limitations requiring application of BAT for toxic pollutants, including the 65 "toxic" pollutants and classes of pollutants which Congress declared "toxic" under section 307(a) of the Act. Likewise, EPA's programs for new source performance standards and pretreatment standards are now aimed principally at toxic pollutant control. Moreover, to strengthen the toxics control program, section 304(e) of the Act authorizes the Administrator to prescribe "best management practices" ("BMPs") to prevent the release of toxic and hazardous pollutants from plant site runoff, spillage or leaks, sludge or waste disposal, and drainage from raw material storage associated with, or ancillary to, the manufacturing or treatment process.

In keeping with its emphasis on toxic pollutants, the Clean Water Act of 1977 also revises the control program for nontoxic pollutants. Instead of BAT for "conventional" pollutants identified under Section 304(a)(4), (including biochemical oxygen demand, suspended solids, fecal coliform, Oil and Grease and pH), the new Section 301(b)(2)(E) requires achievement by July 1, 1984 of "effluent limitations requiring the application of the best conventional pollutant control technology" ("BCT"). The factors considered in assessing BCT for an industry include the costs and benefits of attaining a reduction in effluents, compared to the costs and effluent reduction benefits from the discharge of a publicly owned treatment works (Section 304(b)(4)(B)). For nontoxic, nonconventional pollutants, sections 301(b)(2)(A) and 301(b)(2)(F) require achievement of BAT effluent limitations within three years after their establishment, or July 1, 1984, whichever is later, but not later than July 1, 1987.

PRIOR EPA REGULATIONS

Best Practicable Control Technology Currently Available

Wood Preserving Segment -- EPA has divided the wood preserving segment of the timber industry into three groups of plants; plants that treat wood with waterborne preservatives, or inorganic salts, plants that use steam conditioning to prepare wood for preservative impregnation, and plants that use the Boulton process to prepare wood for preservative impregnation. Those portions of the industry preserving with inorganics, and using the Boulton process are required to meet a BAT limitation of no discharge of process wastewater pollutants promulgated in 1974.

The following BPT effluent limitations were promulgated on April 18, 1974 for the wood preserving segment of the timber products industry:

Wood Preserving-Waterborne or Nonpressure Subcategory (formerly Wood Preserving Subcategory) -- No discharge of process wastewater pollutants.

Wood Preserving-Steam Subcategory

Effluent Characteristic	BPT Effluent Limitations Maximum for any 1 day	Average of daily values for 30 consecutive days shall not exceed
	Metric units (kilograms per 1,000 m³ of product)	
COD	1,100	550
Total Phenols	2.18	0.65
Oil and Grease	24.0	12.0
pH	Within the range 6.0 to 9.0	
	English units (pounds per 1,000 ft³ of product)	
COD	68.5	34.5
Total Phenols	0.14	0.04
Oil and Grease	1.5	0.75
pH	Within the range 6.0 to 9.0	

Wood Preserving-Boulton Subcategory -- No discharge of process wastewater pollutants.

Insulation Board -- On August 26, 1974, effluent guidelines and standards were proposed for the direct discharging portion of the insulation board manufacturing subcategory. These proposed regulations were never promulgated. Promulgation was delayed because review of the proposed regulation indicated that additional information was needed.

Wet Process Hardboard -- On April 18, 1974, the Agency promulgated BPT limitations for the wet process hardboard subcategory.

Following promulgation of wet process hardboard regulations on April 18, 1974, the industry and the Agency held a series of meetings to review the information in the Record supporting these regulations. This review convinced the Agency that the existing regulations should be withdrawn. On September 28, 1977, a notice was published in the Federal Register announcing the withdrawal of 40 CFR Part 429 Subpart E-Hardboard Wet Process, best practicable control technology limitations (BPT), best available technology limitations (BAT), and new source performance standards (NSPS).

Best Available Technology Economically Achievable

Wood Preserving Segment -- The following BAT effluent limitations were promulgated on April 18, 1974 for the wood preserving segment of the timber products industry:

Wood Preserving-Waterborne or Nonpressure Subcategory -- No discharge of process wastewater pollutants.

Wood Preserving-Steam Subcategory

Effluent Characteristic	BAT Effluent Limitations Maximum for any 1 day	Average of daily values for 30 consecutive days shall not exceed
	Metric units (kilograms per 1,000 m^3 of product)	
COD	220	110
Total Phenols	0.21	0.064
Oil and Grease	6.9	3.4
pH	Within the range 6.0 to 9.0	
	English units (pounds per 1,000 ft^3 of product)	
COD	13.7	6.9
Total Phenols	0.014	0.004
Oil and Grease	0.42	0.21
pH	Within the range 6.0 to 9.0	

Wood Preserving-Boulton Subcategory -- No discharge of process wastewater pollutants.

Insulation Board/Wet Process Hardboard Segment -- Following promulgation of wet process hardboard regulations on April 18, 1974, the industry and the Agency held a series of meetings to review the information in the Record supporting these regulations. This review convinced the Agency that the existing regulations should be withdrawn. On September 28, 1977, a notice was published in the Federal Register announcing the withdrawal of 40 CFR Part 429 Subpart E-Hardboard Wet Process, best practicable control technology limitations (BPT), best available technology limitations (BAT), and new source performance standards (NSPS).

Barking -- Effluent guidelines and standards for the Barking subcategory were promulgated in 1974 (39 FR 13942 April 18, 1974). The 1974 rulemaking divided the Barking subcategory into two parts: mechanical barking, a basically dry operation using physical methods, such as blades or abrasive discs, to remove the bark as one technique of bark removal; the second technique is identified as hydraulic barking, i.e., using water applied to the wood under high pressure to separate the bark from the wood.

The 1974 BAT regulations required mechanical barking operations and hydraulic barking operations to meet an effluent limitation requiring no discharge of process wastewater pollutants by 1983.

Veneer -- BPT regulations for this subcategory promulgated in 1974, required no discharge of process wastewater pollutants for all veneer manufacturing plants, except those plants that use direct steam for conditioning of veneer logs. This exception was designed to give plants using direct steam conditioning time to modify their operations before being required to meet the 1983 BAT limitation, requiring no discharge of process wastewater pollutants.

Log Washing -- BPT for this subcategory allows the discharge of process wastewater pollutants. BAT regulations published in 1974 for this subcategory requires no discharge of process wastewater pollutants.

New Source Performance Standards

The following NSPS were promulgated on April 18, 1974.

Wood Preserving Segment -- Wood Preserving Subcategory (now Wood Preserving-Waterborne or Nonpressure) -- No discharge of process wastewater pollutants.

Wood Preserving Steam Subcategory

Effluent Characteristic	NSPS Effluent Limitations Maximum for any 1 day	NSPS Effluent Limitations Average of daily values for 30 consecutive days shall not exceed
	Metric units (kilograms per 1,000 m^3 of product)	
COD	220	110
Total Phenols	0.21	0.064
Oil and Grease	6.9	3.4
pH	Within the range 6.0 to 9.0	
	English units (pounds per 1,000 ft^3 of product)	
COD	13.7	6.9
Total Phenols	0.014	0.004
Oil and Grease	0.42	0.21
pH	Within the range 6.0 to 9.0	

Wood Preserving-Boulton Subcategory -- No discharge of process wastewater pollutants.

Pretreatment Standards, New and Existing

The following pretreatment standards for new sources were promulgated April 18, 1974.

Wood Preserving Subcategory -- Wastewater may be discharged, subject to general pretreatment requirements.

Wood Preserving - Steam Subcategory -- Wastewater may be discharged, subject to general pretreatment requirements.

Wood Preserving-Boulton Subcategory -- Wastewater may be discharged, subject to general pretreatment requirements.

Hardboard-Wet Process (PSNS) -- Wastewater may be discharged, subject to general pretreatment requriements.

The following pretreatment standards were promulgated for existing sources December 9, 1976.

Wood Preserving Subcategory -- No discharge of process wastewater pollutants.

Wood Preserving-Boulton And Steam Subcategories

Pollutant or Pollutant Property	Pretreatment Standard Maximum for any one day (milligrams per liter)	Maximum for any one day (grams per cubic meter production)
Oil and Grease	100	20.5
Copper	5	0.62
Chromium	4	0.41
Arsenic	4	0.41

Hardboard-Wet Process -- Wastewater may be discharged subject to general pretreatment requirements.

OVERVIEW OF THE INDUSTRY

Standard Industrial Classifications

The Standard Industrial Classification list was developed by the United States Department of Commerce and is oriented toward the collection of economic data related to gross production, sales, and unit costs. The list is useful in that it divides American industry into discrete product-related segments.

The SIC codes investigated during the study of the Timber Products Processing industry (timber industry) are:

SIC	2411	Logging Camps and Logging Contractors
SIC	2421	Sawmills and Planing Mills
SIC	2426	Hardwood Dimension and Flooring Mills
SIC	2429	Special Product Sawmills
SIC	2431	Millwork
SIC	2434	Wood Kitchen Cabinets
SIC	2435	Hardwood Veneer and Plywood
SIC	2436	Softwood Veneer and Plywood
SIC	2439	Structural Wood Members
SIC	2491	Wood Preserving
SIC	2499	Timber Products not elsewhere classified (Hardboard)
SIC	2661	Building Paper and Building Board Mills (Insulation Board)

The industry segments addressed in this document are wood preserving (SIC 2491), insulation board production (SIC 2661), and wet process hardboard production (SIC 2499).

Wood Preserving

The American Wood Preserver's Association has identified approximately 476 wood preserving plants in the United States (AWPA, 1978). AWPA sent questionnaires to these plants and responses were received from 326 plants. According to the response, there are 243 companies which manage these 326 plants. Approximately 70 percent of the plants are concentrated in two distinct regions. One area extends from east Texas to Maryland and corresponds roughly to the natural range of the Southern pines, the major species utilized. The second, smaller area is located along the Pacific Coast, where Douglas fir and western red cedar are the predominant species. The distribution of plants by type and location is given in Table II-1, and depicted in Figure II-1.

The major types of preservatives used in wood preserving are creosote, pentachlorophenol (PCP), and various formulations of water-soluble inorganic chemicals, the most common of which are the salts of copper, chromium, and arsenic. Fire retardants are formulations of salts, the principal ones being borates, phosphates, and ammonium compounds. Eighty percent of the plants in the United States use at least two of the three types of preservatives.

Consumption data for the principal preservatives for the year 1978 are given in Table II-2. Creosote and creosote solutions were used to treat approximately 56 percent of the total industry production in 1978. PCP was the preservative used for approximately 25 percent of the 1978 production. About 19 percent of the 1978 production was treated with waterborne inorganic salts. Table II-3 presents a summary of the materials treated, by product, for all preservatives during the two year period of 1977 and 1978.

Insulation Board

Insulation board is a form of fiberboard, which is a broad generic term applied to sheet materials constructed from lignocellulosic fibers. Insulation board is a "noncompressed" fiberboard, which is differentiated from "compressed" fiberboards, such as hardboard, on the basis of density. Densities of insulation board range from about 0.15 to a maximum 0.50 g/cu cm (9.5 to 31 lb/cu ft).

The principal types of insulation board are:

1. Building board--A general purpose product for interior construction.
2. Insulating roof deck--A three-in-one component which provides roof deck, insulation, and finished inside ceiling. (Insulation board sheets are laminated together with waterproof adhesives, with a vapor barrier in between the sheets.)

Table II-1. Wood Preserving Plants in the United States by State and Type, 1978.

	Pressure	Non-Pressure	Pressure and Non-Pressure	Total Number Plants
Northeast				
Delaware	0	0	0	0
Maine	0	0	0	0
Maryland	4	0	1	5
Massachusetts	2	0	0	2
New Hampshire	0	0	1	1
New Jersey	3	0	0	3
New York	5	0	0	5
Pennsylvania	7	0	2	9
Rhode Island	0	0	0	0
West Virginia	3	0	0	3
Total	24	0	4	28
North Central				
Illinois	7	1	0	8
Indiana	5	0	0	5
Iowa	0	0	0	0
Kentucky	5	0	0	5
Michigan	4	0	0	4
Minnesota	5	0	2	7
Missouri	8	0	1	9
Nebraska	1	0	0	1
North Dakota	0	0	0	0
Ohio	7	0	0	7
Wisconsin	9	1	2	12
Total	51	2	5	58
Southeast				
Florida	16	1	4	21
Georgia	26	0	1	27
North Carolina	10	0	4	14
South Carolina	8	0	2	10
Virginia	15	0	1	16
Puerto Rico	1	0	0	1
Total	76	1	12	89

Table II-1. Wood Preserving Plants in the United States by State and Type, 1978. (Continued, Page 2 of 2)

	Pressure	Non-Pressure	Pressure and Non-Pressure	Total Number Plants
South Central				
Alabama	18	0	3	21
Arkansas	10	0	1	11
Louisiana	15	1	1	17
Mississippi	16	0	1	17
Oklahoma	3	0	1	4
Tennessee	2	1	0	3
Texas	20	0	2	22
Total	84	2	9	95
Rocky Mountain				
Arizona	0	1	0	1
Colorado	3	0	0	3
Idaho	4	1	2	7
Montana	3	1	2	6
New Mexico	1	0	0	1
South Dakota	1	0	0	1
Utah	1	1	0	2
Wyoming	3	0	0	3
Total	16	4	4	24
Pacific				
California	6	0	2	8
Hawaii	2	0	0	2
Oregon	7	0	2	9
Washington	9	2	2	13
Total	24	2	6	32
United States Total	275	11	40	326

Source: AWPA, 1978.

GEOGRAPHICAL DISTRIBUTION OF WOOD PRESERVING PLANTS IN THE UNITED STATES

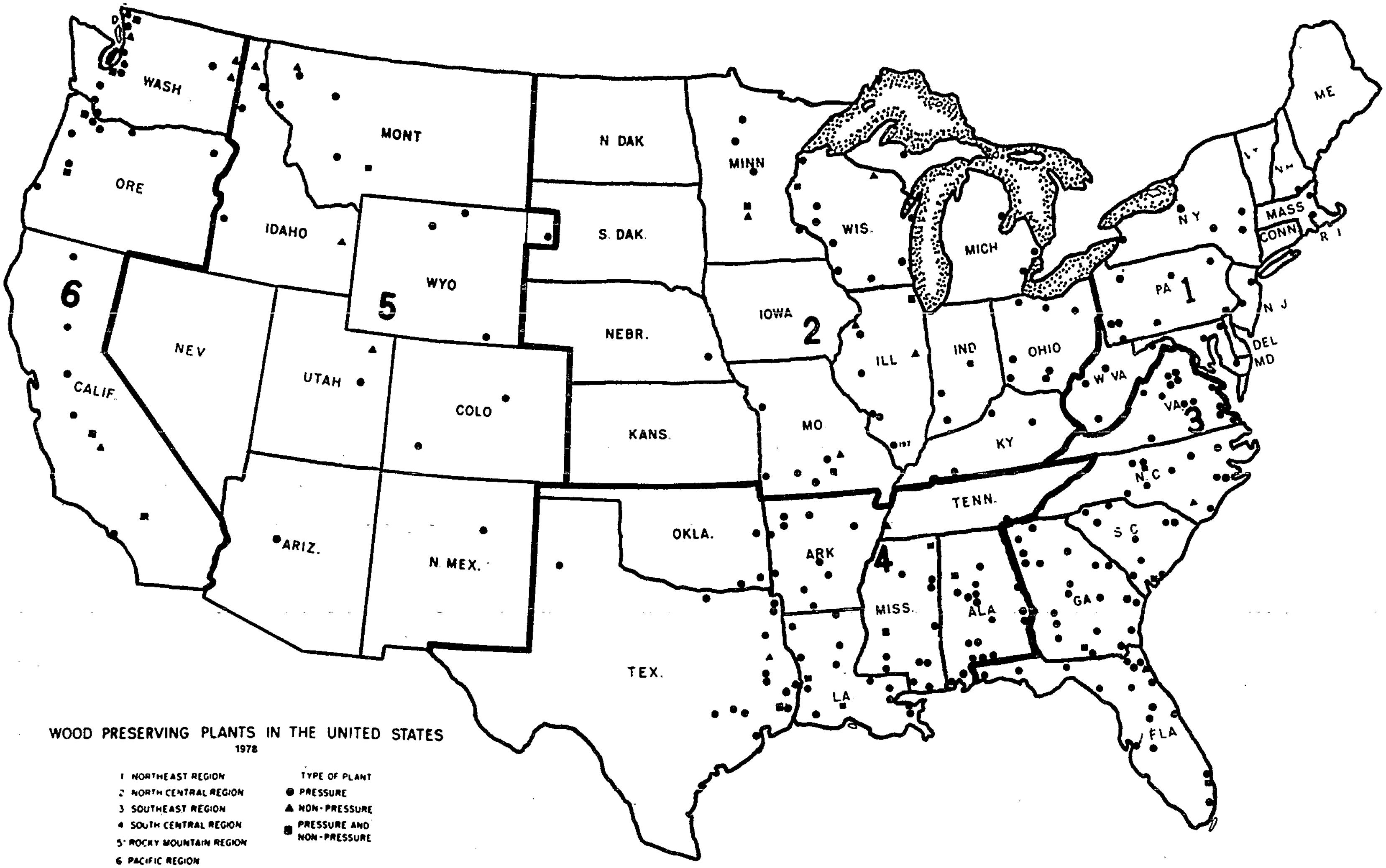


Figure II-1

Table II-2. Consumption of Principal Preservatives and Fire Retardants of Reporting Plants in the United States, 1978

Material	(Units)	Year 1978
Creosote	Million Liters	129
Creosote-Coal Tar	Million Liters	251
Creosote-Petroleum	Million Liters	114
Total Creosote	Million Liters	340
Total Petroleum	Million Liters	225
Total Coal Tar	Million	92.7
Pentachlorophenol	Million Kilograms	13.2
Chromated Zinc Chloride	Million Kilograms	0.2
CCA	Million Kilograms	11.3
ACC	Million Kilograms	0.3
FCAP	Million Kilograms	0.1
Fire Retardants	Million Kilograms	7.9
Other Preservative Solids	Million Kilograms	0.9

NOTE: Data based on information supplied by 326 plants.

SOURCE: AWPA, 1978.

Table II-3. Materials Treated in the United States by Product

Material	Thousand Cubic Meters Year 1977	 1978
Cross-ties	2,648	2,656
Switch-ties	196	177
Piling	321	276
Poles	1,503	1,759
Cross-arms	38.1	31.9
Lumber & timbers	1,748	2,432
Fence posts	304	315
Other	329	381
Total	7,087	8,027

NOTE: Components may not add due to rounding.

SOURCE: AWPA, 1978.

3. Roof insulation--Insulation board designed for flat roof decks.
4. Ceiling tile--Insulation board embossed and decorated for interior use. It is also useful for acoustical qualities.
5. Lay-in panels--A ceiling tile used for suspended ceilings.
6. Sheathing--Insulation board used extensively in construction because of its insulative, bracing strength and noise control qualities.
7. Sound-deadening insulation board--A special product designed explicitly for use in buildings to control noise level.

The American Society for Testing and Materials (ASTM) sets standard specifications for the types of insulation board. Decorative type board products, such as ceiling tiles, lay-in-panels, etc., receive a higher degree of finishing than do structural type boards such as sheathing and building board. Consequently, stricter control during fiber preparation and formation is required in production of decorative-type board to insure that the product can be ironed, edge fabricated, sanded, coated, and painted, resulting in a smooth, beveled, finished surface. Decorative board products cannot contain high amounts of dissolved solids in the production process for this reason. This factor will be significant in later discussions of wastewater recycle.

There are 15 insulation board producing plants in the United States using wood as the predominant raw material with a combined production capacity of over 330 million square meters (3,600 million square feet) on a 13-mm (one-half inch) basis. All of the plants use wood as a raw material for some or all of their production. Four plants use mineral wool, a nonwood based product, as a raw material for part of their insulation board production. Production of mineral wool board is classified under SIC 3296 and is not within the scope of this rulemaking. Five plants produce hardboard products as well as insulation board at the same facility. A list of the 15 plants which produce insulation board using wood as raw material is presented in Table II-4. The geographical distribution of these plants is depicted in Figure II-2.

Production of insulation board in the U.S. between 1968 and 1978 is presented in Figure II-3.

Table II-4. Inventory of Insulation Board Plants Using Wood as Raw Material

---

Armstrong Cork Company
Macon, Georgia

Boise Cascade Corporation
International Falls, Minnesota

The Celotex Corporation
Dubuque, Iowa

The Celotex Corporation
L'anse, Michigan

The Celotex Corporation
Sunbury, Pennsylvania

Owens Corning
Meridian, Mississippi

Huebert Fiberboard, Inc
Boonville, Missouri

Weyerhaeuser Company
Craig, Oklahoma

Owens Corning
St. Helens, Oregon

National Gypsum Company
Mobile, Alabama

Georgia-Pacific
Jarratt, Virginia

Temple-Eastex
Diboll, Texas

United States Gypsum Company
Lisbon Falls, Maine

United States Gypsum Company
Greenville, Mississippi

United States Gypsum Company
Pilot Rock, Oregon

Source: 1980 Directory of the Forest Products Industry.

GEOGRAPHICAL DISTRIBUTION OF INSULATION BOARD MANUFACTURING FACILITIES IN THE UNITED STATES

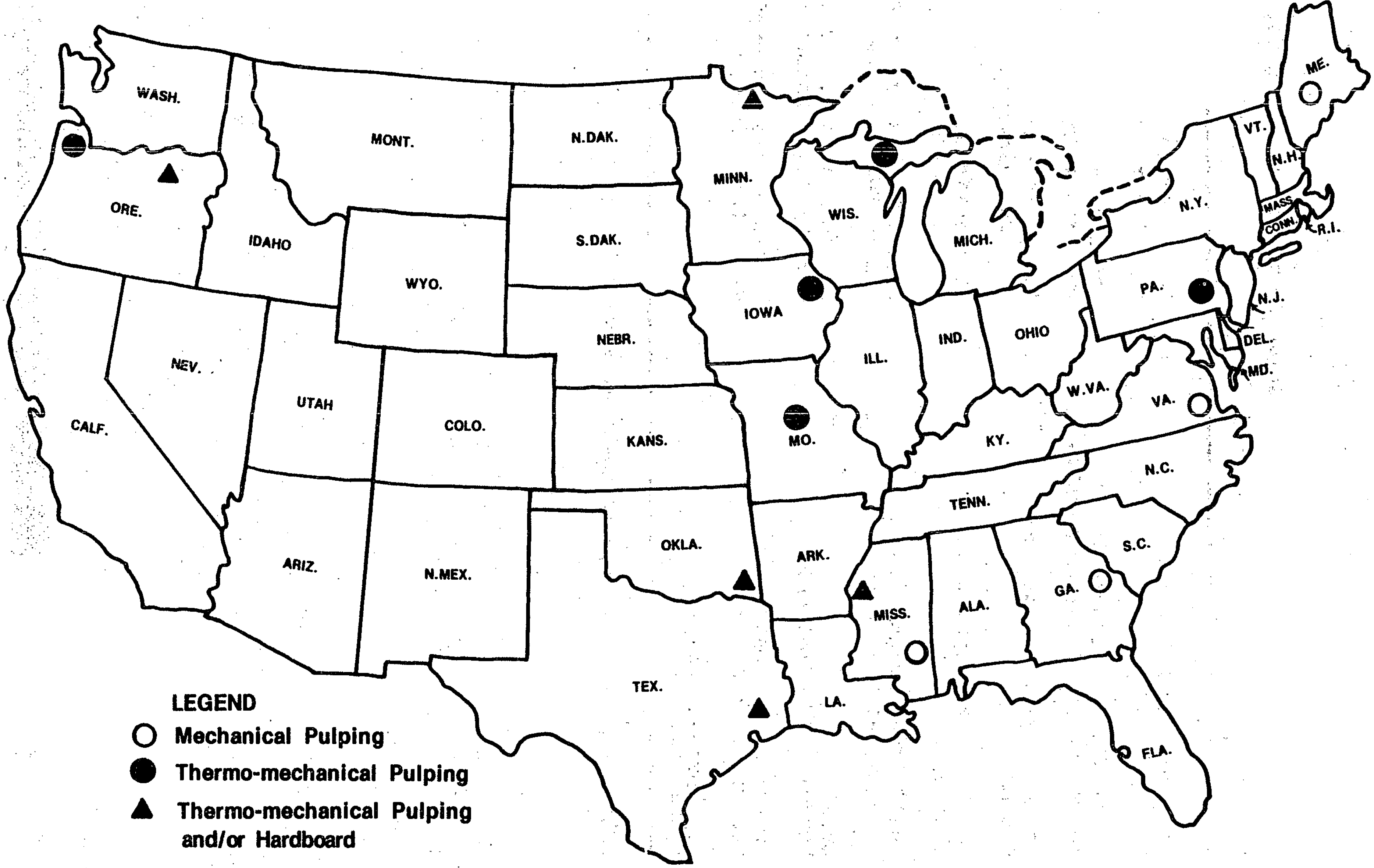


Figure II-2

TOTAL BOARD PRODUCTION FIGURES: INSULATION BOARD

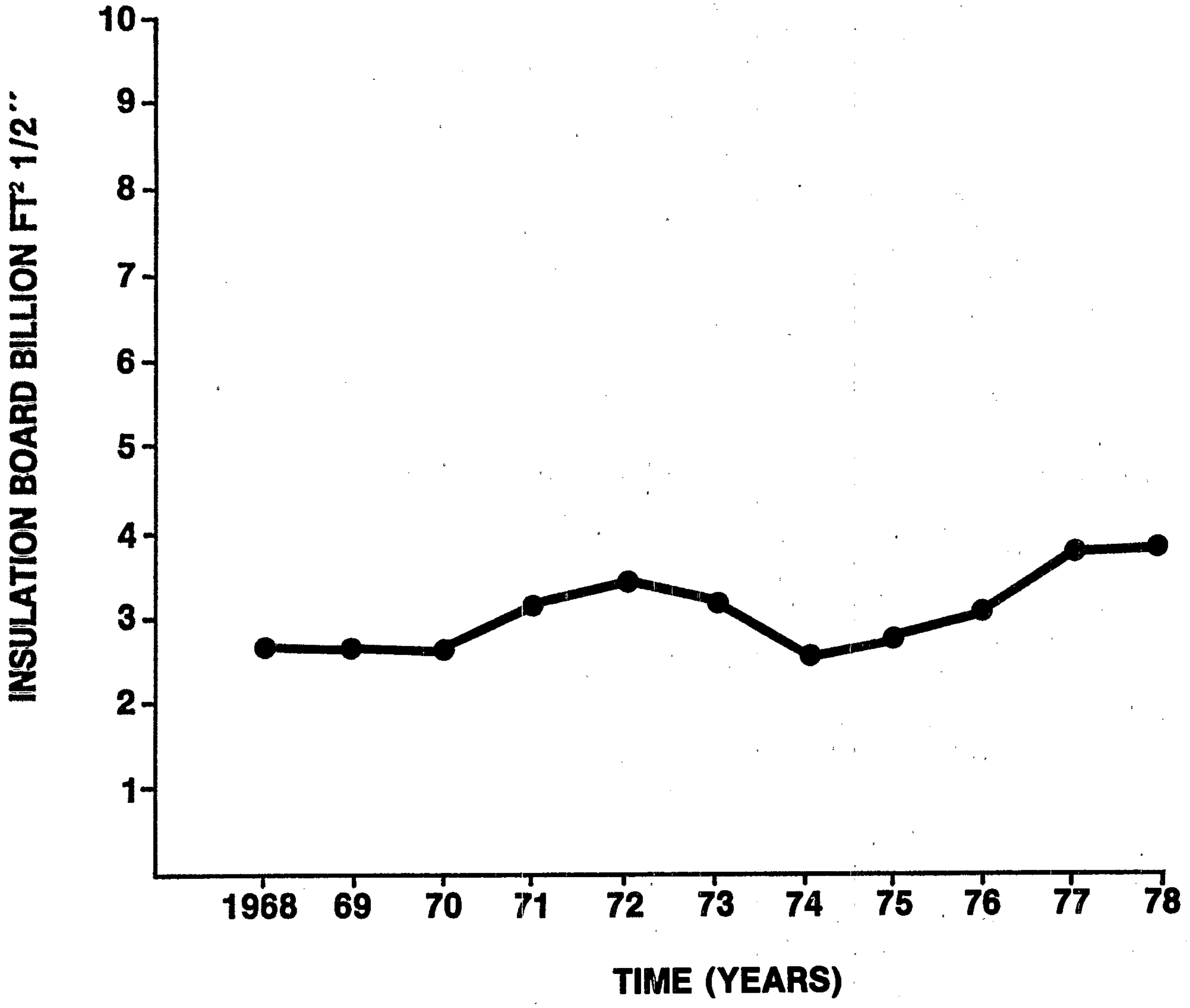


Figure II-3

Wet Process Hardboard

Hardboard is a "compressed" fiberboard, with a density greater than 0.50 g/cu cm (greater than 31 lb/cu ft). The thickness of hardboard products ranges between 2 to 13 mm (nominal 1/12 to 7/16 in).

Production of hardboard by the wet process method is usually accomplished by thermomechanical fiberization of the wood raw material. Dilution of the wood fiber with water is followed by forming of a wet mat of a desired thickness on a forming machine. This wet mat is then pressed either wet or dried and pressed. Chemical additives help the overall strength and uniformity of the product. The use of hardboards are many and varied, requiring different processes and control measures. The quality and type of board is important in the end use of the product.

The following are some of the uses of hardboard:

Interior Wall Paneling
Exterior Siding
Display Cabinets
Base of Painted Tile Panels
Concrete Forms
Nonconductor Material for Electrical Equipment
Door Skins (panels)
TV Cabinets and Furniture

The American Society for Testing and Materials sets standards for the various types of hardboard produced.

Hardboard which is pressed wet immediately following forming of the wet lap is called wet-wet or smooth-one-side (S1S) hardboard; that which is pressed after the wet lap has been dried is called wet-dry or smooth-two-side (S2S) hardboard.

There are 16 plants producing wet process hardboard in the United States, representing an annual production in excess of 1.5 million metric tons per year. Seven of the plants produce only S1S hardboard. Of the nine plants producing S2S hardboard, three plants produce both S2S and S1S, five plants produce S2S and insulation board, and one plant produces S2S only. Table II-5 lists the wet process hardboard plants in the U.S.

The geographic distribution of these plants is depicted in Figure II-4. The total annual U.S. production of hardboard from 1964 through 1978 is shown in Figure II-5. This total production includes dry process hardboard as well as wet process hardboard. Although the relative amounts of production between dry and wet process hardboard vary from year to year, a generalized rule of thumb is that 75 percent of the total production is wet process hardboard.

GEOGRAPHICAL DISTRIBUTION OF HARDBOARD MANUFACTURING FACILITIES IN THE UNITED STATES

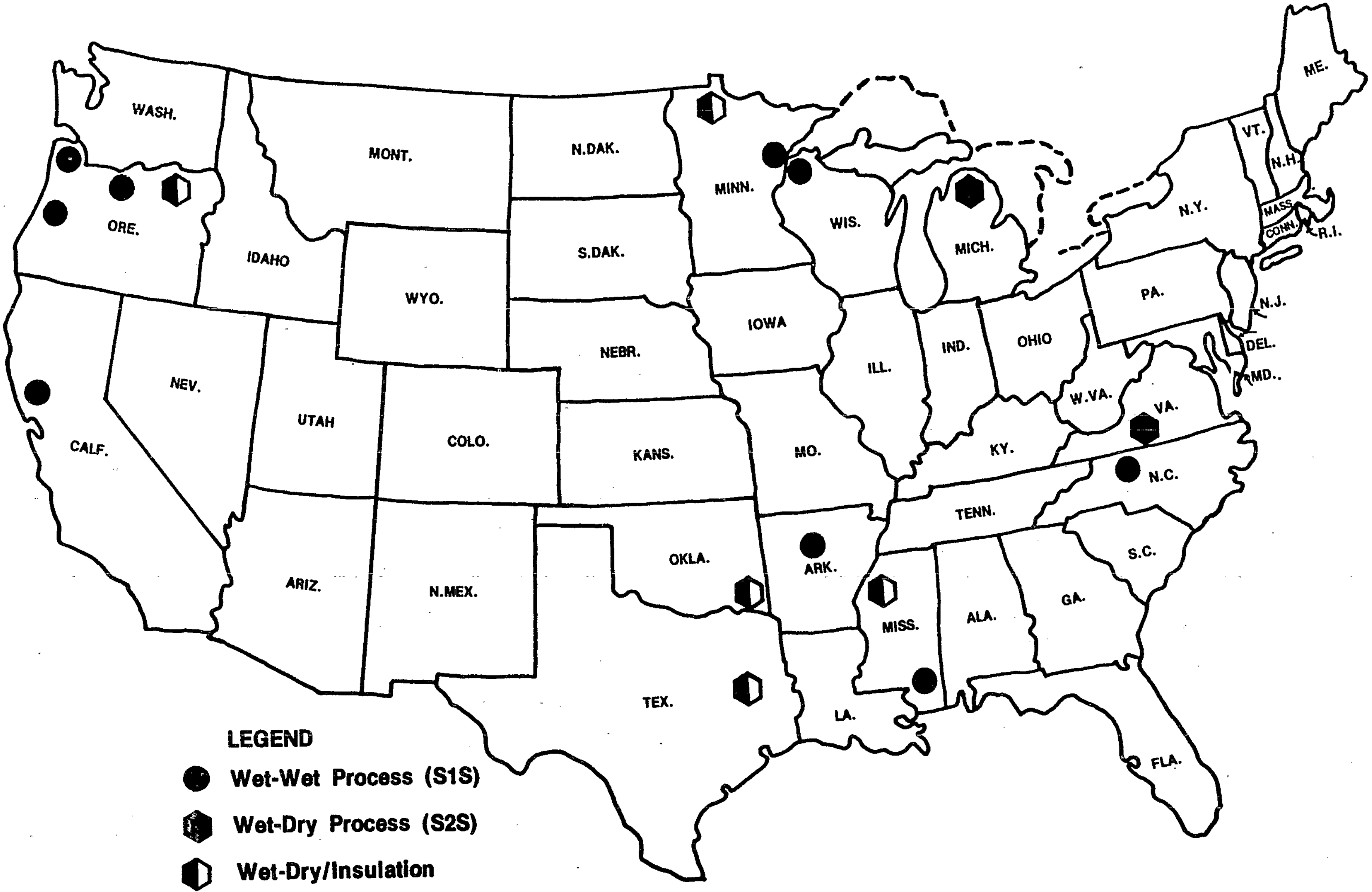


Figure II-4

TOTAL BOARD PRODUCTIONS FIGURES: HARDBOARD

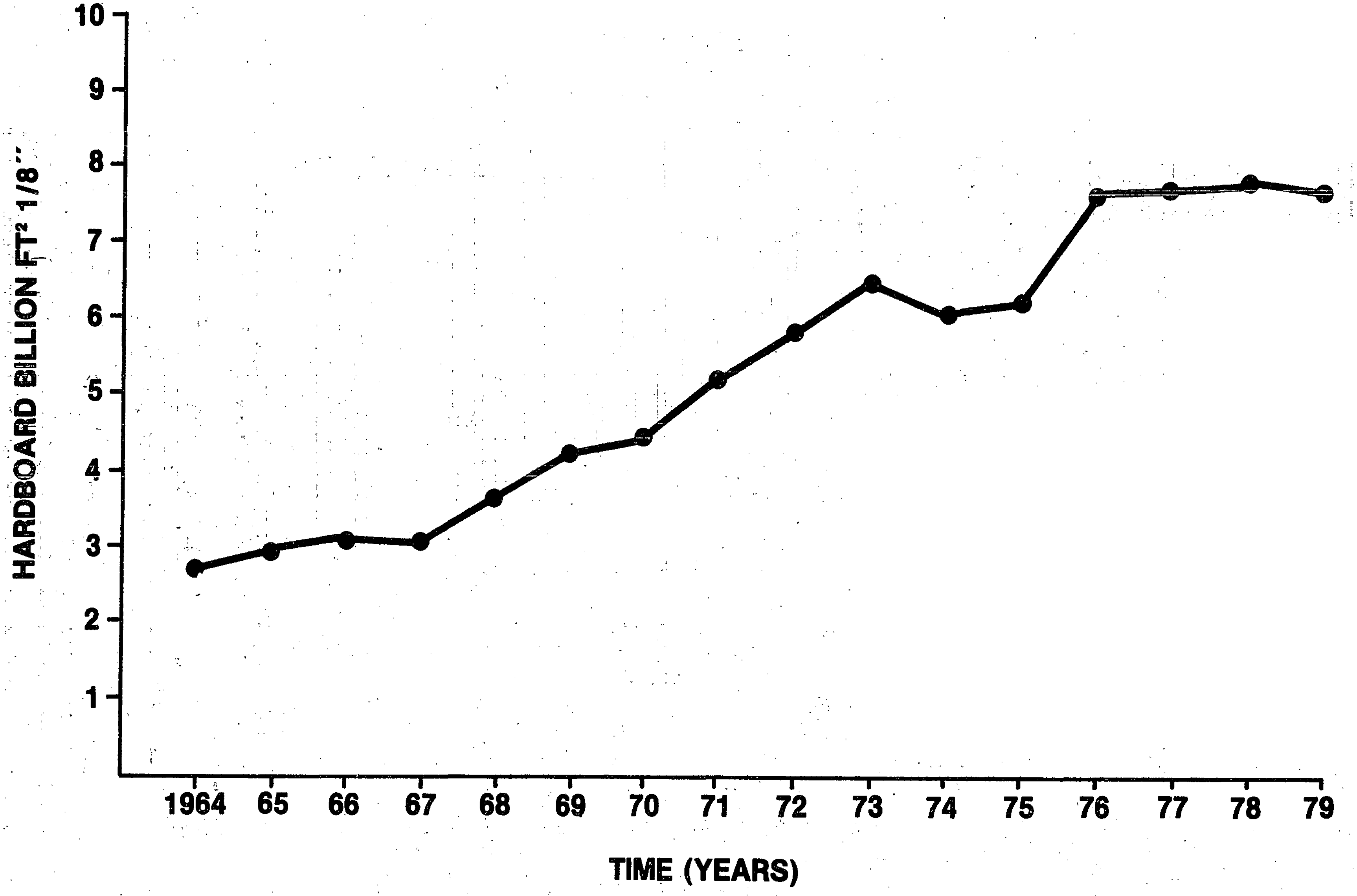


Figure II-5

Table II-5. Inventory of Wet Process Hardboard Plants

Evans Products
Corvallis, Oregon

Champion Building Products
Dee (Hood River), Oregon

Masonite Corporation
Laurel, Mississippi

Abitibi Corporation
Roaring River, North Carolina

Superior Fibre
Superior, Wisconsin

Temple-Eastex
Diboll, Texas

Weyerhaeuser Company
Craig, Oklahoma

Forest Fibre
Stimpson Lumber Company
Forest Grove, Oregon

Masonite Corporation
Ukiah, California

Superwood Corporation
Duluth, Minnesota

Superwood Corporation
North Little Rock, Arkansas

U.S. Gypsum Company
Danville, Virginia

Abitibi Corporation
Alpena, Michigan

Boise Cascade
International Falls, Minnesota

U.S. Gypsum Company
Pilot Rock, Oregon

U.S. Gypsum Company
Greenville, Mississippi

Source: 1977 Directory of the Forest Products Industry.

SUMMARY OF METHODOLOGY AND DATA GATHERING EFFORTS

The first step in the guidelines and standards development process was to assemble and evaluate all existing sources of information on the wastewater management practices and production processes of the Timber industry.

Sources of information reviewed included:

1. Current literature, EPA demonstration project reports, EPA technology transfer reports.
2. Draft Development Document for Effluent Limitations Guidelines and New Source Performance Standards, Timber Products Processing Industry, including supplemental information.
3. Draft Development Document for Pretreatment Standards, Wood Preserving Segment, Timber Products Processing Industry, including supplemental information.
4. Summary Report on the Re-evaluation of the Effluent Guidelines for the Wet Process Hardboard Segment of the Timber Products Processing Industry, including supple-

mental information.

5. Information obtained from regional EPA and state regulatory agencies on timber industry plants within their jurisdiction.
6. Data submitted by individuals, plants and industry trade associations in response to publication of EPA regulations.

A complete bibliography of all literature reviewed during this project is presented in Section XIV of this document.

An analysis of the above sources indicated that additional information would be required, particularly concerning the source, use, treatment and discharge of toxic pollutants. Updated information was also needed on production-related process raw waste loads (RWL), potential in-process waste control techniques, and the identity and effectiveness of end-of-pipe treatment systems.

In recognition of the fact that the best source of existing information was the individual plants, a data collection portfolio (DCP) was prepared and sent directly to manufacturing plants of the wood preserving and insulation board/wet process hardboard segments of the industry. This DCP was the major source of information used to develop the profile of each industry which is presented in Section III of this document. The DCP was designed to update the existing data base concerning production processes, wastewater characterization, raw waste loads based on historical production and wastewater data, method of ultimate wastewater disposal, in-process waste control techniques, and the effectiveness of in-place external treatment technology. Data concerning description of production processes are presented later in this section. Data concerning raw wastewater characteristics are presented in Section V. Section VII contains a compilation of the data concerning treated effluent characteristics as well as end-of-pipe and in-process treatment and control technologies. The DCP also requested information concerning the extent of use of materials which could contribute toxic pollutants to wastewater and any data for toxic pollutants in wastewater discharges. These data are presented in Section VI of this document. Responses to the DCP served as the source of updated, long-term, historical information for the traditional parameters such as BOD, COD, solids, pH, total phenols, and metals.

The long-term daily production and treated effluent data included in the DCP responses from plants in the insulation board/wet process hardboard segment provided a one to two year data base. A statistical analysis of this data base was conducted to develop the numerical limitations for BPT and BCT for the insulation board/wet process hardboard segment. These limitations were presented in the "Development Document for Proposed Effluent Limitations Guidelines New Source Performance Standards and Pretreatment Standards for the Timber Products Processing Point

Source Category" (October 1979). Based on several comments received by the Agency during the public comment period for this document, the Agency decided to evaluate an extended data base in the development of the BPT and BCT numerical limitations. Consequently, additional production and treated effluent data were obtained from the insulation board/wet process hardboard plants to form an extended data base covering a period of two to four years. A statistical analysis of this extended data base, as described in Appendix G, was conducted to develop the insulation board/ wet process hardboard segment BPT and BCT numerical limitations as presented in Sections VIII and IX, respectively.

Additional sources of information included NPDES permits, information provided by industry trade associations, and information obtained from direct interviews and visits to production facilities.

Survey teams composed of project engineers and scientists conducted plant visits. Information on the identity and performance of wastewater treatment systems was obtained through interviews with plant water pollution control or engineering personnel, examination of treatment plant design and historical operating data, and sampling of treatment plant influents and effluents. Nine wood preserving plants, six insulation board plants, and eight wet process hardboard plants were visited from November 1976 through May 1978, with several plants receiving more than one visit.

Only in rare instances did plants report any knowledge of the presence of toxic pollutants in waste discharges. Therefore, toxic pollutant data in waste discharges of the industry were obtained by a thorough engineering review of raw materials and production processes used in each industry and by a screening sampling and analysis program for toxic pollutants at selected plants. Every effort was made to choose facilities where meaningful information on both treatment facilities and manufacturing operations could be obtained.

The screening sampling and analysis program was conducted during November and December of 1976. Seventeen plants in eleven subcategories of the Timber Products Processing point source category were visited and sampled. Among these plants were three wood preserving plants, three insulation board plants, and one wet process hardboard plant. A single 24-hour composite sample was obtained from the raw and treated wastewater streams at each plant and analyzed for the 124 toxic pollutants listed in Appendix B-2 of this document. Sampling procedures followed the <u>Sampling Protocol for Measurement of Toxics</u>, U.S. EPA, October 1976. Analytical methods followed the first draft <u>Protocol for the Measurement of Toxic Substances</u>, U.S. EPA Environmental Monitoring and Support Laboratory, Cincinnati, October 1976.

The purpose of the screening program was to determine toxic pollutants presence in wastewaters from each industrial segment sampled, and to determine the order of magnitude of the contamination. Screening analyses were not used to quantify the levels of contamination in the raw or treated effluents.

The results of the screening analyses were evaluated along with the process engineering review for each subcategory. The toxic pollutants which were found to be present in levels above the detection limits for the analyses, or those which were suspected to be present as a result of their use as raw materials, byproducts, final products, etc., were selected for verification.

The verification sampling and analysis program, conducted over a 14-month period, was designed to obtain as much quantitative data as possible for each subcategory on those toxic pollutants identified during the screening program. The plants for sampling were chosen to represent the full range of in-place technology for each subcategory. Seven wood preserving plants were sampled during verification (three were sampled twice). Five insulation board plants and seven wet process hardboard plants were also sampled during the verification program (three wet process hardboard and three insulation board plants were sampled twice).

Three consecutive 24-hour composite samples of the raw wastewater, final treated effluent, and, in appropriate cases, effluent from intermediate treatment steps were obtained at each plant. A single grab sample of incoming fresh process water was also obtained at each plant.

Sampling and analyses were conducted according to Sampling and Analysis Procedures for Screening of Industrial Effluents for Toxic Pollutants U.S. EPA, Cincinnati, March 1977 (revised April 1977), and Analytical Methods for the Verification Phase of the BAT Review, U.S. EPA Effluent Guidelines Division, Washington, D.C., June 1977.

A detailed discussion of analytical methods, procedures and techniques used during the study is presented in Appendix C of this document.

The review of available literature and of previous studies; analysis of the data collection portfolios; information obtained from EPA regions, state and local regulatory agencies, and industry and trade associations; information obtained during plant visits; and the results of analyses from the screening and verification sampling programs comprised the technical data base which served as the basis for review of subcategorization of the industry and for identification of the full range of in-process and treatment technology options available within each subcategory. Among other factors, the subcategorization review took into consideration the raw materials used, products manufactured, production processes employed, wastewaters generated, and plant characteristics such as size and age.

The raw waste characteristics for each subcategory were then identified. This included an analysis of: (1) the source and volume of water used, the process employed and the sources of wastes and wastewater in the plant; and (2) the constituents of all wastewaters, including conventional, nonconventional and toxic pollutants.

The full range of control and treatment technologies applicable to each candidate subcategory were identified, including both in-plant and end-of-pipe technologies which are in use or capable of being used by the plants in each subcategory. EPA also identified the effluent level resulting from the application of each of these treatment and control technologies, in terms of the amount of constituents present and of the chemical, physical, and biological characteristics of pollutants, including toxic pollutants.

The costs and energy requirements of each of the candidate technologies identified were then estimated, both for a typical, or model plant or plants within the subcategory and on a plant-by-plant basis, taking into consideration in-place technology.

The problems, limitations, and reliability of each treatment and control technology, as well as the required implementation time, were identified. In order to derive variability factors based on existing treatment plant performance, statistical analyses were performed on those treatment systems for which sufficient historical data were available.

Nonwater quality environmental impacts, such as the effects of the application of such technologies on other pollution problems, were also addressed.

Upon consideration of these factors, EPA identified various control and treatment technologies as BPT, BCT, NSPS, PSES and PSNS. The Agency then formulated effluent limitations guidelines and standards which required the attainment of the effluent reduction achieved by the proper operation of these or equivalent technologies.

SECTION III

DESCRIPTION OF THE INDUSTRY

WOOD PRESERVING

Scope of Study

The wood preserving industry applies chemical treatment to round or sawn wood products for the purpose of imparting insecticidal, fungicidal, or fire resistant properties to the wood. The scope of this study includes all wood preserving plants (SIC 2491) regardless of the types of raw materials used, method of preconditioning stock, types of products produced, or means of ultimate waste disposal.

Background

EPA conducted an extensive study of the wood preserving industry in 1973-1974. The information developed during that study provided the technical basis for the effluent guidelines and standards for the industry promulgated in April 1974 (40 CFR Part 429, Subparts F, G, and H). Another study was conducted in 1976, resulting in the promulgation of pretreatment standards for the indirect discharging portion of the wood preserving industry. These technical studies included the use of data collection portfolios to obtain information regarding plant operations, waste loads generated, treatment systems in place, and historical treatment system efficiencies. Plant visits were also conducted in conjunction with the above studies, as was the sampling and analysis of raw and treated wastewaters.

EPA determined that the existing information base should be updated and expanded.

Data Collection Portfolio Development

The primary source of survey information regarding wood preserving plants in the U.S. is Wood Preservation Statistics, published annually by the American Wood Preservers' Association (AWPA). This survey was underwritten, in addition to the AWPA, by the American Wood Preservers' Institute, the Railway Tie Association, the Society of American Wood Preservers, Inc., and the Southern Pressure Treaters Association. The 1975 AWPA survey was the most current source of profile information when the DCP was developed. This survey, published in the 1975 AWPA Proceedings, identified 387, out of an estimated 415 wood treating plants, of which 352 are pressure treating plants.

Using the AWPA information, a list of plants was developed for the DCP. Because the AWPA statistics did not include mailing addresses or the appropriate contact person for each plant, additional resources were required to obtain this information. The 1976 Directory of the Forest Products Industry, Miller Freeman Publications, contained addresses and contacts for many of the plants.

Dr. Warren S. Thompson, Director, Forest Products Utilization Laboratory, Mississippi State University, was the Agency's consultant for this study and all previous wood preserving effluent guidelines development studies. He has also been involved in studies of wood preserving processes and wastewater treatment, and possesses a unique knowledge and familiarity with the industry. Dr. Thompson reviewed the list and provided addresses and contacts for a number of plants.

The Agency identified the complete mailing addresses and contact persons for 284 plants. Previous EPA experience with the industry indicated that the 284 recipients of the DCP included all previously identified dischargers, both direct and indirect, and included a representative cross section of plants in all size categories and geographical locations. The DCP recipients included plants which represented the full range of in-process and end-of-pipe control and treatment technologies.

Response to the DCP

Two hundred sixteen plants responded to the DCP--a 76 percent response rate. One hundred ninety three of the responses were from pressure treating plants and 23 responses were from nonpressure plants.

Table III-1 compares the response to the technical DCP with the plants listed in the AWPA statistics. The table illustrates that the DCP response included 56 percent of the total population of the 1975 AWPA listings.

Characterization of Nonresponders

Thirteen of the 68 plants that did not respond to the DCP are operated by the industry's largest single company. This company received 27 DCPs. The company requested and received permission to respond for 14 of their plants. The request was approved in order to alleviate the paperwork burden placed on the company's technical staff. The approval was contingent, however, on the company providing responses for all plants discharging process wastewater and for a cross section of processes and wastewater treatment systems characteristic of the company's operations.

Using AWPA statistics information, 21 of the nonresponders were identified as plants that treat either with only inorganic salts or use nonpressure processes exclusively. These plants were already subject to a no discharge of process wastewater limitation. Of the remaining 34 nonresponders, 12 are one cylinder pressure plants and 16 are two cylinder pressure plants.

Table III-1. Comparison of DCP Coverage with AWPA 387 Plant Population

Type Plant and Number of Cylinders	Number of Plants According to AWPA Statistics	Plants Receiving DCP		Plants Responding to DCP	
		Number	Percent AWPA Population	Number	Percent AWPA Population
Pressure Retorts*					
1	143	83	58.0	62	43.4
2	113	91	80.5	63	55.8
3	53	44	83.0	39	73.6
4	20	19	95.0	13	65.0
5 or more	23	21	91.3	16	69.6
Subtotal	352	258	73.3	193	54.8
Non-Pressure Retorts Only	35	26	74.3	23	65.7
TOTAL	387**	284	73.4	216	55.8

* These plants may also use non-pressure retorts as well as pressure retorts.

** 1975 AWPA survey identified 387 plants out of an estimated 415 plants.

Data presented in Sections V and VII of this document will document that plants of this size generate very low volumes of process wastewater, and these plants generally do not discharge either directly or indirectly.

Comparison with Independent Surveys

Following the distribution of the technical DCP, EPA's Office of Analysis and Evaluation (OAE) conducted an information collection activity designed to provide information relating to the financial viability of the wood preserving industry, i.e., to determine the economic impact of pollution control costs that might result from these regulations. The mailing list for this economic DCP was developed from 1976 Dun's Marketing Statistics, published by Dun and Bradstreet, Inc. The OAE survey was sent to a total of 574 addressees. Eighty-six responded that they were not involved in wood preserving operations, and one-hundred-fifty did not respond. The remaining three hundred thirty-eight recipients indicated that they were engaged in wood preserving operations. The OAE survey included responses from 94 pressure treating plants that were not included in the technical DCP response.

Information from these 94 plants was collected by the technical contractor through a telephone survey. Eight of the 94 plants were determined to be indirect dischargers. There were no direct dischargers of process wastewater identified by the economic survey. Information concerning the eight indirect discharging plants was incorporated into the technical information base and is presented in this document.

In late 1979, the United States Department of Agriculture (USDA) compiled a list of wood preserving plants as part of a rebuttable presumption against registration activity (RPAR) of all commercial wood preservatives (pentachlorophenol, creosote, and inorganic salts). According to this list, 605 wood preserving plants operated by about 520 companies exist in the United States. This tabulation of plants has not been verified nor has it been officially released by USDA.

Summary

The OAE information survey mailing list was developed from a business/ financially oriented publication (Dun and Bradstreet) rather than a production oriented publication (AWPA). Although the OAE survey identified many pressure treating plants not identified by the DCP, it also clearly demonstrated that the objectives of the technical collection activity were achieved and that the response to the technical DCP included information sufficient to address all process variations, wastewater treatment systems in-place, and the treatment systems' effectiveness.

Based on the Agency's extensive experience with the industry and the results obtained through comparison of the OAE survey to the technical data base, the USDA list, once verified, is not expected to result in significant new information.

Methods of Wastewater Disposal According to the DCP

Tables III-2 through III-5 present a summary of the methods of wastewater disposal practiced by plants in the various subcategories of the wood preserving industry.

Units of Expression

Units of production in the wood preserving industry are shown in cubic meters (cu m). In-plant liquid flows are shown in liters per day (l/day). The industry is not yet metricized and uses English units to express production, cubic feet (cu ft); and in-plant flow, gallons (gal) per day. Conversion factors from English units to metric units are presented in Appendix D.

Process Description

The wood preserving process consists of two basic steps: (1) conditioning the wood to reduce its natural moisture content and increase the permeability, and (2) impregnating the wood with the preservative. Figure III-1 shows common treatment sequences.

The conditioning step may be performed by one of several methods including (1) seasoning or drying wood in yards, at ambient temperatures; (2) kiln drying; (3) steaming the wood at elevated pressure in a retort followed by application of a vacuum; (4) heating the stock in a preservative bath under reduced pressure in a retort (Boulton process); or (5) vapor drying, heating of the unseasoned wood in a solvent to prepare it for preservative treatment. All of these conditioning methods have as their objective the reduction of moisture content of the unseasoned stock to a point where the required amount of preservative can be retained in the wood.

Conventional steam conditioning (open steaming) is a process in which unseasoned or partially seasoned stock is subjected to direct steam impingement at an elevated pressure in a retort. The maximum permissible temperature is set by AWPA standards at 118°C and the duration of the steaming cycle is limited by these standards to no more than 20 hours. Steam condensate that forms in the retort exits through traps and is conducted to oil-water separators for removal of free oils. Removal of emulsified oils requires further treatment. Figure III-2 is a schematic diagram of a typical open steaming wood preserving plant.

Table III-2. Method of Ultimate Wastewater Disposal by Wood Preserving-Boulton Plants Responding to Data Collection Portfolio

Ultimate Disposal Method	Number of Plants
Direct Discharge	0
Discharge to POTW	10
Self-Contained (No-Discharge)	25
-Containment and Evaporation	17
-Cooling Tower Evaporation	4
-Soil Irrigation, Treated Effluent Recycle, etc.	4
TOTAL Plants	35

Table III-3. Method of Ultimate Wastewater Disposal by Wood Preserving-Steam Plants Responding to Data Collection Portfolio

Ultimate Disposal Method	Number of Plants
Direct Discharge	1
Discharge to POTW	29
Self-Contained (No-Discharge)	66
-Containment and Evaporation	56
-Soil Irrigation	10
TOTAL Plants	96

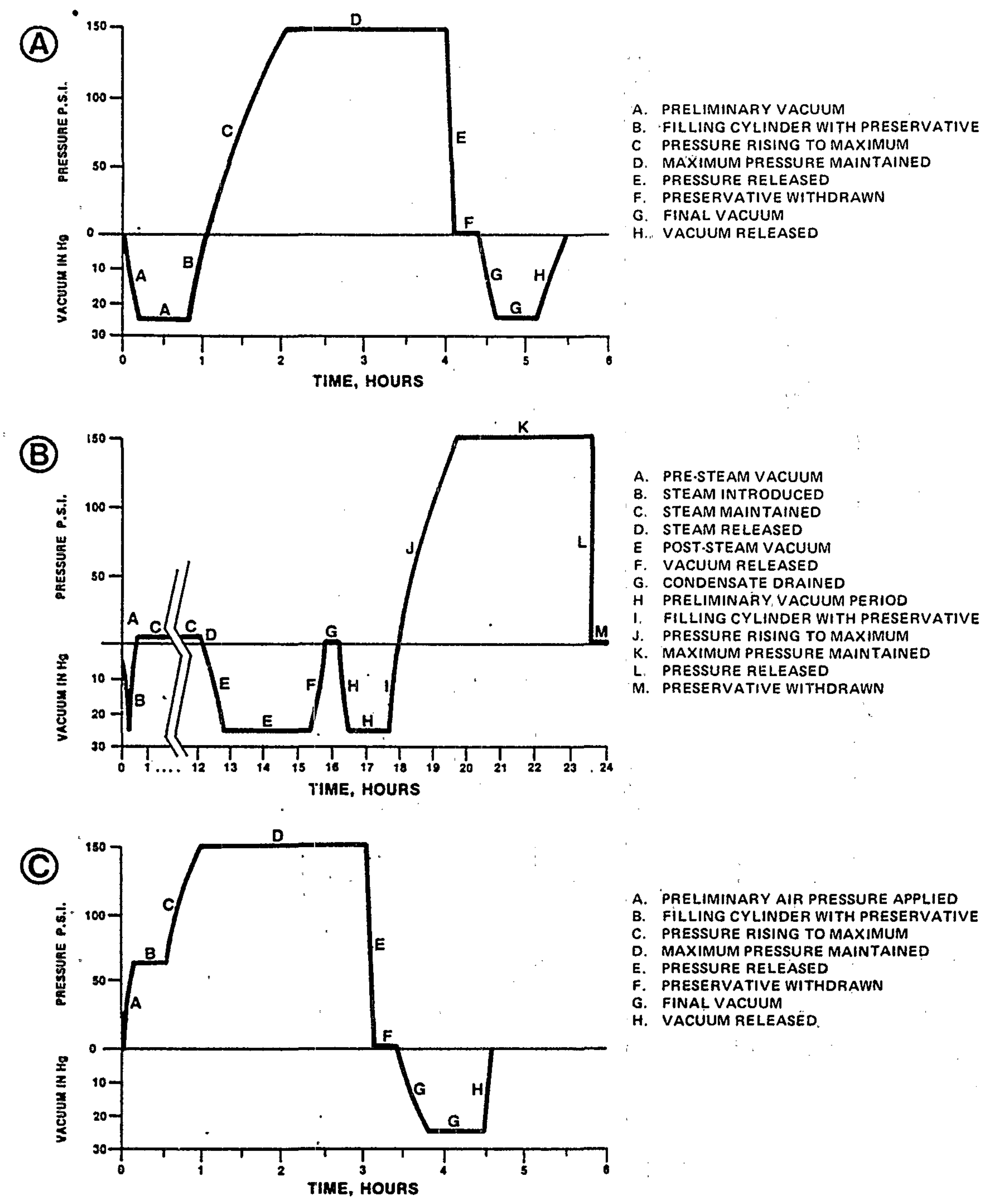
Table III-4. Method of Ultimate Wastewater Disposal by Wood Preserving-Inorganic Salt Plants Responding to Data Collection Portfolio

Ultimate Disposal Method	Number of Plants
Direct Discharge*	1
Discharge to POTW*	5
Self-Contained (No-Discharge)	56
-Generate No Wastewater or Recycle All Wastewater as Makeup Dilution Water	52
-Containment and Evaporation	4
Total Plants	62

* Note: Current regulations prohibit discharge of process wastewater pollutants from plants in this subcategory, either to navigible waters or to a POTW.

Table III-5. Method of Ultimate Wastewater Disposal by Wood Preserving-Nonpressure Plants Responding to Data Collection Portfolio

Ultimate Disposal Method	Number of Plants
No Discharge	23
TOTAL Plants	23

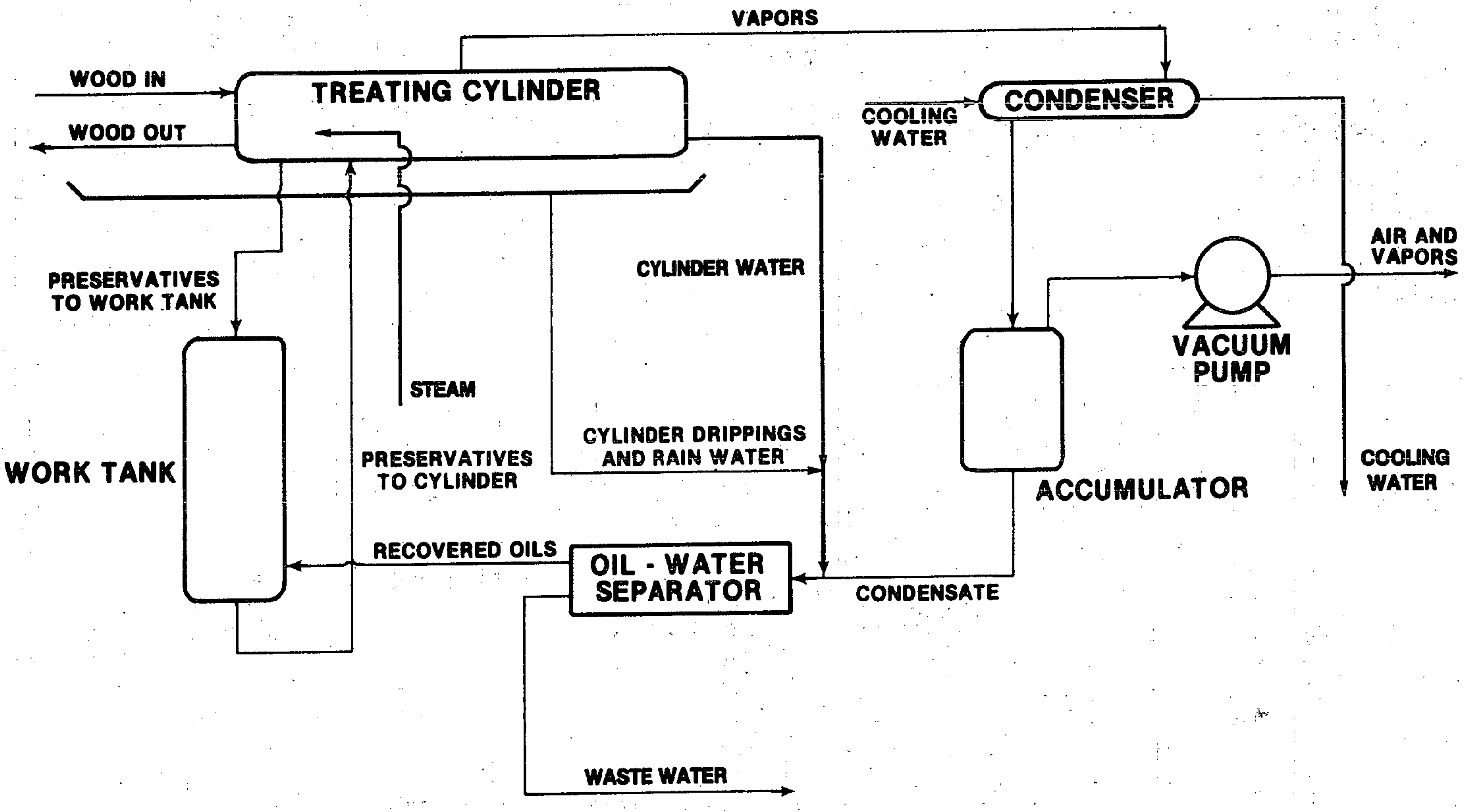


SOURCE: Koppers Company

TYPICAL TREATING CYCLES USED FOR TREATING LUMBER, POLES, AND PILES.

A. FULL-CELL TREATING CYCLE USED FOR DRY SOUTHERN PINE LUMBER
B. FULL-CELL TREATING CYCLE USED FOR GREEN SOUTHERN PINE PILES
C. EMPTY-CELL TREATING CYCLE USED FOR DRY SOUTHERN PINE POLES

Figure III-1



OPEN STEAMING PROCESS WOOD TREATMENT PLANT

Figure III-2

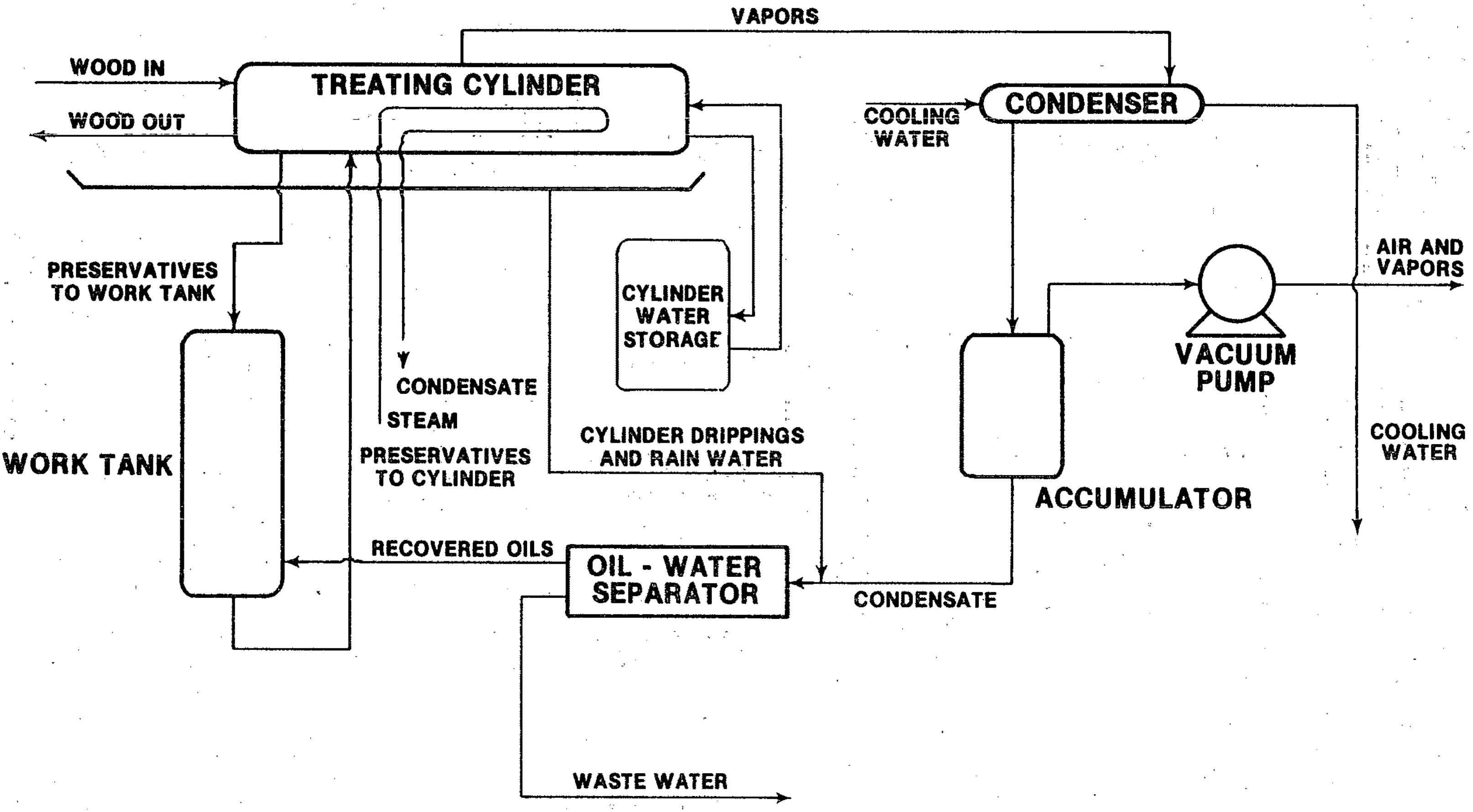
In closed steaming, a widely used variation of conventional steam conditioning, the steam needed for conditioning is generated in situ by covering the coils in the retort with water from a reservoir and heating the water by passing process steam through the coils. The water is returned to the reservoir after oil separation and reused during the next steaming cycle. There is a slight increase in volume of water in the storage tank after each cycle because of the water removed from the wood. A small blowdown from the storage tank is necessary to remove this excess water and also to control the level of wood sugars in the water. Figure III-3 is a schematic diagram of a typical closed steaming wood preserving plant.

Modified closed steaming is a variation of the steam conditioning process in which steam condensate is allowed to accumulate in the retort during the steaming operation until it covers the heating coils. At that point, direct steaming is discontinued and the remaining steam required for the cycle is generated within the retort by utilizing the heating coils. Upon completing the steaming cycle, the water in the cylinder is discarded after recovery of oils. Figure III-4 is a schematic diagram of a typical modified steaming wood preserving plant.

Preconditioning is accomplished in the Boulton process by heating the stock in a preservative bath under reduced pressure in the retort. The preservative serves as a heat transfer medium. After the cylinder level has been raised to operating temperature, a vacuum is drawn and water removed from the wood passes through a condenser in vapor form to an oil-water separator where low-boiling fractions of the preservative are removed. The Boulton cycle may have a duration of 48 hours or longer for large poles and piling, a fact that accounts for the lower production per retort day as compared to plants that steam condition. Figure III-5 is a schematic diagram of the Boulton process.

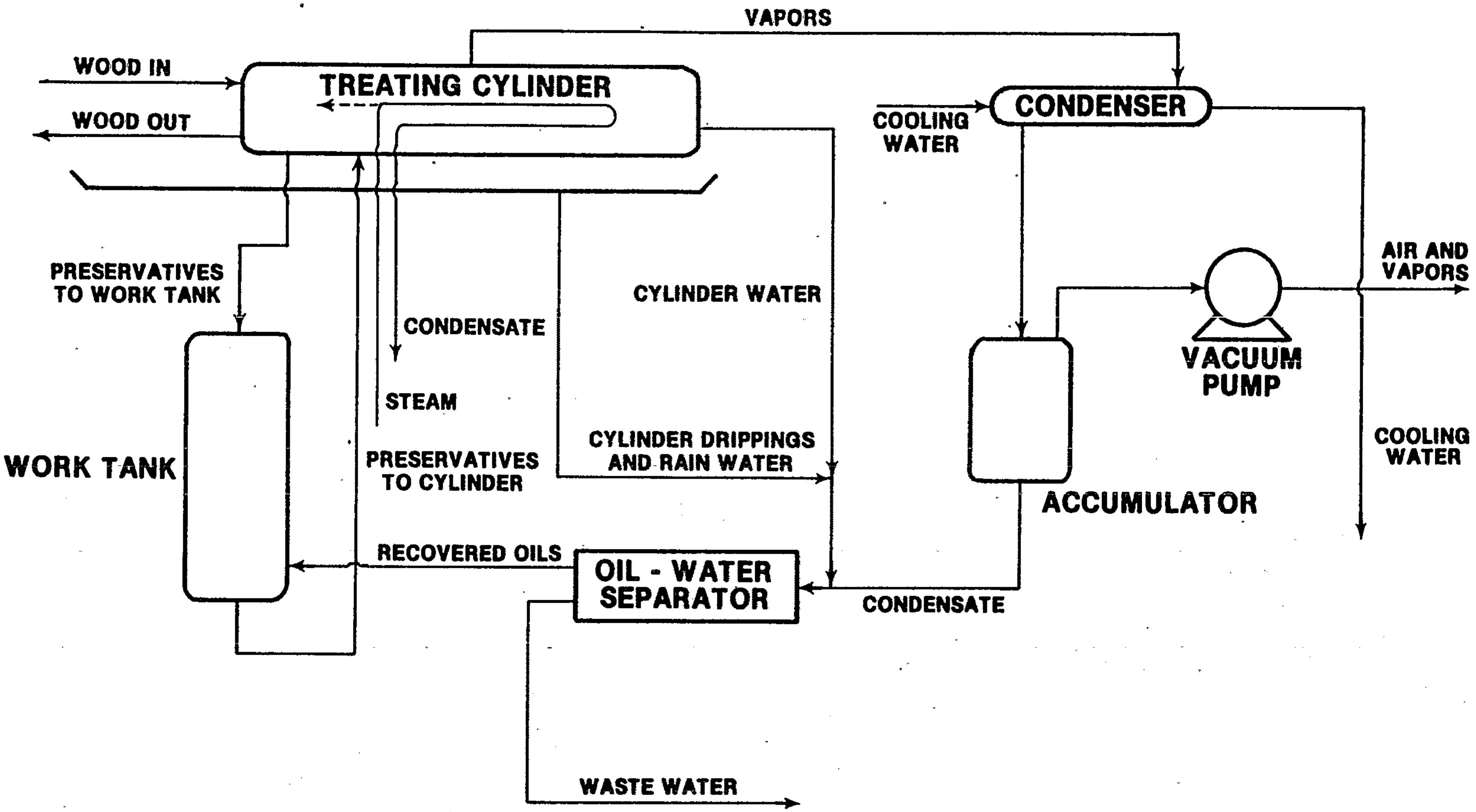
The vapor drying process, illustrated in Figure III-6, consists essentially of exposing wood in a closed vessel to vapors from any one of many organic chemicals that are immiscible with water and have a narrow boiling range. Selected derivatives of petroleum and coal tar, such as high-flash naphtha, and Stoddard solvent, are preferred; but numerous chemicals, including blends, can be and have been employed as drying agents in the process. Chemicals with initial boiling points from 212°F to 400F° (100°C to 204°C) may be used.

Vapors for drying are generated by boiling the chemical in an evaporator. The vapors are conducted to the retort containing the wood, where they condense on the wood, give up their latent heat of vaporization, and cause the water in the wood to vaporize. The water vapor thus produced, along with excess organic vapor, is conducted from the vessel to a condenser and then to a gravity-type separator. The water layer is discharged



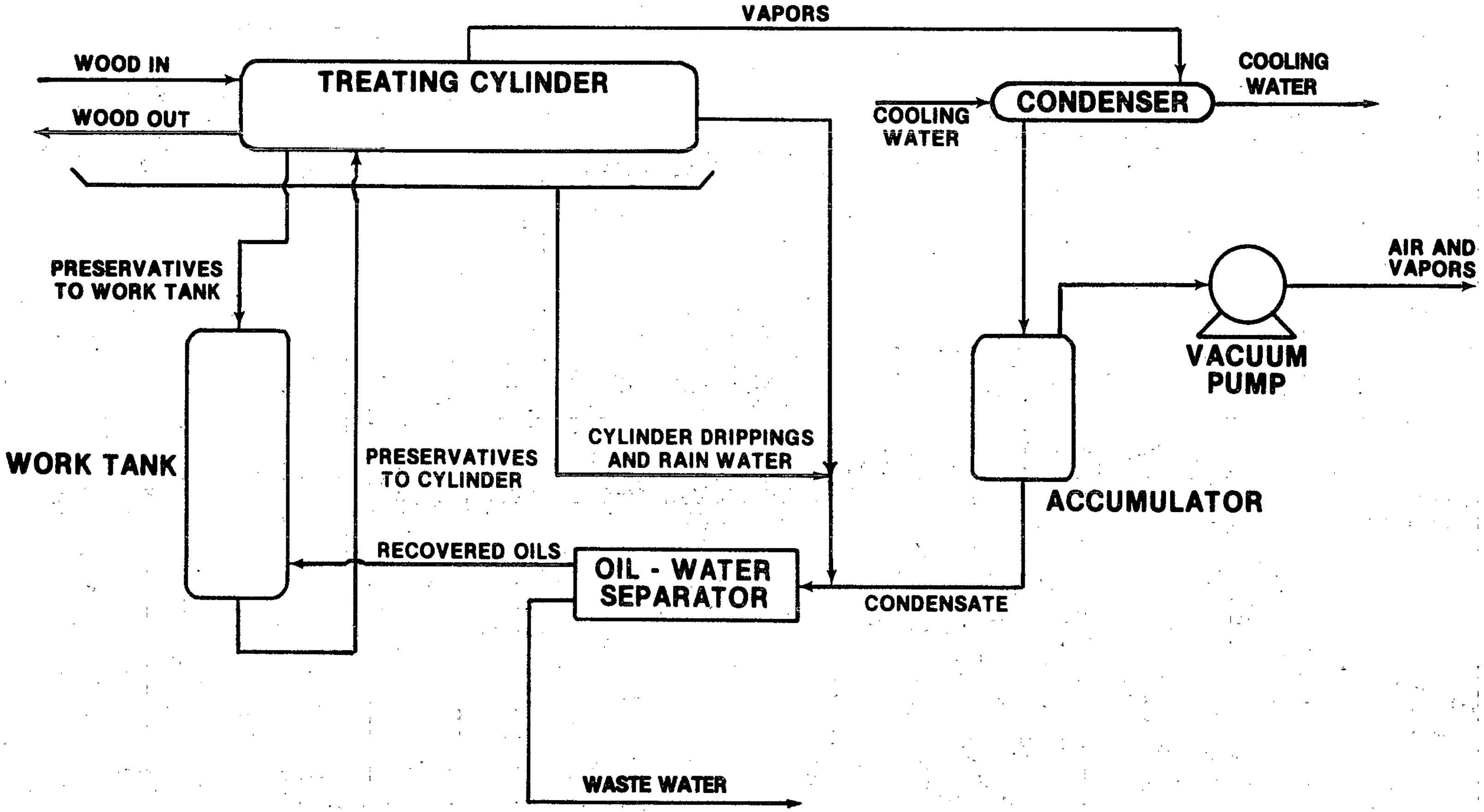
CLOSED STEAMING PROCESS WOOD TREATING PLANT

Figure III-3



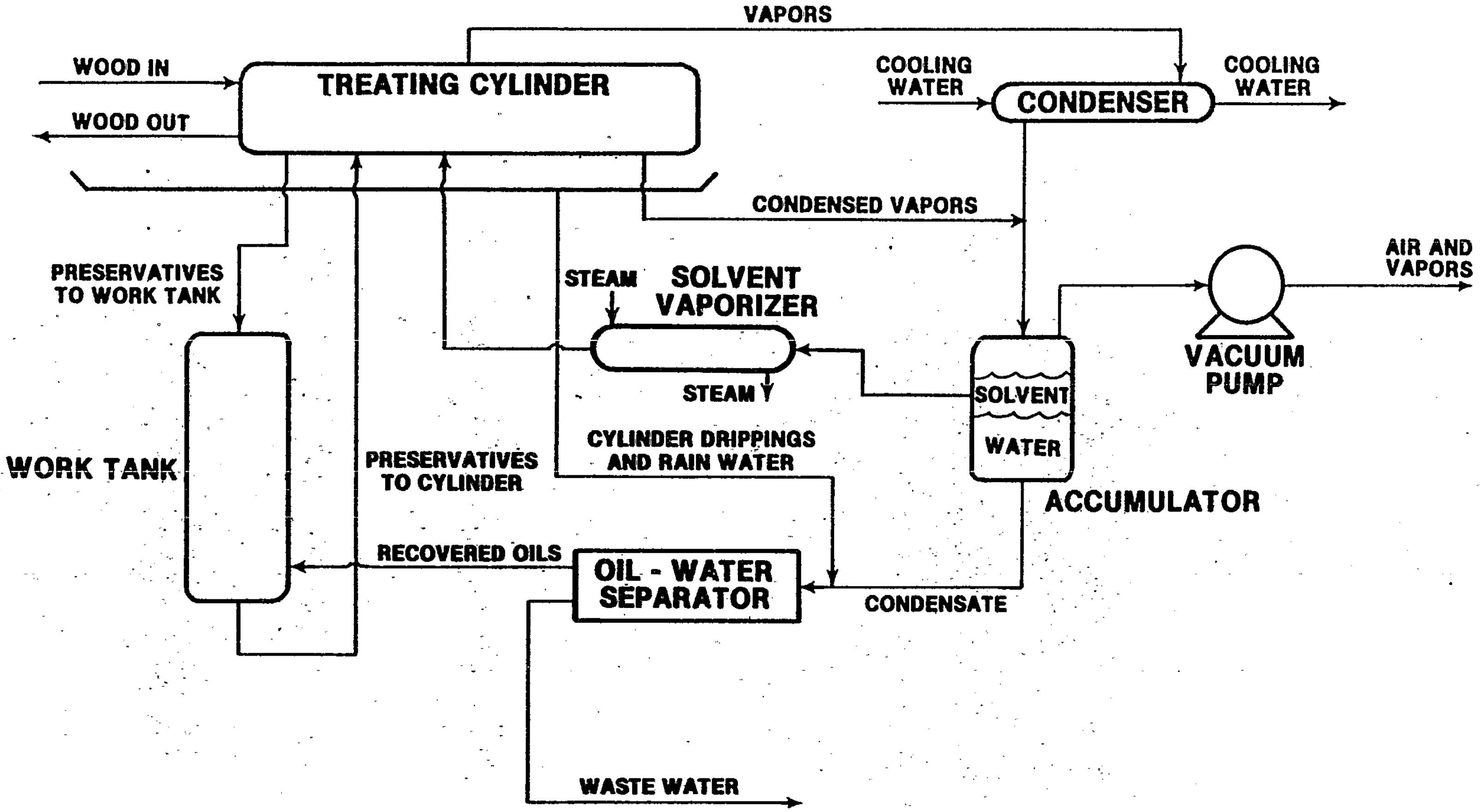
MODIFIED STEAMING PROCESS WOOD TREATING PLANT

Figure III-4



BOULTON WOOD TREATING PLANT

Figure III-5



VAPOR CONDITIONING PROCESS WOOD TREATING PLANT

Figure III-6

from the separator and the organic chemical is returned to the evaporator for reuse.

At the end of the heating period, the flow of organic vapors to the vessel is stopped and a 30-minute to 2-hour vacuum is imposed to remove the excess preservative along with the additional water that is removed from the wood during the vacuum cycle. Since the drying vessel is usually the retort used for preservative treatment, the wood can be treated immediately using any one of the standard preservative processes.

Following any of the above conditioning steps, the treatment step may be accomplished by either pressure or nonpressure processes.

Nonpressure (thermal) processes utilize open tanks which contain the preservative chemicals. Stock to be treated is immersed in the treating chemicals, which may be at ambient temperature, heated, or a combination thereof. Stock treated in nonpressure processes is normally conditioned by air seasoning or kiln drying.

Treatment methods employing pressure processes consist of three basic types, independent of the preconditioning method. Two of the pressure methods, referred to in the industry as "empty cell" processes, are based on the principle that part of the preservative forced into the wood is expelled by entrapped air upon the release of pressure at the conclusion of the treating cycle, thus leaving the cell walls coated with preservative. The pressure cycle is followed by a vacuum to remove additional preservative. The retention of preservatives attained is controlled in part by the initial air pressure employed at the beginning of the cycle.

The third method, which is known as the "full cell" process, differs from the other two in that the treating cycle is begun by evacuating the retort and breaking the vacuum with the preservative. The preservative is then forced into the wood under pressure, as in the other processes. Most of the preservative remains in the wood when the pressure is released. Retentions of preservatives achieved in this process are substantially higher than those achieved in the empty cell processes.

Stock treated by any of the three methods may be given a short steam treatment to "clean" the surface of poles and pilings and to reduce exudation of oil after the products are placed in service.

INSULATION BOARD

Scope of Study

The coverage of this document is limited to those insulation board plants in SIC 2661 (Building Paper and Building Board

Mills) which produce insulation board using wood as the basic raw material.

Scope of Coverage for Data Base

The DCP was sent to all the insulation board plants which use wood as a raw material. All of the plants responded to the survey. Table III-6 presents the method of ultimate waste disposal utilized by the plants responding to the survey. Six of these plants were selected for visits and sampling.

Units of Expression

Units of production in the insulation board industry are reported in square meters (sq m) on a 13 mm (1/2 in) thick basis. Density figures obtained from the surveyed plants are used to convert this production to metric tons. The insulation board industry is not yet metricized and uses English units to express production, i.e., square feet (sq ft) on a one-half inch (in) basis. Liquid flows from the industry are reported in million gallons per day (MGD) and kiloliters per day (kl/day). Conversion factors from English units to metric units are shown in Appendix D.

Process Description

Insulation board can be formed from a variety of raw materials including both softwoods and hardwoods, mineral fiber, waste paper, bagasse, and other fibrous materials. In this study, only those processes employing wood as raw material are considered. Plants utilizing wood may receive it as roundwood, fractionated wood, and/or whole tree chips. Fractionated wood can be in the form of chips, sawdust, or planer shavings. Figure III-7 provides an illustration of a representative insulation board process.

When roundwood is used as a raw material, it is usually shipped to the plant by rail or truck and stored in a dry deck before use. The roundwood is usually debarked by drum or ring barkers before use, although in some operations a percentage of bark is allowable in the board. The barked wood then may be chipped, in which case the unit processes are the same as those plants using chips exclusively as raw materials. Those plants utilizing roundwood normally cut the logs into 1.2- to 1.5-meter (4- to 5-foot) sections either before or after debarking.

Groundwood, as used by two insulation board plants in the U.S. is usually produced in conventional pulpwood grinders equipped with coarse burred artificial stones of 16- to 25-grit with various patterns. The operation of the machine consists primarily of hydraulically forcing a piece of wood against a rotating stone mounted horizontally. The wood held against the abrasive surface of the revolving stone is reduced to fiber bundles. Water is sprayed on the stone not only to carry away the fibers into the system, but also to keep the stone cool and clean and lubricate its surface. The water spray onto the stone also reduces the possibility of fires occurring from the friction of the stone against the wood.

Table III-6. Method of Ultimate Waste Disposal by Insulation Board Plants Responding to Data Collection Portfolio

Ultimate Disposal Method	Number of Plants
Direct Discharge	5
Discharge to POTW	6
Self-Contained Dischargers Spray Irrigation	3*
No-Discharge (Plants generating no wastewater or recycling all wastewater)	1

* One plant uses spray irrigation as a treatment method; however, the irrigation tail water is eventually discharged from the field to a nearby river.

Source: Data collection portfolios.

DIAGRAM OF A TYPICAL INSULATION BOARD PROCESS

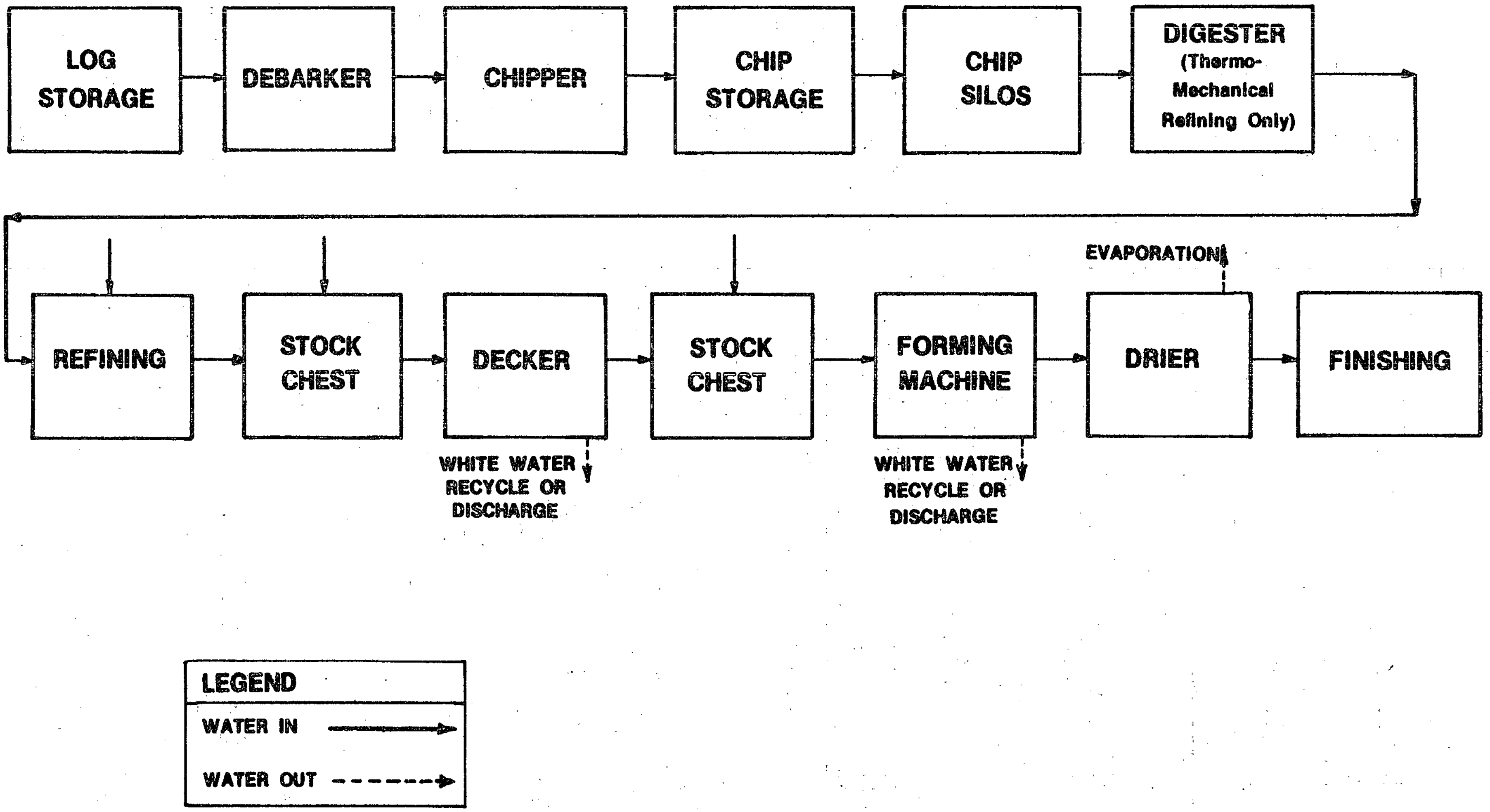


Figure III-7

While most fractionated wood is purchased from other timber products operations, in some cases it is produced on site. Currently, little chipping occurs in the forest; however, in the future this is expected to become a major source of chips. Chips are usually transported to the plants in large trucks or railcars. They are stored in piles which may be covered but are more commonly exposed. The chips may pass through a device used to remove grit, dirt, and other trash which could harm equipment and possibly cause plate damage in the refiners. This may be done wet or dry. Pulp preparation is usually accomplished by mechanical or thermomechanical refining.

Refining Operations--Mechanical refiners basically consist of two discs between which the chips or wood residues are passed. In a single disc refiner, one disc rotates while the other is stationary. The feed material passes between the plates and is discharged at the bottom of the case. The two discs in double disc refiners rotate in opposite directions, but the product flows are similar to a single disc refiner. Disc refiners produce fibers that may pass through a 30- or 40-mesh screen, although 60 percent of the fibers will not pass through a 65-mesh screen. The disc plates generally rotate at 1,200 or 1,800 rpm or a relative speed of 2,400 or 3,600 rpm for a double disc mill. Plate separations are generally less than 1.0 cm (0.40 in). A variety of the disc patterns are available, and the particular pattern used depends on the feed characteristics and type of fiber desired.

A thermomechanical refiner is basically the same as a disc refiner except that the feed material is subjected to a steam pressure of 4 to 15 atm (40 to 200 psi) for a period of time from 1 to 45 minutes before it enters the refiner. In some cases, the pressure continues through the actual refining process.

Presteaming softens the feed material and thus makes refining easier and provides savings on energy requirements; however, yield may be reduced up to 10 percent. The longer the presteaming and the higher the pressure, the softer the wood becomes. The heat plasticizes portions of the hemicellulose and lignin components of wood which bind the fibers together and results in a longer and stronger fiber produced.

Subsequent to the refining of the wood, the fibers produced are dispersed in water to achieve consistencies amenable to screening. For most screening operations, consistencies of approximately one percent fiber are required. Screening is done primarily to remove coarse fiber bundles, knots, and slivers. The coarse material may be recycled and passed through secondary refiners which further reduce the rejects into usable fibers for return to the process. After screening, the fibers produced by any method may be sent to a decker or washer.

Decker Operations--Deckers are essentially rotating wire covered cylinders, usually with an internal vacuum, into which the suspension of fibers in water is passed. The fibers are separated and the water is usually recirculated into the system. There are a number of reasons for deckering or washing, the two primary ones being to clean the pulp, and consistency control. Control of dissolved solids is also a factor in some cases. While being variable on a plant-to-plant basis, the consistency of the pulp upon reaching the forming machine in any insulation board process is extremely critical. By dewatering the pulp from the water suspension at this point, it can be mixed with greater accuracy to the desired consistency. Washing of the pulp is sometimes desirable in order to remove dissolved solids and soluble organics which may result in surface flaws in the board. The high concentration of these substances tends to stay in the board and during the drying stages migrates to the surface. This results in stains when a finish is applied to the board.

After the washing or deckering operation, the pulp is reslurried in stages. The initial dilution to approximately 5 percent consistency is usually followed by dilutions to 3 percent and finally, just prior to mat formation, a dilution to approximately 1.5 percent. This procedure is followed primarily for two reasons: (1) it allows for accurate consistency controls and more efficient dispersion of additives; and (2) it reduces the required pump and storage capacities for the pulp. During the various stages of dilution, additives are usually added to the pulp suspension. These range from 5 to 20 percent of the weight of the board, depending on the product used. Additives may include wax emulsion, paraffin, asphalt, starch, polyelectrolytes, and aluminum sulfate. The purpose of additives is to give the board desired properties such as strength, dimensional stability, and water absorption resistance.

After passing through the series of storage and consistency controls, the pulp may pass through a pump-through refiner, directly ahead of the forming machine. The purpose of the pump-through refiner is to disperse agglomerated fiber clumps and to shorten the fiber bundles. The fibrous slurry, at approximately 1.5 percent consistency, is then pumped into a forming machine which removes water from the pulp suspension and forms a mat.

Forming Operations--While there are various types of forming machines used to make insulation board, the two most common are the fourdrinier and the cylinder machines. The fourdrinier machine used in the manufacture of insulation board is similar in nature to those used in the manufacture of hardboard or paper. The stock is pumped into the head box and onto a table with an endless traveling screen running over it. The stock is spread evenly across the screen by special control devices and an interlaced fibrous blanket, referred to as a mat, is formed by allowing the dewatering of the stock through the screen by gravity assisted by vacuum boxes. The partially formed mat travelling on the wire screen then passes through press rollers, some with a vacuum imposed, for further dewatering.

Cylinder machines are basically large rotating drum vacuum filters with screens. Stock is pumped through a head box to a vat where again a mat is formed onto the screen. In this case, the mat is formed by use of a vacuum imposed on the interior of the rotating drum. A portion of the rotating drum is immersed into the stock solution. As water is forced through a screen, a mat is formed when the portion of the cylinder rotates beyond the water level in the tank and required amount of fiber is deposited on the screen. The mat is further dewatered by the vacuum in the interior of the rotating drum and is then transferred off the cylinder onto a screen conveyor, or felt, where it then passes through roller presses similar to those utilized in fourdrinier operations.

Both the fourdrinier and the cylinder machines produce a mat that leaves the roller press with a moisture content of about 40 to 45 percent and the ability to support its own weight over short spans. At this point, the mat leaves the forming screen and continues its travel over a conveyor. The wet mat is then trimmed to width and cut to length by a traveling saw which moves across the mat on a bias, making a square cut without the necessity of stopping the continuous wetlap sheet.

After being cut to desired lengths, the mats are dried to a moisture content of 5 percent or less. Most dryers now in use are gas- or oil-fired tunnel dryers. Mats are conveyed on rollers through the tunnel with hot air being circulated throughout. Most dryers have 8 or 10 decks and various zones of heat to control the rate of drying and to reduce the danger of fire. These heat zones allow for higher temperatures when the board is "wet" (where the mat first enters) and lower temperatures when the mat is almost dry.

The dried board then goes through various finishing operations such as painting, asphalt coating, and embossing. Those operations which manufacture decorative products will usually have finishing operations which use water-base paints containing such chemicals as various inorganic pigments, i.e., clays, talc, carbonates, and certain amounts of binders such as starch, protein, PVA, PVAC, acrylics, urea formaldehyde resin, and melamine formaldehyde resins. These are applied in stages by rollers, sprayers, or brushes. The decorative tile then may be embossed, beveled, or cut to size depending on the product desired.

Sheathing in some operations receives additional molten asphalt applications to both sides and the edges. It is then sprayed with water and stacked to allow humidification to a uniform moisture content.

Various sanding and sawing operations give insulation board products the correct dimensions. Generally, the dust, trim, and reject materials created in finishing operations are recycled into the process.

WET PROCESS HARDBOARD

Scope of Study

The scope of this document includes all wet process hardboard plants (SIC 2499) in the U.S. using wood as the primary raw material.

Scope of Coverage for Data Base

Data collection portfolios were sent to 15 of the 16 wet process hardboard plants. The remaining plant did not receive a data collection portfolio, but did provide historical monitoring and production data, as well as complete process and wastewater treatment information requested. All 15 plants responded to the survey. Eight plants were visited during this study, and seven were sampled. In addition, the full record compiled by the E.C. Jordan Company during their 1975-1976 study of the wet process hardboard industry was reviewed during the course of this study. All 16 plants were visited by E.C. Jordan personnel at that time. Table III-7 presents the method of ultimate disposal utilized by each of the 16 wet process hardboard plants.

Table III-7. Method of Ultimate Waste Disposal by Wet Process Hardboard Plants

Ultimate Disposal Method	Number of Plants
Direct Discharge	12
Discharge to POTW	2
*Self-Contained Dischargers	2
Spray Irrigation (1 plant)	
Total Recycle of Treated Effluent (1 plant)	

* Two other plants use spray irrigation to dispose of part of their wastewater. One plant spray irrigates a portion of its sludge. Source: Data collection portfolios.

Units of Expression

Units of production in the hardboard industry are reported in square meters (sq m) on a 3.2-mm (1/8-in) thick basis, as well as in thousand kilograms per day (Kkg/day). Most plants provided production data directly on a weight basis. The hardboard industry is not yet metricized and uses English units to express production, square feet (sq ft) on a one-eighth inch basis or in tons per day (TPD). Liquid flows from the industry are reported in kiloliters per day (kl/day) and million gallons per day (MGD). Conversion factors from English units to metric units are shown in Appendix D.

Process Description

Raw Material Usage--The basic raw material used in the manufacture of hardboard is wood. The wood species include both hardwoods (oak, gum, aspen, cottonwood, willow, sycamore, ash, elm, maple, cherry, birch, and beech) and softwoods (pine, Douglas fir, and redwood).

Wood receipts may vary in form from unbarked long and short logs to chips. Chip receipts may be from whole tree chipping, forest residue (which includes limbs, bark, and stumps), sawmill waste, plywood trim, and sawdust. The deliveries may be of one species, a mixture of hardwoods, or a mixture of softwoods. The geographic location of each mill determines the species of wood used to produce the hardboard. The species and mixture at a given plant may change according to availability.

Moisture content of the wood receipts varies from 10 percent in plywood trim to 60 percent in green (fresh) wood.

Chemicals used as raw material in the hardboard process consist of vegetable oils, primarily linseed or tung, tall oil, ferric sulfate, wax, sulphuric acid, thermoplastic and/or thermosetting resin, aluminum sulfate, petrolatum, defoamer, and paint. No one mill uses all these chemicals in its process, nor is the degree of chemical use the same for all mills. Some of the functions of these chemicals are for binding, sizing, pH control, retention, weather proofing, and foam reduction. The chemical usage ranges from 0.5 to 11.0 percent of the total production.

Wood Storage and Chipping--Most of the mills surveyed stored the wood raw material as chips in segregated storage piles. In most cases a paved base is provided for the storage piles. Rough logs received are stockpiled prior to debarking and chipping.

Of those mills receiving rough logs, four out of eight remove the bark by mechanical means and either burn it or dispose of it in landfills. The other four mills chip the logs with the bark attached. Seven mills receive wood in chip form only, which in most cases includes the bark from the log. Only six mills screen chips before processing. Some of the mills using chips containing bark can tolerate only a minimal amount of bark in the final product and have auxiliary equipment (i.e., centricleaners) to clean the stock. One mill reported that bark in the stock improves the cleanliness of the caul plates in the press and presents no problems in production. Only seven of the sixteen mills surveyed washed the chips before processing.

For production control and consistency, the majority of the mills maintain a chip inventory of 60 to 90 days. Although the yield is lower and the chips are more contaminated (bark, dirt, etc.), the use of waste material and forest residue is increasing each year in the production of hardboard. As the availability of quality chips decreases and the costs increase, the greater use of lower quality fiber requires additional equipment to clean the chips before processing.

Fiber Preparation--Before refining or defibering, the chips are pretreated with steam in a pressure vessel or digester. The steaming of the chips under pressure softens the lignin material that binds the individual fibers together and reduces the power consumption required for mechanical defibering. The degree of softening when the chips are raised to a certain temperature varies with different wood species. Steaming of the chips also increases the bonding between fibers when the board is pressed.

Cooking conditions are determined by the wood species involved and the pulp quality required for the grade of hardboard being produced. A major difference exists in the cooking conditions used in the manufacturing of S1S (smooth-one-side) and S2S (smooth-two-sides) hardboard. The cooking cycles for S1S hardboard have ranges of 2 to 5 minutes at 5.4 to 10.2 atm (80 to 150 psi) for softwood and 40 seconds to 15 minutes at 9.5 to 12.2 atm (140 to 180 psi) for hardwood. S2S hardboard, which requires stronger and finer fibers, is produced with cooking times of 1.5 to 14 minutes at 10.2 to 13.6 atm (150 to 200 psi).

Most S1S hardboard is usually manufactured with the same pulp throughout the board, but occasionally it is produced with a thick mat of coarsely refined fiber and an overlay of a thin layer of highly refined fiber. The overlay produces a high quality, shive-free, smooth surface. The bulk of the board can contain coarse fiber, which allows proper drainage during the pressing operation. Refining requires less energy and the cooking conditions are less stringent.

S2S hardboard requires more highly refined fiber and more thorough softening than S1S. This requires higher preheating pressures and longer retention time and, therefore, more refining equipment and horsepower. The severity of the cook significantly affects the raw waste loading of the mill effluent. Most S2S hardboard is manufactured using an overlay system of fine fiber.

To contend with frozen chips, some mills in cold climates add preheating for thawing prior to the cooking cycle.

The predominant method used for fiber preparation consists of a combination of thermal and mechanical pulping. This involves a preliminary treatment of the raw chips with steam and pressure prior to mechanical pulping of the softened chips. The thermomechanical process may take place with a digester-refiner as one unit (e.g., Asplund system), or in separate units.

Primary, secondary, and tickler refiners may be found in the process depending on the type of pulp required. The pulp becomes stronger with more refining, but its drainage characteristics are reduced.

Some mills use raw chips which bypass the digester and are refined in a raffinator or refiner. These chips are usually of a species that breaks down easily and has a tendency to overcook in the digester. The raw chips, which produce a weaker pulp and are a small percentage of the total chips used, are blended, after refining, with the cooked chips.

Some mills employ a method of fiber preparation called the explosion or gun process. The chips are cooked in a small pressure vessel and released--suddenly and at a high pressure--through a quick-opening valve to a cyclone. The sudden release of pressure explodes the chips into a mass of fiber. The steam condenses in the cyclone and fibers fall into a stock chest where they are mixed with water. Fiber yield is lower than the thermomechanical process because of the hydrolysis of the hemicelluloses under high pressure, and the raw waste loading is considerably higher.

To restore moisture to chips containing a low moisture content (e.g., plywood trim), one mill injects water with the chips as they are being cooked in the digester.

Refining or defibering equipment is of the disc type, in which one disc or both may rotate; the unit may be pressurized or a gravity type. A combination of pressure- and gravity-type refiners is usually used in the process. Both types of refiners have adjustable clearances between the rotating or fixed discs, depending on the type of stock desired. The maintenance and life of the refiner discs are dependent on the cleanliness of incoming chips.

Small tickler or tertiary pump-through refiners are used to provide a highly refined, shive-free stock for the overlay system required by some mills. Small refiners are also used for rejects from the stock cleaning systems.

Primary and most secondary refiners use large amounts of fresh water for noncontact cooling which may be reused in the process water system. Fresh or process white water is injected directly into the refiner to facilitate refining.

Stock Washing and Deckers--A washer is used to remove soluble materials. A decker, which is a screen used to separate fibers from the main body of water, also removes some solubles from the fiber bundles.

After primary refining and dilution with white water, the majority of the mills wash the stock to remove dissolved solids. The most widely used washing equipment is of the drum-type, which may operate under a gravity or vacuum mode. The washer is equipped with showers that wash the stock as it is picked up by the drum. Two mills used counter-current washers which consist of two or three drum washers in series. The extracted solids are used in a byproduct system. One mill uses a two-roll press for washing. As the water is squeezed from the stock passing through the nip of the press, it carries away dissolved solids.

The effluent from a stock washer has a high concentration of soluble organics which are usually mixed into the white water system and are either discharged for treatment or are recycled within the washing system. The amount of dissolved solids that are readily washed from the stock is dependent on the species of wood and the amount of cooking.

Of the sixteen hardboard mills surveyed, four of seven S1S mills and seven of nine S2S mills wash their stock before mat formation.

Stock washers are usually located after the primary refiners. Some mills screen the washed stock and send the slivers and oversize back through the primary refiner. Five mills, one without a stock washer, used centricleaners in the system to remove non-fiber material (bark, dirt, etc.) from the stock.

Consistency of the stock as it travels through the process is controlled by instruments using recycled white water for dilution. One mill, based on experience, checks the consistency by "feel." The pH may be controlled by the addition of fresh water or chemicals. Other chemicals are added at various locations as required.

Forming--Most wet process mills form their product on a fourdrinier-type machine similar to that used in producing paper. Diluted stock is pumped to the headbox where the consistency is controlled (usually with white water) to an average of 1.5 to 1.7 percent while the stock is being fed to the traveling wire of the fourdrinier. As the stock travels with the wire, water is drained away. At first the water drains by gravity, but as the stock and wire continue, a series of suction boxes remove additional water. As the water is being removed, the stock is felted together into a continuous fibrous sheet called a "wet mat." At the end of the forming machine the wet mat leaves the traveling wire and is picked up by another moving screen that carries the mat through one or more roll presses. This step not only removes more water but also compacts and solidifies the mat to a level at which it can support its own weight over short spans. As the wet mat leaves the prepress section, it is cut, on the fly, into lengths as required for the board being produced. In the production of S1S hardboard the mat, still with a moisture content of 50 to 65 percent, is carried to the hydraulic press section. In the manufacture of S2S hardboard, the mat is conveyed first through the dryer and then is pressed in a dry state.

The water drained from the mat as it travels across the forming machine is collected in a pit under the machine or in a chest. This "white water" contains a certain amount of wood fibers (suspended solids), wood chemicals (dissolved solids), and dissolved additive chemicals depending on the size of the machine wire, the amount and number of suction boxes, the freeness or drainage of the stock, and the physical properties of the product.

The water draining by gravity from the first section of the former contains the larger amount (rich) of fiber and is usually recycled to the fan pumps that supply the stock to the forming machine. The lean white water collected under vacuum in some plants is collected and recycled as dilution water throughout the process.

The amount of white water that can be recycled is sometimes limited by board quality demands. Recycled white water causes an increase in the sugar content (dissolved solids) of the process water and therefore in the board. If the sugar content is allowed to accumulate beyond a certain point, problems such as boards sticking in the press, bleedouts from the finished products, objectionable board color, and decreased paintability may be encountered. Some board products can tolerate a degree of such problems, and in some cases, some of the problems can be overcome by operational changes.

The wet trim from the mat on the forming machine is sent to a repulper, diluted, usually screened, and recycled into the process system ahead of the forming machine.

Pressing--After forming to the desired thickness, the fibers in the mat are welded together into a grainless board by the hardboard press. The hydraulically-operated press is capable of simultaneously pressing 8 to 26 boards. Press plates may be heated with steam or with a heat transfer medium up to 230°C. Unit pressures on the board up to 68 atm (1,000 psi) are achieved in the press. In S1S hardboard manufacturing the wet mat is fed into the press as it comes from the forming machine. Screens are used on the back side of S1S mats in the press. In this state the S1S requires 4 to 10 minutes in the press. In S2S hardboard manufacturing, the press may be fitted with caul plates or the board may be pressed directly between the press platens. Caul plates may be smooth or embossed for a special surface effect on the board. The press may be hand or automatically loaded and unloaded.

The squeezing of the water from the wet mat removes some of the dissolved solids. The water from the press squeeze-out on S1S hardboard has a high organic content and is usually drained away for treatment. To assist the bond of the fibers in the press, resins are added to the stock before it reaches the forming machine. From the press the S1S hardboard may be conveyed to a dryer, kiln, or humidifier.

As the S2S hardboard leaves the forming machine, it may enter a pre-drying oven which evaporates 95 percent of the moisture in the board. When a pre-dryer is used, the hot board is delivered directly to the press. After drying, the board may be pressed or sent to storage and pressed when required. The strength of the S2S hardboard has to be sufficient to withstand the many handling situations that occur while the board is in the unpressed state.

As stated before, the S2S hardboard requires a harder cook and more refining than S1S hardboard. These finer fibers allow the consolidating chemical reaction to take place when pressing the dry board. Thermosetting phenolic resins cannot be used as a binder in S2S hardboard mat because it precures in the mat dryer. Higher temperatures, higher pressures, and shorter pressing time (1 to 5 minutes) are required in pressing the dry S2S hardboard.

Oil Tempering and Baking--After pressing, both S1S and S2S hardboard may receive a special treatment called tempering. This consists of treating the sheets with various drying oils (usually vegetable oils) either by pan dripping or roll coaters. In some cases the hardboard is passed through a series of pressure rolls which increase the absorption of the oils and remove any excess. The oil is stabilized by baking the sheet from 1 to 4 hours at temperatures of 150°C to 177°C. Tempering increases the hardness, strength, and water resistance of the board.

Humidification--As the sheets of hardboard discharge from the press or the tempering baking oven they are hot and dry. To stabilize the board so as to prevent warping and dimensional changes, it is subjected to a humidification chamber in which the sheets are retained until the proper moisture content, usually 4.5 to 5 percent, is reached. In the case of siding products where exposure to the elements is expected, humidification to 7 percent is common.

Figures III-8 and III-9 depict diagrams of typical S1S and S2S production processes, respectively.

FLOW DIAGRAM OF A TYPICAL WET PROCESS HARDBOARD MILL

S1S HARDBOARD PRODUCTION LINE

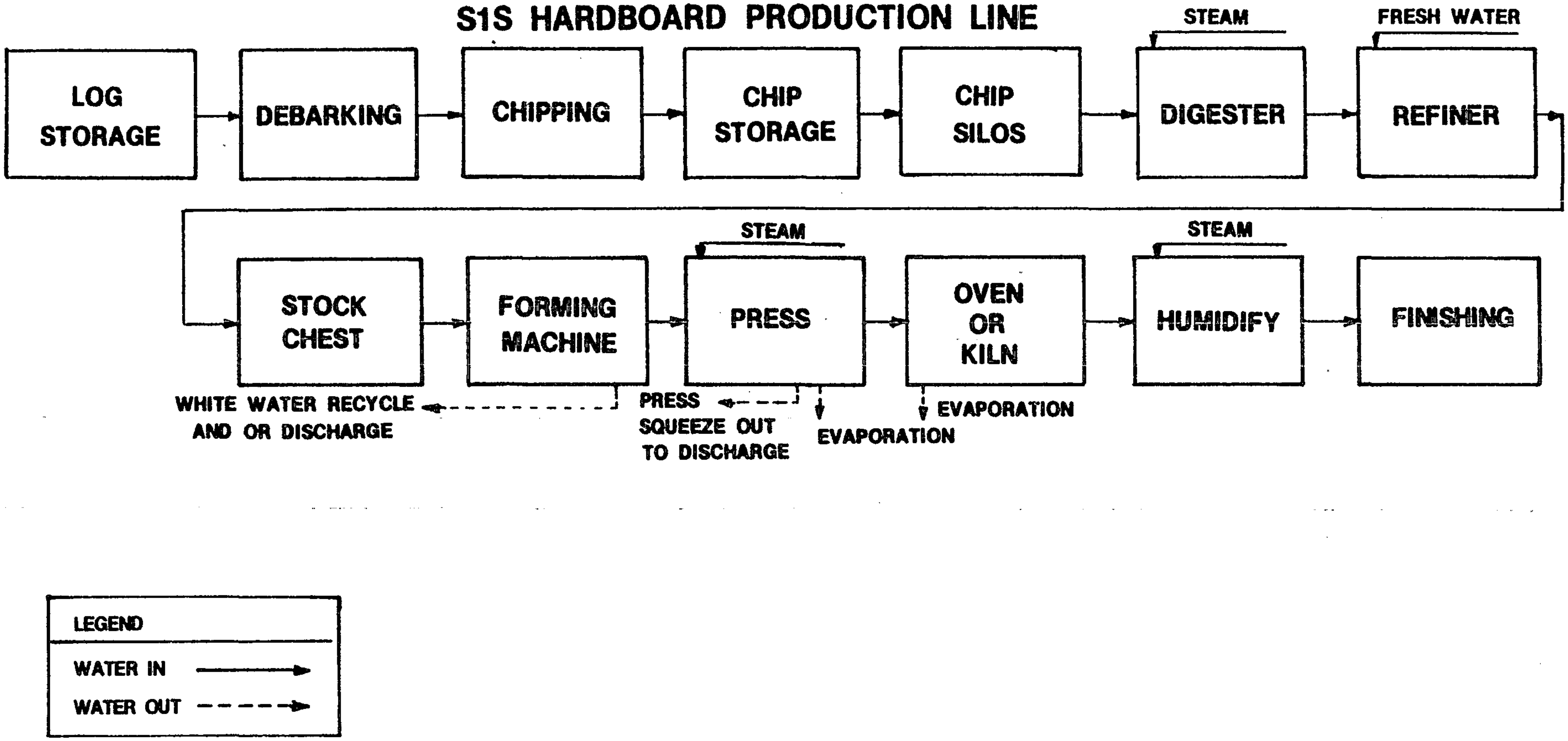


Figure III-8

FLOW DIAGRAM OF A TYPICAL WET-PROCESS HARDBOARD MILL
S2S HARDBOARD PRODUCTION LINE

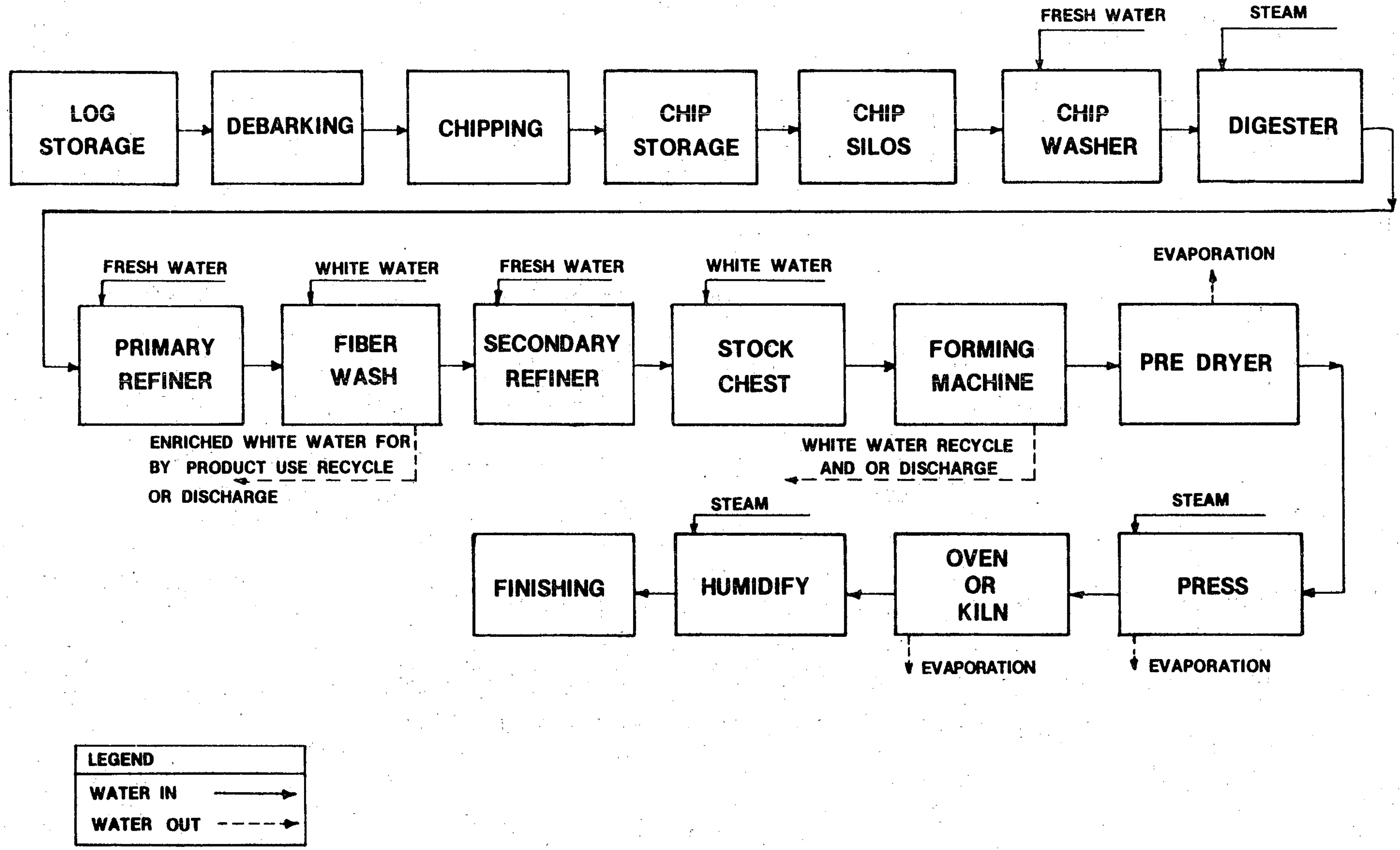


Figure III-9

SECTION IV

INDUSTRIAL SUBCATEGORIZATION

GENERAL

In the review of existing industrial subcategorization for the wood preserving, insulation board, and wet process hardboard subcategories of the timber industry, it was necessary to determine whether significant differences exist within each segment to support the previous subcategorization scheme, or whether modifications are required. Subcategorization is based upon emphasized differences and similarities in such factors as: (1) plant characteristics (size, age, and products produced) and raw materials; (2) wastewater characteristics, including toxic pollutant characteristics; (3) manufacturing processes; (4) applicable methods of wastewater treatment and disposal and (5) nonwater quality impacts and energy.

The entire technical data base, described in Section II, was used in the review of subcategorization.

WOOD PRESERVING

Review of Existing Subcategorization

In developing the previously published effluent limitation guidelines and pretreatment standards for the wood preserving segment of the timber products industry, it was determined that plants comprising this segment exhibited significant differences which sufficiently justified subcategorization. The definitions of the three previously published subcategories (1974) are as follows:

Wood Preserving--All pressure processes which employ waterborne salts and in which steaming, the Boulton process, or vapor drying is not the predominant method of conditioning. All nonpressure processes.

Wood Preserving-Steam-All wood preserving processes that use direct steam impingement on wood as the predominant conditioning method, processes that use vapor drying as the predominant conditioning method, fluor-chromium-arsenate-phenol (FCAP) processes, processes where the same retort is used to treat with both salt- and oil-type preservatives, and processes which steam condition and which apply both salt- and oil-type preservatives to the same stock.

Wood Preserving-Boulton-All wood preserving processes which use the Boulton process as the predominant method of conditioning stock.

The rationale for selecting these subcategories was anchored to differences within the industry in the volume of process wastewater generated and the applicable wastewater technology existing when the subcategories were developed in 1974. Plants in the Wood Preserving subcategory were required to meet a no discharge of process wastewater limitations and standards because a widely used technology existed to achieve no discharge by recycling the small volumes of process wastewater. Likewise, in 1974 plants employing the Boulton method of conditioning had achieved no discharge of process wastewater by means of forced evaporation using waste heat, and this was the basis for separate subcategorization of Boulton plants. Plants that used steaming as the predominant method of conditioning were permitted a discharge because of the relatively large volume of wastewater generated by the open steaming method used by most of the plants at that time, and because steaming plants did not have sufficient waste heat available to achieve no discharge through forced evaporation.

Factors considered in the subcategorization review included the following:

Plant Characteristics and Raw Materials
Wastewater Characteristics
Manufacturing Processes
Methods of Wastewater Treatment and Disposal
Nonwater Quality Impacts

Plant Characteristics and Raw Materials

Raw Materials and Conditioning Processes--Most plants employing the Boulton process as the predominant method of conditioning are located in the Douglas fir region of the western states; those that use steam conditioning are concentrated in the Southern pine areas of the South and East. However, many plants that treat unseasoned Douglas fir also employ steaming for special purposes such as thawing frozen stock before treatment or flash cleaning of the surfaces of stock following treatment. Likewise, since current AWPA standards permit steam conditioning of certain western species such as Ponderosa pine, some plants that use the Boulton process as the predominant method of conditioning also use steam conditioning occasionally. Similarly, some eastern plants that steam condition most of their stock may use the Boulton process to condition green oak piling or cross ties. The Boulton process is the predominant conditioning method at a few of the plants in the South and East that specialize in cross tie production.

Because the wood species being treated plays a role in determining the method used to condition the raw material, and because the conditioning process used may affect the volume of wastewater generated; conditioning process used played a major role in establishing the subcategorization of the wood preserving segment.

Age--With the exception of method of conditioning the wood, Boulton and steaming plants have very similar characteristics. Average is more than 45 years for both Boulton and steaming plants.

Plant age in and of itself is not a significant factor in determining the efficiency of a plant; nor does it necessarily influence either the volume or the quality of process wastewater. Regardless of age, all plants employ the same basic treating processes, use the same type of equipment, and treat with the same preservatives. The average age of wood preserving plants is high because the industry developed rapidly in the 1920's and 1930's in consort with the demand for treated wood products by the railroads and utilities. Most of the old plants have been modified several times since they were first constructed. In most cases, the waste management programs at these plants are as advanced as those at plants constructed more recently.

Size--Table IV-1 shows the size distribution of wood preserving plants within each subcategory. It can be readily observed from this table that plants which treat only with inorganic preservatives have a much greater percentage (79 percent) of one- and two-cylinder plants than do the Boulton (57 percent) or steam (53 percent) subcategories. Boulton plants have a greater percentage of large plants with over four retorts (21 percent) as compared to steaming plants (8 percent) or inorganic preservative plants (2 percent).

Production capacity is perhaps a better indicator of plant size than number of retorts. For plants with the same number of retorts that treat only stump-green stock, the production of the steaming plant would exceed that of the Boulton plant by a factor of two or more because of the longer treating cycle time required for the Boulton process. This inherent production advantage of steaming plants is mitigated in part by the fact that the Boulton subcategory of the industry has a higher percentage of four- and five-cylinder plants than the Steam subcategory. Plant size and production capacity are insignificant factors in subcategorization of the wood preserving segment.

Products Treated--Boulton and steaming plants produce the same range of treated products. Overall, the Boulton plants tend to be more diversified than the remainder of the industry. This is not a significant factor in subcategorization.

Preservatives Used--The types of organic preservatives used by a plant are an important consideration in determining the pollutants contained in the process wastewater and, to some degree, the quality of the wastewater. Boulton plants use the same range of preservatives as the industry as a whole. However, more Boulton plants use creosote and salt-type preservatives than the remainder of the industry.

Table IV-1. Size Distribution of Wood Preserving Plants by Subcategory

Number of Retorts	Boulton Number of Plants	Boulton Percent	Steam Number of Plants	Steam Percent	Inorganic Perservatives Number of Plants	Inorganic Perservatives Percent
1	8	24	11	13	30	55
2	11	33	34	40	13	24
3	3	9	24	28	11	20
4	4	12	9	11	0	0
>4	7	21	7	8	1	2

Components may not add to 100 percent due to rounding.

Source: Data Collection Portfolios, 1977, and AWPA, 1975.

Wastewater Characteristics

Wastewater Volume--Data collected in 1973-1974 in preparation of the Development Document for the Wood Preserving Segment of the Timber Industry revealed significant differences between the volume of wastewater generated by plants in the Wood Preserving subcategory which use nonpressure processes or which treat with inorganic salts, and plants in the Steam and Boulton subcategories which use pressure processes and treat with oily preservatives. Non-pressure plants generate no process wastewater. Inorganic salts plants generate much lower volumes of wastewater than do plants treating with oily preservatives, and this wastewater can be reclaimed by recycling as dilution water for future batches of waterborne preservatives. Steaming plants generate a larger volume of wastewater than Boulton plants of similar size. However, this difference has narrowed considerably during the period 1974-1978 as a result of aggressive pollution control efforts among steaming plants in the East. Factors that have contributed to this change include the following:

1. Adoption of closed steaming as a replacement for open steaming by some plants.
2. Replacement of barometric-type with surface-type condensers.
3. Recycling of barometric cooling water.
4. Predrying of a higher percentage of production, thus

reducing total steaming time and excess wood water.
5. Segregation of contaminated and uncontaminated waste streams.
6. Inauguration of effective plant maintenance and sanitation programs.
7. Recycle of coil condensate.

Improvements have also been made in the waste management programs at Boulton plants. However, the changes that produced the greatest result with the smallest investment were made at these plants prior to 1973 in response to local and state pollution control regulations.

Data presented in Section V of this document demonstrate that while differences in wastewater volumes between steaming plants and Boulton plants still exist, the differences are less than those which existed in 1973 and 1974. The average steaming plant generates approximately 30 percent more wastewater on a gallon per cubic foot basis than does the average Boulton plant. Steaming plants which treat a large portion of dry stock and closed steaming plants generate 12 and 56 percent less wastewater, respectively, than do Boulton plants. In 1973 and 1974, 75 percent of all steaming plants surveyed by EPA indicated that they either then practiced or were planning to adopt closed steaming technology. Current information indicates that fewer than 50 percent of all steaming plants have adopted closed steaming. Many plants reported that high product color and low aesthetic quality of poles and lumber treated by closed steaming techniques were instrumental in their decision to discontinue or not to adopt closed steaming.

The previously promulgated subcategorization scheme is being retained because the methods commonly in use to treat and dispose of process wastewater differ significantly between the -Steam and -Boulton subcategories.

Wastewater Parameters--Inorganic salts plants generate a wastewater containing water soluble heavy metals, which can be recycled using commonly practiced reuse technology. Boulton and steaming plants treat with the same types of oily preservatives. Consequently, the wastewater generated by the two types of plants contains similar preservative contaminants. This is verified by data presented in Section V.

Differences between Boulton and steaming wastewater in COD and pentachlorophenol concentrations are largely due to differences in oil and grease content. Oil-water emulsions are more common in steaming plant wastewaters, a fact that accounts for the correspondingly higher average oil content. It is probable that wood extractives, principally resins and carbohydrates, act as emulsifiers. Because the water removed from wood during the Boulton process leaves the retort in vapor form and thus free of wood extractives, emulsions occur with considerably less frequency in Boulton wastewater. The higher oil content of the steaming wastewater accounts in large part for the relatively higher oxygen demand of these wastes and serves as a carrier for pentachlorophenol at concentrations far in excess of its solubility in water (17 mg/l at 20°C).

Manufacturing Processes

The conditioning method employed is the only step in the manufacturing process that distinguishes Boulton plants from steaming plants. Both conditioning methods have the same function, i.e., to reduce the moisture content of unseasoned stock to a level which allows the requisite amount of preservative to be forced into the wood. Conditioning also increases the depth of treatment as required by AWPA standards. Process descriptions of both Boulton and steam conditioning are presented in Section III of this document. As stated above, differences in wastewater volume and treatment/disposal options enter into the decision to continue with the same subcategorization scheme.

Methods of Wastewater Treatment and Disposal

Plants which treat solely with inorganic salts can achieve no discharge of process wastewater by collecting cylinder drippings and rainfall from the sump under the cylinders and recycling this wastewater to dilute treating solutions for future charges. This technology is effective and widely employed in the industry. Plants that treat with salts have, with few exceptions, achieved no discharge as required by previously promulgated effluent guidelines and standards.

Capital requirements to achieve no discharge for a plant that treats only with salt-type preservatives are relatively small compared to those that treat with oil-type preservatives. Because of the nature of the closed system for salt treating plants, operating costs are low. Some small return on the initial investment can be realized in that small quantities of otherwise wasted chemicals are recovered and reused.

Wastewater treatment methods utilized by plants treating with oily preservatives include gravity oil-water separation; chemical flocculation followed by slow sand filtration; biological treatment; soil irrigation; and natural or forced (spray, pan or cooling tower) evaporation. These treatment methods are equally applicable to steaming and Boulton plants with the exception of cooling tower evaporation, which is more appropriate for Boulton plants, because of the availability of waste heat.

Nearly all plants treating with oily preservatives use gravity oil-water separation, regardless of subsequent treatment steps or ultimate disposal of wastewater. Primary oil separation is used partly for economic reasons--to recover oil and treating solutions, and partly to facilitate subsequent treatment steps. Plants which use chemical flocculation/filtration and/or biological treatment technology do so to pretreat the wastewater prior to discharge, additional treatment, or disposal.

Plants treating with oily preservatives have generally chosen to meet previously published effluent limitations by discharging pretreated wastewater to a POTW or by achieving no discharge status through either soil irrigation or evaporation. Soil irrigation and spray evaporation, equally applicable to steaming and Boulton wastewaters, require the availability of land. The amount of land required depends on the size of the plant, amount of wastewater generated, and local soil and atmospheric conditions.

Boulton plants have a significant source of waste heat available in the vaporized wood water and light oils sent to the condenser during the long vacuum phase of the treating cycle. This waste heat can be used to evaporate all or most of the process wastewater by recirculation through a mechanical draft cooling tower. This method of forced evaporation, while occasionally requiring an external heat source to evaporate excess rainwater or other process water, is currently used by many Boulton plants to achieve no discharge. This technology requires very little land, generally less than one-tenth of an acre.

The vacuum cycle of steaming plants is too short to effectively utilize the waste heat of the vaporized wood water, and reliance must be made on the more land-intensive technologies of soil irrigation or spray evaporation to achieve no discharge.

Nonwater Quality Impacts

For the purposes of subcategorization, EPA is not aware of any nonwater quality environmental impacts that would justify a change to the previously published subcategorization scheme.

Subcategory Description and Selection Rationale

A careful consideration of the plant characteristics, raw materials, wastewater volume produced, wastewater characteristics, manufacturing processes, available methods of wastewater treatment and disposal, and nonwater quality impacts as currently exist in the industry today suggests that the existing subcategorization of the wood preserving industry should be retained, with minor wording changes to clarify the applicability of the regulation.

EPA is, however, shifting plants treating with fluoro-chromium-arsenic-phenol (FCAP) solution from the Wood Preserving-Steam to the Wood Preserving-Waterborne or Nonpressure subcategory. These plants were previously included in the Wood Preserving-Steam subcategory because plants that use the FCAP preservative often steam condition wood. The recent update of information, however, indicates that FCAP, which is a waterborne solution, is more properly included in the Wood Preserving-

Waterborne or Nonpressure subcategory (previously the Wood Preserving subcategory). FCAP may be applied to air or kiln dried wood, and its low volumes of wastewater may be recycled in the same manner as other waterborne salt solutions. Furthermore, the technical data base did not identify any direct or indirect discharging plants treating with FCAP.

Although there are similarities among all plants which treat with oily preservatives in terms of plant characteristics, raw materials, wastewater volume and characteristics, and manufacturing processes, the ability of the plants in the Boulton subcategory to use available waste heat to evaporate most, if not all, process wastewater indicates that current subcategorization, with the minor, recommended changes, is still valid.

The widespread use and low cost of technology resulting in no discharge for plants which are currently in the Wood Preserving-Water Borne or Nonpressure subcategory is the primary reason for retaining this subcategory.

The definitions of the wood preserving subcategories as finally promulgated are:

Wood Preserving - Waterborne or Nonpressure -- Includes all nonpressure wood preserving treatment processes, and all pressure wood preserving treatment processes employing waterborne inorganic salts.

Wood Preserving-Steam -- Includes all wood preserving processes that use direct steam impingement on wood as the predominant conditioning method; processes that use the vapor drying process as the predominant conditioning method; direct steam conditioning processes which use the same retort to treat with both salt and oil-type preservatives; and steam conditioning processes which apply both salt-type and oil-type preservatives to the same stock.

Wood Preserving-Boulton -- Includes those wood preserving processes which use the Boulton process as the predominant method of conditioning stock.

INSULATION BOARD

Review of Existing Subcategorization

Effluent limitations guidelines have never been promulgated for the Insulation Board segment of the timber industry. The August 1974 Development Document for the Timber Products Processing Industry proposed two subcategories, based on differences in raw wastewater volume and strength between plants which steam precondition the wood raw material (thermomechanical refining) or which produce hardboard at the same facility, and plants which do not (mechanical refining). The Agency reviewed the proposed subcategorization with respect to the updated technical data base, and decided that a single subcategory for all insulation board plants was appropriate.

During the review of the proposed subcategorization for the Insulation Board segment, the industry was reviewed and surveyed with a focus on wastewater characteristics and treatability as related to:

Raw Materials
Manufacturing Processes
Products Produced
Plant Size and Age
Nonwater Quality Impacts

<u>Raw Materials</u>

The primary raw material used in the manufacture of wood fiber insulation board is wood. This material is responsible for the major portion of the BOD and suspended solids in the raw waste. Other additives, such as wax emulsions, asphalt, paraffin, starch, and aluminum sulfate, comprise less than 20 percent of the board weight and add very little to the raw waste load. Information submitted by several mills has indicated that wood species, season of wood harvesting, and the presence of bark and/or whole tree chips in wood furnish affect the raw waste load of insulation board plants. However, due to a lack of sufficiently detailed plant data to quantify the effects of these variables upon raw waste load, there was no sound basis for subcategorization strictly on the basis of raw material used to produce the board.

Four insulation board plants produce insulation board using mineral wool as a raw material. Two of these plants produce large quantities of mineral wool insulation board on separate forming lines within the same facility or in facilities separate from the wood fiber insulation board plant. One plant produces approximately 50 percent of its total production as mineral wool insulation board on the same forming machine that it uses to produce wood fiber insulation board. Wood fiber and mineral wool wastewater from these three plants completely comingle prior to monitoring. These plants were not used to determine raw waste loads for wood fiber insulation board. One plant produces less than 10 percent of its total production as mineral wool insulation board, using the same forming equipment as is used for wood fiber insulation board. Raw waste load data from this plant were used to develop raw waste loads for wood fiber insulation board as the contribution from the mineral wood production was considered to have no significant effect on the overall raw waste load. All other plants analyzed for raw waste load used only wood as the primary material.

Four plants indicated in their response to the DCP that wastepaper was used for a minor portion of their raw material in wood fiber insulation board production. The small amounts of wastepaper furnish used by these plants are not likely to appreciably affect their raw waste loads.

Manufacturing Process

Although a plant may have various auxiliary components in its operation, the major factor which affects raw waste loads is whether steam, under pressure, is used to precondition the chips prior to refining, or whether preconditioning is accomplished mechanically. Plants which do not steam their furnish under pressure, i.e., mechanical refining plants, demonstrate lower raw waste loads than plants which precondition chips using steam under pressure, i.e., thermomechanical refining plants. This was the primary reason for proposing separate subcategorization of this industry segment. The steam cook softens the wood chips and results in the release of more soluble organics. Data presented in Section V, WASTEWATER CHARACTERISTICS, support the general validity of subcategorization based on whether or not a plant preconditions its furnish using steam under pressure.

Products Produced

The ability of an insulation board plant to recycle process wastewater is highly dependent upon the type of product produced. Insulation board plants which produce primarily structural type board products such as sheathing, shinglebacker, etc., demonstrate lower raw waste loads primarily because of the increased opportunity of process water recycle at these plants. Two insulation board plants that do not steam condition their wood furnish have reduced their flow per unit of production to less than 3,000 liters/metric ton (750 gallons/ton). These plants produce primarily structural type board products. Two insulation board plants that steam condition their wood furnish achieved complete recycle of process whitewater, resulting in no discharge of process wastewater. Both of these plants produce solely structural type products.

Structural type products do not require the uniform color surface finish of decorative products and can contain a greater amount of wood sugars and other dissolved material from the process whitewater system.

Consideration was given to subcategorization on the basis of type of board product produced, i.e., structural versus decorative. However, the equipment at most plants is readily adaptable to the production of both types of board, and most plants rotate the type of board produced based on product demand, which is highly variable. Subcategorization according to board type would severely limit the ability of these plants to respond to competitive pressures, and would make the issuance of permits by enforcement agencies a difficult task. Therefore, subcategorization solely on the basis of product type is not considered feasible.

Plant Size and Age

There is a substantial difference in the age and size of the plants in the insulation board industry. However, older plants have been upgraded, modernized, and expanded to the point that age, in terms of process, is meaningless. Because of this, the differences in wastewater characteristics related to the age of the plant are not discernible, nor is the prorated raw waste load due to plant size. Raw waste load data presented in Section V support this conclusion.

Nonwater Quality Impacts

For the purposes of subcategorization, EPA is not aware of any nonwater quality environmental impacts that would justify a change to the previously published subcategorization scheme.

Subcategory Description and Selection Rationale

The Agency has decided to combine all insulation board plants into a single subcategory. This decision is based on the practical reason that there are only two direct discharging plants which produce solely insulation board, and that these plants have similar raw waste characteristics even though one plant practices thermomechanical refining and one plant practices mechanical refining. Although data presented in Section V support the fact that thermomechancial refining generally results in higher strength wastewaters, the single direct discharging mechanical refining plant is an exception since it uses 100 percent whole tree chips as its primary raw material, resulting in a higher raw waste load than that of a typical mechanical refining plant. Based on treatment system performance data presented for this sole direct discharging mechanical refining plant in Section VII, CONTROL AND TREATMENT TECHNOLOGY, it is expected that this plant will be able to comply with proposed effluent limitations for all insulation board plants.

Because the raw waste loads of BOD and TSS for thermomechanical insulation board plants are similar to the raw waste loads exhibited by S1S hardboard plants, the Agency considered combining the insulation board plants and S1S hardboard plants into one subcategory. Significant differences were found to exist, however, in the unit flow of wastewater generated by insulation board and S1S hardboard plants due to the greater amount of internal recycle possible for the insulation board plants. These differences in unit flow, combined with differences in the treatability of insulation board and S1S hardboard wastes due to additive differences, led the Agency to decide against combining insulation board and S1S hardboard plants into one subcategory.

As finally promulgated, the Insulation Board subcategory comprises plants which produce insulation board using wood as the raw material. Specifically excluded from this subpart is the manufacture of insulation board from the primary raw material bagasse.

WET PROCESS HARDBOARD

Review of Existing Subcategorization

Effluent limitations guidelines for wet process hardboard plants promulgated previously (1974) included all wet process hardboard plants in a single subcategory defined as plants engaged in the manufacture of hardboard using the wet matting process for forming the board mat.

After these regulations were promulgated, industry representatives presented data which they believed supported separate limitations and subcategorization for wet-wet (S1S) hardboard and wet-dry (S2S) hardboard.

In November 1975, the EPA retained a contractor to evaluate and review the regulations and the existing subcategorization of the industry. The Summary Report on the Re-Evaluation of the Effluent Guidelines for the Wet Process Hardboard Segment of the Timber Products Processing Point Source Category, completed in July 1976, recommended that the wet process hardboard industry be divided into two parts wet-wet hardboard and wet-dry hardboard. This recommendation was based on significant differences in the raw waste load characteristics of plants which produce hardboard by the two different processes.

In order to determine the validity of the resubcategorization and to determine whether changes within the industry since the Summary Evaluation Report was completed in 1976 occurred, the industry was reviewed and surveyed with a focus on wastewater characteristics and treatability as related to:

Raw Materials
Manufacturing Processes
Products Produced
Plant Size and Age
Nonwater Quality Impacts

Raw Materials

The primary raw material used in the manufacture of hardboard is wood, and this material is responsible for the major portion of the BOD and suspended solids in the raw waste. Other additives, such as vegetable oils, tall oil, ferric sulfate, thermoplastic and/or thermosetting resins, and aluminum sulfate, comprise less than 15 percent of the board weight and add very little to the raw waste load. Information submitted by several plants has indicated that wood species, season of wood harvesting, and the presence of bark in wood furnish affect the raw waste load of hardboard plants. Because of a lack of sufficiently detailed plant data to quantify the effects of these variables upon raw waste load, there was no sound basis for subcategorization strictly on the basis of raw material used to produce the board.

Manufacturing Processes

A plant may have various auxiliary components in its operation; however, the basic processes in the production of either S1S or S2S hardboard are similar except for the pressing operation. S1S board is pressed wet immediately after forming. S2S board is dried prior to being pressed.

S1S hardboard is produced with coarse fiber bundles cooked a relatively short time and at low pressure--40 seconds to 5 minutes at pressures of 80 to 180 psi. S2S hardboard, which requires finer fibers, is produced with cooking times of 1.5 to 14 minutes at pressures of 150 to 200 psi. The longer time and higher pressure cooks release more soluble organics from the raw material (wood), thus affecting the effluent raw waste loading.

The S2S board also requires more effective fiber washing to reduce the soluble solids that affect the product in the pressing and finishing operations. These operations result in more raw waste discharge to the effluent; less soluble solids are retained in the finished board. After analyzing the available information and observing the obvious differences between the processes for wet-wet (S1S) and wet-dry (S2S) hardboard, it appears justifiable to allow for differences between wet-wet (S1S) and wet-dry (S2S) hardboard.

Products Produced

A hardboard plant may produce S1S or S2S board, or both, but the end products at each plant cover a wide range of applications, surface designs, and thickness.

In conjunction with hardboard, some plants produce other products such as insulation board, battery separators, and mineral insulation. Insulation board is produced either on its own forming line or on the same line used for S2S hardboard. The various effluents for each line are comingled upon discharge for treatment with little or no monitoring of flow and/or wastewater characteristics of the separate wastewater streams. The effluent limitations promulgated are applicable only to the hardboard manufacturing operations.

Three plants produce a marketable animal feed byproduct by the evaporation of the highly concentrated wastewater. Several other mills are investigating this process, which not only yields a salable product but also reduces the raw waste load that would require treatment. Because this process is plant specific, it is not addressed in the subcategorization.

Size and Age of Plants

There are considerable differences in age and size of hardboard plants. Older plants have been upgraded, modernized, and expanded to the point that age in terms of manufacturing process is insignificant. Because of this, the differences in wastewater characteristics related to age of the plant are not discernible nor is the prorated raw waste flow due to the plant size. Raw waste load data presented in Section V support this conclusion.

Nonwater Quality Impacts

For the purposes of subcategorization, EPA is not aware of any nonwater quality environmental impacts that would justify a change to the previously published subcategorization scheme.

Subcategory Description and Selection Rationale

Analysis of the above factors, supported by data presented in Section V of this document, WASTEWATER CHARACTERISTICS, affirms the validity of separate subcategorization for wet-wet (S1S) hardboard and wet-dry (S2S) hardboard.

The Agency decided, therefore, to divide the Wet Process Hardboard subcategory into two parts. Part (a) establishes limits for plants producing wet-wet hardboard (S1S), part (b) establishes limits for plants producing wet-dry hardboard (S2S).

As finally promulgated, the Wet Process Hardboard subcategory is defined to include any plant which produces hardboard products using the wet matting process for forming the board mat.

SECTION V

WASTEWATER CHARACTERISTICS

GENERAL

The purpose of this section is to define the wastewater quantity and quality for plants in those subcategories identified in Section IV. Raw waste concentration and load data are presented for conventional pollutants, nonconventional pollutants, and toxic pollutants in each subcategory.

The term "raw waste load" (RWL), as utilized in this document, is defined as the quantity of a pollutant in wastewater prior to an end-of-pipe treatment process. Where treatment processes are designed primarily to recover raw materials from the wastewater stream, raw waste loads are obtained following these processes. Examples are gravity oil-water separators in wood preserving, or fine screens used for fiber recovery in insulation board and hardboard plants. The raw waste load is normally expressed in terms of mass (weight) units per day or per production unit.

For the purpose of cost analysis only, representative raw waste characteristics have been defined for each subcategory in order to establish design parameters for model plants.

The data presented in this document are based on the most current, representative information available from each plant contacted. Verification sampling data are used to supplement historical data obtained from the plants for the traditional pollutants, and in most cases verification sampling data are the sole source of quantitative information for toxic pollutant raw waste loads.

WOOD PRESERVING

General Characteristics

Wastewater characteristics vary with the particular preservative used, the volume of stock that is conditioned prior to treatment, the conditioning method used, and the extent to which wastewaters from the retorts are diluted with water from other sources.

Wastewaters from creosote and pentachlorophenol treatments often have high phenolic, COD, and oil concentrations and a turbid appearance that results from emulsified oils. They are always acid in reaction, the pH values usually falling within the range of 4.1 to 6.0. The high COD contents of such wastes are caused by entrained oils and wood extractives, principally simple sugars, that are removed from wood during steam conditioning. These wastewaters may also contain traces of copper, chromium, arsenic, zinc, and boron at plants that use the same retort for both waterborne salts and oil-type preservatives, or that apply dual treatments to the same stock; i.e., treat with two preservatives, one of which is a salt formulation. Organic toxic pollutants in wastewaters from plants which treat with pentachlorophenol and creosote preservatives only are principally volatile organic solvents such as benzene and toluene, and polynuclear aromatic components of creosote which are contained in the entrained oils. Specific phenolic compounds identified in these wastewaters include phenol, chloro-phenols, and the nitrophenols.

Preservatives and basic treating practices and, therefore, the qualitative nature of wastewaters vary little from plant to plant. Quantitatively, however, wastewaters differ widely among plants and vary with time at the same plant.

Among the factors influencing both the concentration of pollutants and volume of effluent, the moisture content of the wood prior to conditioning, whether by steaming or the Boulton process, is the most important. Water removed from the wood during conditioning accounts for most of the loading of pollutants in a plant's effluent and influences wastewater flow rate. The moisture content of the wood before conditioning determines the length of the conditioning cycle; the wetter the wood, the longer the conditioning cycle.

Rainwater that falls on or in the immediate vicinity of the retorts and work tank area--an area of from about one-quarter to one-half of an acre for the average plant--becomes contaminated and can present a treatment and disposal problem at any plant, but especially at plants in areas of high rainfall. For example, a plant located in an area that receives 152 cm (60 in) of rain annually must be equipped to process an additional 1.5 to 3.0 million liters (400,000 to 800,000 gallons) per year of contaminated water.

Another factor which influences the concentration of pollutants, particularly organic pollutants, is the type of solution or solvent used as a carrier for the preservative (coal tar, oil, etc.).

Wastewaters resulting from treatments with inorganic salt formulations are low in organic content, but contain varying concentrations of heavy metals used in the preservatives and fire retardants employed. The nature and concentration of a specific ion in wastewater from such treatments depend on the formulation employed and the extent to which the waste is diluted by washwater and stormwater.

Wastewater Quantity

The quantity of wastewater generated by a wood preserving plant is a function of the method of conditioning used, the moisture content of wood to be treated, the amount of rainwater draining toward the treating cylinder, and the quantity of other wastewater streams (such as boiler blowdown, cooling water, sanitary wastewater, water softening regenerant, etc.). Ignoring the amount of dilution from other wastewater streams, the sources and approximate ranges of wastewater generated per unit of production for Boulton and steaming plants (including vapor drying plants) are discussed below. It should be noted that most wood preserving plants treat stock having a wide range of moisture contents, and often air- or kiln-dry stock. Although most plants will predominantly use one of the major conditioning methods, many plants will use a combination of several conditioning methods. For this reason, the actual quantity of wastewater generated by a specific plant may vary considerably.

Steam Conditioning and Vapor Drying

Primary sources of wastewater from steam conditioning include steam condensate in cylinders, wood water, and precipitation. In open steaming, steam is injected directly into the retort and allowed to condense on the wood and cylinder walls. The amount of water produced is dependent upon the length of conditioning time and the amount of insulation, if any, around the cylinder. Steam condensate in the cylinder may range between 240 to 1,200 kg/cu m (15 lb/cu ft to 75 lb/cu ft). In modified closed steaming, steam is added to the cylinder until the steam coils are just covered with condensate. Then the steam is no longer injected directly into the cylinder but passed through coils to boil the condensate. Water added is about 112 kg/cu m (7 lb/cu ft), depending upon the diameter of the retort and the height of the steaming coils.

In closed steaming, water is drawn from a storage tank and put into the cylinder until the steam coils are covered. Steam is turned on, passed through the coils, the steam condensate returned to the boiler, and the water in the cylinder is boiled to condition the wood. After steaming, the water in the cylinder is returned to the storage tank. There is a slight increase in volume of water in the storage tank with each conditioning cycle due to wood water exuding when green wood is conditioned. There is a small blowdown from the storage tank to prevent the wood sugar concentration in the water from becoming too high.

In the vapor drying process, the primary sources of wastewater are wood water and precipitation. As in any wood preserving process, small amounts of condensate may result from a short exposure to live steam applied following preservative application to clean the surface of the stock. The vapor drying process consists essentially of exposing wood in a closed vessel to vapors from any one of many organic chemicals that are immiscible with water and that have a narrow boiling range. Chemicals with initial boiling points of from 100°C to 204°C (212°F to 400°F) may be used. Vapors for drying are generated by boiling the chemical in an evaporator. The vapors are conducted to the retort containing the wood, where they condense on the wood, giving up their latent heat of vaporization and causing the water in the wood to vaporize. The water vapor thus produced, along with excess organic vapor, is conducted from the vessel to a condenser and then to a gravity-type separator. The water layer is discharged from the separator, and the organic chemical is returned to the evaporator for reuse.

After the treating cylinder has been drained, a vacuum is pulled from one to three hours to remove water from the wood. The quantity of water removed depends upon the initial moisture concentration of the wood, the strength of the vacuum pulled, and the temperature in the cylinder. Common vacuums are 55 cm (22 in) to 70 cm (28 in), and common temperatures are from 118°C (220°F) to 140°C (245°F). The maximum temperature allowable is 140°C (245°F), above which wood strength deterioration is experienced. The vapors are condensed and collected in an accumulator. The amount of water removed from the wood is generally between 64 and 128 kg/cu m (4 and 8 lb/cu ft).

Cylinder drippings and rain water are often added to the flow from the cylinder and fed to the oil-water separator. In some plants they are fed to a separate oil-water separator to prevent cross contamination of preservatives. Rain water can vary between 0 kg/cu m (0 lb/cu ft) when no rain is falling, to 181 kg/cu m (11.3 lb/cu ft) during a 5-cm (2-in) rainfall in 24 hours, depending on the area drained toward the treating cylinder. The minimum area in which rain water is collected includes the immediate cylinder area, the area where the wood removed from the cylinder drips extra preservatives, and the preservative work tank area.

Boulton Conditioning

Primary sources of wastewater from Boulton conditioning include wood water and precipitation. Steam condensate inside the cylinders is not a primary source of wastewater as it is in steam conditioning. Small amounts of condensate, however, may result from a short exposure to live steam applied following preservative application to clean the surface of the stock.

Conditioning is accomplished in the Boulton process by heating the stock in a preservative bath under reduced pressure in the retort. The preservative serves as a heat transfer medium. Water removed in vapor form from the wood during the Boulton process passes through a condenser to an oil-water separator where low boiling fractions of the preservative are removed. The Boulton cycle may have a duration of 48 hours or longer for large poles and piling, a fact that accounts for the lower production per retort day as compared to plants that steam condition.

After the oil has been heated a vacuum is drawn on the cylinder for 10 to 48 hours for Douglas fir and 6 to 12 hours for oak, depending upon the initial moisture content of the wood. The oil transfers heat to the wood and vaporizes the wood water. Between 64 and 192 kg/cu m (4 and 12 lb/cu ft) of water is removed.

Cylinder drippings and rain water are often added to the flow in the same manner as steam conditioning.

Historical Data

Historical data on wastewater generation relating to production were requested as part of the DCP, during plant visits, and in conjunction with telephone follow-up requests for information. These data are presented in Tables V-1 through V-4. Data appearing in these tables represent historical information on the average wastewater flow and production of treated wood (oily preservatives only) for a one-year period, 1976.

Where the information available was sufficiently detailed, other wastewater sources such as boiler blowdown, noncontact cooling water, sanitary water, and rainfall runoff from treated material storage yards were subtracted from the total wastewater flow reported by the plant in order to obtain information on the generation of process wastewater only. Rainfall falling directly on or draining into the cylinder or work tank area was included in the wastewater flows reported in Tables V-1 through V-4.

It is apparent from these data that closed steaming plants and plants which treat predominantly dry stock generate the least amount of wastewater per unit of production, followed by Boulton plants and open steaming plants, respectively. As shown in Tables V-2 and V-3, the average volume of wastewater generated per unit of production for plants which treat significant amounts of dry stock is greater than that for the closed steaming plants. This is most likely because of the fact that some of the plants which treat significant amounts of dry stock, condition the remaining stock by open steaming and/or post steam the treated stock to clean it. As a result, the net wastewater production exceeds that for plants which practice closed steaming.

The long-term historical wastewater information for some plants, as presented in Tables V-1 to V-4, may differ somewhat with the sampling data presented later in this section. The sampling data is based on the production and wastewater generation during a one or three-day composite sampling period; the historical data is for a one year period and was used to determine overall differences in wastewater volumes among wood preserving Boulton and Steam subcategory plants as input to industrial subcategorization determinations discussed in Section IV.

Table V-1. Wastewater Volume Data for 14 Boulton Plants

Plant	PRODUCTION (ft3/day)	(m3/day)	VOLUME (gal/day)	(1/day)	(gal/ft3)	(1/m3)
587*	17,950	508	7,000	26,500	0.39	52.1
1028*	2,040	57.7	1,000	3,790	0.49	65.5
583*	7,370	209	7,000	26,500	0.95	127
1078++	8,475	240	5,000	18,900	0.59	78.9
67*	1,765	49.9	2,010	7,600	1.14	152
759+*	1,665	47.1	5,040	19,100	3.03	405
1114+*	2,175	61.6	1,500	5,680	0.69	92.3
176+*	4,400	125	2,510	9,500	0.57	76.2
577++	8,430	239	15,000	56,800	1.78	238
534*	1,365	38.6	900	3,410	0.66	88.2
61*	7,140	202	5,500	20,800	0.77	103
552*	6,085	172	4,320	16,400	0.71	94.9
555++	5,310	150	17,300	65,500	3.26	436
1110++	1,700	48.1	4,320	16,400	2.54	340
AVERAGE	5,420	153	5,600	21,210	1.03	139

* Achieving no discharge.

\+ Data from 1975 Pretreatment Study.

** Includes boiler blowdown, uncontaminated steam condensate.

++ Discharges to a POTW

Table V-2. Wastewater Volume Data for Eight Closed Steaming Plants

Plant	PRODUCTION (ft3/day)	(m3/day)	(gal/day)	VOLUME (l/day)	(gal/ft3)	(l/m3)
40*	4,920	139	3,000	11,400	0.61	81.6
237*	3,300	93.4	800	3,030	0.24	32.4
355*	6,100	173	3,300	12,500	0.54	72.3
335++	2,620	74.1	2,500	9,460	0.95	128
750*	1,785	50.5	300	1,140	0.17	22.6
656*	830	23.5	500	1,890	0.60	80.4
43*	360	10.2	350	1,320	0.97	130
226+*	4,600	130	230	870	0.05	6.68
AVERAGE	3,065	86.7	1,370	5,200	0.45	60.0

* Achieving no discharge.

\+ Data from 1975 Pretreatment Study.

++ Discharges to a POTW

Table V-3. Wastewater Volume Data for 11 Plants Which Treat Significant Amounts of Dry Stock

Plant	PRODUCTION (ft3/day)	(m3/day)	VOLUME (gal/day)	(l/day)	(gal/ft3)	(l/m3)
596++	1,200	34.0	2,500	9,460	2.08	278
591*	19,000	538	12,500	47,300	0.66	87.9
620++	1,370	38.8	7,200+	27,300	5.26	703
688*	360	10.2	400	1,510	1.11	148
1105*	800	22.6	750	2,840	0.94	126
1071*	4,660	132	4,000	15,100	1.03	138
631*	2,040	57.7	876	3,320	0.43	57.5
350*	985	27.9	1,500	5,680	1.52	203
665*	3,330	94.2	400	1,510	0.15	20.1
267++	5,000	141	5,000	18,920	1.18	158
140*	--	--	4,500	17,000	--	--
AVERAGE	3,870	110	3,510	13,300	0.91	121

* Achieving no discharge.

\+ Includes 5,400 gal/day boiler blowdown and noncontact water; process wastewater per cubic foot production = 1.31.

++ Discharges to a POTW

NOTE: Plant 140 not included in average since no production data are available.

Table V-4. Wastewater Volume Data for 14 Open Steaming Plants

	PRODUCTION		VOLUME			
Plant	(ft3/day)	(m3/day)	(gal/day)	(l/day)	(gal/ft3)	(l/m3)
847*	800	22.6	1,780	6,740	2.22	298
895*	4,160	118	7,200+	27,300	1.73	231
897*	10,300	291	33,000	12,500	3.20	428
900*	8,170	231	16,500	62,500	2.02	270
901++	4,225	120	3,000	11,400	0.71	94.9
894++	6,580	186	5,000	18,900	0.76	102
899++	1,110	31.4	10,000	37,800	9.01	1200
898++	5,000	142	2,750	10,400	0.55	73.5
701*	6,275	178	15,000	56,800	2.39	320
548*	10,000	238	14,000	53,000	1.40	187
693++	1,445	40.9	2,500	9,460	1.73	231
1076++	3,865	109	5,750	21,800	2.07	277
910++	1,040	29.4	3,000	11,400	2.88	385
547++	6,150	174	10,000	37,800	3.25	435
AVERAGE	4,940	137	9,250	32,300	1.87	236

* Achieving no discharge.

\+ Includes stormwater from treating area.

++ Discharges to a POTW

Plant and Wastewater Characteristics

Very little historical data on toxic pollutants in wastewater effluent were available from individual wood preserving plants. The source of the toxic pollutant data presented in this section is analytical results from verification sampling programs conducted by the Agency. Characteristics of wood preserving plants which were visited and sampled during the 1975 Pretreatment Study and during the BAT review study are presented in Table V-5 for steam conditioning plants and in Table V-6 for Boulton plants.

Data from three sampling and analytical programs comprise the verification data base and are presented in Tables V-7 through V-20. Data for plants sampled during the 1975 Pretreatment Study represent the average of two or more grab samples collected at each plant. Data for plants sampled during the 1977 and 1978 verification sampling programs represent the average of three 24-hour composite samples collected at each plant. Unless otherwise noted, the raw wastewater sampling point at each plant was immediately following gravity oil-water separation.

Pollutant concentrations and raw waste loads for individual plants are shown in Tables V-7 through V-19. Variations in pollutant concentrations from plant to plant can be attributed to the degree of emulsification of oils in the wastewater, the type of oily preservatives or carrier solution used, i.e., creosote in coal tar, creosote in oil, pentachlorophenol in oil, etc., and the amount of nonprocess wastewater added to the process wastewater stream, i.e., boiler blowdown, rainfall, steam condensate, etc.

Metals data are presented separately in Tables V-16 and V-17 for plants which treat with oily preservatives only, and in Tables V-18 and V-19 for plants which also treat with inorganic preservatives at the same facility. Increased concentrations and waste loads for heavy metals, particularly copper, chromium, and arsenic, are apparent for plants which treat with both types of preservatives. Although the inorganic treating operations at these plants are for the most part self contained and produce little or no wastewater, the process wastewater from the organic treating operations contains heavy metals. This "fugitive metal" phenomenon is the result of cross contamination between the inorganic and organic treating operations. Personnel, vehicles, and soil which come in contact with heavy metals from the inorganic treating operations can transport the metals into the organic treating area where rainfall washes them into collection sumps. Some plants may also alternate organic and inorganic charges in the same retort, causing cross contamination.

Plants which treat with inorganic salts only are not allowed to discharge process wastewater under previously published regulations either to a navigable waterway or to a POTW. All but a few of these plants recycle all their process water as dilution water for future batches of treating solution.

No plants treating with inorganic salts only were sampled during the verification sampling program. One such plant, however, was sampled once a week for one year in conjunction with the Pretreatment Study. The concentration range of COD, total phenols, heavy metals, fluoride, and nutrients found in the recycled wastewater at this plant are presented in Table V-20.

Table V-5. Characteristics of Wood-Preserving Steam Plants from which Wastewater Samples were Collected during 1975 Pretreatment Study, 1977 Verification Sampling Study, and 1978 Verification Sampling Study

Plant Number	Conditioning Process	Preservatives[1]	Treatment or Pretreatment[2]	Raw Flow (l/day)	Production (m^3/day)
173-a	Steaming	C,P,CCA	pH Adjustment, Flocculation, Chlorination, Sand Filtration	11,400	110
237-a	Steaming	C,P,CCA	pH Adjustment	7,570	142
267-a	Steaming	C,P	Flocculation	22,700	187
267-b	Steaming	C,P	Flocculation	28,800	164
267-c	Steaming	C,P	Flocculation, Sand Filtration	34,500	280
335-a	Steaming	C,CCA	Flocculation, pH Adjustment, Chlorination	6,430	96
499-a	Steaming	P,CCA	pH Adjustment	<950	55
547-a	Steaming	C,P	Oxidation Pond	94,600	226
548-b	Steaming	C	Aerated Lagoon, Oxidation Pond, Spray Evaporation	31,000	248*
548-c	Steaming	C,P	Aerated Lagoon, Oxidation Pond, Spray Evaporation	122,500	439
582-a	Steaming	C,P,CCA,FR	Flocculation	52,040	212
591-b	Steaming	C,P	Activated Sludge, Oxidation Ponds, Spray Irrigation	35,400	320
591-c	Steaming	C	Activated Sludge, Oxidation Ponds, Spray Irrigation	13,200	224

Table V-5. Characteristics of Wood-Preserving Steam Plants from which Wastewater Samples were Collected during 1975 Pretreatment Study, 1977 Verification Sampling Study, and 1978 Verification Sampling Study (Continued, page 2 of 2)

Plant Number	Conditioning Process	Preservatives[1]	Treatment or Pretreatment[2]	Raw Flow (l/day)	Production (m^3/day)
593-a	Steaming	C,P	Flocculation, Oxidation Pond, Lagoon, Sand Filtration for PCP Effluent	34,100	348
693-a	Steaming	C,P	Oxidation Pond, pH Adjustment	20,800	85
765-a	Steaming	C	Flocculation	18,900	76
897-c	Steaming, Vapor Drying	C,CCA	Aeration Ponds, Spray Irrigation, Sand Filtration	160,500†	515
898-a	Steaming	C,P	Oxidation Pond, Spray Evaporation	7,570	85
1076-a	Steaming	C,P	Flocculation	45,360	156
1100-b	Steaming	C,P	Secondary Oil Separation, Oxidation Pond, Spray Irrigation, Aerated Racetrack	236,600	461
1111-a	Vapor Drying	C	Flocculation, Sand Filtration, pH Adjustment, Aerated Lagoon, Oxidation Pond	94,600	198

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[1] Creosote (C), pentachlorophenol (P), salt-type preservatives (CCA, ACA, CZC), fire retardants (FR).

[2] All plants process wastewater through gravity-type separators.

* Information obtained from historical data supplied by plant.

† Figure includes rainfall runoff from large area.

a Data collected during 1975 Pretreatment Study.

b Data collected during 1977 Verification Sampling Study.

c Data collected during 1978 Verification Sampling Study.

Table V-6. Characteristics of Wood Preserving Boulton Plants from which Wastewater Samples were Collected during 1975 Pretreatment Study, 1977 Verification Sampling Study, and 1978 Verification Sampling Study

Plant Number	Conditioning Process	Preservatives[1]	Treatment or Pretreatment[2]	Raw Flow (l/day)	Production (m^3/day)
65-a	Boulton	C,P,CZC,FR	Flocculation	18,900	142
65-c	Boulton	P,CZC,FR	Inline Flocculation, Secondary Oil Separation, Gravel Filtration	8,330	78
67-b	Boulton	P	Evaporation Tower	28,400	62
1078-a	Boulton	C,P,ACA,FR	Secondary Oil Separation, Oil Adsorbing Media	26,500	283
1078-b	Boulton	C,P,ACA,FR	Secondary Oil Separation, Oil Adsorbing Media	57,900	308

[1] Creosote (C), pentachlorophenol (P), salt-type preservatives (CCA, ACA, CZC), fire retardants (FR).
[2] All plants process wastewater through gravity-type separators.
a Data collected during 1975 Pretreatment Study.
b Data collected during 1977 Verification Sampling Study.
c Data collected during 1978 Verification Sampling Study.

Table V-7. Wood Preserving Traditional Parameter Data

Plant Number	Data Source	Flow (gal/day)	Prod. (ft^3/day)	STEAM Raw Concentrations (mg/l) Total Phenols	PCP	O+G	COD	Raw Wasteloads (lb/1,000 ft^3) Total Phenols	PCP	O+G	COD
173††	PS '75	3000	3880	10.8	306.0	1755	10460	0.0697	1.97	11.3	67.4
237	PS '75	2000	5000	302.4	49.0	979.2	3593	1.01	0.163	3.27	12.0
267††	PS '75	6000	6600	69.2	34.5	718.5	6377	0.525	0.262	5.45	48.3
267††	ESE '77	7600	5800	40.0	6.29	1902	8979	0.437	0.0687	20.8	98.1
267*	ESE '78	9120	9890	14.9	16.0	143	14600				
267†	ESE '78	9120	9890	8.17	25.0	68.0	14300				
335††	PS '75	1700	3400	334.4	--	32.2	2457	1.39	<0.0001	0.134	10.2
547**	PS '75	25000	8000	62.1	35.4	518.0	7079	1.62	0.923	13.5	184.5
548***	ESE '77	8200	8760	45.0	158.0	927.0	3706	0.351	1.23	7.24	28.9
548***	ESE '78	32260	15500	0.640	9.49	351.3	2806	0.011	0.165	6.10	48.7
582††	PS '75	13750	7500	101.3	26.7	1785	15273	1.55	0.408	27.3	233.5
591***	ESE '77	9350	11300	237.5	22.3	474.0	3010	1.64	0.154	3.27	20.8
591***	ESE '78	3500	7920	22.0	1.20	17	3200	0.0811	0.0044	0.0627	11.8
593**	PS '75	9000	12300	335.3	47.9	1365	8880	2.05	0.292	8.33	54.2
693	PS '75	5500	3000	32.3	18.0	536.3	3079	0.494	0.275	8.20	47.1
765††	PS '75	5000	2700	501.3	--	732.8	15694	7.74	<0.0001	11.3	242
897***	ESE '78	42400	18200	49.0	2.70	460	1900	0.952	0.0525	8.94	36.9
898**	PS '75	2000	3000	292.4	50.3	773.0	7116	1.63	0.280	4.30	39.6
1100	ESE '77	62500	16300	34.3	57.1	950.2	8844	1.10	1.83	30.4	283
1111***	PS '75	25000	7000	383.3	--	11.0	1356	11.4	<0.0001	0.328	40.4
Average Wasteloads								1.89	0.539	9.46	83.7

NA: Not Analyzed.

-- Hyphen denotes that parameter was analyzed for but was below detection limit.

* Data from creosote separator (wasteloads cannot be calculated since flow measurements for the individual separators were unobtainable). Not included in averages.

† Data from PCP separator (wasteloads cannot be calculated since flow measurements for the individual separators were unobtainable). Not included in averages.

** Plants used to calculate raw averages in Table VII-35.

†† Plants used to calculate raw averages in Table VII-36.

*** Plants used to calculate raw averages in Table VII-37.

Table V-8. Wood Preserving Traditional Parameter Data

				BOULTON									
				Raw Concentrations (mg/l)					Raw Wasteloads (lb/1,000 ft^3)				
Plant Number	Data Source	Flow (gal/day)	Prod. (ft^3/day)	Total phenols	PCP	O+G	COD	TSS	Total phenols	PCP	O+G	COD	TSS
65*	PS '75	5000	5000	184.0	5.70	34.7	1711	NA	1.53	0.0475	0.289	14.3	NA
65*	ESE '78	2200	2770	0.910	27.0	164	520	81	0.0060	0.179	1.09	3.44	0.537
67	ESE '77	7500	2200	—	—	1357	7316	NA	<0.0001	<0.0001	38.6	208.0	NA
1078*	PS '75	7000	10000	508.6	0.01	12.3	3704	NA	2.97	0.0001	0.0718	21.6	NA
1078*	ESE '77	15300	10900	1272	—	39.4	5797	NA	14.9	<0.0001	0.461	67.9	NA
									<3.88	<0.0454	8.10	63.0	0.537

NA: Not Analyzed.

* Plants used to calculate raw averages in Table VII-36.

— Hyphen denotes that parameter was analyzed for but was below detection limit.

Table V-9. Wood Preserving VOA Data

				Raw Concentrations (mg/l)					Raw Wasteloads (lb/1000 ft^3)				
Plant Number	Data Source	Flow (gal/day)	Prod. (ft^3/day)	mecl	trclme	benzene	etbenzene	toluene	mecl	trclme	benzene	etbenzene	toluene
STEAM													
267*	ESE '78	9120	9890	0.006	--	0.003	0.037	0.027					
267†	ESE '78	9120	9890	--	--	0.013	0.170	0.170					
548††	ESE '78	32360	15500	0.702	--	1.05	0.867	2.84	0.0122	<0.0001	0.0183	0.0151	0.0495
591††	ESE '78	3500	7920	0.280	0.020	2.80	2.10	3.20	0.0010	0.0001	0.0103	0.0077	0.0118
895††	ESE '78	42400	18200	0.077	--	>1.62	0.380	0.500	0.0015	<0.0001	>0.0315	0.0074	0.0097
Wasteload Averages									0.0049	<0.0001	>0.0200	0.0101	0.0237
BOULTON													
154**	ESE '78	2200	2770	2.60	0.009	--	--	--	0.0172	<0.0001	<0.0001	<0.0001	<0.0001

* Data from creosote separator (wasteloads cannot be calculated since flow measurements for the individual separators were unobtainable). Not included in averages.

† Data from PCP separator (wasteloads cannot be calculated since flow measurements for the individual separators were unobtainable). Not included in averages.

** Plant uses methylene chloride as a carrier solvent in a proprietary treatment process. Not included in averages.

†† Plants used to calculate raw averages in Table VII-38.

-- Hyphen denotes that parameter was analyzed for but was below detection limit.

Table V-10. Substances Analyzed for but Not Found in Volatile Organic Fractions During 1978 Verification Sampling

vinyl chloride
chloroethane
chloromethane
bromomethane
tribromomethane
bromodichloromethane
dibromochloromethane
carbon tetrachloride
dichlorodifluoromethane
trichlorofluoromethane
1,2-dichloroethane
1,1-dichloroethane
1,1,1-trichloroethane
1,1,2-trichloroethane
tetrachloroethane
1,1-dichloroethylene
trans 1,2-dichloroethylene
tetrachloroethylene
trichloroethylene
1,2-dichloropropane
1,3-dichloropropylene
Bis-chloromethylether
Bis-chloroethylether
2-chloroethylvinylether
acrolein
acrylonitrile

The average detection limit for these compounds is 10 ug/l.

Table V-11. Wood Preserving Base Neutrals Data

Plant Number	Data Source	Flow (gal/day)	Prod. (ft^3/day)	Raw Waste Concentrations (mg/l) 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
											STEAM								
267	ESE '77	7600	5800	1.27	--	--	0.816	--	--	--	6.72	0.111	--	0.378	1.30	1.01	2.31	0.065	0.126
267*	ESE '78	9120	9890	35.0	0.087	--	22.0	0.043	0.130	--	14.0	7.70	--	45.0	55.0	1.20	48.0	4.70	--
267**	ESE '78	9120	9890	4.80	--	--	3.40	--	--	--	18.0	2.40	--	17.0	10.0	--	8.40	--	--
548	ESE '77	8200	8760	0.633	0.027	0.027	0.360	0.007	--	--	2.52	0.067	--	2.20	1.06	1.21	0.82	0.073	0.437
548	ESE '78	32360	15500	6.43	1.68	1.68	4.85	1.35	0.490	0.315	11.5	1.33	--	31.0	4.36	0.526	3.59	1.43	--
591	ESE '77	9350	11300	0.870	--	0.017	0.644	--	--	--	1.95	0.157	--	0.970	1.46	0.933	1.01	0.246	0.087
591	ESE '78	3500	7920	17.0	--	3.90	13.0	2.70	5.50	0.006	39.0	7.40	0.430	34.7	15.0	1.10	11.0	--	--
897	ESE '78	42400	18200	1.60	0.350	0.350	1.10	0.420	0.006	0.006	6.50	--	--	>3.47	1.70	0.006	1.50	0.930	--
1100	ESE '77	62500	16300	0.636	--	--	0.502	--	--	--	2.96	0.094	--	0.464	1.11	0.725	1.11	0.098	0.201
											BOULTON								
65***	ESE '78	2200	2770	--	--	--	--	--	--	--	0.920	--	--	--	--	--	--	--	--
67***	ESE '77	6550	2200	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.433
1078	ESE '77	15300	10900	0.282	--	--	0.194	--	--	--	1.51	0.034	--	3.14	2.83	2.06	0.824	0.018	1.46

* Data from creosote separator (wasteloads cannot be calculated since flow measurements for the individual separators were unobtainable. Not included in averages.

** Data from PCP separator (wasteloads cannot be calculated since flow measurements for the individual separators were unobtainable. Not included in averages.

*** These plants were treating solely with PCP and not creosote formulations during the sampling period.

-- Hyphen denotes that parameter was analyzed for but was below detection limit.

Key to Base Neutral Data Tables

1. Fluoranthene
2. Benzo (B) Fluoranthene
3. Benzo (k) Fluoranthene
4. Pyrene
5. Benzo (A) Pyrene
6. Indero (1, 2, 3-CD) Pyrene
7. Benzo (ghi) Perylene
8. Phenanthrene and/or Anthracene
9. Benzo (a) Anthracene
10. Dibenzo (a, h) Anthracene
11. Naphthalene
12. Acenaphthene
13. Acenaphthylene
14. Fluorene
15. Chrysene
16. Bis-2-ethyl-hexyl phthalate

Table V-12. Wood Preserving Base Neutrals Data

Plant Number	Data Source	Flow (gal/day)	Prod. (ft^3/day)	Raw Waste Loads (lb/1,000 ft^3)															
				1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
				STEAM															
267†	ESE '77	7600	5800	0.0139	<0.0001	<0.0001	0.0089	<0.0001	<0.0001	<0.0001	0.0734	0.0012	<0.0001	0.0041	0.0142	0.0110	0.0252	0.0007	0.0014
548	ESE '77	8200	8760	0.0049	0.0002	0.0002	0.0028	0.0001	<0.0001	<0.0001	0.0197	0.0005	<0.0001	0.0172	0.0083	0.0094	0.0064	0.0006	0.0034
548**	ESE '78	32360	15500	0.112	0.0293	0.0293	0.0844	0.0235	0.0085	0.0055	0.200	0.0232	<0.0001	0.540	0.0759	0.0092	0.0611	0.0249	<0.0001
591**	ESE '77	9350	11300	0.0060	<0.0001	0.0001	0.0044	<0.0001	<0.0001	<0.0001	0.0135	0.0011	<0.0001	0.0067	0.0101	0.0064	0.0070	0.0017	0.0006
591**	ESE '78	3500	7920	0.0627	<0.0001	0.0144	0.0479	0.0100	0.0203	<0.0001	0.144	0.0273	0.0016	0.128	0.0553	0.0041	0.0405	<0.0001	<0.0001
897**	ESE '78	42400	18200	0.0311	0.0068	0.0068	0.0214	0.0082	0.0001	0.0001	0.126	<0.0001	<0.0001	>0.0674	0.0330	0.0001	0.0291	0.0181	<0.0001
1100	ESE '77	62500	16300	0.0203	<0.0001	<0.0001	0.0161	<0.0001	<0.0001	<0.0001	0.0947	0.0030	<0.0001	0.0148	0.0355	0.0232	0.0355	0.0031	0.0064
Wasteload Averages				0.0358	<0.0052	<0.0073	0.0266	<0.0060	<0.0042	<0.0009	<0.0959	<0.0081	<0.0003	>0.111	0.0332	0.0091	0.0292	0.0070	<0.0017
				BOULTON															
65*†	ESE '78	2200	2770	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	0.0061	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
67*	ESE '77	6550	2200	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	0.0108
1078†	ESE '77	15300	10900	0.0033	<0.0001	<0.0001	0.0023	<0.0001	<0.0001	<0.0001	0.0177	0.0004	<0.0001	0.0368	0.0331	0.0241	0.0096	0.0002	0.0171
Wasteload Averages				<0.0012	<0.0001	<0.0001	<0.0008	<0.0001	<0.0001	<0.0001	<0.0008	<0.0002	<0.0001	<0.0123	<0.0111	<0.0081	<0.0033	<0.0001	<0.0093

* These plants were treating solely with PCP and not creosote formulations during the sampling period.
† Plants used to calculate raw averages in Table VII-39.
** Plants used to calculate raw averages in Table VII-40.

Key to Base Neutral Data Tables

1. Fluoranthene
2. Benzo (B) Fluoranthene
3. Benzo (k) Fluoranthene
4. Pyrene
5. Benzo (A) Pyrene
6. Indero (1, 2, 3-CD) Pyrene
7. Benzo (ghi) Perylene
8. Phenanthrene and/or Anthracene
9. Benzo (a) Anthracene
10. Dibenzo (a, h) Anthracene
11. Naphthalene
12. Acenaphthene
13. Acenaphthylene
14. Fluorene
15. Chrysene
16. Bis-2-ethyl-hexyl phthalate

Table V-13. Substances Not Found in Base Neutral Fractions During 1977 and 1978 Verification Sampling

2-chloronaphthalene
diethylphthalate
di-n-butylphthalate
butylbenzylphthalate
dimethylphthalate
4-chlorophenyl-phenylether
bis(2-chloroisopropyl) ether
bis(2-chloroethoxy) methane
4-bromophenyl phenylether
N-nitrosodimethylamine
N-nitrosodi-n-propylamine
N-nitrosodiphenylamine
1,2-dichlorobenzene
1,3-dichlorobenzene
1,4-dichlorobenzene
1,2,4-trichlorobenzene
hexachlorobenzene
2,6-dinitrotoluene
2,4-dinitrotoluene
benzidine
3,3'-dichlorobenzidine
nitrobenzene
hexachlorobutadiene
hexachlorocyclopentadiene
hexachloroethane
isophorone
1,2-diphenylhydrazine
2,3,7,8-tetrachlorodibenzo-p-dioxin

The average detection limit for these compounds is 10 ug/l.

Table V-14. Wood Preserving Toxic Pollutant Phenols Data

Plant Number	Data Source	Flow (gal/day)	Prod. (ft^3/day)	Raw Concentrations (mg/l)					Raw Wasteloads (lb/1,000 ft^3)				
				phen	2-clphen	2,4-dimeph	2,4,6-triclph	PCP	phen	2-clphen	2,4-dimeph	2,4,6-triclph	PCP
						STEAM							
173**	PS '75	3000	3880	NA	NA	NA	NA	306.0	NA	NA	NA	NA	1.97
237	PS '75	2000	5000	NA	NA	NA	NA	49.0	NA	NA	NA	NA	0.163
267**	PS '75	6000	6600	NA	NA	NA	NA	34.5	NA	NA	NA	NA	0.262
267**	ESE '77	7600	5800	NA	NA	NA	NA	6.3	NA	NA	NA	NA	0.0688
267*	ESE '78	9120	9890	9.20	—	—	—	16.0					
267†	ESE '78	9120	9890	1.40	—	—	—	25.0					
547	PS '75	25000	8000	NA	NA	NA	NA	24.3	NA	NA	NA	NA	0.633
548††	ESE '77	8200	8760	NA	NA	NA	NA	158.0	NA	NA	NA	NA	1.23
548††	ESE '78	32360	15500	24.4	0.042	0.130	0.252	9.41	0.425	0.0007	0.0023	0.0044	0.164
582**	PS '75	13750	7500	NA	NA	NA	NA	26.7	NA	NA	NA	NA	0.408
591††	ESE '77	9350	11300	NA	NA	NA	NA	22.3	NA	NA	NA	NA	0.154
591††	ESE '78	3500	7920	87.0	—	6.60	—	1.20	0.321	<0.0001	0.0243	<0.0001	0.0044
593	PS '75	9000	12300	NA	NA	NA	NA	47.8	NA	NA	NA	NA	0.292
693	PS '75	5500	3000	NA	NA	NA	NA	17.9	NA	NA	NA	NA	0.274
897††	ESE '78	42400	18200	16.0	0.015	5.50	0.533	2.70	0.311	0.0003	0.107	0.0104	0.0525
898	PS '75	2000	3000	NA	NA	NA	NA	50.3	NA	NA	NA	NA	0.769
1100	ESE '77	62500	16300	NA	NA	NA	NA	57.1	NA	NA	NA	NA	1.83
Wasteload Averages									0.352	<0.0004	0.0445	<0.0050	0.552
						BOULTON							
65**	PS '75	5000	5000	NA	NA	NA	NA	5.70	NA	NA	NA	NA	0.0475
65**	ESE '78	2200	2770	0.071	—	—	—	27.0	0.0066	<0.0001	<0.0001	<0.0001	0.179
1078**	PS '75	7000	10000	NA	NA	NA	NA	0.09	NA	NA	NA	NA	0.0005
Wasteload Averages									0.0066	<0.0001	<0.0001	<0.0001	0.0757

-- Hyphen denotes that parameter was analyzed for but was below detection limit.

* Data from creosote separator (wasteloads cannot be calculated since flow measurements for the individual separators were unobtainable). Not included in averages.

† Data from PCP separator (wasteloads cannot be calculated since flow measurements for the individual separators were unobtainable). Not included in averages.

** Plants used in calculating averages in Table VII-41.

†† Plants used in calculating averages in Table VII-42.

Table V-15. Toxic Pollutant Phenols Analyzed for But Not Found During 1978 Verification Sampling

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2-nitrophenol
4-nitrophenol
2,4-dichlorophenol
2,4-dinitrophenol
para-chloro-meta-cresol
4,6-dinitro-ortho-cresol

The average detection limit for these compounds is 25 ug/l.

Table V-16. Wood Preserving Metals Data--Plants Which Treat With Organic Preservatives Only

Plant	Source	Flow (GPD)	Prod. (ft^3/day)	RAW CONCENTRATIONS (mg/l)												
				Arsenic	Antimony	Beryllium	Cadmium	Copper	Chromium	Lead	Mercury	Nickel	Selenium	Silver	Thallium	Zinc
67	ESE '77	7500	2200	0.007	0.003	--	--	1.60	0.009	0.005	0.0037	0.210	0.003	0.001	0.002	0.843
267	ESE '78*	9120	9890	0.093	--	0.012	0.010	0.850	0.064	0.052	--	0.028	--	0.006	0.010	0.370
267	ESE '78**	9120	9890	0.033	0.003	0.019	0.008	0.610	0.098	0.071	--	0.150	--	0.005	--	0.820
267	ESE '77	7600	5800	0.003	--	--	--	0.125	0.001	0.007	--	0.005	0.001	--	0.001	0.309
548	ESE '78	32260	15500	14.2	0.047	--	0.001	0.041	0.023	0.091	0.0011	0.015	0.001	--	--	0.119
548	ESE '77	8200	8760	0.009	0.002	--	--	0.008	0.007	0.009	--	0.006	0.001	--	0.001	0.177
591	ESE '78	3500	7920	0.086	0.007	--	0.003	0.031	0.007	0.011	0.0011	0.016	0.007	--	--	0.180
591	ESE '77	9350	11300	0.003	0.001	--	--	0.150	0.001	0.001	--	0.003	0.001	--	0.001	0.350
1100	ESE '77	62500	16300	0.006	--	--	0.001	0.180	0.023	0.014	--	0.135	0.002	--	0.004	0.627

* From Creosote Separator.

** From PCP Separator.

-- Hyphen denotes that parameter was analyzed for but was below detection limit.

Table V-17. Wood Preserving Metals Data--Plants Which Treat With Organic Preservatives Only

				RAW WASTELOADS (lb/1,000 ft^3)												
Plant	Source	Flow (GPD)	Prod. (ft^3/day)	Arsenic	Antimony	Beryllium	Cadmium	Copper	Chromium	Lead	Mercury	Nickel	Selenium	Silver	Thallium	Zinc
67	ESE '77	7500	2200	0.0002	0.00009	<0.00001	<0.00001	0.0465	0.0003	0.0001	0.00011	0.00597	0.00009	0.00003	0.00006	0.0240
267*	ESE '77	7600	5800	0.00003	<0.00001	<0.00001	<0.00001	0.00137	0.00001	0.00008	<0.00001	0.00005	0.00001	<0.00001	0.00001	0.00338
548†	ESE '78	32260	15,500	0.246**	0.00082	<0.00001	0.00002	0.00071	0.00040	0.0016	0.00002	0.00026	0.00002	<0.00001	<0.00001	0.00207
548†	ESE '77	8200	8760	0.00007	0.00002	<0.00001	<0.00001	0.00006	0.00005	0.00007	<0.00001	0.00005	0.00001	<0.00001	0.00001	0.00138
591†	ESE '78	3500	7920	0.00032	0.00003	<0.00001	<0.00001	0.00011	0.00003	0.00004	<0.00001	0.00006	0.00003	<0.00001	<0.00001	0.00066
591†	ESE '77	9350	11300	0.00002	0.00001	<0.00001	<0.00001	0.00104	0.00001	0.00001	<0.00001	0.00002	0.00001	<0.00001	0.00001	0.00242
1100	ESE '77	62500	16300	0.0002	<0.00001	<0.00001	0.00003	0.00576	0.00074	0.00045	<0.00001	0.00432	0.00006	<0.00001	0.00013	0.0201
Average Wasteloads				0.0353	0.00014	<0.00001	<0.00001	0.00794	0.0002	0.00034	<0.00001	0.00153	0.00003	<0.00001	<0.00003	0.00772

* Plant used in calculating raw averages in Table VII-43.

† Plants used in calculating raw averages in Table VII-44.

** Not used in calculating raw averages due to the high background levels of arsenic in the raw water intake.

Table V-18. Wood Preserving Metals Data--Plants Which Treat With Both Organic and Inorganic Preservatives

Plant	Source	Flow (GPD)	Prod. (ft^3/day)	Raw Concentrations (mg/l)												
				Arsenic	Antimony	Beryllium	Cadmium	Copper	Chromium	Lead	Mercury	Nickel	Selenium	Silver	Thallium	Zinc
65	ESE '78	2200	2770	0.014	0.013	0.002	0.005	0.110	3.90	0.014	0.0002	0.020	0.053	0.001	--	26.0
65	PS '75	5000	5000	--	NA	NA	NA	0.060	13.9	NA	NA	NA	NA	NA	NA	78.2
237	PS '75	2000	5000	0.050	NA	NA	NA	0.700	0.440	NA	NA	NA	NA	NA	NA	NA
335	PS '75	1700	3400	0.250	NA	NA	NA	2.30	0.780	NA	NA	NA	NA	NA	NA	NA
499	PS '75	<100	1950	1.00	NA	NA	NA	3.91	1.23	NA	NA	NA	NA	NA	NA	NA
582	PS '75	13750	7500	0.040	NA	NA	NA	0.600	NA	NA	NA	NA	NA	NA	NA	NA
897	ESE '78	42400	18,200	0.130	--	--	0.001	0.079	0.023	0.016	0.0013	0.100	--	--	--	0.120
1078	ESE '77	15300	10,900	0.003	--	--	--	0.080	0.004	0.001	0.0002	0.094	0.002	0.002	0.001	0.321
1078	PS '75	7000	10,000	--	NA	NA	NA	0.430	--	NA	NA	NA	NA	NA	NA	0.780

NA Not analyzed for.

-- Hyphen denotes that parameter was analyzed for but was below detection limit.

Table V-19. Wood Preserving Metals Data--Plants Which Treat With Both Organic and Inorganic Preservatives

Plant	Source	Flow (GPD)	Prod. (ft^3/day)	Raw Wasteloads (lb/1,000 ft^3)												
				Arsenic	Antimony	Beryllium	Cadmium	Copper	Chromium	Lead	Mercury	Nickel	Selenium	Silver	Thallium	Zinc
65†	ESE '78	2200	2770	0.00009	0.00009	0.00001	0.00003	0.00073	0.0258	0.00009	<0.00001	0.00013	0.00035	0.00001	<0.00001	0.172*
65†	PS '75	5000	5000	<0.00001	NA	NA	NA	0.00050	0.116*	NA	NA	NA	NA	NA	NA	0.652*
237	PS '75	2000	5000	0.00017	NA	NA	NA	0.00234	0.00147	NA	NA	NA	NA	NA	NA	NA
335†	PS '75	1700	3400	0.00104	NA	NA	NA	0.00959	0.00325	NA	NA	NA	NA	NA	NA	NA
499††	PS '75	<100	1950	0.00043	NA	NA	NA	0.00167	0.00053	NA	NA	NA	NA	NA	NA	NA
582†	PS '75	13750	7500	0.00061	NA	NA	NA	0.00917	NA	NA	NA	NA	NA	NA	NA	NA
897**	ESE '78	42400	18200	0.00253	<0.00001	<0.00001	0.00002	0.0015	0.00045	0.00031	0.00003	0.00194	<0.00001	<0.00001	<0.00001	0.00233
1078†	ESE '77	15300	10900	0.00004	<0.00001	<0.00001	<0.00001	0.00094	0.00005	0.00001	<0.00001	0.0011	0.00002	0.00002	0.00001	0.00376
1078†	PS '75	7000	10000	<0.00001	NA	NA	NA	0.00251	<0.00001	NA	NA	NA	NA	NA	NA	0.00455
Average Wasteloads				<0.00055	<0.00004	<0.00001	<0.00002	0.0032	<0.00451	0.00014	<0.00002	0.0011	<0.00013	<0.00001	<0.00001	0.0457

NA Not analyzed for.
* Not used in calculation of averages because the process involves direct metals contamination of wastewater.
† Plants used in calculating raw averages in Table VII-46.
** Plants used in calculating raw averages in Table VII-47.
†† Plants used in calculating raw averages in Table VII-45.

Table V-20. Range of Pollutant Concentrations in Wastewater from a Plant Treating with CCA- and FCAP-Type Preservatives and a Fire Retardant

Parameter	Concentration Range (mg/liter)
COD	10-50
As	13-50
Total Phenols	0.005-0.16
Cu	.05-1.1
Cr+6	0.23-1.5
Cr+3	0-0.8
F	4-20
PO_4	15-150
NH_3-N	80-200
pH	5.0-6.8

Source of Data: Pretreatment Document

Design for Model Plant

Table V-21 presents the design criteria for the wood preserving model plants. These criteria were used as a basis of estimating capital, operating, and energy costs for the model plants which are presented in Appendix A of this document.

The flow characteristics of these model plants are based on average historical unit flows for Boulton and closed steaming plants as presented in Tables V-1 and V-2. Pollutant concentrations are based on average data presented in Table V-7.

Model plant wastewater characteristics for plants which use solely inorganic preservatives are not presented in this document because, under existing BPT, BAT, NSPS, PSNS, PSES regulations, this subcategory is subject to no discharge of process wastewater limitations and standards. The technology to achieve no discharge is available for complete recycling of effluents from these plants and was costed previously.

INSULATION BOARD

Insulation board plants responding to the data collection portfolio reported fresh water usage rates ranging from 95,000 to 5,700,000 liters per day for process water (0.025 to 1.5 MGD). One insulation board plant, 108, which also produces hardboard in approximately equal amounts, uses over 15 million liters per day (4 MGD) of fresh water for process water.

Water becomes contaminated during the production of insulation board primarily through contact with the wood during fiber preparation and forming operations, and the vast majority of pollutants are fine wood fibers and soluble wood sugars and extractives.

The process whitewater used to process and transport the wood from the fiber preparation stage through mat formation accounts for over 95 percent of a plant's total wastewater discharge (excluding cooling water). The water produced by the dewatering of stock at any stage of the process is usually recycled to be used as stock dilution water. However, as a result of the build up of suspended solids and dissolved organic material, which can cause undesirable effects in the board, there may be a need to bleed off a quantity of excess process whitewater. Various additives used to improve the characteristics of the board also enter the process whitewater and contribute to the waste load.

Specifically, potential sources of wastewater in an insulation board plant include:

Chip wash water
Process whitewater generated during fiber preparation
  (refining and washing)

Table V-21. Raw Waste Characteristics of Wood Preserving Model Plants

Plant	Production (cu ft)	Unit Flow (gal/cu ft)	Process Wastewater Flow (gpd)	Area of Cylinders & Work Tank (sq ft)	Annual Rainfall (in)	Process Contaminated Runoff (gpd)	Design Wastewater Flow (gpd)	COD (mg/1)	Oil & Grease (mg/1)	Total Phenols (mg/1)
Boulton Model Plant 1	3,200	1.03	3,300	6,000	45	460	4,000	4,000	300	500
Boulton Model Plant 2	8,000	1.03	8,240	20,000	45	1,540	10,000	4,000	300	500
Steam Model Plant 3	6,000	0.45	2,700	6,000	50	510	3,250	6,000	800	175
Steam Model Plant 4	15,000	0.45	6,750	20,000	50	1,710	8,500	6,000	800	175

Process whitewater generated during forming
Wastewater generated during miscellaneous operations
(dryer washing, finishing, housekeeping, etc.)

Chip Wash Water

Water used for chip washing is capable of being recycled to a large extent. A minimal makeup of approximately 400 liters per metric ton (95 gallons per ton) is required in a closed system because of water leaving with the chips and with sludge removed from settling tanks. Water used for makeup in the chip washer may be fresh water, cooling water, vacuum seal water from in-plant equipment, or recycled process water. Chip wash water, when not fully recycled, contributes to the raw waste load of an insulation board plant. Insulation board plants 108, 537, 979, 943, 977, and 1035 indicated in the response to the data collection portfolio that chip washing is done. Plants 943 and 1035 fully recycle chip wash water.

Fiber Preparation

The fiber preparation or refiner whitewater system is considered to be the water used in the refining of stock up to and including the dewatering of stock by a decker or washer. As previously discussed, there are three major types of fiber preparation in the insulation board industry: (1) stone groundwood; (2) mechanical disc refining (refiner groundwood); and (3) thermomechanical disc refining. The water volume required by each of the three methods is essentially the same. In the general case, the wood enters the refining machine at approximately 50 percent moisture content. During the refining operation, the fiber bundles are diluted with either fresh water or recycled whitewater to a consistency of approximately 1 percent solids prior to dewatering to about 15 percent solids at the decker or washer. The water which results from the stock washing or deckering operation is rich in organic solids dissolved from the wood during refining and is referred to as refiner whitewater. This water may be combined with whitewater produced during forming, the machine whitewater (for further use in the system), or it may be discharged from the plant as wastewater.

Forming

After the dewatered stock leaves the decker at approximately 15 percent consistency, it must again be diluted to a consistency of approximately 1.5 percent to be suitable for machine forming. This requires a relatively large quantity of recycled process whitewater or fresh water. The redilution of stock is usually accomplished in a series of steps to allow consistency controls and more efficient dispersion of additives, and to reduce the required stock pump and storage capacities. The stock usually receives an initial dilution to approximately 5 percent consistency, then to 3 percent, and finally, just prior to mat formation, to approximately 1.5 percent.

During the mat formation stage of the insulation board process, the diluted stock is dewatered at the forming machine to a consistency of approximately 40 to 45 percent. The water drained from the stock during formation is referred to as machine whitewater. Water from the machine whitewater system may be recycled for use as stock dilution water or for use in the refining operations. Excess machine whitewater may be discharged as wastewater.

Miscellaneous Operations

While the majority of wastewater generated during insulation board production occurs during fiber preparation and mat formation operations, various other operations may contribute to the overall raw waste load.

Drying--The boards leaving the forming machine with a consistency of approximately 40 percent are dried to a consistency of greater than 97 percent in the dryers. This water is evaporated to the atmosphere. It is occasionally necessary to remove wood dust from the dryers to reduce fire danger and to maintain proper energy utilization. This produces a minor wastewater stream in most operations.

Finishing--After the board leaves the dryer, it is usually sanded and trimmed to size. The dust from the sanding and trim saws is often controlled by dust collectors of a wet scrubber type, and the water supplied to the scrubbers is sometimes excess process water; however, fresh water is occasionally used. This water is usually returned to the process with the dust.

Plants that produce coated products such as ceiling tile usually paint the board after it is sanded and trimmed. Paint composition will vary with both plant and product; however, most plants utilize a water-based paint. The resulting washup contributes to the wastewater stream or is metered to the process whitewater system. In addition, there are sometimes imperfect batches of paint mixed which are discharged to the wastewater stream or metered to the process whitewater system.

Broke System--Reject boards and trim are reclaimed as fiber and recycled by placing the waste board and trim into a hydropulper and producing a reusable fiber slurry. While there is need for a large quantity of water in the hydropulping operation, it is normally recycled process water. There is normally no water discharged from this operation.

Other Sources--Other potential sources of wastewater in an insulation board plant include water used for screen washing, fire control, and general housekeeping. The water used for washing screens in the forming and decker areas usually enters the process whitewater system. Housekeeping water varies widely from plant to plant depending on plant operation and many other factors. While wastewater can result from water used to extinguish dryer fires, it is an infrequent and intermittent source of wastewater.

Wastewater Characteristics

The major portion of insulation board wastewater pollutants results from leachable materials from the wood and materials added during the production process. If a chip washer is used, a portion of the solubles is leached into the chip wash water. A small fraction of the raw waste load results from cleanup and finishing operations; however, these operations appear to have little influence on the overall raw waste load. The finishing wastewater in some plants is metered back into the process water with no reported adverse effects.

Process whitewater, accounting for over 95 percent of the waste load and flow from a typical insulation board plant, is characterized by high quantities of BOD (900 to 7,500 mg/l) and suspended solids (500 to 4,000 mg/l).

The four major factors affecting process wastewater quality are: (1) the extent of steam pretreatment; (2) the types of products produced; (3) raw material species; and (4) the extent of whole tree chips, forest residue, and bark in the raw material.

The major source of dissolved organic material is the wood raw material. From 1 to 8 percent (on a dry weight basis) of wood is composed of water-soluble sugars stored as residual sap and, regardless of the type of refining or pretreatment utilized, these sugars form a major source of BOD and COD. Steam conditioning of the furnish during thermomechanical refining greatly increases the amount of wood sugars and hemicellulose decomposition products entering the process whitewater. The use of steam under pressure during thermomechanical refining is the predominant factor in the increased raw waste loads of plants which employ this refining method.

Back and Larsson (1972) observe that, basically, two phenomena occur during heating of the wood raw material under pressure: the physically reversible thermal softening of the lignin and hemicellulose, and time dependent chemical reactions in which hemicellulose undergoes hydrolysis and produces oligosaccharides (short chained, water soluble wood sugars, including disaccharides). In addition, hydrolysis of the acetyl groups forms acetic acid. The resulting lowered pH causes an increase in the rate of hydrolysis. Thus, the reactions can be said to be autocatalytic. For this reason, the reaction rates are difficult to calculate. Rough estimations indicate that the reaction rates double when an increase in temperature of 8°C to 10°C has been made.

Figure V-1 demonstrates the increased BOD loading which results from increasingly severe cooking conditions.

Dallons (1976) has noted that the amount of BOD increases because of cooking conditions which varies with wood species. Hardwoods contain a greater percentage of potentially soluble material than do softwoods. The effect of species variations on raw waste load is less important than the degree of steaming to which the furnish is subjected.

Two insulation board plants, 108 and 1035, presented limited information concerning the effects of whole tree chips, forest residue, and bark in wood furnish on raw waste load. Plant 36, which has the highest raw waste loads of all the mechanical refining insulation board data collection portfolio respondents, uses whole tree chips (pine) for the majority of the wood furnish. While the use of whole tree chips, residue, and bark results in some increase in raw waste loadings, information currently available is not sufficient to justify a subcategorization scheme based on raw material.

While the larger portion of the BOD in the process wastewater is a result of organics leaching from the wood, a significant portion results from additives. Additives vary in both type and quantity according to the type of product being produced.

The three basic types of board products sheathing, finished tile (ceiling tile, etc.), and hardboard (including medium density siding) receive various amounts of additives. Sheathing contains up to 25 percent additives which include asphalt, alum, starch, and size (either wax or rosin). Finished tile contains up to 10 percent additives which are the same as those used in sheathing, with the exception of asphalt. Hardboard contains up to 11 percent additives including organic resins, as well as emulsions and tempering agents such as tall oil. Therefore, the process wastewater will contain not only leachates from the wood and fibers, but also the portion of the additives not retained in the product.

Maximum retention of additives in the product is advantageous from both production cost and wastewater standpoints. Several retention aids are marketed--the most common of which are alum, ferric salts, and synthetic polyelectrolytes.

Raw Waste Loads

Tables V-22 and V-23 summarize the raw wastewater characteristics of those insulation board plants which provided raw waste monitoring data in response to the data collection portfolio. Data presented in Tables V-22 through V-23 are daily averages over a 12-month period, unless otherwise specified. The average daily raw waste loads were calculated in the following manner:

1. All data from each plant were coded for keypunching directly from the data sheets provided by the plant according to waste stream.

2. Concentration and flow data for each day were converted by the computer program to a corresponding waste load in pounds per day (lbs/day).

3. Each plant's annual average daily production was calculated in tons per day for each plant by dividing the total year's production by the number of actual operating days. This value was then used with applicable conversion factors to determine waste loadings on a pounds-per-ton basis.

4. The resulting waste loads were averaged over the one-year period to determine the average annual daily raw waste loads.

Eight of the fifteen insulation board plants provided raw waste historical data for the 12-month period from January through December 1976 and four plants also provided raw waste historical data for the 12-month period from January through December 1977.

The raw waste loads of the plants which employ thermomechanical refining methods or which also produce hardboard products are demonstrably higher than the raw waste loads of the plants which only employ mechanical refining and which produce no hardboard products. Plant 36, the only direct discharging plant among the mechanical refining plants, is an exception to this trend as discussed below.

Of the five plants which use mechanical refining only, and which produce no hardboard, three of the plants (360, 978, and 889) provided sufficient 1976 historical raw waste data for analysis. Plant 36 provided raw waste data for 1976 and 1977 for analysis. Data from these plants were for raw waste prior to primary treatment, with the exception of Plant 360 which provided information for wastewater following polymer-assisted primary clarification (flocculation-clarification). Verification sampling was performed at Plant 360 and samples were collected before and after the primary floc-clarifier. Analysis of verification data showed that a BOD reduction of 24 percent and a TSS reduction of 79 percent were achieved in the primary floc-clarifier.

Plant 360 uses primarily Southern pine for furnish with some mixed hardwoods. Plant 537 uses primarily Douglas fir with other mixed softwoods. Plant 978 employs stone grinders to refine a pine furnish. Plant 36 uses a mixture of predominantly Southern pine, in the form of whole tree chips, and mixed hardwoods. Plant 889 uses a furnish of Southern pine mixed with some hardwood.

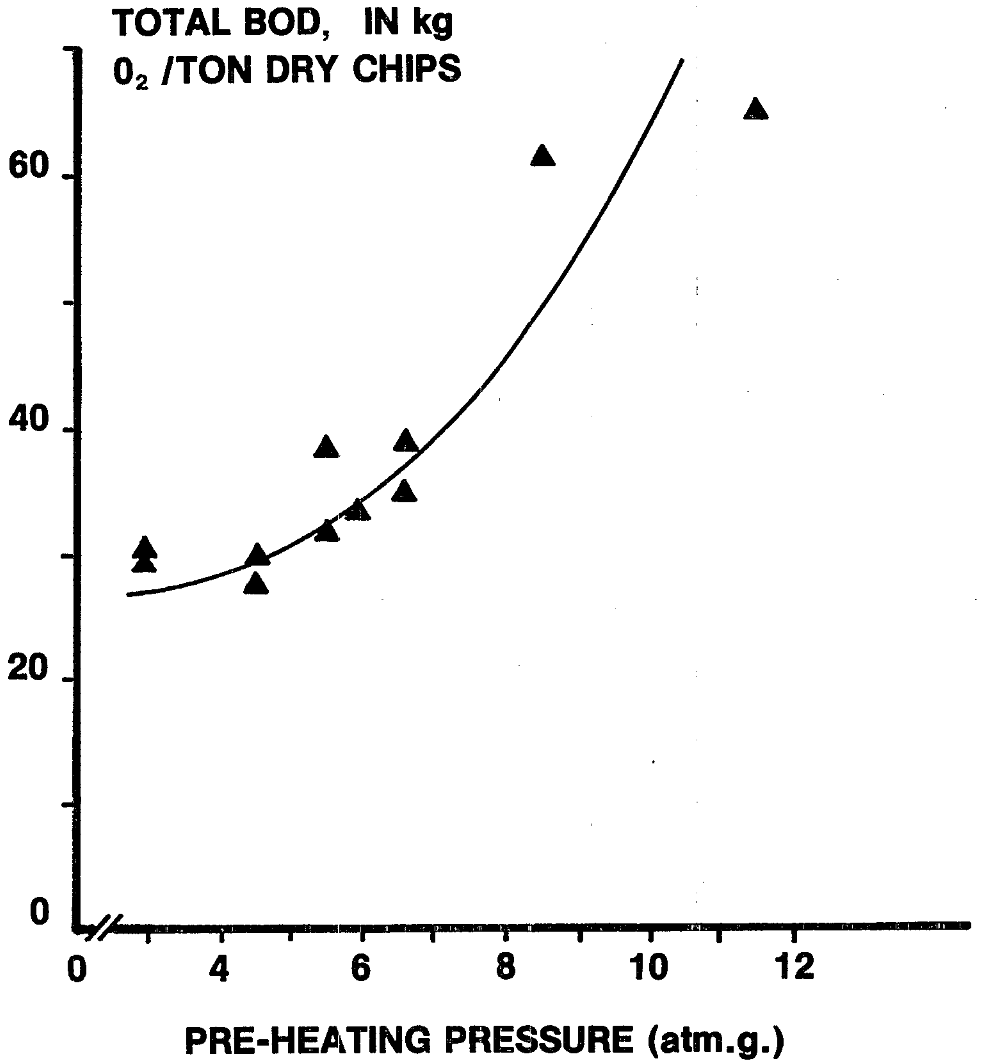


Figure V-1. Variation of BOD with pre-heating pressure

Table V-22. Insulation Board Mechanical Refining Raw Waste Characteristics (Annual Averages)*

Plant Number	Production		Flow		BOD		TSS	
	kkg/day	(TPD)	kl/kkg	(kgal/ton)	kg/kkg	(lbs/ton)	kg/kkg	(lbs/ton)
360[†]	201	(220)	3.13	(0.750)	4.46	(8.91)	0.735	(1.47)
	189	(208)	4.51	(1.08)	4.81	(9.62)	1.04	(2.07)
	195	(215)	3.80	(0.912)	4.61	(9.22)	0.880	(1.76)
978	106	(117)	21.6	(5.21)	5.95	(11.9)	4.67	(9.33)
	—	—	—	—	—	—	—	—
	—	—	—	—	—	—	—	—
36	606	(668)	10.4	(2.49)	20.8	(41.6)[†]	45.2	(90.5)
	600	(661)	8.84	(2.12)	20.9	(41.8)[†]	31.4	(63.0)
	603	(665)	9.60	(2.30)	20.9	(41.8)[†]	38.4	(76.8)
889	246	(270)	1.02	(0.24)	1.27	(2.54)	0.46	(0.923)
	—	—	—	—	—	—	—	—
	—	—	—	—	—	—	—	—

* First row of data represents 1976 average annual daily data; second row represents 1977 average annual daily data; third row represents average annual daily data for two-year period of 1976 and 1977; except as noted.

[†] In 1976, 0.075 kg/kkg (0.15 lb/ton) of BOD is recycled.
In 1977, 0.095 kg/kkg (0.19 lb/ton) of BOD is recycled.
For the two-year period of 1976-1977, 0.085 kg/kkg (0.17 lb/ton) of BOD is recycled.

Table V-23. Insulation Board Thermomechanical Refining and/or Hardboard Raw Waste Characteristics (Annual Averages)*

Plant Number	Production		Flow		BOD		TSS	
	kkg/day	(TPD)	kl/kkg	(kgal/ton)	kg/kkg	(lbs/ton)	kg/kkg	(lbs/ton)
183	193	(212)	8.11	(1.95)	33.6	(67.1)	17.3	(34.5)
	144	(159)	5.05	(1.21)	35.5	(71.0)	13.3	(26.6)
	169	(186)	6.84	(1.64)	34.5	(69.0)	15.6	(31.2)
537†	139	(153)	13.5	(3.23)	17.0	(34.1)**	42.8	(85.7)
	145	(160)	12.8	(3.08)	23.5	(47.0)**	38.6	(77.3)
	--	--	--	--	--	--	--	--
108	605	(665)††	74.0	(17.8)	29.8	(59.5)	28.6	(57.1)
	--	--	--	--	26.3	(52.6)***	6.25	(12.5)***
	570	(628)††	23.9	(5.73)†††	22.8	(45.6)†††	6.80	(13.6)†††
1035	359	(395)††	11.1	(2.68)	43.2	(86.3)	--	--
	--	--	--	--	--	--	--	--
	--	--	--	--	--	--	--	--

* First row of data represents 1976 average annual daily data; second row represents 1977 average annual daily data; third row represents average annual daily data for two-year period of 1976 and 1977; except as noted.

† Raw flow and wasteload data presented in first row obtained during 1977 verification sampling. Raw flow and wasteload data presented in second row obtained during 1978 verification sampling.

** In 1976, 12.5 kg/kkg (25.0 lbs/ton) of BOD is recycled.
In 1977, 12.2 kg/kkg (24.5 lbs/ton) of BOD is recycled.

†† Includes production of both insulation board and hardboard.

*** Raw waste loads based on 1977 estimated primary effluent data provided by plant, and on 1976 average daily production.

††† Data represent period of 9/21/79 through 4/30/80.

Plant 36 demonstrated raw waste loads for BOD and TSS significantly higher than any other plant in the mechanical refining subcategory. This is most likely attributable to the use of wood furnish consisting of predominantly whole tree chips. In 1976, the plant recycled all of its waste activated sludge, in addition to all of the primary sludge, back into the process. In 1977, the plant discontinued recycling of the waste activated sludge and reduced the primary sludge recycling by 10 percent because of board quality problems. Ninety percent of the primary sludge was still recycled to the process, while the remaining 10 percent of the primary sludge and all of the waste activated sludge were dewatered and disposed of in a landfill. The build up in the process whitewater system of suspended solids due to the sludge recycling is the most probable reason for the high 1976 average TSS waste loads.

Plant 725 does not monitor the raw wastewater from its wood fiber insulation board plant. Effluent from this plant, following primary treatment, is used as process whitewater in the plant's mineral wool insulation board facility. Although the plant provided 1976 historical data for raw wastewater effluent from the mineral wool facility, these data could not be used to characterize raw wastewater from the wood fiber plant; and thus, Plant 725 was not included in Table V-22.

The annual average daily unit flow, and waste load data for insulation board, mechanical refining Plant 36, presented in Table V-22, were used to develop the design criteria presented in Table V-24 and used as a basis for cost estimates presented in Appendix A of this document.

The average unit flow for Plant 36, which is 8.3 kl/Kkg (2.0 kgal/ton), is considered to be representative of an insulation board, mechanical refining plant which produces a full line of insulation board products and which practices internal recycling to the extent practicable. Plant 978 has a high unit flow of 21.6 kl/Kkg (5.21 kgal/ton), due to the fact that this plant uses process water on a once through basis, with no internal recycle. Plants 360 and 889 achieve a much higher degree of internal recycle which is due to their particular product and raw material mix. Therefore, their unit flows are not considered to be applicable to the industry as a whole. The raw waste load of TSS produced by Plant 36 is somewhat higher than the other plants in the insulation board-mechanical refining group because the plant uses a furnish which predominantly consists of whole tree chips. The contribution of TSS to overall treatment system costs is negligible compared to the BOD contribution.

Of the 10 plants which produce insulation board using thermomechanical refining and/or which produce hardboard at the same facility, only three plants (183, 108, and 1035) provided sufficient 1976 historical data for calculation of raw waste loads. Plant 183 also provided sufficient 1977 historical data for raw waste analysis.

Plant 108 has upgraded its wastewater treatment system and provided an estimate of the raw waste loads (primary effluent). The estimated waste loads are 16,000 kg/day (35,000 lbs/day) of BOD and 3,800 kg/day (8,300 lbs/day) of TSS. The raw waste loads presented in the second row for Plant 108 in Table V-23 are based on these estimated data and on 1976 average annual daily production data.

Plant 537 does not monitor raw wastewater quality and provided no historical raw wastewater quality data. Verification sampling was performed at this plant in 1977 and 1978, and raw wastewater data were obtained. Verification data were used to calculate the raw waste load using historical average daily production and average daily flow data provided by the plant in response to the data collection portfolio.

Of the four plants which provided historical raw waste data, only Plants 183 and 537 produce solely insulation board. Plant 183 steam conditions all of its furnish, which consists primarily of hardwood chips. Plant 537 steam conditions all of its furnish which consists of softwood chips, primarily of Douglas fir. Some sawdust is also used as furnish at this plant.

Plant 108 steam conditions approximately 10 percent of its furnish, which consists primarily of aspen with some whole tree chips. Although this plant differs considerably from the other plants in the subcategory in the proportion of furnish that is preconditioned by steam, the raw waste loads from this plant fall well within the range of other plants in the insulation board-thermomechanical refining or hardboard production group, as demonstrated in Table V-23.

Plant 1035 uses thermomechanical pulping to prepare all of its furnish, which consists primarily of pine with some hardwood and panel trim. This plant produces approximately 70 percent insulation board and 30 percent hardboard.

Plant 943 produces approximately 60 percent insulation board and 40 percent hardboard using a pine furnish for hardboard, and pine and hardwood mix for insulation board. This plant steam conditions all of its furnish. Since it does not monitor its raw waste effluent, the raw waste load could not be determined.

Plant 979 produces approximately 60 percent insulation board and 40 percent hardboard using a pine furnish which is totally steam conditioned. Since this plant does not monitor its raw waste effluent, the raw waste load could not be determined.

Plant 186 steam conditions all of its hardwood furnish. Since this plant does not monitor its raw waste effluent, the raw waste load could not be determined.

Plant 977 steam conditions all of its mixed hardwood furnish. This plant produces approximately 50 percent insulation board and

50 percent hardboard. Raw waste effluent from the wood fiber plant at this facility is combined with raw waste effluent from a mineral wool facility at the same location prior to monitoring. Therefore, the actual wood fiber raw waste load could not be determined.

Plant 502 steam conditions all of its hardwood furnish and produces only insulation board. Since this plant does not monitor its raw waste effluent, the raw waste load from this plant could not be determined.

Plants 184 and 2 have achieved no discharge of process wastewater through complete close up of process whitewater systems, however, Plant 2 has discontinued operations. Both plants steam condition all furnish and produce solely structural insulation board. Plant 184 uses a hardwood furnish, and Plant 2 used low moisture plywood and furniture trim furnish.

Raw waste load data provided by Plants 183, 537, and 1035 were averaged to develop the design criteria presented in Table V-25 as the basis for cost estimates presented in Appendix A of this document. These plants are considered representative of plants producing insulation board thermomechanically and hardboard. Data from Plant 108 were not used for two reasons: (1) the raw waste data provided by this plant were following primary treatment, and (2) the plant in 1976 practiced only a minimal amount of internal recycle which resulted in an unrepresentative unit flow of 11.1 kl/Kkg (17.8 K gal/ton).

A unit flow of 10.0 kl/Kkg (2.4 kgal/ton) is considered to be representative of an insulation board, thermomechanical refining plant which produces a full line of insulation board products and which practices internal recycle to the extent practicable.

Table V-24. Insulation Board, Mechanical Refining--Design Criteria

Unit Wastewater Flow = 8.3 kl/Kkg (2.0 kgal/ton)

	Design Criteria	
	1	2
Production, Kkg/day (TPD)	230 (250)	540 (600)
Wastewater Flow, Kkl/day (MGD)	1.9 (0.5)	4.5 (1.2)
Influent BOD Concentrations, mg/l	2,200	2,200
Influent TSS Concentrations, mg/l	3,900	3,900

Table V-25. Insulation Board Thermomechanical Refining--Design Criteria

Unit Wastewater Flow = 10.0 kl/Kkg (2.4 kgal/ton)

	Design Criteria	
	1	2
Production, Kkg/day (TPD)	180 (200)	360 (400)
Wastewater Flow, Kkl/day (MGD)	1.8 (0.48)	3.6 (0.96)
Influent BOD Concentrations, mg/l	3,600	3,600
Influent TSS Concentrations, mg/l	1,600	1,600

Toxic Pollutant Raw Waste Loads

Raw waste concentrations and raw waste loads for total phenols are shown for four insulation board plants in Table V-26. Data presented in this table were obtained during the 1977 and 1978 verification sampling programs. These data represent the average of three 24-hour composite samples collected during each verification program. Annual average daily production and annual average daily waste flow provided by the plants in the data collection portfolio were used to calculate the raw waste loads. None of the insulation board plants presented historical data on raw wastewater total phenols concentrations in their raw wastewater effluents.

Raw waste concentrations of 13 heavy metals are presented for four insulation board plants in Table V-27. Data presented in this table were obtained during the 1977 verification sampling program. Annual average daily production and annual average daily waste flow for 1976 provided by the plants in the data collection portfolio were used to calculate the raw waste loads.

None of the insulation board plants presented historical data for wastewater heavy metals concentrations.

No significant differences in heavy metals concentrations between the two types of insulation board plants were found. The source of heavy metals in the wastewater from insulation board plants is: (1) small amounts of metals present in the wood raw material; and (2) byproducts of the corrosion of metal equipment in contact with the process whitewater.

The average concentrations and the average raw wastewater loadings of each heavy metal are also presented in Table V-27.

Table V-28 presents the raw wastewater concentrations of organic toxic pollutants for insulation board plants that were sampled during the 1978 verification sampling program. None of the insulation board plants presented organic toxic pollutants historical data.

No organic toxic pollutants were found in the raw waste for Plant 537, a thermomechanical refining plant. Extremely low concentrations of chloroform, benzene, and toluene were found in the raw wastewater for Plant 183, also a thermomechanical refining plant. All of these pollutants probably originated in common industrial solvents.

Extremely low concentrations of benzene, toluene, and phenol were found in the raw wastewater for Plant 36, a mechanical refining plant, but benzene and toluene were also found in the plant intake water. Phenol is an expected byproduct of hydrolysis reactions that occur as the wood furnish is refined.

Table V-26. Raw Waste Concentrations and Loadings for Insulation Board Plants--Total Phenols

Plant	Raw Waste Concentrations (mg/l)*		Average+ Raw Waste Loads	
	1977	1978	kg/Kkg	(lbs/ton)
36	0.09	0.796	0.0040	(0.0080)
183	0.29	1.8	0.0055	(0.011)
360	0.14	NS**	0.00040	(0.00079)
537	0.11	0.42	0.0075	(0.015)

* Data obtained during 1977 and 1978 verification sampling programs.

\+ Average of the 1977 and 1978 raw waste loads. Average daily waste flow and production data supplied by plants in response to the data collection portfolio were used to calculate the 1977 and 1978 waste loads.

** NS = Plant 360 was not sampled during the 1978 verification program.

Table V-27. Raw Waste Concentrations and Loadings for Insulation Board—Metals

	Raw Waste Concentrations (mg/l)					Raw Waste Loadings (kg/Kkg)/(lb/ton)				
	Plant Number				Average Value	Plant Number				Average Value
	360	183	537	36		360	183	537	36	
Beryllium	.0005	.00083	.0005	.0005	.0006	.0000042 (.0000083)	.000007 (.000014)	.00001 (.00002)	.0000055 (.000011)	.0000067 .0000133
Cadmium	.00083	.001	.0005	.0005	.0007	.0000028 (.0000056)	.000008 (.000016)	.00001 (.00002)	.0000055 (.000011)	.0000065 .0000132
Copper	.450	.280	.20	.340	.320	.0019 (.0037)	.0023 (.0046)	.000041 (.000082)	.0036 (.0072)	.0019 .0039
Lead	.0013	.021	.0013	.0053	.0072	.000006 (.000011)	.00017 (.00034)	.000027 (.000053)	.000055 (.00011)	.000063 .000126
Nickel	.240	.105	.012	.0088	.0920	.0008 (.0016)	.00085 (.0017)	.00025 (.00049)	.00009 (.00018)	.0005 .0010
Zinc	.720	.517	.250	.550	.510	.003 (.0059)	.0042 (.0084)	.005 (.01)	.006 (.012)	.0046 .0091
Antimony	.00083	.003	.00067	.0021	.0016	.0000021 (.0000042)	.000025 (.000049)	.000014 (.00027)	.000022 (.000044)	.000015 .000037
Arsenic	.002	.0033	.003	.0016	.0025	.000013 (.000025)	.000027 (.000054)	.00006 (.00012)	.000017 (.000034)	.000029 .000058
Selenium	.005	.0043	.0047	.0033	.0043	.000014 (.000027)	.000035 (.00007)	.00007 (.000014)	.000035 (.00007)	.000038 .000076
Silver	.0005	.0006	.0005	.0005	.0005	.0000021 (.0000042)	.0000049 (.0000098)	.00001 (.00002)	.0000055 (.000011)	.0000056 .0000112
Thallium	.00083	.0005	.0008	.0006	.0007	.0000028 (.0000056)	.0000041 (.0000082)	.000017 (.000033)	.0000065 (.000013)	.0000076 .0000152
Chromium	.0013	.0075	.0023	.011	.0055	.0000055 (.000011)	.00006 (.00012)	.00047 (.00084)	.00012 (.00023)	.00016 .00033
Mercury	.0066	.005	.001	.0075	.005	.000028 (.000042)	.000041 (.000082)	.000021 (.000041)	.00008 (.00016)	.000042 .000085

Table V-28. Insulation Board, Raw Wastewater Toxic Pollutant Data, Organics

	Average Concentration (ug/l)		
		Raw Wastewater	
Parameter	Plant 183	Plant 36	Plant 537
Chloroform	20	--*	--
Benzene	70	40**	--
Toluene	60	40**	--
Phenol	--	40	--

* One sample of raw wastewater contained 20 ug/l of chloroform. Plant intake water contained 10 ug/l of chloroform.

** Plant intake water contained 50 ug/l and 30 ug/l of benzene and toluene, respectively.

-- Hyphen denotes that the parameter was not detected above the detection limit for the compound.

WET PROCESS HARDBOARD

Production of hardboard by wet process requires significant amounts of water. Plants responding to the data collection portfolio reported fresh water usage rates for process water ranging from approximately 190 thousand to 19 million liters per day (0.05 to 5 MGD). One plant, 108, which produces both hardboard and insulation board in approximately equal amounts, reported fresh water use of over 15 million liters per day (4 MGD).

Water becomes contaminated during the production of hardboard primarily through contact with the wood raw material during the fiber preparation, forming, and--in the case of S1S hardboard--pressing operations. The vast majority of pollutants consist of fine wood fibers, soluble wood sugars, and extractives. Additives not retained in the board also add to the pollutant load.

The water used to process and transport the wood from the fiber preparation stage through mat formation is referred to as process whitewater. Process whitewater produced by the dewatering of stock at any stage of the process is usually recycled to be used as stock dilution water. However, because of the build-up of suspended solids and dissolved organic material which can cause undesirable effects in the board, there may be a need to bleed-off a quantity of excess process whitewater.

Potential wastewater sources in the production of wet process hardboard include:

- Chip wash water
- Process whitewater generated during fiber preparation (refining and washing)
- Process whitewater generated during forming
- Hot press squeezeout water
- Wastewater generated during miscellaneous operations (dryer washing, finishing, housekeeping, etc.)

Chip Wash Water

Water used for chip washing is capable of being recycled to a large extent. A minimum makeup of approximately 400 liters per metric ton (95 gallons per ton) is required in a closed system because of water leaving with the chips and with sludge removed from settling tanks. Water used for makeup in the chip washer may be fresh water, cooling water, vacuum seal water from in-plant equipment, or recycled process water. Chip wash water, when not fully recycled, contributes to the raw waste load of a hardboard plant. Hardboard Plants 980, 979, 977, 943, 108, 1035, and 3 indicated in responses to the data collection portfolio that chip washing is done. Plants 943 and 1035 recycle chip wash water.

Fiber Preparation

The fiber preparation or refiner whitewater system is considered to be the water used in the refining of stock up to and including the dewatering of stock by a decker or washer. There are two major types of fiber preparation in the wet process hardboard industry: thermomechanical pulping and refining, and the explosion or gun process. Steam, under pressure, is used to soften and prepare the chips in both processes.

Fiber yield is lower in the explosion process than in the thermomechanical process due to the hydrolysis of the hemicellulose under the high pressures required in the gun digesters. The resulting raw waste loading is also higher.

The wood furnish enters the refiner at a moisture content of about 50 percent. Subsequent to refining, the fiber bundles are diluted with fresh or recycled process whitewater to a consistency of approximately 1 percent solids prior to dewatering at the decker or stock washer to about 15 percent solids. The water which results from the stock washing or deckering operation is rich in organic solids dissolved from the wood during refining and is referred to as "refiner whitewater." This water may be combined with the machine whitewater, which is produced during forming, for further use in the system; or it may be discharged from the plant as wastewater.

Three plants, 678, 673, and 943 make use of the high dissolved organic solids in this stream by collecting and evaporating the fiber preparation whitewater to produce a concentrated wood molasses byproduct which is used for animal feed.

Forming

After the dewatered stock leaves the washer decker at approximately 15 percent consistency, it must again be diluted to a consistency of approximately 1.5 percent to be suitable for machine forming. This requires a relatively large amount of recycled process whitewater or fresh water. The redilution of stock is usually accomplished in a series of steps to allow accurate consistency controls and more efficient dispersion of additives and to reduce the required stock pump and storage capacities. The stock usually receives an initial dilution down to approximately 5 percent consistency, then to 3 percent, and finally, just prior to mat formation, to approximately 1.5 percent.

During the mat formation stage of the hardboard process, the diluted stock is dewatered in the forming machine to a consistency of approximately 40 to 45 percent. The water drained from the stock during formation is referred to as machine whitewater. Water from the machine whitewater system may be recycled for use as stock dilution water. Excess machine whitewater may be combined with other process whitewater and discharged as wastewater.

Pressing

In the production of S1S hardboard, the mat which leaves the forming machine at 40 to 45 percent solids consistency is loaded into "hot" hydraulic presses to be pressed into hardboard.

The board leaves the press at about 5 percent moisture or less. Although much of the water in the board is evaporated in the press, a considerable amount of wastewater is generated during pressing. This wastewater is generally collected in a pit below the press and discharged as wastewater from the plant, although two plants, 929 and 673, return the press water to the process whitewater system. Wastewater resulting from the pressing operation is more concentrated in dissolved solids than the machine whitewater due to the large amount of water which is evaporated from the board during pressing.

Miscellaneous Operations

While the majority of wastewater generated during the production of hardboard occurs during the fiber preparation, forming and pressing operations, various other operations may contribute to the overall raw waste load.

Drying--It is occasionally necessary to clean the dryers in a hardboard plant to reduce fire danger and to maintain proper energy utilization. This produces a minor wastewater stream in most operations.

Finishing--After the board leaves the press or humidifier, it is usually sanded and trimmed to size. The dust from the sanding and trim saws is often controlled by dust collectors of a wet scrubber type and the water supplied to the scrubbers is sometimes excess process water; however, fresh water is occasionally used. This water may be returned to the process with the dust, or it may be discharged as wastewater.

Many plants paint or stain the board after it is sanded and trimmed. Paint composition will vary with both plant and product; however, most plants utilize a water-based paint. The resulting washup contributes to the wastewater stream or to the process whitewater system. In addition, there are sometimes imperfect batches of paint which are discharged to the wastewater stream or metered to the process whitewater system.

Caul or Press Plate--Another wastewater source is caul and press plate wash water. After a period of use, cauls and press plates acquire a surface build-up of resin and organics which results in sticking in the presses and blemishes on the hardboard surface. The cleaning operation consists of submerging the plates in a caustic cleaning solution for a period of time to loosen the organic matter. Press plates are also cleaned in-place with a caustic solution. The cauls are removed, rinsed with fresh water, then put back in use. The tanks used for soaking the cauls are emptied as needed, normally only a few times each year. Rinse water volume varies with frequency of washing of cauls or plates.

Other Sources--Other potential sources of wastewater in a hardboard plant include water used for screen washing, fire control, and general housekeeping.

The water used for washing screens in the forming and decker areas usually enters the process whitewater system. Housekeeping water can vary widely from plant to plant depending on plant practices and many other factors. Wastewater can result from water used to extinguish dryer fires. This is an infrequent and intermittent source of wastewater.

Wastewater Characteristics

The major portion of hardboard wastewater pollutants results from leachable materials from the wood and materials added during the production process. If a chip washer is used, a portion of the solubles is leached into the chip wash water. A small fraction of the raw waste load results from cleanup and finishing operations; however, these operations appear to have little influence on the overall raw waste load.

The major factors which affect process wastewater quality include: (1) the severity of cook to which the wood is subjected, (2) the types of products produced and additives used, (3) raw material species, and (4) the extent of whole tree chips, forest residue, and bark in the raw material.

The effect of steaming on raw waste load was discussed in this section for insulation board. The severity of cook to which wood furnish is subjected in S2S hardboard production generally exceeds that used in S1S hardboard production because of the requirement for more highly refined fiber bundles in the S2S product. It would be expected, therefore, that the raw waste load of S2S plants would be higher than that of S1S plants. Inspection of the raw waste characteristics for both types of plants presented in Tables V-29 and V-30 supports this conclusion.

A thorough review of the literature and information presented by industry sources pertaining to factors influencing variation in raw wastewater characteristics was performed by an EPA contractor in 1976. The conclusions reached were published in Section V of the Summary Report on the Re-Evaluation of the Effluent Guidelines for the Wet Process Hardboard Segment of the Timber Products Processing Point Source Category. An attempt was made in the 1976 study to quantify the effects of wood species, seasonal variations in raw materials, and the use of whole tree chips and/or forest residue on raw waste characteristics. The conclusion reached in the 1976 study was as follows:

> It is easily apparent, from the sources discussed, that large variabilities in raw waste characteristics exist from plant to plant in the hardboard industry. It is also apparent that the factors identified as causing the variability are probably valid. However, it is equally apparent that none of the sources investigated thus far has been able to supply the type of data necessary to determine how the reference information relates to quantification of the factors influencing variations in raw waste.

During the course of the present study, the material available to the 1976 contractor was reviewed in detail, as well as current literature and material presented by the plants in the data collection portfolios. No substantial new material was presented to allow quantification of the effects of wood species, whole tree chips and/or forest residue, or seasonal variations in raw material.

While a large portion of the BOD in the process wastewater is a result of organics leaching from the wood, a significant (although lesser) portion results from additives not retained in the product. Additives vary in both type and quantity according to the type of product being produced. Chemicals used as additives in the production of hardboard include vegetable oils, ferric sulfate, aluminum sulfate, petrolatum, thermoplastic and/or thermosetting resins, defoamers, and paints. Thermosetting resins are not used in S2S production since the board is dried prior to pressing. The differences in the type and quantity of additives used from plant to plant did not appear to significantly affect raw waste loads.

Maximum retention of these additives is advantageous from both a production cost as well as a wastewater standpoint. Several retention aids are marketed for use in board products to increase the retention of fiber and additives in the mat, the most common of which are alum and ferric salts. Some plants use synthetic polyelectrolytes as retention aids.

As previously discussed, the primary effect of product type on raw waste loads occurs with the production of S2S hardboard. S2S hardboard production exhibits a marked effect on raw waste loads as shown by data presented in Tables V-29 and V-30. The effect of product type on raw waste loads within the S1S and S2S parts of the wet process hardboard subcategory is generally not discernible, with the exception that Plant 929 has succeeded in significantly reducing its raw waste load by achieving nearly complete close up of its process whitewater system. This plant produces primarily industrial grade board.

Table V-29. SIS Hardboard Raw Waste Characteristics (Annual Averages)*

Plant Number	Production		Flow		BOD		TSS	
	Kkg/day	(TPD)	kl/Kkg	(kgal/ton)	kg/Kkg	(lbs/ton)	kg/Kkg	(lbs/ton)
348	88.7	(97.5)	—	—	32.7	(65.4)†	6.90	(13.8)†
	—	—	—	—	—	—	—	—
	—	—	—	—	—	—	—	—
933	297	(326)	10.6	(2.54)	37.4	(74.7)	9.15	(18.3)
	—	—	—	—	—	—	—	—
	—	—	—	—	—	—	—	—
3	194	(213)	7.68	(1.84)	29.3	(58.6)	12.4	(24.8)
	194	(213)	6.17	(1.48)	25.4	(50.7)	12.8	(25.7)
	194	(213)	7.05	(1.69	26.0	(52.0)	12.6	(25.2)
931	117	(129)	8.82	(2.12)	35.6	(71.2)	22.5	(44.9)
	115	(127)	8.14	(1.95)	33.8	(67.7)	13.0	(25.9)
	113	(125)**	8.14	(1.95)**	37.0	(74.1)**	13.8	(27.6)**
919††	91.9	(101)	14.0	(3.36)	68.5	(137)	16.8	(33.5)
	—	—	—	—	—	—	—	—
	—	—	—	—	—	—	—	—
207	83.2	(91.7)	—	—	30.1	(60.2)	10.2	(20.3)
	79.7	(87.8)	—	—	33.8	(67.8)	5.20	(10.4)
	81.5	(89.8)	—	—	32.2	(64.3)	7.70	(15.4)
673	343	(377)	13.6	(3.26)	1.89	(3.77)	0.56	(1.15)
	—	—	—	—	—	—	—	—
	—	—	—	—	—	—	—	—
678†††	1446	(1589)	12.3	(2.96)	21.9	(43.8)	5.85	(11.7)
	—	—	—	—	—	—	—	—
	—	—	—	—	—	—	—	—

* First row of data represents 1976 average annual daily data; second row represents 1977 average annual daily data; third row represents average annual daily data for two-year period of 1976 and 1977; except as noted.

† After primary settling, hardboard and paper wastewater streams are comingled.

** Data represent period of 10/1/76 through 12/31/77 when upgraded system was in normal operation.

†† All of treated effluent is recycled to plant process.

*** Raw waste loads shown are for combined weak and strong wastewater streams.

††† Raw waste load data taken after primary clarification, pH adjustment, and nutrient addition.

Table V-30. S2S Hardboard Raw Waste Characteristics (Annual Averages)*

Plant	Production		Flow		BOD		TSS	
Number	kkg/day	(TPD)	kl/kkg	(kgal/ton)	kg/kkg	(lbs/ton)	kg/kkg	(lbs/ton)
980	210	(231)	24.7	(5.93)	66.5	(133)	—	—
	216	(238)	24.9	(5.97)	61.5	(123)	15.2	(30.4)
	213	(235)†	24.9	(5.96)†	64.5	(129)†	—	—
	218	(240)**	24.5	(5.88)**	—	—	11.7	(23.4)**
1035	359	(395)††	11.1	(2.68)	43.2	(86.3)	—	—
	—	—	—	—	—	—	—	—
	—	—	—	—	—	—	—	—
1	311	(343)	25.8	(6.18)	116	(232)	20.0	(40.0)
	—	—	—	—	—	—	—	—
	—	—	—	—	—	—	—	—

* First row of data represents 1976 average annual daily data; second row represents 1977 average annual daily data; third row represents average annual daily data for two-year period of 1976 and 1977; except as noted.

† Data represents period of 1/1/76 through 4/30/78.

** Data represents period of 6/16/77 through 4/30/78 when standard TSS analyses were performed.

†† Includes production of both insulation board and hardboard.

Raw Waste Loads

Tables V-29 and V-30 summarize the raw waste characteristics of those hardboard plants which provided historical raw waste monitoring data in response to the data collection portfolio. Nine of the sixteen hardboard plants provided raw waste historical data for the 12-month period from January through December 1976. Plant 673 provided data from May 1976 to April 1977. Three plants also provided raw waste historical data for the 12-month period from January through December 1977. Plant 980 provided data from January 1, 1976 through April 1978. The average annual daily raw waste loads presented in Tables V-29 and V-30 were calculated in the same manner as described for the insulation board subcategory earlier in this section.

Plants 943 and 979 do not monitor raw waste effluents, and Plant 977 combines the raw waste effluent from its hardboard/insulation board facility with the raw waste effluent from an adjacent mineral wool fiber plant prior to monitoring. The data provided by Plant 977 could not be used to characterize raw waste loads for hardboard production.

Plant 929 provided data from January 1976 through February 1977 for its treated effluent only. These data were not used to calculate a raw waste load.

Of the nine predominantly S1S hardboard plants, eight plants (348, 933, 3, 931, 919, 207, 673, and 678) provided sufficient historical raw waste data for analysis.

Approximately 90 percent of the total production of Plant 348 is S1S hardboard produced with a plywood trim furnish. The other 10 percent of the plant's production consists of battery separators--a paper product. Although the plant indicates that 80 to 90 percent of the raw waste load results from hardboard production, monitoring by the plant is performed after the raw waste streams are combined. The plant did not monitor the flow rates of the separate wastewater streams during 1976. No flow data were reported by Plant 348. BOD and TSS raw waste loads were reported directly in lb/ton. The raw waste load for this plant is included in Table V-29, but is not included in the development of the S1S part design criteria.

Plant 919 produces all S1S hardboard using Douglas fir for furnish. The raw BOD waste load discharged from this plant is 68.7 kg/Kkg (137.4 lb/ton); however, some of this waste load entered the process through recycle of treated effluent. Since the waste load contribution resulting from recycle of treated effluent is unknown, the raw waste loads for this plant were not used to develop the S1S part design criteria.

Plant 3 produces all S1S hardboard using a furnish which is 55 percent mixed hardwoods and 45 percent mixed softwoods. Thirty percent of this plant's furnish is in the form of unbarked roundwood.

Plant 933 produces all S1S hardboard using an aspen furnish, approximately half of which is unbarked roundwood and half is received as whole tree chips.

Plant 931 produces all S1S hardboard using 75 percent oak and 25 percent mixed hardwoods.

Plant 207 produces all S1S hardboard using all Douglas fir in the form of chips, sawdust, shavings, and plywood trim. The raw waste load data presented for 1976 were not used to develop the S1S part design criteria because a major in-plant refitting program which significantly reduced the raw waste flow was completed during the latter half of 1976.

Plant 673, which produces approximately equal amounts of S1S and S2S hardboard using redwood and Douglas fir, evaporates most of its process wastewater to produce a cattle feed byproduct. Data for this plant are shown in Table V-29, but were not included in the development of the S1S part design criteria.

Plant 678 produces approximately 10 percent S2S and 90 percent S1S hardboard using about 80 percent mixed hardwoods (40 percent of which is oak) and 20 percent Southern pine. This plant evaporates a large amount of process water to produce a cattle feed byproduct. Raw waste data reported in Table V-29 for this plant were obtained following primary clarification, pH adjustment, and nutrient addition. Plant 678 is not included in the development of the S1S part design criteria; however, data for the plant are shown in Table V-29.

The average annual daily flows and raw waste loads for the S1S hardboard plants presented in Table V-29 (excluding the data for Plants 348, 919, 673, and 678) were used to determine the design criteria used for the S1S part of the wet process hardboard subcategory cost estimates presented in Appendix A of this document. The S1S part design criteria are presented in Table V-31.

Table V-31. S1S Hardboard--Design Criteria

Unit Wastewater Flow = 12 kl/Kkg (2.8 kgal/ton)

	Design Criteria 1	Design Criteria 2
Production, Kkg/day (TPD)	91 (100)	270 (300)
Wastewater Flow, Kkl/day (MGD)	1.1 (0.28)	3.2 (0.84)
Influent BOD Concentrations, mg/l	3,300	3,300
Influent TSS Concentrations, mg/l	1,300	1,300

Of the seven plants which produce predominantly S2S hardboard, three provided sufficient 1976 historical raw waste data for analysis and one plant provided 1975 historical raw waste data. One of the four plants also provided sufficient 1977 historical raw waste data for analysis.

Plant 108 uses thermomechanical pulping to prepare approximately 10 percent of its furnish, which consists primarily of aspen with some whole tree chips. This plant produces approximately 50 percent insulation board and 50 percent hardboard.

Plant 1035 uses thermomechanical pulping to prepare all of its furnish, which consists primarily of pine with some hardwood and panel trim. This plant produces approximately 70 percent insulation board and 30 percent hardboard.

The raw waste effluents from insulation board and hardboard production of Plants 108 and 1035 are combined prior to raw waste monitoring. Therefore, the individual raw waste load generated by hardboard production could not be calculated, and values for these plants are not included in the development of the design criteria for the S2S part of the wet process hardboard subcategory.

Plant 980 used a nonstandard method for the raw waste TSS concentration analysis during 1976, and therefore the raw waste load was not used in developing the design criteria for the S2S part. As of June 16, 1977 the plant has changed its method of TSS analysis to the standard method. The data presented for 1977 are for the period from June 16, 1977 through April 1978.

Plant 1 produces about 80 percent S2S hardboard and 20 percent S1S hardboard. Its furnish consists of poplar, birch, oak, and pine; 23 percent received as bark-free chips and 77 percent as roundwood. Raw waste load BOD for this plant, 116 kg/Kkg (232 lb/ton), is the highest by far of any fiberboard plant in the country and is considered to be atypical of the S2S part. For this reason the BOD raw waste load for this plant is not included in the development of the S2S part design criteria. Its TSS raw waste load is, however, characteristic of S2S plants and is included in the development of the S2S part design criteria.

The unit flow and raw BOD waste load data for Plant 980 were used to obtain the unit flow and BOD design criteria for the S2S part as presented in Table V-32. The TSS design criteria were developed using the average of the TSS raw waste loads from Plants 980 and 1. The design criteria were used as a basis for the cost estimates presented in Appendix A of this document.

A unit flow of 24.6 kl/Kkg (5.9 kgal/ton) is considered to be representative of an S2S hardboard plant which produces a full line of hardboard products and which practices internal recycling to the extent practicable.

Table V-32. S2S Hardboard--Design Criteria

Unit Wastewater Flow = 24.6 kl/Kkg (5.9 kgal/ton)

Production = 230 Kkg/day (250 TPD)

Wastewater Flow = 5.7 kl/day (1.5 MGD)

Influent BOD Concentration = 2,600 mg/l

Influent TSS Concentration = 600 mg/l

Toxic Pollutant Raw Waste Loads

Raw waste concentrations and raw waste loads for total phenols are shown in Table V-33. Data presented in this table were obtained during the 1977 and 1978 verification sampling programs. Two hardboard plants provided historical total phenols raw waste data, also included in Table V-33. Annual average daily production and waste flow data provided by the plants in response to the data collection portfolio were used to calculate the 1977 and 1978 raw waste loads. The average of the 1977 and 1978 loads are presented in Table V-33.

The average raw waste concentration of total phenols for the five S1S hardboard plants (207, 673, 678, 931, 3) is 2.4 mg/l and for the single S2S hardboard plant (980) is 0.16 mg/l. The S1S hardboard average raw waste load for total phenols is 0.019 kg/Kkg (0.038 lb/ton). The S2S hardboard average is 0.0038 kg/Kkg (0.0075 lb/ton).

Raw waste concentrations of heavy metals are presented for six hardboard plants in Table V-34. Data presented in this table were obtained during the 1977 verification sampling program. One hardboard plant provided 1976 historical data for lead and chromium which are also presented in the table. Annual average daily production and annual daily waste flow provided by the plants in the data collection portfolio were used to calculate the raw waste loads.

Table V-33. Raw Waste Concentrations and Loads for Hardboard Plants-

Total Phenols

	Raw Waste Concentrations (mg/l)*		Average+ Raw Waste Loads	
Plant	1977	1978	kg/Kkg	(lbs/ton)
980	0.07	0.243	0.0038	(0.0075)
207	0.38	0.610	0.009	(0.018)
673	1.2	--	0.015	(0.02)
678	0.24	--	0.003	(0.006)
	0.29**	--	0.0037**	(0.0074)**
931	6.4	3.8	0.043	(0.086)**
3	3.4**	8.9**	0.040**	(0.080)**

* Data obtained during 1977 and 1978 verification sampling programs. These data represent the average of three 24-hour composite samples.

\+ Average of 1977 and 1978 raw waste loads. Average daily waste flow and production data supplied by plants in response to data collection portfolio were used to calculate waste loads.

** Data are historical data supplied by plant in response to data collection portfolio.

Table V-34. Raw Waste Concentrations and Loadings for Hardboard Plants—Metals

	Raw Waste Concentrations (mg/l)						Raw Waste Loadings (kg/kkg) (lb/ton)					
	Plant Number						Plant Number					
	931	980	673	933	207	678	931	980	673	933	207	678
Beryllium	.00067	.0005	.00059	.0005	.0005	.0005	.000006 (.000012)	.000013 (.000025)	.000008 (.000016)	.000005 (.000001)	.000009 (.000017)	.000007 (.000013)
Cadmium	.0031	.0023	.0005	.005	.0005	.0005	.000027 (.000054)	.00006 (.00012)	.000007 (.000013)	.00005 (.0001)	.000009 (.000017)	.000007 (.00013)
Copper	.450	.530	.033	.1	.49	.260	.0039 (.0078)	.014 (.027)	.00044 (.00088)	.0011 (.0021)	.009 (.017)	.0033 (.0065)
Lead	.007	.0047	.055	.002	.002	.003 — .053* —	.00006 (.00012) — —	.00012 (.00024) — —	.0008 (.0015) — —	.00002 (.00004) — —	.000035 (.000069) — —	.000042 (.000083) .00065* (.0013)*
Nickel	.270	.070	.0057	.006	.0033	.009	.0024 (.0047)	.0018 (.0035)	.0008 (.00015)	.00006 (.00012)	.00006 (.00011)	.00012 .00023
Zinc	1.0	.190	.19	2.3	.78	.550	.009 (.017)	.0048 (.0096)	.003 (.005)	.024 (.048)	.014 (.027)	.007 (.014)
Antimony	.0018	.003	.0058	.0023	.0005	.008	.000016 (.000031)	.00008 (.00015)	.00008 (.00015)	.000024 (.000048)	.000009 (.000017)	.0001 (.00020)
Arsenic	.0013	.001	.0012	.0013	.001	.0012	.000016 (.000023)	.000026 (.000051)	.000016 (.000032)	.000014 (.000027)	.000017 (.000034)	.000015 (.000030)
Selenium	.002	.0008	.0038	.0023	.0033	.0018	.000018 (.000035)	.000020 (.000040)	.00005 (.0001)	.000024 (.000048)	.00006 (.00011)	.000023 (.000045)
Silver	.00067	.007	.0005	.0005	.0005	.00067	.000006 (.000012)	.00018 (.00035)	.000007 (.00013)	.000005 (.000010)	.000009 (.000017)	.000009 (.000017)
Thallium	.0015	.0005	.00099	.0005	.0005	.00067	.000013 (.000026)	.000013 (.000025)	.000013 (.000026)	.000005 (.000010)	.000009 (.000017)	.000009 (.000017)
Chromium	.033	.0073	.072	.008	.001	.420 .470*	.00029 (.00058)	.00019 (.00037)	.0001 (.0019)	.00009 (.00017)	.000017 (.000034)	.006 (.011) .006* (.012)*
Mercury	.002	.00005	.0002	.001	.018	.0017	.000018 (.000035)	.0000012 (.0000025)	.0000027 (.0000053)	.000011 (.000021)	.00031 (.00062)	.000022 (.000043)

* Data are 1976 historical data supplied by plant in response to data collection portfolio.

No significant differences in heavy metals concentrations between S1S and S2S hardboard production were found. The sources of heavy metals in the wastewater from hardboard plants are: (1) trace metals present in the wood raw material; and (2) byproducts of the corrosion of metal equipment in contact with the process wastewater. The average concentrations and the average raw waste loadings of each heavy metal are presented in Table V-35.

Table V-36 presents the raw waste concentrations of organic toxic pollutants for S1S hardboard plants that were sampled during the 1978 verification sampling program. None of the S1S hardboard plants presented organic toxic pollutant historical data.

Extremely low concentrations of ethylbenzene and toluene were found in the raw wastewater for Plant 207. The origin of these pollutants is probably common industrial solvents. The intake water for Plant 207 contained 10 ug/l of toluene, which is the analytical detection limit for this compound. Available data on potable water sources demonstrate that few surface waters are entirely free of trace organic contaminants.

Extremely low concentrations of chloroform, benzene, and toluene were found in the raw wastewater for Plant 931. These pollutants most likely originated in industrial solvents. Phenol was also found in the raw wastewater and is an expected byproduct of hydrolysis reactions that occur as the wood furnish is refined.

Table V-37 presents the organic toxic pollutant concentrations of the raw waste for S2S hardboard plants that were sampled during the 1978 verification sampling program. None of the S2S hardboard plants presented organic toxic pollutant data.

No organic toxic pollutants were found in the raw wastewater for Plant 980. Extremely low concentrations of chloroform, benzene, and toluene were found in the raw waste for Plant 1, however, the plant intake water contained 120 ug/l benzene and 80 ug/l toluene. Chloroform most likely originated in industrial solvents. Phenol was also found in the raw waste for Plant 1 and is an expected byproduct of hydrolysis reactions that occur as the wood furnish is refined.

Extremely low concentrations of 1,2-trichloroethane and toluene were found in the raw waste for Plant 943, the origin of which is most likely industrial solvents.

Table V-35. Average Raw Waste Concentration and Loadings for Hardboard Plants--Metals

Metal	Average Concentration mg/l	Average Raw Waste Load kg/Kkg	 lb/ton
Beryllium	0.00054	0.000008	0.000016
Cadmium	0.0020	0.000027	0.000053
Copper	0.31	0.0053	0.011
Lead	0.21	0.00018	0.00036
Nickel	0.061	0.00087	0.0017
Zinc	0.84	0.010	0.021
Antimony	0.0036	0.000052	0.00010
Arsenic	0.0012	0.000017	0.000035
Selenium	0.0023	0.000032	0.000065
Silver	0.0016	0.000036	0.000072
Thallium	0.00078	0.000010	0.000021
Chromium	0.099	0.0011	0.0022
Mercury	0.0038	0.000061	0.00012

Table V-36. S1S Hardboard, Raw Wastewater Toxic Pollutant Data, Organics

Parameter	Average Concentration (ug/l) Raw Wastewater Plant 207	 Plant 931
Chloroform	--	20
Benzene	--	80
Ethylbenzene	20	--
Toluene*	15	70
Phenol**	--	680

* Plant 207 intake water contained 10 ug/l toluene.

** Plant 207 intake water contained 97 ug/l phenol.

-- Hyphen denotes that the parameter was not found in concentrations above the detection limit for the compound.

Table V-37. S2S Hardboard, Raw Wastewater Toxic Pollutant Data, Organics

Parameter	Average Concentration (ug/l) Raw Wastewater Plant 980	 Plant 1	 Plant 943
Chloroform	--	20	--
1,1,2 Trichloroethane	--	--	90
Benzene	--	90*	--
Toluene	--	60*	10
Phenol	--	300	--

* Plant intake water was measured at 120 ug/l benzene and 80 ug/l toluene.

-- Hyphen indicates that the parameter was not found in concentrations above the detection limit for the compound.

SECTION VI

SELECTION OF POLLUTANT PARAMETERS

A review of timber industry technical information from the literature, data provided by the industry and by Agency sampling and analytical activities has revealed that toxic, nonconventional and conventional pollutants are present in wastewaters generated by the timber industry. Table VI-1 illustrates the type of information requested from the industry plants.

TOXIC POLLUTANTS

This section divides the toxic pollutants, as identified by Section 307(a) of the Clean Water Act of 1977, into three major groups. The toxic pollutant groups are: Group 1 - Found Most Frequently; Group 2 - Found Infrequently; and Group 3 - Not Generally Found.

Information is also presented regarding the nonconventional and conventional pollutants found in timber industry wastewaters.

The pollutant groupings for the wood preserving and the insulation board/wet process hardboard segments of the industry are presented separately.

Wood Preserving Segment

Group 1
Found Most Frequently

phenol
2-chlorophenol
2,4,6-trichlorophenol
pentachlorophenol
fluoranthene
benzo(b)fluoranthene
benzo(k)fluoranthene
pyrene
benzo(a)pyrene
indeno(1,2,3-cd)pyrene
benzo(ghi)perylene
zinc
phenanthrene/anthracene
benzo(a)anthracene
dibenzo(a,h)anthracene
naphthalene
acenaphthene
acenaphthylene
fluorene
chrysene
copper
chromium
arsenic
total phenols

TABLE VI-1

TOXIC CHEMICAL INFORMATION

For each toxic chemical check on list, and for each wood preservative, fire retardant, fungicide, or mildewcide used in plant, complete the following form:

1. Name of Chemical ____________________
   Is this a (check one):

   _____ Wood Preservative   _____ Other
   _____ Fire Retardant
   _____ Fungicide
   _____ Mildewcide

2. Quantity and frequency of use

   __________ per __________
   amount   period

3. Process or operation in which substance is used or generated. ____________________

   ____

   ____

   ____

4. Is substance discharged from plant? _____ Yes _____ No _____ Don't Know

   If yes, is it: _____ Air _____ Water _____ Solid Waste

   If water, is it: _____ Direct Discharge _____ To POTW

5. Quantity and frequency of substance discharged:

	Amount (in units, lbs, tons etc.)	Period per (day, year, etc.)
Gas		
Liquid		
Solid Waste		

6. Description of sampling or monitoring program.

   Does your plant sample or monitor for substance?

   _____ Yes _____ No

   If yes, give details. ____________________

   ____

   ____

   ____

Group 2
Found Infrequently

benzene
ethylbenzene
toluene
trichloromethane
lead
nickel

Group 3
Not Generally Found

The pollutants identified as toxic in the 1977 Clean Water Act but not listed in Group 1 or Group 2.

Wet Process Hardboard/Insulation Board Segment

Group 1
Found Most Frequently

total phenols
copper
nickel
zinc

Group 2
Found Infrequently

phenol
benzene
ethylbenzene
toluene
trichloromethane
lead
chromium

Group 3
Not Generally Found

The pollutants identified as toxic in the 1977 Clean Water Act but not listed in Group 1 or Group 2.

TOXIC ORGANIC COMPOUNDS

Pentachlorophenol

Pentachlorophenol (PCP) (C_6Cl_5OH) is a commercially produced biocide used primarily for wood preservation (90%), as a bactericide/fungicide in cooling tower water, as a preservative in paints, in tanning and textile processing, and as a herbicide.

Transport and Fate - PCP is only sparingly soluble in water (14 mg/l at 20°C) but is highly lipophilic, indicating that it will probably sorb into suspended particulates and organic sediments when introduced to the aquatic environment. Because of its very low vapor pressure (0.00011 torr at 20°C), volatilization of PCP is not expected to be a significant transport process.

Photolysis and biodegradation appear to be the most important processes affecting the ultimate fate of PCP. In clear surface waters, PCP appears to photolyze rapidly, often forming less chlorinated phenols, anisoles, and other compounds which, like PCP, can be highly toxic and bioaccumulate. The lifetime of PCP in natural waters is estimated to be one week when conditions are optimal for photolysis.

At low concentrations, PCP can be degraded by certain microbial cultures in the laboratory; however, the extent of biodegradation in the aquatic environment is not well documented.

Data concerning the effectiveness of biological wastewater treatment in a publicly owned treatment works (POTW) on the removal of PCP are limited and contradictory. The PCP removal efficiencies reported in several studies, including the ongoing EPA POTW study, range from 4% removal to 100% removal. Based on aquatic fate information, PCP would be expected to undergo biodegradation slowly and to sorb to a large extent onto suspended solids and subsequently be incorporated into the sludge. Monitoring data at several POTW does indicate that PCP accumulates in sludge.

Toxicity and Exposure - PCP has been found to be toxic to man and animals. The lowest calculated oral dose of PCP lethal to man is 29 mg/kg. Reported lethal doses to rats vary from 11.7 mg/kg to 320 mg/kg, depending on route of exposure and the grade of PCP administered. Non-fatal acute exposure of humans to PCP can result in skin irritation, nasal and respiratory tract irritation, headache, abdominal pain, fever, fatigue, and eye irritation. Dietary exposure to 100-500 mg/kg technical grade PCP for 90 days is associated with pronounced liver damage in rats. PCP has been found to be fetotoxic and teratogenic to rats orally exposed to 30 mg/kg/day or more during gestation.

Humans are widely exposed to low levels of PCP. PCP residues have been found in food, water, and human tissues. An analysis of human urine samples from the general U.S. population revealed 85% with detectable levels of PCP. Residues of PCP were detected in 11 of 360 composite food samples collected by the Food and Drug Administration. Residues of 0.004 to 0.017 mg/kg were found in dairy products, grains and cereals, root vegetables, and sugars. PCP has also been found in drinking water at low concentrations. PCP was detected in 86 to 108 finished drinking waters sampled by EPA in 1976. The mean concentration of the positive samples was 0.07 μg/l and the median was less than 0.01 μg/l. Inhalation exposure data for the general population are not available. Air levels as high as 15 $\mu g/m^3$ have been measured in industrial settings.

Phenol

Phenol (C_6H_5OH) is a large volume industrial chemical produced almost entirely for use in the manufacture of commercial products such as adhesive resins, plastics and films, and other organic chemicals. Total production based on 1977 figures was approximately 1,075,000 metric tons. Phenol is known to occur naturally in the environment. Some aquatic plants release sufficient phenol to establish water levels of 300-960 µg/l. The decomposition of surface vegetation such as oak leaves also releases phenol. Phenol is produced by microbial action in mammalian intestinal tracts and as a result will be found in raw sewage. Phenol also occurs naturally in fossil fuel deposits.

Transport and Fate - Because phenol is highly soluble in water (solubility at 20°C = 93,000 mg/l) and has a moderately low vapor pressure of (.53 torr at 20°C), the majority of phenol discharged into an aquatic system should remain in solution rather than sorbing to sediments or vaporizing into the atmosphere. Laboratory and field studies indicate that biodegradation is probably the most important process that determines the fate of phenol in the aquatic environment, although evidence suggests that photooxidation and metal catalyzed oxidation may also be important degradative processes in aerated-clear surface waters. Neither sorption nor bioaccumulation appear to be important processes in the aquatic fate of phenol.

The primary fate of phenol in POTW is probably biodegradation. Lab studies indicated that at concentrations of 1 mg/l to 10 mg/l, phenol was biodegraded in biological treatment systems to levels lower than the detection limit; at a concentration of 100 mg/l, only 20 percent of the phenol was removed. At concentrations as low as 10 mg/l, however, phenol can inhibit the oxygen uptake of unacclimated activated sludge. With long acclimation periods, activated sludge can be conditioned to metabolize up to 500 mg/l phenol without exhibiting toxic effects.

Phenol toxicity has also been found to vary with water temperature, hardness, salinity, and dissolved oxygen.

Toxicity and Exposure - Phenol is known to be toxic to man and a variety of animals at high concentrations. Lethal dose ranges of 4.8 to 128.0 grams have been reported for man. The primary effect of exposure to acutely toxic levels of phenol is central nervous system depression. Chronic exposure to phenol via ingestion, 0.1 g/kg for six months, has been found to cause kidney and liver damage in rats. Repeated exposures to phenol at high concentrations have resulted in chronic liver damage in man. Although there is no evidence of human cancer due to phenol, it produces cancer in specially bred laboratory-tested mice when applied repeatedly to the clipped skin after initiations with known carcinogens.

Mammals, including man, appear to be constantly exposed to low levels of phenol since it is produced by microbial actions in their intestinal tracts. Reported human urinary free and conjugated phenol concentrations range from 5 to 55 mg/l.

2-Chlorophenol

2-Chlorophenol (c_6H_4OCl), also known as ortho-chlorophenol, is a commercially produced chemical used entirely as an intermediate in the production of other chemicals. It represents a basic chemical feedstock in the manufacture of higher chlorophenols for such uses as fungicides, slimicides, bactericides, antiseptics, disinfectants, and wood ang glue preservatives. 2-Chlorophenol is also used to form intermediates in the production of phenolic resins, and has been utilized in a process for extracting sulfur and nitrogen compounds from coal.

Aquatic Transport and Fate - Contamination of water with 2-chlorophenol may occur by (1) chlorination of phenol present in natural water and primary and secondary effluents of waste treatment plants, (2) direct addition of the chemicals or as contaminants or degradation products of 2,4-D used for aquatic weed control, and (3) wet and dry atmospheric fallout.

2-Chlorophenol may be removed from water by several mechanisms. One study indicates that the dissipation of 2-chlorophenol is largely microbiological. Persistence appears to be short, but limnological factors, such as oxygen deficiency, may delay degradation. Microorganisms found in activated sludge and waste lagoons have been demonstrated to degrade 2-chlorophenol rather readily.

A study has found that low concentrations (1 mg/l) of 2-chlorophenol added to a usual dilution of domestic sewage were not removed during periods of 20 to 30 days, presumably due to the absence of microoganisms capable of attacking the chemical. When a similar concentration was added to polluted river waters, the compound dissipated in 15 to 23 days.

Addition of a seed, consisting of water from a previous persistence experiment, increased significantly the removal of 2-chlorophenol. Apparently, the seed introduced some organisms already adapted to the chemical. This study also indicated that the removal of monochlorophenols requires the presence of an adapted microflora.

Data is available indicating the dechloroination of 2-chlorophenol and other monochlorophenols within three days of exposure to an activated sludge system.

Toxicity and Exposure - The potential for exposure of man to any synthetic chemical exists through any of several modes. These modes include: 1) exposure of industrial workers during synthesis, formulation, packaging, or transport; 2) exposure of users of the product at either a commercial or retail level; 3) contact with residues or metabolites of the product as a result of using commodities or environments containing the material; and 4) contact with the chemical as a metabolite of some other product.

While a number of studies indicate rapid dissipation of 2-chlorophenol from waters by several mechanisms, human exposure cannot be fully evaluated unless studies are conducted measuring the 2-chlorophenol content in waters receiving wastes from point sources of chlorophenols or their precursors. Evidence of such studies was not found.

Contamination of human foods with 2-chlorophenol could occur via soil, plants, animals, or aquatic sources. In all cases, any contamination is probably indirect and primarily a result of the use and subsequent metabolism of phenoxyalkanoic herbicides.

Although 2-chlorophenol appears to be short lived in soils, the data are inconclusive, and factors affecting its persistence need further study.

The acute toxicity of 2-chlorophenol has been studied in a variety of organisms. The compound is considered to be an uncoupler of oxidative phosphorylation and a convulsant poison. No reports of the subacute or chronic toxicity of 2-chlorophenol have been found.

Trichlorophenol

Trichlorophenol ($CHCl_3$), also known as chloroform or trichloromethane is derived from the reaction of chlorinated lime with acetone, acetaldehyde or ethyl alcohol, or as a by-product from the chlorination of methane. Its uses are: fluorocarbon refrigerants and propellants, fluorocarbon plastics, solvent, analytical chemistry fungant and insectides.

Aquatic Transportation and Fate - In an 80 city study, chloroform was found in all finished drinking water supplies produced from raw water which had been chlorinated. Chloroform concentrations in the influent and effluent of the Cincinnati, Ohio sewage treatment plant where chlorination was practiced were 9.3 µg/l and 12.1 µg/l, respectively. Much higher levels of chloroform have been found in wastewater effluents and also as the result of accidental industrial spills.

Researchers reviewed the incidence, significance, and movement of chlorinated hydrocarbons in the food chain. They concluded that chloroform is widely distributed in the environment and is present in fish, water birds, marine mammals, and various foods.

In food, the typical range of chloroform was 1 to 30 µg/kg. The highest concentration noted was in Cheshire cheese, at 33 µg/kg. It was concluded that chloroform levels in food would not be acutely toxic to humans.

Pearson and McConnell (1975) also reviewed the incidence of chlorinated hydrocarbons in various marine organisms and water birds and found that the concentrations of chloroform in edible fish and marine organisms ranges from 3 to 180 µg/kg.

It was estimated that the consumption of products such as bread derived from chloroform treated (as a fumigant) grains would contribute 0.56 μg of chloroform per day to the adult human diet. This number was derived assuming: (1) consumption of 140 g of bread per day, (2) a chloroform level of 0.4 μg/g in the bread where chloroform was used as the grain fumigant, and (3) chloroform comprises only one percent of total fumigant use in the United States.

Toxicity and Exposure - Human exposure to chloroform may be via inhalation, ingestion, or by cutaneous contact.

Chloroform is well absorbed via the respiratory system (49 to 77 percent). In an early study (1910), chloroform required 80 to 100 minutes to reach equilibrium between blood concentration and inhaled air concentration. Chloroform absorption from the gastrointestinal tract approximates 100 percent (Fry, et al. 1972).

The National Institute for Occupational Safety and Health (NIOSH) Criteria Document (1974) contains a tabulation of the effects of chronic chloroform exposure on humans. One 33 year old male, who habitually had inhaled chloroform for 12 years, was noted to have the psychiatric and neuroligic symptoms of depression, loss of appetite, hallucination, ataxia, and dysarthria. Other symptoms from habitual use are moodiness, mental and physical sluggishness, nausea, rheumatic pain, and delirium.

Most human toxicological data have resulted from the use of chloroform as a general anesthetic in operations. Delayed chloroform poisoning has often occurred after delivery in obstetrical cases. The delayed toxic effects were usually preceded by a latent period ranging from a few hours to one day. Initially drowsiness, restlessness, jaundice, and vomiting occurred, followed by fever, elevated pulse rate, liver enlargement, abdominal tenderness, delirium, coma, and abnormal findings in liver and kidney function tests were also reported. Death often ensued, three to ten days post partum. Autopsy reports generally described the liver as having a bright yellowish color, fatty infiltration with necrosis was found. Other hepatotoxic effects have been reviewed (NIOSH, 1974).

2,4-Dimethylphenol

2,4-Dimethylphenol (2,4-DMP), ($C_6H_3(CH_3)_2OH$), also known as 2,4-xylenol, is found, along with several other isomers of dimethylphenol, in complex mixtures derived from coal and petroleum sources. 2,4-Dimethylphenol is a natural product found in cresylic acids derived from coal and petroleum sources. Except for one manufacturer, 2,4-dimethylphenol is not separated from the cresylic acids, but is left in this mixture of cresols, dimethylphenols and phenols. Based on 1976 figures, the total production of dimethylphenols, was approximately 5000 metric tons. Cresylic acid, along with its constituent 2,4-dimethylphenol, is used in the manufacture of solvents, plasticizers, disinfectants, and pesticides, as well as many other miscellaneous uses. It is also found in lubricants, gasolines, and other fossil fuel derived products. Pure 2,4-dimethylphenol is mainly used in the manufacture of pharmaceuticals and as a chemical intermediate.

Aquatic Transport and Fate - Because relevant data are lacking, the aquatic fate of 2,4-dimethylphenol must be inferred from its physical properties and from the behavior of structurally similar compounds. 2,4-Dimethylphenol is transported to the aquatic environment via direct discharge in industrial effluents, leaching from soil, and by atmospheric rainout. Because of its low vapor pressure (0.0621 torr at 20°C) and moderately high water solubility (at least 1000 mg/l at 20°C), volatilization of 2,4-dimethylphenol from water is not expected to be significant. Based on studies with similar compounds, 2,4-dimethylphenol should not sorb to inorganic clay and sediments; however, it may sorb to organic detritus and sediments as indicated by its relatively high log octanol/water partition coefficient of 2.5. The log octanol/water partition coefficient also indicates that 2,4-dimethylphenol may have a tendency to be sorbed by aquatic organisms; however, no information concerning the bioaccumulation of 2,4-dimethylphenol has been reported.

The two most important fate mechanisms for 2,4-dimethylphenol in the aquatic environment are probably photooxidation and biodegradation. Based on the photolytic behavior of structurally similar compounds such as toluene, 2,4-dimethylphenol should undergo photooxidation in well aerated, clear surface waters. Data concerning biodegradation are somewhat conflicting and inconclusive. Cultures of microorganisms obtained from garden soil, compost, river mud, activated sludge, and the sediment of a petroleum refinery waste lagoon were all shown to be capable of degrading 2,4-dimethylphenol. However, a series of experiments attempting to duplicate the conditions for biodegradability that would occur in a river indicated that 2,4-dimethylphenol seemed to be very persistent.

Toxicity and Exposure - Although the data are limited, adverse health effects of 2,4-DMP have been demonstrated. Oral LD_{50} values for 2,4-dimethylphenol of 3,200 mg/kg for the rat and

809 mg/kg for the mouse have been reported. Pathological changes as a result of exposure to acute toxic levels of 2,4-dimethylphenol are not available; however, information for high doses of other dimethylphenol isomers, in general, shows kidney, spleen, and heart cell damage. In a carcinogenic bioassay, 12% of specially bred mice exposed to 2,4-dimethylphenol dissolved in benzene developed carcinomas; however, benzene was not evaluated by itself. In a related study, 2,4-dimethylphenol, when initiated with a single subcarcinogenic dose of 7,12-dimethylbenz(a)anthracene (DMBA) produced carcinomas in 18% of the mice, indicating that 2,4-dimethylphenol may be a promoting agent for carcinogenesis. No data are available on possible mutagenic, teratogenic, or other reproductive effects of 2,4-dimethylphenol.

Data pertaining to mammalian exposure and toxicity to 2,4-dimethylphenol are limited. Although 2,4-dimethylphenol has been detected in drinking water, the data is limited and no specific estimates are available on the amounts of 2,4-dimethylphenol ingested in drinking water. Although it is produced naturally in some plants, such as tea and tobacco, there is no evidence to suggest that 2,4-dimethylphenol occurs in many plants used for food, though it may be assumed that trace amounts are ingested. Inhalation, as a result of cresol vapors, cigarette smoke and vapors from the combustion of building materials and fossil fuels, is a possible route of mammalian exposure. Even though adverse health effects have been reported as the result of exposure of workers to complex mixtures containing dimethylphenols, the compounds were present in low concentrations relative to other hydrocarbons and the adverse effects were not attributed to dimethylphenol. No quantitative estimates have been made of the amounts of 2,4-dimethylphenols inhaled by the general population. Dermal absorption of 2,4-dimethylphenol is rapid and thought to be the primary route of human exposure to complex mixtures containing the chemical. In 1978, NIOSH estimated that 11,000 workers were occupationally exposed to cresol containing 2,4-DMP.

2,4,6,-Trichlorophenol

Production data for 2,4,6-trichlorophenol are confidential; however, the production in 1977 was estimated to be as high as 16,000 metric tons.

2,4,6-Trichlorophenol is used directly as a germicide, wood preservative, glue preservative, insecticide ingredient, and antimildew treatment for textiles. It is also used as an intermediate in the synthesis of certain pesticides and disinfectants.

Although no environmental emmission estimates are available for 2,4,6- trichlorophenol, available data indicate that various chlorinated phenols, including 2,4,6-trichlorophenol, are formed during the biological degradation and transformation of several pesticides. 2,4,6-Trichlorophenol is also reported to be formed during the chlorination of wastewater and drinking water for disinfection.

Transport and Fate - Microbial degradation has been demonstrated in soil samples and in acclimated sewage sludge but it is uncertain as a fate process in ambient surface waters. Similarly, photolysis of 2,4,6-trichlorophenol and related compounds has been reported in the laboratory, but the environmental relevance of this process is uncertain. Other fate processes probably do not contribute significantly to the aquatic fate of this compound.

Due to its moderate solubility in water (800 mg/l at 25°C) and low vapor pressure (1 torr at 76.5°C) volatilization is not considered to be a significant transport process for 2,4,6-trichlorophenol. Although the value of the log octanol/water partition coefficient for 2,4,6-trichlorophenol (log P=3.38) indicates a definite potential for 2,4,6-trichlorophenol sorption to organic sediments and particulates and for bioaccumulation, no data are available indicating that these processes remove significant amounts of 2,4,6-tichlorophenol from water.

Toxicity and Exposure - There are no available data on human exposure levels to 2,4,6-trichlorophenol. It can be formed during the chlorination of drinking water, and it has been detected in drinking water but the amount was not quantified. Exposure to certain pesticides and disinfectants could result in exposure to 2,4,6-trichlorophenol via metabolic degradation of the parent compound.

Benzene

Benzene (C_6H_6) is thirteenth in order of high volume chemicals produced in the United States. It is derived from fractional distillation of coal tar, catalytic reforming of petroleum and other methods.

Tranport and Fate - Benzene is slightly soluble in surface waters and may volatilize from water to the atmosphere, where it may then wash out with precipitation to surface water. Benzene accumulates in aquatic organisms; for example, it accumulates up to 8,450 times in the gall bladder of the Northern Anchovy. The rate of biodegradation for benzene in the aquatic environment is slow, and thus, any benzene remaining in water is likely to be persistent.

Toxicity and Exposure - Humans and animals may be exposed to benzene in air because of its volatility. Inhalation may cause depression of the central nervous system, resulting in paralysis of the respiratory system and death. At 20,000 ppm, benzene can be fatal in a few minutes. Benzene is a mutagen and a suspected carcinogen in man. The National Institute for Occupational

Safety and Health (NIOSH) has recommended a 1-ppm limit for worker exposure to benzene in air.

When benzene is discharged to surface water, it can be toxic to aquatic life, humans, and other animals through ingestion or inhalation. Because benzene is not completely removed by current waste treatment facilities, drinking and irrigation water exposes humans to benzene; it has been detected in drinking water.

Toluene

Toluene (C_7H_8) is the seventeenth highest volume chemical produced in the United States. Its derivation is by catalytic reforming of petroleum and by fractional distillation of coal tar light oil.

Transport and Fate - Because it is slightly soluble, toluene discharges to surface water will form a colorless slick, dissolving slowly into the water column. Toluene readily volatilizes from water to the atmosphere (half-life in water may be on the order of 31 minutes to 5 hours). Where toluene is subject to photochemical degradation, primarily forming benzaldehyde, the half-life may be about 12 hours. Sorption onto suspended particulates may be an important transport process, but it is unclear how sorption competes with volatilization. Biodegradation of toluene may occur in water. Bioaccumulation of toluene occurs in the marine mussel, and may occur in freshwater aquatic organisms as well.

Toxicity and Exposure - Toluene is moderately toxic to humans when ingested or inhaled. The lowest calculated dose lethal to humans is 50 mg/kg when ingested. Inhalation of 200 ppm can cause central nervous system depression, while increased exposure may induce narcosis, addiction, and death. The Occupational Safety and Health Administration has set 200 ppm in air as the upper limit value for the safety of workers occupationally exposed to toluene.

Benzo(a)pyrene

Benzo(a)pyrene ($C_{20}H_{12}$) is a polynuclear aromatic compound found in coal tar, cigarette smoke and in the atmosphere as a product of incomplete combustion.

Transport and Fate - Very little benzo(a)pyrene dissolves in surface water due to its extreme insolubility. Most of it quickly adsorbs onto suspended sediments and other particulates. In this form, it is available for bioaccumulation by aquatic species. In a laboratory model ecosystem, marine snails accumulated benzo(a) pyrene to 2177 times the ambient water concentration; benzo(a)pyrene was bioconcentrated 882-fold in freshwater worms.

Toxicity and Exposure - Although there is no firm evidence that benzo(a)pyrene is carcinogenic to man, coal tar and other materials containing this compound and other polynuclear aromatic hydrocarbons are human carcinogens. Benzo(a)pyrene is carcinogenic to mice, rats, hamsters, and other lab animals when they are exposed to doses as low as 1 mg/kg, and it produces more tumors in a shorter period of time than other polynuclear aromatic hydrocarbons. Benzo(a)pyrene is a teratogen and mutagen in laboratory rats, mice, and rabbits.

Human exposures to benzo(a)pyrene come from many sources including fuel exhaust, air, food crops, and drinking water. The World Health Organization recommends 0.2 μg/l as the maximum level of total polynuclear aromatic hydrocarbons safely allowed in drinking water. There are no data available on the amount of benzo(a)pyrene entering the human body from these sources.

Chrysene

Chrysene (also known as 1,2-benzphenanthrene or benzo(a)phenanthrene) ($C_{18}H_{12}$) is a polynuclear aromatic hydrocarbon (PNA) of man-made and perhaps natural origin.

Man is exposed to chrysene and other PNAs from many sources including automobile and diesel exhaust, incinerator effluents, food crops, cigarette smoke, and water.

Transport and Fate - Polynuclear aromatics (PNAs) such as chrysene enter aquatic systems from the atmosphere adsorbed onto particulates and bacteria and exist in water in association with organic matter or colloids formed from synthetic detergents. That portion of chrysene which is dissolved in water probably photolyzes like other PNAs, but because of the relative aqueous insolubility of chrysene, this may not be a significant removal process.

In general PNA compounds are believed to be incorporated and metabolized by organisms throughout the phylogenetic scale. Chrysene's log partition coefficient (log P) of 5.61, together with the theoretical and empirical data that compounds with high log P values tend to accumulate in biota, indicate that chrysene is bioaccumulated. Unlike persistent chlorinated organics such as DDT and the PCBs, PNAs, once bioaccumulated, appear to be metabolized and eliminated from the organism. Thus bioaccumulation is not considered an important fate process.

In mammals metabolism of PNAs is incomplete, the major products being hydroxylated derivatives and epoxides. Both parent compounds and these metabolites are excreted via the urinary system. Bacteria have been shown to utilize PNA compounds as a carbon source, and evidence indicates that they can metabolize PNAs much more completely than mammals. Although microbes are capable of degrading tricyclic aromatic hydrocarbons, they probably do not degrade higher polynuclear hydrocarbons such as chrysene.

Toxicity and Exposure - Although there is no firm evidence that individual PNAs are carcinogenic in man, chrysene and other PNAs are present in coal tars and pitch which are known human carcinogens. Tests with laboratory mice show chrysene to be carcinogenic.

The World Health Organization recommends 0.2μg/1 as the maximum safe level of total PNAs in surface water to protect aquatic life.

Naphthalene

Naphthalene is a polynuclear aromatic compound ($C_{10}H_8$). It is derived from distillation and crystallization of coal tar, and from petroleum fractions after various catalytic processing operations.

Naphthalene is found in treated effluents, and drinking and surface waters. It is toxic to aquatic organisms, tumorogenic to mammals, and can taint fish flesh.

Transport and Fate - Naphthalene is slightly soluble in water and when discharged to surface water, will adsorb onto suspended particulate matter where it is subject to metabolism by microorganisms. Volatilization and photolysis may be important fates for the dissolved portion.

Toxicity and Exposure - There is no evidence that naphthalene is carcinogenic to man, although coal tar and other materials that contain naphthalene and other polynuclear aromatic hydrocarbons are human carcinogens. While no data were found specifically linking cancer to naphthalene, it is toxic to humans and other mammals.

Human exposure to polynuclear aromatic hydrocarbons, including naphthalene, comes from many sources such as car exhaust, incinerator effluents, food crops and water. Inhalation exposure by workers to naphthalene is regulated by the Occupational Safety and Health Administration which has set 10 ppm in air as the upper limit for health and safety.

Polynuclear Aromatics (PNAs)

Fluoranthene, fluorene, phenanthrene, pyrene, anthracene, benzo(k)fluoranthene, benzo(b)fluoran-thene, indeno(1,2,3-cd) pyrene, benzo(ghi)perylene, benzo(b) anthracene, dibenzo(ah)anthracene, acenaphthylene and acenapthene are polynuclear aromatic hydrocarbons. As a group, polynuclear aromatic hydrocarbons are known to be toxic, mutagenic, teratogenic, and carcinogenic to aquatic organisms and mammals. Little information exists specific to fluoranthene, and its probable environmental effects are, for the most part, inferred from data on polynuclear aromatic hydrocarbons as a group. Fluorene is thought to be an inactive carcinogen; its carcinogenic properties are activated in the presence of other polynuclear aromatic hydrocarbons.

Transport and Fate - Polynuclear aromatic compounds are relatively insoluble in water and when discharged to surface waters will strongly adsorb onto suspended particulate matter. Volatilization from the sorbed state is thought to be very slow and they will likely remain with and be transported by the suspended particulates. In this form, polynuclear aromatic hydrocarbons are available for bioaccumulation and biotransformation. Direct photolysis of the smaller dissolved portion may occur, although evidence is taken from other polynuclear aromatic hydrocarbons (e.g., benzo(a)pyrene). While bioaccumulation factors for polynuclear aromatic hydrocarbons have been reported as high as 2177 in laboratory ecosystems, they are in general rapidly metabolized or depurated from an aquatic organism. Long-term bioaccumulation, such as that reported for some chlorinated organics (e.g., DDT and PCBs), is not thought to be an important fate process. Biodegradation of polynuclear aromatic compounds is known to occur and is believed to be their ultimate aquatic fate.

Toxicity and Exposure - There is no firm evidence that polynuclear aromatic hydrocarbons are carcinogenic to man, although coal tar and other materials that contain fluoranthene and other polynuclear aromatic hydrocarbons are human carcinogens. While no data were found specifically linking cancer to fluoranthene, it is known to be toxic to laboratory animals. Human exposure to polynuclear aromatic hydrocarbons comes from fuel exhaust, industrial air, food crops and water.

Ethylbenzene

Ethylbenzene ($C_6H_5C_2H_5$) is the twentieth highest volume chemical produced in the United States. It is derived by heating benzene and ethylene in the presence of aluminum chloride and by fractionation directly from the mixed xylene stream in petroleum refining.

Transport and Fate - Ethylbenzene forms a colorless slick on surface waters because it is slightly soluble. Some of it probably adsorbs slowly to suspended particulates, although adsorption rates are not available. Vapor pressure data suggest that ethylbenzene is likely to volatilize from the water column, though rates are unavailable. Bioaccumulation of ethylbenzene is unlikely.

Toxicity and Exposure - Humans absorb ethylbenzene through the skin after exposure to the pure liquid or aqueous solution at rates of 22 to 33 $mg/cm^2/hr$ and 0.118 to 0.215 $mg/cm^2/hr$, respectively. Such exposure to the skin of a rabbit is lethal at

5000 mg/kg. Ethylbenzene taken orally at 3.5 g/kg is acutely toxic to rats, and chronic exposure induced changes in the liver and kidneys of rats.

Humans are adversely affected by ethylbenzene in air, through inhalation or skin contact. Ethylbenzene can irritate the eyes, affect the respiratory tract, and cause vertigo. Human health effects occur at 100 ppm with 8 hours of exposure. The Occupational Safety and Health Administration (OSHA) has set 100 ppm in air as a limit to protect workers, although adverse effects on the skin may occur at lower concentrations.

Copper

Copper (Cu) is a metallic element. It occurs naturally as an ore and its derivation is dependent on the type of ore.

Transport and Fate - Several processes determine the fate of copper in the aquatic environment, including complex formations, sorption to hydrous metal oxides, clay, and organic materials, and bioaccumulation. Sorption processes are most active in scavenging dissolved copper from solution and thus control its mobility. The effectiveness of the various sorption processes is dependent on pH, oxidation-reduction potential, and the concentration of inorganic and organic materials. Bioaccumulation of copper by various species has been demonstrated.

Toxicity and Exposure - Copper is toxic to many types of aquatic organisms and has been used as an effective algicide. It is usually more toxic in soft water than hard water.

Copper in trace amounts is essential for humans. Larger amounts, however are toxic; acute copper poisoning can result in nausea, vomiting, diarrhea, liver enlargement, kidney failure, and hemolytic anemia. Humans exposed for several months to 4 to 7.6 mg/l of copper in their drinking water developed a prominent skin rash.

Chromium

Chromium (Cr) is a metallic element. It is derived from chrome iron ore by direct reduction, by reducing the oxide with finely divided aluminum or carbon and by electrolysis of chromium solutions.

Transport and Fate - Chromium is usually found in the trivalent and hexavalent forms in the aquatic environment.

The hexavalent form is quite soluble in water and is thus quite mobile in the aquatic environment. It is not sorbed to any significant degree by clays or hydrous metal oxides, but it sorbs strongly to activated carbon and therefore may sorb to organic material. In organic-rich, sulfide-rich, or reducing waters the hexavalent form is converted to the trivalent form.

The trivalent form is readily hydrolyzed to form insoluble compounds, and precipitation of this material to the sediment is thought to be the dominant fate of trivalent chromium in natural waters. The trivalent form can also be removed from the water column by sorption onto inorganic materials. The trivalent form does form soluble complexes with a variety of organic materials but this is probably not a significant process. Both forms of chromium can also be accumulated by aquatic organisms. Bioconcentration factors as high as 152 have been reported in marine organisms.

It appears, therefore, that chemical speciation plays a dominant role in the fate of chromium in the aquatic environment. Conditions favorable for the hexavalent form will keep chromium in a soluble form in the water, while conditions favorable for the trivalent form will lead to accumulation of chromium in the sediments.

Toxicity and Exposure - The data base for the aquatic toxicity of chromium is fairly extensive. Both trivalent and hexavalent chromium are toxic to aquatic organisms. Trivalent chromium is substantially more toxic to aquatic life in soft than in hard water. The effect of water hardness on the toxicity of hexavalent chromium is not as significant.

Chromium can be absorbed to some extent by the digestive tract, the skin, and the lungs. In general, hexavalent chromium is more readily absorbed by body tissues than trivalent chromium, presumably because of its greater solubility and ease of movement across biological membranes. Once within cells, hexavalent chromium is likely to be converted to the trivalent form. Absorption of chromium from the digestive tract is slight and may amount to only a few percent of the ingested dose.

Arsenic

Arsenic (As) is a metallic element. It is derived from flue dust of copper and lead smelters, as arsenic trioxide. Arsenic trioxide is reduced to the element with charcoal.

Transport and Fate - Arsenic is characterized by its extreme mobility and cycling through the water column, sediments, and biota. The prevailing redox and pH conditions are important in determining the forms in which arsenic will be present in the dissolved and solid phase. In the surface layer of the aquatic environment where oxidizing conditions prevail, the dominant species is arsenate. This arsenate can either be transported by dispersion and convection to the oxygen depleted region where reduction to arsenite occurs or be coprecipitated with ferric hydroxide to the sediment. In the sediment where conditions are normally very reducing, chemical reduction of ferric arsenate and arsenite results in solubilization or stabilization as an insoluble sulfide or arsenic metal. Microbial transmethylation or reduction of the sulfide or metal to arsine mobilizes the remaining arsenic and thus returns it to the cycle. Because of its continuous resolubilization, much if not all of the arsenic introduced to the environment eventually ends up in the ocean. Fish and invertebrate aquatic species enter this cycle by concentrating arsenic, especially trimethylarsine. When discharged to a publicly owned treatment works (POTW), arsenic is likely to be distributed in both the sludge and the effluent. The form of arsenic is not known, but since most arsenic compounds are unstable toward oxidation in the aquatic environment, it is likely that the dominant species in a POTW will be arsenate (+5) or arsenite (+3).

Toxicity and Exposure - In humans, the trivalent form (arsenite) is reported to be 60 times more toxic than the pentavalent form (arsenate). Symptoms of acute arsenic poisoning by ingestion include abdominal pain and vomiting. Acute poisoning by inhalation causes giddyness, headache, extreme general weakness and, later nausea, vomiting, colic, diarrhea, and pain in the limbs. Chronic ingestion causes loss of weight, gastrointestinal disturbances, pigmentation and eruptions of the skin, hair loss, and peripheral neuritis. Exposure to arsenic in drinking water has been shown to result in a higher incidence of certain types of cancer, in particular epithelial lesions.

Arsenic is ubiquitous in the environment and found in all plants and animals. Arsenic may reach the aquatic environment through atmospheric fallout, industrial emissions and the improper application of arsenical herbicides and pesticides.

Poisoning of domestic animals by arsenic appears to occur with a frequency second only to poisoning by lead. It appears to be limited for the most part to forage contaminated by arsenical herbicides, pesticides, and feedstock supplemented by improper amounts of phenylarsonic acid. Because of the numerous factors that influence toxicity of arsenic, it is virtually impossible to specify toxicity in terms of body weight. The lethal ingested dose for most species, however, appears to range between 1 and 25 mg/kg of body weight as sodium arsenite.

Lead

Lead (Pb) is a metallic element. It is derived by the roasting and reduction of lead sulfate, lead sulfide and lead carbonate.

Transport and Fate - The most important physical process controlling the aquatic fate of lead and its compounds is adsorption by the particulate phase followed by deposition in the sediment. Because this process occurs rapidly, lead generally remains in the vicinity of the source. In severely contaminated areas, precipitation may also play a role in removal from solution. Salts of lead are generally not very soluble except at low pH, a situation encountered infrequently in natural waters. Benthic microbes can remobilize lead from the sediment by bioaccumulation or by biomethylation to tetramethyl lead. The latter may either be reoxidized as it moves to the aerobic region of the water column or be volatilized to the atmosphere. Although lead can be passed along the food chain, it is not biomagnified. Bioconcentration factors fall between 60 and 1000 for several aquatic species. Bioaccumulation may play a bigger role in the fate or lead under acidic conditions where lead salts are either more soluble or less adsorbed.

Toxicity and Exposure - Lead poisoning in humans may cause several well known but nonspecific clinical syndromes such as acute abdominal pain, acute or chronic encephalopathy, peripheral neuropathy and chronic nephropathy. Children are in general more susceptible to lead poisoning because, 1) they are more likely to exhibit neurotoxic symptoms, 2) they absorb more lead from food, 3) they mobilize more lead from that accumulated in the body, 4) they have a greater caloric intake and hence food intake on a body surface area basis and 5) their intake is not limited to food but may also include street dust, flakes of paint, etc. Unlike most heavy metals, lead crosses the placenta with blood levels in newborn children closely correlated with those of their mothers.

There is considerable evidence from laboratory studies that lead is carcinogenic, mutagenic, teratogenic and may even cause reproductive impairment. In pregnant laboratory rats malformations in fetuses were observed following intravenous injection of 50 mg/kg of lead nitrate. Ingestion of lead acetate and subcutaneous injection of tetraethyl lead may lead to kidney and lung tumors and various other malignancies. Cultures of human leukocytes obtained from workers exposed to fumes in a storage battery plant exhibited increased chromosomal abnormalities. Another study showed alterations in spermatogenesis and subsequent loss of ferility in 150 occupationally exposed men.

Zinc

Zinc (Zn) is a metallic element. It is derived by one of two main processes, toasting followed by either (1) pyrometallurgical or distillation process, or (2) hydrometallurgical or electrolytic process.

Fate and Transport - The potential for exposure to zinc is linked in part to its fate in the aquatic environment. Removal from solution through adsorption by hydrous iron and manganese oxides, clay minerals, and organic material is the dominant fate process for zinc in aerobic waters. The effectiveness of adsorption depends upon the composition of the absorbing matrix, pH, redox potential, salinity, concentration of available ligands, and concentrations of zinc. Above a pH of 7, zinc is almost completely adsorbed from solution by sediment or soils; below pH

6, where zinc is present predominantly as Zn++, very little is adsorbed. As salinity increases, zinc is also desorbed from sediment. Generally speaking, since salts of zinc are highly soluble in aerobic waters precipitation will play a minor role in determining the fate of zinc. However, in reducing conditions, precipitation of the sulfide may occur, or when certain ligands are present, highly soluble complexes may be formed, thereby decreasing the process of precipitation which in turn will favor adsorption of zinc.

Zinc is bioaccumulated by all organisms and passed along the food chain. Uptake via the food chain appears to be the most important route for fish, whereas uptake from sea water appears to be the preferred route for zooplankton. Even though the biota represent a relatively minor sink when compared to the sediment, they may play a significant role in the mobility of zinc. Microcosm studies generally indicate that zinc is not biomagnified.

Toxicity and Exposure - Zinc and its compounds are toxic to mammals including humans. Although death in humans may occur, the most commonly observed effects of zinc poisoning are nonfatal metal fume fever caused by inhalation of zinc oxide fumes, various illnesses (congestion of the lung, liver, spleen, and brain) caused by ingestion of acidic foods prepared in zinc galvanized containers, and dermatitis by contact with zinc salts.

Nickel

Nickel (Ni) is a metallic element. It is derived by flotation and roasting of nickel ores, or by leaching with ammonia.

Transport and Fate - As an element, nickel cannot be degraded in the aquatic environment and appears to be a relatively mobile heavy metal. Although it has several known oxidation states, nickel in the aqueous environment exists primarily in the divalent state. Sorption and precipitation do not appear to be as effective in reducing aqueous nickel concentrations as they are with many other heavy metals (e.g., copper and chromium). However, the hydrous oxides of iron and manganese may exert some control over the mobility of nickel via co-precipitation and sorption. Precipitation of nickel compounds may be important in reducing environments, where the insoluble sulfide is formed. Nickel may be bioaccumulated by some aquatic organisms, but most concentration factors are less than 1000. Because these processes occur with only low or moderate efficiencies, most nickel added to the aqueous environment eventually goes to the ocean.

Toxicity and Exposure - A wide variety of physiological effects have been linked with exposure of mammals to nickel and its compounds. Exposure in laboratory animals, following both inhalation and ingestion by other routes, has caused lung congestion, inhibition of insulin release, depressed growth, carcinogenesis, and death. In humans, airborne nickel may cause throat irritation, weakness, fever, headache, nausea, muscle and joint pain, eczema or dermatitis, and vomiting. In addition, it is suspected that nickel inhalation leads to lung and nose cancer. Nickel carbonyl, an extremely volatile compound, is by far the most toxic of the nickel compounds and is approximately 5 times as toxic as carbon monoxide. Therefore, inhalation can lead to high concentrations of elemental nickel in the lungs.

CONVENTIONAL POLLUTANTS

Biochemical Oxygen Demand (BOD)

Biochemical oxygen demand is the quantity of oxygen required for the biological and chemical oxidation of waterborne substances under ambient or test conditions. Materials which may contribute to the BOD include: carbonaceous organic materials usable as a food source by aerobic organisms; oxidizable nitrogen derived from nitrites, ammonia, and organic nitrogen compounds which serve as food for specific bacteria; and certain chemically oxidizable materials such as ferrous iron, sulfides, sulfite, etc., which will react with dissolved oxygen or which are metabolized by bacteria. In timber industry wastewaters, the BOD derives principally from organic materials leached from the wood raw material.

The BOD of a waste adversely affects the dissolved oxygen resources of a body of water by reducing the oxygen available to fish, plant life and other aquatic species. It is possible to reach conditions which totally exhaust the dissolved oxygen in the water, resulting in anaerobic conditions and the production of undesirable gases such as hydrogen sulfide and methane. The reduction of dissolved oxygen can be detrimental to fish populations, fish growth rate, and organisms used as fish food. A total lack of oxygen due to excessive BOD can result in the death of all aerobic aquatic inhabitants in the affected area.

Water with a high BOD indicates the presence of decomposing organic matter and associated increased bacterial concentrations that degrade its quality and potential uses. High BOD increases algal concentrations and blooms; these result from decaying organic matter and form the basis of algal populations.

The BOD_5 (5 day BOD) test is used widely to estimate the oxygen requirements of discharged domestic and industrial wastes. Complete biochemical oxidation of a given waste may require a period of incubation too long for practical analytical test purposes. For this reason, the 5 day period has been accepted as standard, and the test results have been designated as BOD. Specific chemical test methods are not readily available for measuring the quantity of many degradable substances and their reaction products. In such cases, testing relies on the collective parameter, BOD. This procedure measures the weight of dissolved oxygen utilized by microorganisms as they oxidize or transform the gross mixture of chemical compounds in the wastewater. The biochemical reactions involved in the oxidation of carbon compounds are related to the period of incubation. The 5 day BOD normally measures only 60 to 80 percent of the carbonaceous biochemical oxygen demand of the sample, and for many purposes this is a reasonable parameter. Additionally, it can be used to estimate the gross quantity of oxidizable organic matter. Throughout this document BOD_5 is expressed as BOD.

Some treated wastewaters result from treatment systems designed to remove ammonia through the nitrification process. In some cases, the nitrifying bacteria present can exert an additional noncarbonaceous, nitrogenous oxygen demand (NOD), within the prescribed 5 day incubation period. In these instances, special inhibitors are added to standard dilution waters to ensure the measurement only of carbonaceous organic matter. Ultimate BOD, which is measured after a 20 day incubation period, tests for aggregate measurement of both carbonaceous and nitrogenous oxygen demand when nitrification inhibitors are not added to standard dilution waters. Ultimate BOD is important in the evaluation and design of biological treatment systems. Ultimate BOD can also be useful in estimating the total dissolved oxygen demand of wastewaters discharged to receiving streams with long residence periods.

Oil and Grease

Oil is a constituent of both creosote and pentachlorophenol petroleum solutions which occurs in either a free or an emulsified form in wood preserving wastewaters. Concentrations ranging from less than 100 mg/liter to well over 1000 mg/liter are common after primary oil separation. Many of the toxic pollutants found in wood preserving wastewaters, such as pentachlorophenol and polynuclear aromatics, are much more soluble in the oil phase than in the water phase of the waste stream. Oil and grease in the wastewater, therefore, serves as a carrier of these toxic pollutants. The key to satisfactory control of toxic and conventional pollutants in wood preserving wastewaters is the removal of as much free and emulsified oil and grease as possible.

Data from recent sampling programs indicate that removal of oil and grease from indirect discharging wood preserving plants to levels below 100 mg/l will result in control of PCP to levels consistent with this compound's solubility in water (approximately 15 mg/l) and will result in control of total toxic pollutant PNAs to approximately one milligram per liter.

Aside from the fact that oil and grease in wood preserving wastewaters serves as a carrier for toxic pollutants, the compounds which comprise the oil and grease phase can settle or float in receiving waters and may exist as solids or liquids. Even in small quantities, oil and grease causes troublesome taste and odor problems. They produce scum lines on water treatment basin walls and other containers and adversely affect fish and water fowl. Oil emulsions may adhere to the gills of fish, causing suffocation, and may taint the flesh of fish microorganisms that were exposed to waste oil. Oil deposits in the bottom sediments of water can serve to inhibit normal benthic growth. Oil and grease exhibit an oxygen demand.

Oil and grease levels which are toxic to aquatic organisms vary greatly, depending on the type of pollutant and the species susceptibility. In addition, the presence of oil in water can increase the toxicity of other substances discharged into the receiving bodies of water.

Total Suspended Solids (TSS)

Suspended solids may include both organic and inorganic materials. The inorganic compounds may include sand, silt, clay and precipitated metals. The organic fraction may include such materials as wood fibers and unsettled biomass from biological treatment systems.

These solids may settle out rapidly and bottom deposits are often a mixture of both organic and inorganic solids. Solids may be suspended in water for a time and then settle to the bed of the stream or lake. They may be inert, slowly biodegradable materials, or rapidly decomposable substances. While in suspension they increase the turbidity of the water, reduce light penetration, and impair the photosynthetic activity of aquatic plants.

Suspended solids may kill fish and shellfish by causing abrasive injuries, by clogging gills and respiratory passages, by screening out light, and by promoting and maintaining the development of noxious conditions through oxygen depletion. Suspended solids also reduce the recreational value of the water.

Total suspended solids are a significant pollutant parameter in the insulation board and wet process hardboard subcategories of the industry. Raw wastewaters from these subcategories contain high amounts of wood fibers and solids which are not retained in the wet lap or on the forming screen. Additionally, a significant amount of biological suspended solids is generated in the large biological treatment systems common to these subcategories.

pH

Although not a specific pollutant, pH is related to the acidity or alkalinity of a wastewater stream. It is not a linear or direct measure of either; however, it may properly be used to control both excess acidity and excess alkalinity in water. The term pH describes the hydrogen ion hydroxyl ion balance in water. Technically, pH is the hydrogen ion concentration or activity present in a given solution. pH numbers are the negative logarithm of the hydrogen ion concentration. A pH of 7 generally indicates neutrality or a balance between free hydrogen and free hydroxyl ions. Solutions with a pH above 7 indicate that the solution is alkaline, while a pH below 7 indicates that the solution is acidic.

Knowledge of the pH of water or wastewater aids in determining measures necessary for corrosion control, pollution control, and disinfection. Waters with a pH below 6.0 corrode waterworks structures, distribution lines, and household plumbing fixtures. This corrosion can add such constituents to drinking water 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. The hydrogen ion concentration also can affect the taste of water; at a low pH, water tastes "sour." Extremes of pH or rapid pH changes can stress or kill aquatic life. Even moderate changes from "acceptable" pH limits can harm some species. Changes in water pH increase the relative toxicity to aquatic life of many materials. Metalocyanide complexes can increase a thousand-fold in toxicity with a drop of 1.5 pH units. The toxicity of ammonia similarly is a function of pH. The bactericidal effect of chlorine in most cases lessens as the pH increases, and it is economically advantageous to keep the pH close to 7.

The lacrimal fluid of the human eye has a pH of approximately 7.0 and a deviation of 0.1 pH unit from the norm may result in eye irritation for the swimmer. Appreciable irritation will cause severe pain.

Problems of hydrogen sulfide gas evolution and "bulking" of mixed liquor in biological treatment systems may occur if pH of wastewater drops below 6.0. On the other hand, unusually high pH (for instance 11.0) can cause significant loss of active biomass in biological treatment systems, especially activated sludge.

NONCONVENTIONAL POLLUTANTS

Chemical Oxygen Demand (COD)

Chemical oxygen demand is a purely chemical oxidation test devised as an alternate method of estimating the total oxygen demand of a wastewater. Since the method relies on the oxidation-reduction system of chemical analyses, rather than on biological factors, it is more precise, accurate, and rapid than the BOD test. The COD test estimates the total oxygen demand (ultimate) required to oxidize the compounds in a wastewater. It is based on the fact that organic compounds, with a few exceptions, can be oxidized by strong chemical oxidizing agents under acid conditions with the assistance of certain inorganic catalysts.

When an industrial wastewater contains substances which tend to inhibit biological degradation of the carbonaceous substrate, such as wood preserving wastewaters, COD is a more reliable indicator of organic pollutant strength than is BOD.

The COD test measures those pollutants resistant to biological oxidation in addition to the ones measured by the BOD test. COD is therefore a more inclusive measure of oxygen demand than is BOD and results in higher oxygen demand values than the BOD test.

The compounds which are more resistant to biological oxidation are becoming of greater and greater concern, not only because of their slow but continuing oxygen demand on the resources of the receiving water, but also because of their potential health effects on aquatic and human life. Many of these compounds have been found to have carcinogenic, mutagenic, and similar adverse effects, either singly or in combination. Concern about these compounds has increased as a result of demonstrations that their long life in receiving waters--the result of a slow 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 (such as chlorination) may convert them into even more hazardous materials.

Oil and grease contamination from preservative solutions, as well as organic material leached from the wood raw material contribute to the relatively high COD content common to wastewaters from the wood preserving segment.

SECTION VII

CONTROL AND TREATMENT TECHNOLOGY

GENERAL

This section presents a discussion of the range of wastewater control and treatment technology currently in use and available to the wood preserving, and insulation board/wet process hardboard segments of the timber products processing industry. In-plant pollution control is discussed as well as end-of-pipe treatment.

Performance data for plants in each industry segment are presented, as well as technology capable of being transferred from related industries. For the purpose of cost analysis, one or more candidate technologies have been selected for each subcategory. For each technology, achievable treated effluent pollutant concentrations are reported for conventional, nonconventional and toxic pollutants.

It should be noted that there are many possible combinations of in-plant and end-of-pipe systems capable of attaining the pollutant reductions reported for the candidate technologies. The performance levels reported for the candidate treatment technologies are based upon demonstrated performance of similar systems within the industry or upon well documented results of readily transferable technology. These performance levels can be achieved within the industry using the model treatment systems proposed. The model treatment systems serve as a basis for a conservative economic analysis of the cost of achieving the effluent levels reported for the candidate treatment technologies. Each individual plant must make the final decision concerning the specific combination of pollution control measures which are best suited to its particular situation, and should do so only after a careful study of the treatability of its wastewater, including waste characterization and pilot plant investigations.

Pollution abatement and control technologies applicable to the industry as a whole were discussed in earlier Agency documents. Summarized versions, which included updated information on current industry practice, were presented in supplemental studies for wood preserving and hardboard production. The portion of the previous studies which detailed in-plant process changes, waste flow management, and other measures having the potential to reduce discharge volume or improve effluent quality are repeated in this document for the purpose of continuity. Additional information available from the data collection portfolios and/or the verification sampling program is included in order to present the most recent information.

Various treatment technologies that are either currently employed, or which may be readily transferred to the industry, are summarized in this section. Included in this section are descriptions of exemplary plants and, where available, wastewater treatment data for these exemplary plants. This description is followed by a selection of several treatment regimes applicable to each subcategory.

WOOD PRESERVING

In-Plant Control Measures

Reduction in Wastewater Volume--The characteristics of wood preserving wastewater differ among plants that practice open, modified closed or closed steaming. In the modified closed steaming process, steam condensate is allowed to accumulate in the retort during the steaming operation until it covers the heating coils. At that point, direct steaming is stopped and the remaining steam needed is generated within the retort by utilizing the heating coils. Upon completion of the steaming cycle and after recovery of oils, the water from the cylinder is discarded. In closed steaming, after recovery of free oils, the water in the retort at the end of a steaming cycle is returned to a reservoir and is reused instead of being discarded.

The principal advantage of modified closed steaming over open steaming, aside from reducing the volume of wastewater released by a plant, is that effluents from the retorts are less likely to contain emulsified oils. Free oils are readily separated from the wastewater; and, as a result of the reduction in oil content, the oxygen demand and the solids content of the waste are reduced significantly relative to effluents from plants using conventional open steaming. Typical oil and COD values for wastewater from a single plant before and after the plant commenced modified closed steaming are shown in Figures VII-1 and VII-2, respectively. The COD of the wastewater was reduced by about two-thirds when modified closed steaming was initiated. Oil content was reduced by a factor of ten.

Water used in closed steaming operations increases in oxygen demand, solids content, and total phenols concentration with each reuse. The high oxygen demand is attributable primarily to wood extracts, principally simple sugars, the concentration of which increases with each use of the water. Because practically all of the solids content of the waste is dissolved solids, only insignificant reductions in oxygen demand and improvement in color result from treatments involving flocculation. The progressive changes in the parameters for water used in a closed steaming operation are shown in Table VII-1. It is apparent that in time a blowdown of the steaming water is necessary because of the buildup of dissolved materials.

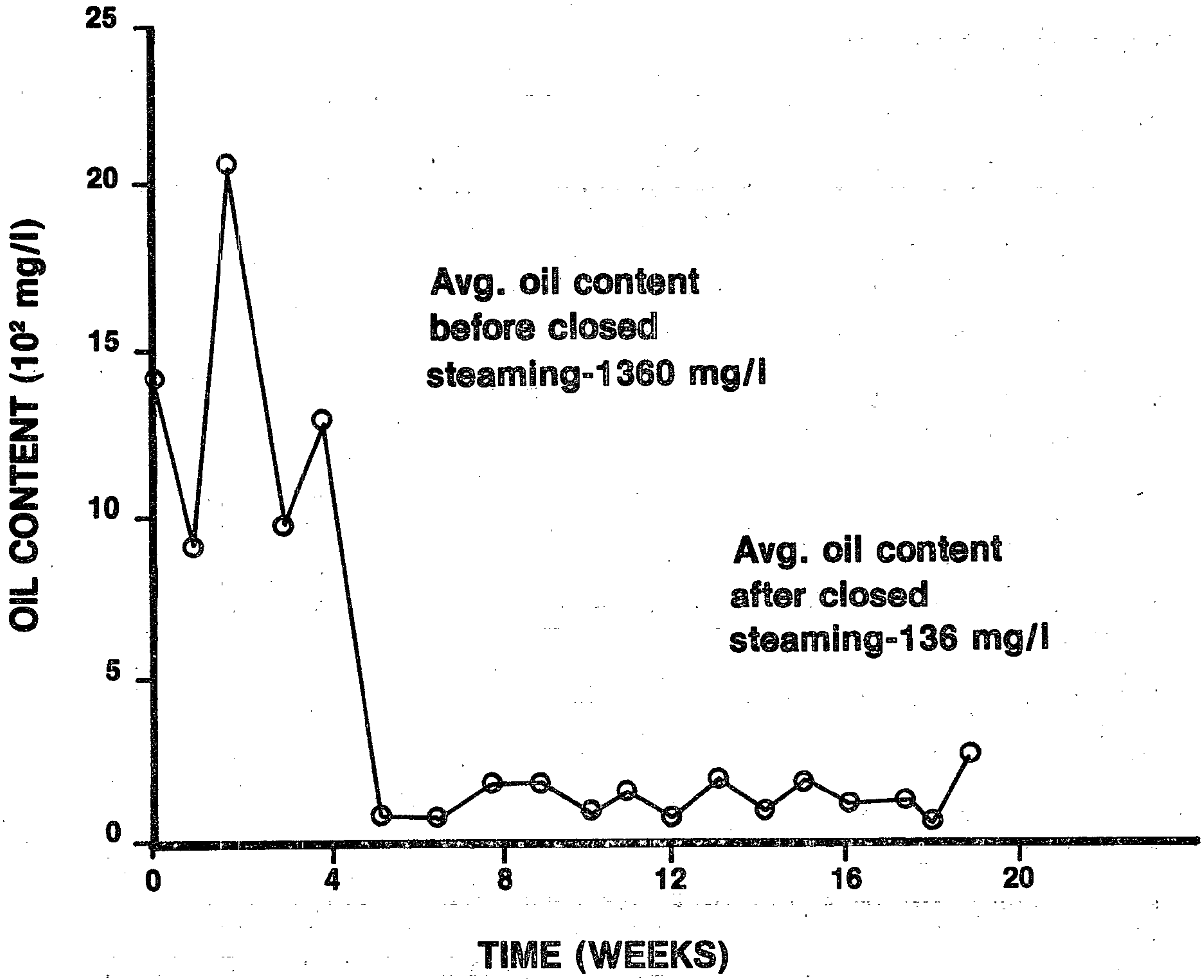


Figure VII - 1 Variation in oil content of effluent with time before and after initiating closed steaming (Thompson and Dust, 1971)

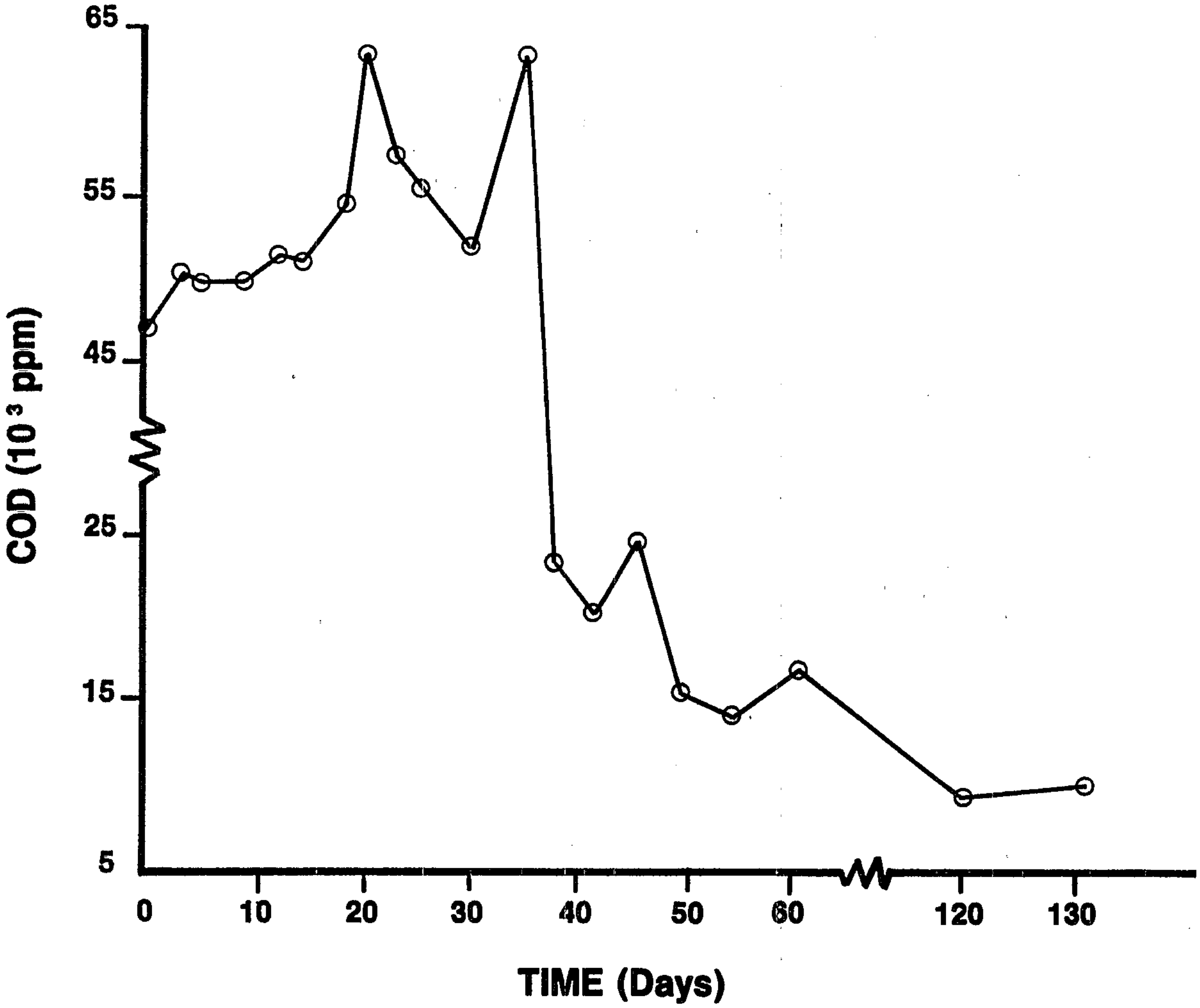


Figure VII - 2 Variation in COD of effluent with time before and after closed steaming: Days 0-35 open steaming; Days 35-130 closed steaming (Thompson and Dust, 1971)

Table VII-1. Progressive Changes in Selected Characteristics of Water Recycled in Closed Steaming Operations

		(mg/liter)		
Charge No.	Total Phenols	COD	Solids	Dissolved Solids
1	46	15,516	10,156	8,176
2	169	22,208	17,956	15,176
3	200	22,412	22,204	20,676
4	215	49,552	37,668	31,832
5	231	54,824	66,284	37,048
7	254	75,856	66,968	40,424
8	315	99,992	67,604	41,608
12	208	129,914	99,276	91,848
13	230	121,367	104,960	101,676
14	223	110,541	92,092	91,028
20	323	123,429	114,924	88,796

SOURCE: Mississippi State Forest Products Laboratory, 1970.

The technical feasibility of converting a wood preserving plant from open steaming to modified or closed steaming has been demonstrated by many plants within the past five years. The decision to convert a plant is an economic and product quality decision related to the reduced cost of subsequent end-of-pipe treatment of the resulting smaller volume of wastewater generated by a converted plant, and the marketability of the plant's production.

Using the historical wastewater flow data presented in Section V, an average two retort open steaming plant can reduce its process wastewater flow from over 41,600 liters/day (11,000 gpd) to less than 11,400 liters/day (3,000 gpd). Neither figure includes rainwater.

Other possible methods of reducing discharge volume are through reuse of cooling and process water and segregation of waste streams. Recycling of cooling water at plants that employ barometric condensers is essential because it is not economically feasible to treat the large volume of contaminated water generated when a single pass system is used. This fact has been recognized by the industry, and within the past five years there has been a significant increase in the percentage of plants recycling barometric cooling water.

As an alternative solution to the problem associated with the use of barometric condensers, many plants have installed surface type condensers as replacement equipment.

Reuse of process water is not widely practiced in the industry. There are, however, noteworthy exceptions to this generalization. Process wastewater from salt treatments is so widely used as makeup water for treating solutions that the practice is now considered normal practice. One hundred sixty of 184 plants treating with salts that were questioned in 1974 indicated that no discharge of direct process wastewater has been achieved through a combination of water conservation measures, including recycling.

Several plants which treat with organic preservatives reuse treated wastewater for boiler make-up or cooling water. Due to the nature of contamination present in wood preserving wastewater, a high degree of treatment is required prior to reuse of wastewater for these purposes.

One of the main sources of uncontaminated water at wood preserving plants is steam coil condensate. While in the past this water was frequently allowed to mix with process wastewater, most plants now segregate it, thus reducing the total volume of waste water, and some reuse coil condensate for boiler feed water. This latter practice became feasible with the development of turbidity sensing equipment to monitor the water and sound a warning if oil enters the coil condensate return system. Reuse of coil condensate, while of some consequence from a pollution standpoint, can also represent a significant energy saving to a plant.

End-of-Pipe Treatment

Primary Treatment--Primary treatment is defined in this document as treatment applied to the wastewater prior to biological treatment or its equivalent.

Oil-Water Separation--Because of the deleterious effects that oil has on all subsequent steps in wastewater treatment, efficient oil-water separation is necessary for effective treatment in the wood preserving industry. Oil, whether free or in an emulsified form, accounts for a significant part of the oxygen demand of wood preserving effluents and serves as a carrier for concentrations of the toxic pollutants such as PNAs and pentachlorophenol that far exceed their respective solubilities in oil free water. In a real sense, control of oils is the key to wastewater management in the wood preserving industry.

Oil-water separators of the API type are extensively used by wood preserving plants and are the equipment of choice to impart the "primary oil separation" referred to in the proposed treatment regimes which follow. It is preceded and followed at many plants by a rough oil separation and a second oil separation stage, respectively. The former operation occurs either in the blowdown tank or in a surge tank preceding the API separator. Secondary separation usually occurs in another API separator operated in series with the first, or it may be conducted in any vessel or lagoon where the detention time is sufficient to permit further separation of free oil. Primary oil separation, as used in this document, refers to a system which contains rough oil separation in a blowdown tank followed by a two-stage gravity separator.

The oil content of wastewater entering the blowdown tank may be as high as 10 percent, with 1 to 5 percent being a more normal range. Depending on the efficiency of rough separation, the influent to the primary separator will have a free oil content ranging from less than 200 mg/l to several thousand mg/l. Removal efficiencies of 60 to 95 percent can be achieved, but the results obtained are affected by temperature, oil content, and separator design--especially detention time. Data published by the American Petroleum Institute (API, 1959) show that 80 percent removal of free oils is normal in the petroleum industry. Secondary separation should remove up to 90 percent of the residual free oil, depending on the technique used.

The costs for primary oil-water separation presented in Appendix A include both the blowdown tanks and the API type separators for a parallel separation system handling both creosote and pentachlorophenol wastewaters. Due to the value of the oil and the preservatives recovered in this system, 50 percent of the capital and annual operating costs can be returned. Therefore, 50 percent of the capital and operating costs of the total system should not be allocated to pollution control.

The following example will serve to illustrate this hypothesis: Table VII-2 depicts a cost estimate for a primary oil-water separation system for a plant treating with both creosote and pentachlorophenol and generating 12,500 gallons per day of combined wastewater. Assuming that:

1. Half of the wastewater is due to creosote treating and half is due to PCP treating (6,250 gpd each system);
2. Process wastewater enters the blowdown tanks at 1.5 percent (15,000 mg/l) oil content and leaves the API separator at 500 mg/l;
3. Creosote cost is $0.75 per gallon;
4. Fuel oil cost is $0.40 per gallon;
5. PCP (solid) cost is $0.60 per pound; and
6. PCP solution is 7 percent PCP and 93 percent oil;

then 831 lbs/day of creosote valued at approximately $68 and 680 lbs/day of PCP solution valued at $62 are recovered. If the plant operates for 300 days per year, a total of $20,400 worth of creosote and $18,000 worth of PCP solution are recovered per year. This represents 62 percent of the total annual cost of the creosote system and 78 percent of the total annual cost of the PCP system. The 50 percent figure was chosen to reflect the decreased value of the recovered material as compared to new solutions.

It should be noted that primary oil separation was a component of the treatment technology identified for BPT and PSES. Since the costs of primary oil separation were previously considered in establishing BPT and PSES, there are no additional costs required to achieve satisfactory primary oil separation for these two treatment technologies. However, the costs of achieving satisfactory primary oil separation are allocable to the costs of achieving NSPS and PSNS.

Table VII-2. Annual Cost of Primary Oil-Water Separation System

Creosote System		PCP System	
Capital Cost		**Capital Cost**	
Blowdown Tanks	$ 15,800	Blowdown Tanks	$15,800
Surge, Skimming Tanks	9,000	Surge, Skimming Tanks	9,000
Reclaim Pumps	3,200	Reclaim Pumps	3,200
Prim. Sep. w/5 hp Pump	22,000	PCP Primary w/5 hp Pump	6,300
Sec. w/Skimmers	23,300	PCP Polishing Sep.	7,200
Land, 0.75 Acre	7,500	Land, 0.75 Acre	7,500
Engineering	11,000	Engineering	6,200
Site Prep. Foundation, etc.	20,200	Site Prep., Foundation etc.	12,000
Contingency	16,800	Contingency	10,000
TOTAL	$128,800	TOTAL	$77,200
Amortization 20 yrs @ 10% = $15,100		Amortization 20 yrs @ 10% = $9,050	
Annual Operating Cost:		**Annual Operating Cost:**	
Labor	$ 9,300	Labor	$ 9,300
Maint.	1,900	Maint.	1,150
Energy	2,150	Energy	1,450
Sludge Disposal	500	Sludge Disposal	500
Ins. and Taxes	3,850	Ins. and Taxes	2,300
TOTAL	$17,600	TOTAL	$14,700
TOTAL ANNUAL COST = $32,700		TOTAL ANNUAL COST = $23,750	

Chemical Flocculation--Because oil-water emulsions are not broken by mechanical oil removal procedures, chemical flocculation is required to reduce the oil content of wastewaters containing emulsions. Lime, ferric chloride, various polyelectrolytes, and clays of several types are used in the industry for this purpose. Automatic metering pumps and mixing equipment have been installed at some plants to expedite the process, which is usually carried out on a batch basis. COD reductions of 30 to 80 percent or higher are achieved--primarily as a result of oil removal. Average COD removal is about 50 percent.

Influent oil concentration varies with the efficiency of mechanical oil separation and the amount of emulsified oil. The latter variable in turn is affected by type of preservative (either pentachlorophenol in petroleum, creosote, or a creosote solution of coal tar or petroleum), conditioning method used, and design of oil-transfer equipment. Pentachlorophenol preservative solutions cause more emulsion problems than creosote or its solutions, and plants that steam condition--especially those that employ open steaming--have more emulsion problems than plants that use the Boulton conditioning method. Plants that use low pressure, high volume oil transfer pumps have less trouble with emulsions than those that use high pressure, low volume equipment.

Typically, influent to the flocculation equipment from a creosote process will have an oil content of less than 500 mg/liter, while that from a pentachlorophenol process may have a value of 1,000 mg/liter or higher. For example, analyses of samples taken from the separator outfalls at ten plants revealed average oil contents of 1,470 mg/liter and 365 mg/liter for pentachlorophenol and creosote wastewaters, respectively. The respective ranges of values were 540 to 2,640 mg/liter and 35 to 735 mg/liter. Average separator effluents for three steaming plants sampled in conjunction with the present study gave Oil and Grease values of 1,690 mg/liter and 935 mg/liter for pentachlorophenol and creosote separators, respectively.

Flocculated effluent generally has an oil content of less than 100 mg/liter. Data presented later in this section demonstrate that proper application of gravity oil-water separation followed by chemical flocculation provides control of PNAs to about 1 mg/l and control of PCP to about 15 mg/l.

A few plants achieve almost complete removal of free oils by filtering the wastewater through an oil absorbent medium. This practice is unnecessary if the wastewater is to be chemically flocculated.

Slow Sand Filtration--Many plants which flocculate wastewater subsequently filter it through sand beds to remove the solids. When properly conducted, this procedure is highly efficient in removing both the solids resulting from the process as well as some of the residual oil. The solids which accumulate on the bed are removed periodically along with the upper inch or so of sand.

A common mistake that renders filter beds almost useless is the application of incompletely flocculated wastewater. The residual oil retards percolation of the water through the bed, thus necessitating the replacement of the oil saturated sand. This has happened frequently enough at some plants that the sand filters have been abandoned and a decantation process used instead. At many plants decantation is part of the flocculation system. Solids removal is expedited by use of vessels with cone shaped bottoms. Frequently, the solids are allowed to accumulate from batch to batch, a practice which is reported to reduce the amount of flocculating agents required.

<u>Biological Treatment</u>--Wastewater generated by the wood preserving industry is amenable to biological treatment. A discussion of biological treatment as well as specific examples of treatment systems is presented in Appendix E of this document.

Biological treatment has been shown to be quite effective in reducing concentrations of COD, total phenols, Oil and Grease, pentachlorophenol, and organic toxic pollutants in wood preserving wastewaters. Actual reduction of these pollutants in the wastewater depends upon influent wastewater quality, detention time in the biological system, amount of aeration provided, and the type of biological system employed.

Trickling filters, aerated lagoons, oxidation ponds, and activated sludge systems are all used by one or more plants in the industry. Several plants also use spray or soil irrigation as a biological treatment method. In this system, wastewater is sprayed on an irrigation field, and the effluent is either allowed to run off into a collection basin or is collected in underdrains.

The biological systems in-place in the industry vary from aerated tanks with insufficient detention time and aeration capacity to sophisticated multi stage systems comprised of activated sludge followed by aerated lagoons and oxidation ponds.

Removal efficiencies for various pollutants by biological systems in the industry are presented later in this section.

Most plants which employ biological treatment do so for treatment prior to discharge to a POTW, or for treatment prior to a no discharge system such as spray irrigation, spray evaporation, or recycle of treated effluent.

<u>Removal of Metals from Wastewater</u>--A method of metals removal recommended for wood preserving wastewaters as early as 1965 by Hyde, but not used by that industry, was adopted from the plating industry. This procedure is based on the fact that hexavalent chromium is the only metal (boron excepted) used by the industry

that will not precipitate from solution at a neutral or alkaline pH. Thus, the first step in treating wastewaters containing chromium is to reduce it from the hexavalent to the trivalent form. The use of sulfur dioxide for this purpose has been discussed in detail by Chamberline and Day (1956). Chromium reduction proceeds most rapidly in acid solution. Therefore, the wastewater is acidified with sulfuric acid to a pH of 4 or less before introducing the sulfur dioxide. The latter chemical will itself lower the pH to the desired level, but it is less expensive to use the acid.

When the chromium has been reduced, the pH of the wastewater is increased to 8.5 or 9.0 to precipitate not only the trivalent chromium, but also the copper and zinc. If lime is used for the pH adjustment, fluorides and most of the arsenic will also be precipitated. Care must be taken not to raise the pH beyond 9.5, since trivalent chromium is slightly soluble at higher values. Additional arsenic and most residual copper and chromium in solution can be precipitated by hydrogen sulfide gas or sodium sulfide. Ammonium and phosphate compounds are also reduced by this process.

The procedure is based on the fact that most heavy metals are precipitated as relatively insoluble metal hydroxides at an alkaline pH. The theoretical solubilities of some of the hydroxides are quite low, ranging down to less than 10 ug/l. However, theoretical levels are seldom achieved because of unfavorable settling properties of the precipitates, slow reaction rates, interference of other ions in solution, and other factors. Copper, zinc, chromium, and arsenic can be reduced to levels substantially lower than 1.0 mg/liter by the above procedure.

The metals removal technology upon which the candidate treatment technology is based consists of reduction of chromium by pH reduction with sulfuric acid and the addition of SO_2 gas, followed by precipitation of the metal hydroxides after pH adjustment with lime or caustic soda. Final concentrations of copper, chromium, zinc, and arsenic of less than 0.25 mg/l can be expected, given influent levels similar to those presented in Table V-18. It should be noted that since no wood preserving plant is currently applying metals removal technology to its wastewater, performance data are not available from the industry to confirm the expected final effluent levels.

Carbon adsorption following metals removal by lime precipitation has been reported to provide the most encouraging results for removal of heavy metals, as reported in an EPA study (Technology Transfer, January 1977). The study found that pretreatment of wastes with lime, ferric chloride, or alum followed by carbon adsorption was highly effective. Reductions of chromium, copper, zinc, and arsenic following this treatment were, in order, 98.2, 90.0, 76.0, and 84.0 percent. Influent concentrations used in this study were 5.0 mg/l for all the above listed metals.

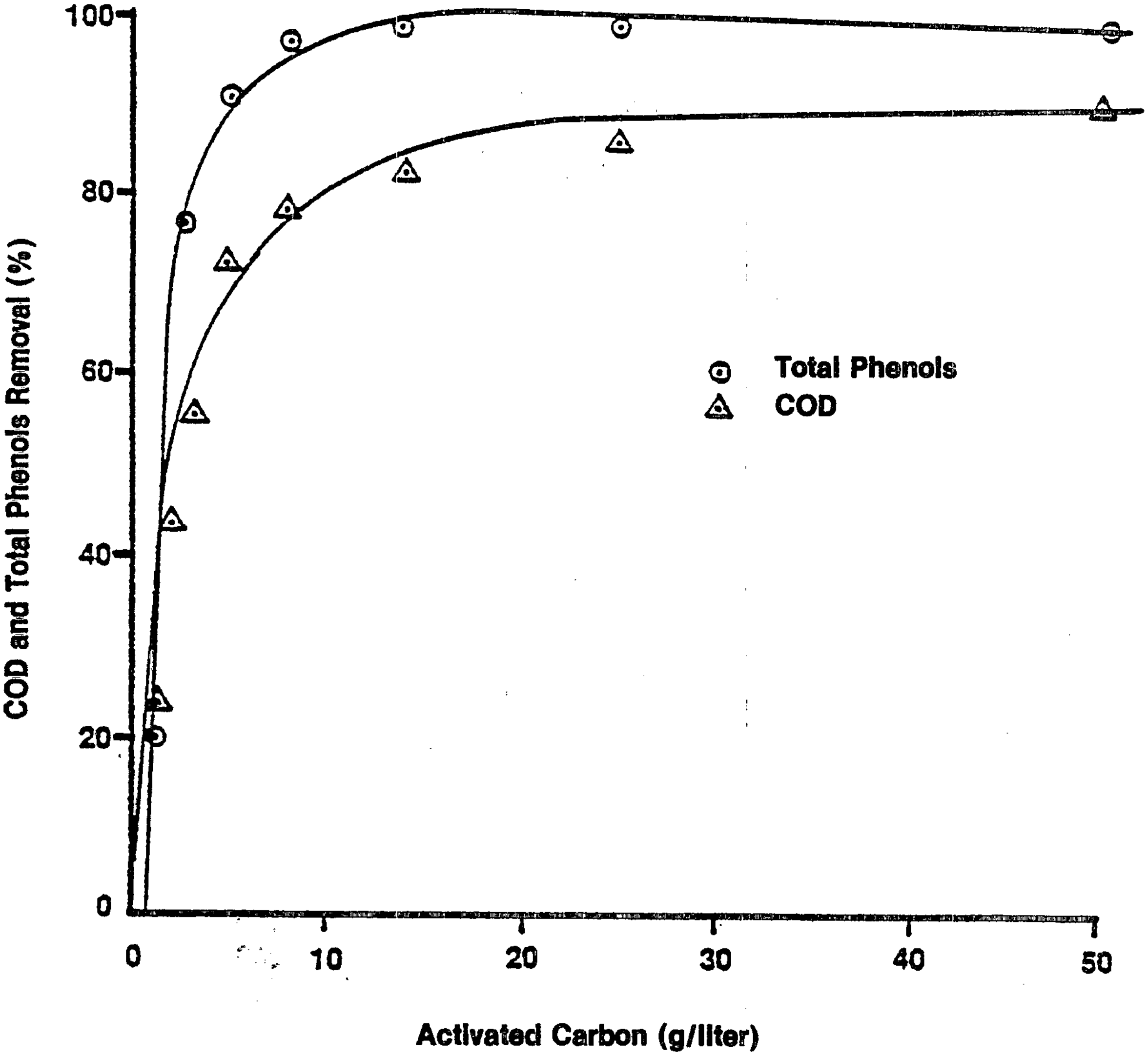
Carbon Adsorption--Results of carbon adsorption studies conducted by Thompson and Dust (1972) on a creosote wastewater are shown in Figure VII-3. Granular carbon was used with a contact time of 24 hours. The wastewater was flocculated with ferric chloride and its pH adjusted to 4.0 prior to exposure to the carbon. Typical concentrations of COD and total phenols in flocculated wastewater are 4,000 mg/l and 200 mg/l, respectively. As shown in the figure, 96 percent of the total phenols and 80 percent of the COD were removed from the wastewater at a carbon dosage of 8 g/liter. The loading rate dropped off sharply at that point, and no further increases in total phenols removal and only small increases in COD removal occurred by increasing carbon dosage to 50 g/liter. Similar results were obtained in tests using pentachlorophenol wastewater.

Results of adsorption isotherms that were run on raw pentachlorophenol wastewater and other samples of raw creosote wastewater followed a pattern similar to that shown in Figure VII-3. In some instances a residual content of phenolic compounds remained in wastewater after a contact period of 24 hours with the highest dosage of activated carbon employed, while in other instances all of the total phenols were removed. Loading rates of 0.16 kilogram of total phenols and 1.2 kilograms of COD per kilogram of carbon were typical, but much lower rates were obtained with some wastewaters.

Adsorption isotherms have been developed for wood preserving wastes from several plants to determine the economic feasibility of employing activated carbon in lieu of conventional secondary treatments. The wastewater used for this purpose was usually pretreated by flocculation and filtration to remove oils. Theoretical carbon usage rates obtained from the isotherms ranged from 85 to almost 454 kg per 3,785 liters (187 to 1,000 pounds per 1,000 gallons) of wastewater.

Use of activated carbon to treat wastewater from a plant producing herbicides was described by Henshaw. With the exception of wood sugars, this waste was similar to wood preserving effluents, especially in terms of COD (3,600 mg/liter) and phenolic materials (210 mg/liter). Raw wastewater was piped directly to a carbon adsorber and the carbon was regenerated thermally. Flow rate and loading rate were not reported, but the effluent from the system had a total phenols content of 1 mg/liter. Cost of the treatment was reported to be about $0.36 per 3,785 liters (1,000 gallons).

The effect of high organic content on carbon usage rate is well known in industry. Recent work to develop adsorption isotherms for 220 wastewater samples representing 75 SIC categories showed a strong relationship between carbon usage rate and organic content of the samples, as measured by TOC. Usage rates as high as 681 kg per 3,785 liters (1,500 pounds per 1,000 gallons) were reported for wastewater samples from the organic chemicals industry. For petroleum refining, the values ranged from 0.1 to



Relationship Between Weight of Activated Carbon Added and Removal of COD and Total Phenols from a Creosote Wastewater

64 kg per liter (0.2 to 141 pounds per gallon), depending upon the TOC of the waste.

Use of activated carbon in wastewater treatment in oil refineries is common. Because this industry is related to wood preserving in terms of wastewater characteristics, a few of the more pertinent articles dealing with activated carbon treatment of refinery wastewater are summarized here.

Workers dealing with treatment process methodology emphasized the necessity of pretreatment of activated carbon column influent. Based on these reports, suspended solids in amounts exceeding 50 mg/liter should be removed. Oil and grease in concentrations above 10 mg/liter should likewise not be applied directly to carbon. Both materials cause head loss and can reduce adsorption efficiency by coating the carbon particles. This is apparently more critical in the case of oil and grease than for suspended solids.

Common pretreatment processes used by the industry include chemical clarification, oil flotation, and filtration. Adjustments in pH are frequently made to enhance adsorption efficiency. An acid pH has been shown to be best for total phenols and other weak acids. Flow equalization is, of course, necessary for most treatment processes.

Efficiency of adsorption varies among molecular species. In a study of 93 petrochemicals commonly found in that industry's wastewater, adsorption was found to increase with molecular weight and decrease with polarity, solubility, and branching. However, molecules possessing three or more carbons apparently respond favorably to adsorption treatments.

Researchers studied the relative efficiency of lignite and bituminous coal carbons and concluded that the former is better for refinery wastes because it contains more surface area due to its 20- to 500-Angstrom pore size.

The feasibility of activated carbon adsorption for reduction of phenolic compounds, including chlorophenols, and high molecular weight organics, such as polynuclear aromatics and phthalates, has been demonstrated by several investigators. Since carbon adsorption of flocculated wood preserving wastewaters results in high carbon usage rates as described above, the concept of activated carbon as a polishing treatment for removal of total phenols, PNAs, and residual COD following biological treatment appears to have merit. In this configuration, biological treatment removes most of the wood sugars and other readily biodegradable organics prior to carbon adsorption, thus decreasing carbon doses required and greatly increasing carbon life. Such a system including an activated carbon column system has been chosen as a candidate treatment technology for wood preserving wastewaters.

Experience with carbon adsorption of biologically treated effluents from other industries indicates that a conservative carbon dosage of 4.54 kg per 3,785 liters (10.0 lb/1,000 gal) with two hours contact time is sufficient to result in an expected 80 percent removal of COD and 95 percent removal of total phenols, PCP, and PNAs from biologically treated wood preserving effluent. (Average concentrations of these parameters present in biologically treated effluents are presented later in this section.) According to Hutchins (1975), it is most economical to discard carbon at usage rates lower than 159 to 182 kg (350 to 400 pounds) per day, and to thermally regenerate at higher usage rates.

It should again be noted that the expected removals of pollutants and design criteria presented above are engineering judgments based on experience with similar industries, and have not been demonstrated within the wood preserving industry since there are no carbon adsorption systems operating for the treatment of wood preserving wastewaters.

Evaporation--Because of the relatively low volumes of wastewater generated by wood preserving plants, evaporation is a feasible and widely used technology for achieving no discharge status. Based on the large number of plants which have adopted evaporation technology to achieve no discharge status, this technology appears to be the method of choice for many wood preserving plants to comply with Federal, State and local regulations.

Three types of evaporative systems are common in the industry. The first type, spray evaporation, is common to Boulton and steaming plants. This technology involves containing the wastewater in lined lagoons of sufficient size to accommodate several months of process wastewater, as well as the rainwater falling directly on the lagoon. The wastewater is sprayed under pressure through nozzles producing fine aerosols which are evaporated in the atmosphere. The driving force for this evaporation is the difference in relative humidity between the atmosphere and the humidity within the spray evaporation area. Temperature, wind speed, spray nozzle height, and pressure are all variables which affect the amount of wastewater which can be evaporated.

Reynolds and Shack (1976) have developed the following design equation for spray evaporation ponds:

$$E = 1260.5\ Wh\rho \left[1 - e^{-\left(\frac{Ky'\ L + Cw\ WL}{5280\ Wh\rho}\right)}\right] \left[\frac{(1-Hr)Ps}{Pa}\right] RLn$$

Climatic Factors: W = Wind speed (mph)
ρ = Air density = $\frac{39.66\ Pa}{460 + Ta}$

where: Pa = Atmospheric Pres. (AT.)
Ta = Atmospheric Temp. (°F)
Hr = Relative Humidity
Ps = Saturation Vapor Pressure

Operational Factors: h = Height of spray above surface of pond
Ky' = Spray mass transfer coefficient
Cw = Surface mass transfer coefficient
L = Pond length (in direction of prevailing wind)
R = Ratio of width to the length of the pond
RL = Width of pond
n = Number of days in the month
E = Evaporation in cu ft per month

Constants: e = Base of the natural logarithms (2.718)

This design is considered by the authors to be conservative as it neglects pan evaporation (which occurs in most areas of the country), assumes no drift loss, and assumes no evaporation when the sprays are off.

To be effective, spray evaporation should be preceded by primary and secondary oil removal. Excess oil content in the wastewater may retard evaporation and increase the potential for air pollution. Careful segregation of uncontaminated water from the wastewater stream is particularly important in evaporative technologies to minimize the amount of wastewater to be evaporated.

The second type of evaporation technology is cooling tower evaporation. This technology is feasible for Boulton plants only. In this system, as the wood water vapor is condensed, it gives up heat to the cooling water passing through the surface condenser. The condensed wood water is sent to an accumulator, and from there to an oil-water separator for removal of oils. Rain water and cylinder drippings may also be routed to the separator. This wastewater stream is then added to the cooling water which recirculates through the surface condenser picking up heat, then through a forced draft cooling tower where evaporation occurs. Figure VII-4 depicts a cooling tower evaporation system.

Since the vacuum cycle in a Boulton plant lasts from 12 to 40 hours, sufficient waste heat is usually available to evaporate all of the wastewater. Heat from an external source, usually process steam, can be added to an additional heat exchanger to assist the evaporation of peaks in wastewater generated from time to time.

In steaming plants, the vacuum cycle is much shorter, ranging from 1 to 3 hours. Therefore, there is not a continuous (or nearly continuous) source of waste heat available to affect the evaporation of wastewater. Generally, about 25 percent of the process wastewater is the maximum amount that can be evaporated by cooling tower evaporation at a steaming plant.

The third method of evaporation is thermal evaporation using an external heat source. As this method is particularly energy intensive and expensive, it is not generally feasible except when used to supplement other treatment methods and when peak surges in wastewater generation occur, as in the cooling tower system.

Soil Irrigation--About ten plants in the wood preserving industry currently use spray or soil irrigation as a final treatment step. As shown by the following discussion, this technique is a viable method of treatment for this industry even though it is more land intensive and may be more expensive than other alternatives.

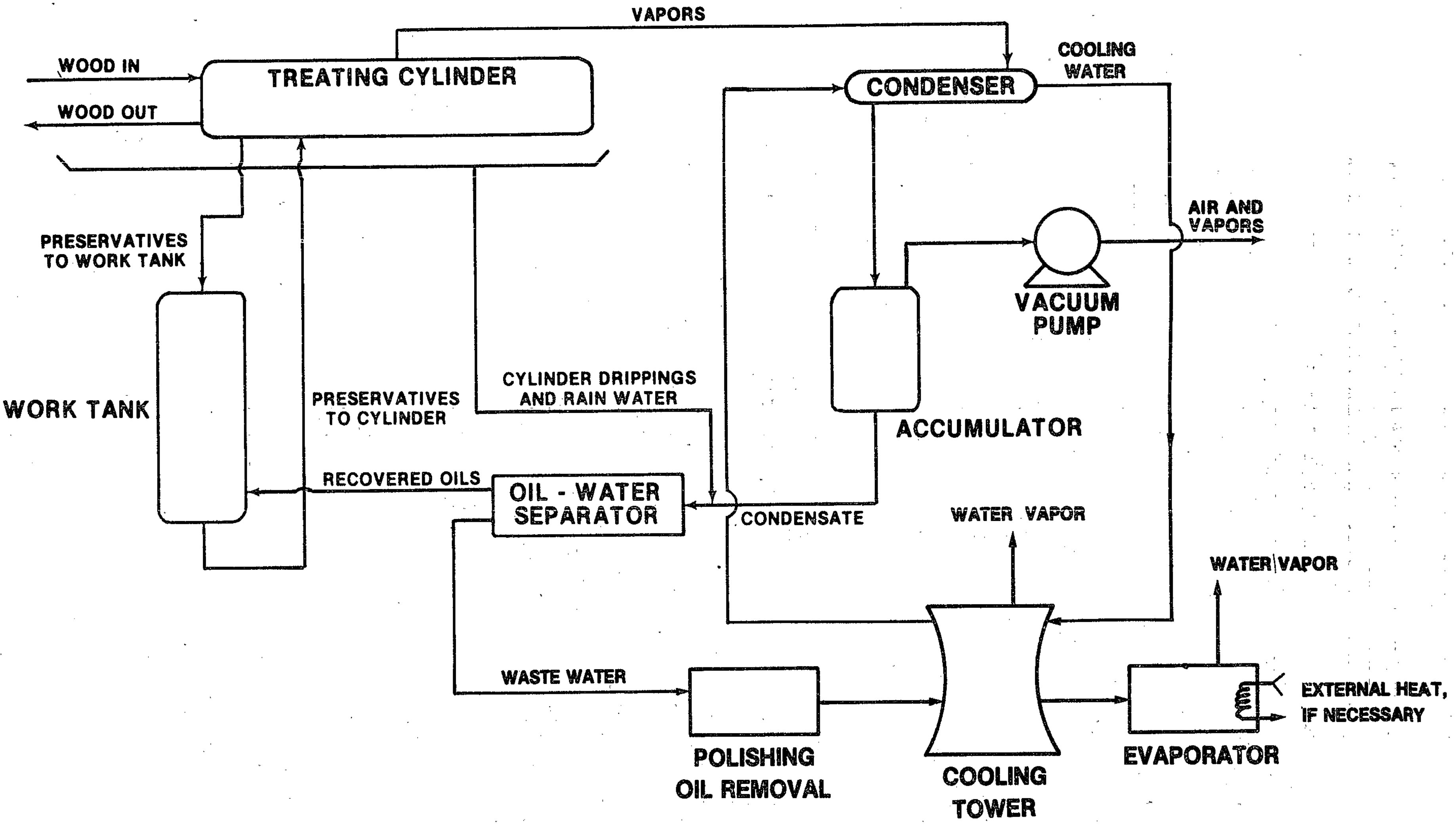
Several applications of wastewaters containing high total phenols concentrations to soil irrigation have been reported. One such report by Fisher related the use of soil irrigation to treat wastewaters from a chemical plant that had the following characteristics:

pH	9 to 10
Color	5,000 to 42,000 units
COD	1,600 to 5,000 mg/liter
BOD	800 to 2,000 mg/liter

Operating data from a 0.81 hectare (2 acre) field, when irrigated at a rate of 7,570 liters/hectare/day (2,000 gal/acre/day) for a year, showed color removal of 88 to 99 percent and COD removal of 85 to 99 percent.

The same author reported on the use of soil irrigation to treat effluent from two tar plants that contained 7,000 to 15,000 mg/liter total phenols and 20,000 to 54,000 mg/liter COD. The waste was applied to the field at a rate of about 20,000 liters (5,000 gal) per day. Water leaving the area had COD and total phenols concentrations of 60 and 1 mg/liter, respectively. Based on the lower influent concentration for each parameter, these values represent oxidation efficiencies of well over 99 percent for both total phenols and COD.

Figure VII-4



MECHANICAL DRAFT COOLING TOWER EVAPORATION SYSTEM

Bench-scale treatment of coke plant effluent by soil irrigation was also studied by Fisher. Wastes containing BOD and total phenols concentrations of 5,000 and 1,550 mg/liter, respectively, were reduced by 95+ and 99+ percent when percolated through 0.9 meter (36 inches) of soil. Fisher pointed out that less efficient removal was achieved with coke plant effluents using the activated sludge process, even when the waste was diluted with high quality water prior to treatment. The effluent from the units had a color rating of 1,000 to 3,000 units, compared to 150 units for water that had been treated by soil irrigation.

Both laboratory and pilot scale field tests of soil irrigation treatments of wood preserving wastewater were conducted by Dust and Thompson (1972). In the laboratory tests, 210-liter (55-gallon) drums containing a heavy clay soil 60 centimeters (24 inches) deep were loaded at rates of 32,800; 49,260; and 82,000 liters/hectare/day (3,500; 5,250; and 8,750 gallons/acre/day). Influent COD and total phenols concentrations were 11,500 and 150 mg/liter, respectively. Sufficient nitrogen and phosphorus were added to the waste to provide a COD:N:P ratio of 100:5:1. Weekly effluent samples collected at the bottom of the drums were analyzed for COD and total phenols.

Reductions of more than 99 percent in COD content of the wastewater were observed for the first week in the case of the two highest loadings and through the fourth week for the lowest loading. A breakthrough occurred during the 22nd week for the lowest loading rate and during the fourth week for the highest loading rate. The COD removal steadily decreased thereafter for the duration of the test. Total phenols removal showed no such reduction, but instead remained high throughout the test. The average test results for the three loading rates are given in Table VII-3. Average total phenols removal was 99+ percent. Removal of COD exceeded 99 percent prior to breakthrough and averaged over 85 percent during the last week of the test.

The field portion of Thompson and Dust's study (1972) was carried out on an 0.28-hectare (0.8-acre) plot prepared by grading to an approximately uniform slope and seeded to native grasses. Wood preserving wastewater from an equalization pond was applied to the field at the rate of 32,800 liters/hectare/day (3,500 gallons/acre/day) for a period of nine months. Average monthly influent COD and total phenols concentrations ranged from 2,000 to 3,800 mg/liter and 235 to 900 mg/liter, respectively. Supplementary nitrogen and phosphorus were not added. Samples for analyses were collected weekly at soil depths of 0 (surface), 30, 60, and 120 centimeters (1, 2, and 4 feet).

The major biological reduction in COD and total phenols content occurred at the surface and in the upper 30 centimeters (1 foot) of soil. A COD reduction of 55.0 percent was attributed to overland flow. The comparable reduction for total phenols content was 55.4 percent (Table VII-4). COD reductions at the three soil depths, based on raw waste to the field, were 94.9, 95.3, and 97.4 percent, respectively, for the 30-, 60-, and 120-centimeter (1-, 2-, and 4-foot) depths. For total phenols, the reductions were, in order, 98.9, 99.2, and 99.6 percent.

Table VII-3. Results of Laboratory Tests of Soil Irrigation Method of Wastewater Treatment*

Loading Rates (Liter/ha/day)	Length of Test (Week)	COD Average % Removal to Breakthrough	COD Average % Removal Last Week of Test	Total Phenols Average % Removal (All Weeks)
32,800 (3,500)**	31	99.1 (22 wks)	85.8	98.5
49,260 (5,250)	13	99.6	99.2	99.7
82,000 (8,750)	14	99.0 (4 wks)	84.3	99.7

* Creosote wastewater containing 11,500 mg/liter of COD and 150 mg/liter of total phenols was used.

** Loading rates in parentheses in gallons/acre/day.

SOURCE: Thompson and Dust, 1972.

Table VII-4. Reduction of COD and Total Phenols Content in Wastewater Treated by Soil Irrigation*

Month	Raw Waste	Soil Depth (centimeters)			
		0	30	60	120
		COD (mg/liter)			
July	2,235	1,400	--	--	66
August	2,030	1,150	--	--	64
September	2,355	1,410	--	--	90
October	1,780	960	150	--	61
November	2,060	1,150	170	--	46
December	3,810	670	72	91	58
January	2,230	940	121	127	64
February	2,420	580	144	92	64
March	2,460	810	101	102	68
April	2,980	2,410	126	--	76
Average % Removal (weighted)		55.0	94.9	95.3	97.4
		Total Phenols (mg/liter)			
July	235	186	--	--	1.8
August	512	268	--	--	0.0
September	923	433	--	--	0.0
October	310	150	4.6	--	2.8
November	234	86	7.7	3.8	0.0
December	327	6	1.8	9.0	3.8
January	236	70	1.9	3.8	0.0
February	246	111	4.9	2.3	1.8
March	277	77	2.3	1.9	1.3
April	236	172	1.9	0.0	0.8
Average % Removal (weighted)		55.4	98.9	99.2	99.6

* Adapted from Thompson and Dust (1972).

Other Applicable Technologies--Wood Preserving--Several additional treatment technologies were evaluated to determine their feasibility as candidate treatment technologies for BAT, NSPS, and pretreatment standards. The technologies evaluated for wood preserving included:

Tertiary Metals Removal Systems
Membrane Systems
Adsorption on Synthetic Adsorbents
Oxidation by Chlorine
Oxidation by Hydrogen Peroxide
Oxidation by Ozone

A discussion of each of these technologies and case studies of their application to the wood preserving industry are presented in Appendix F, DISCUSSION OF POTENTIALLY APPLICABLE TECHNOLOGIES.

None of these technologies are candidate technologies because they are experimental in nature, and further research is necessary to sufficiently determine the effectiveness of treatment which could be expected if these technologies were to be applied to wood preserving wastewaters.

In-Place Technology

The current levels of in-place technology for plants responding to the DCP and the follow-up telephone survey are presented in Tables VII-5 through VII-9 for Boulton no dischargers, Boulton indirect dischargers, steam no dischargers, steam direct discharger, and steam indirect dischargers, respectively.

Table VII-5. Current Level of In-Place Technology, Boulton, No Dischargers

Plant	Primary Oil Separation	Oil Separation by Dissolved Air Flotation	Evaporation Ponds	Spray or Soil Irrigation	Cooling Tower Evaporation	Thermal Evaporation	Effluent Recycle to Boilers or Condensers
61	X				X		
62	X			X			
63	X				X		
64	X		X*				
67	X				X		
144	X		X				
145	X		X				
146	X		X				
147	X		X				
162			X				X
273	X		X				X
447†							
515	X		X				
534		X	X				
546	X						X
552	X		X				
554	X		X				X
583	X		X				
85	X		X				
593	X		X				
657	X				X		
934	X					X	
940†							
1028†							
1085			X				

* Evaporation—Ground Infiltration Ponds.
† Information not available for this plant, other than it is no-discharge.

SOURCE: Data collection portfolio and follow-up telephone survey.

Table VII-6. Current Level of In-Place Technology, Wood Preserving, Boulton, Indirect Dischargers

Plant	Primary Oil Separation	Chemical Flocculation and/or Oil Absorbent Media	Biological Treatment
65	X	X	
549	X	X	
555	X		X
577	X		
655	X		
743	X		
1027	X		
1078	X	X	
1110	X		
1111	X	X	X

SOURCE: Data collection portfolio and follow-up telephone survey.

Table VII-7. Current Level of In-Place Technology, Steam, No-Dischargers

Plant	Gravity Oil-Water Separation	Chemical Flocculation or Oil Absorptive Media	Sand Filtration	Oxidation Lagoon	Aerated Lagoon	Spray Irrigation	Holding Basin	Thermal Evaporation	Solar Evaporation Pond	Spray-Assisted Solar Evaporation	Effluent Recycle to Boiler or Condenser
5	X									X	
27	X						X	X			
40	X						X			X	
42											X
43*	X						X				X
87									X		
138	X	X	X			X					
140						X					
158	X						X		X		
164	X								X		
177	X							X	X		
226	X						X			X	
237	X						X				
247									X		
266	X	X			X		X			X	X
307	X						X				X
330	X				X	X					
340	X						X			X	
350	X						X				X
355	X	X	X			X	X				X
375	X								X		
376	X									X	
381	X								X		X
441	X								X		
456	X		X				X	X			
548	X				X				X		
580	X			X	X	X					
587	X								X		
590											
591	X										
597	X		X	X		X					
617	X						X		X		
631	X		X							X	
651	X	X			X						
660											

Table VII-7. Current Level of In-Place Technology, Steam, No-Dischargers (Continued, page 2 of 2)

Plant	Gravity Oil-Water Separation	Chemical Flocculation or Oil Absorptive Media	Sand Filtration	Oxidation Lagoon	Aerated Lagoon	Spray Irrigation	Holding Basin	Thermal Evaporation	Solar Evaporation Pond	Spray-Assisted Solar Evaporation	Effluent Recycle to Boiler or Condenser
488							X			X	
499	X				X		X				X
665	X									X	
701	X		X		X					X	
705									X		
707	X								X		
717	X						X		X		
750	X						X		X		
752							X				
790	X		X				X				X
800									X		
852	X						X		X		
893									X		
895	X				X	X				X	
897	X				X	X	X				
900	X									X	
946									X		
1016	X								X	X	
1071	X									X	
1100	X			X			X			X	
1101									X		
1105	X	X	X								X
1113	X									X	
503	X								X		
595	X			X		X					
656	X			X							
666	X								X		
688	X								X		
847	X								X		X
1009	X						X			X	
1112	X	X	X						X		

* Plant incinerates excess oily wastewater.

SOURCE: Data collection portfolio and follow-up telephone survey.

Table VII-8. Current Level of In-Place Technology, Steam, Direct Dischargers

Plant	Gravity Oil-Water Separation	Chemical Flocculation or Oil Absorptive Media	Sand Filtration	Oxidation Lagoon	Aerated Lagoon	Spray Irrigation	Holding Basin	Thermal Evaporation	Solar Evaporation Pond	Spray-Assisted Solar Evaporation	Effluent Recycle to Boiler or Condenser
268	X	X			X		X			X	X

SOURCE: Data collection portfolio and follow-up telephone survey.

Table VII-9. Current Level of In-Place Technology, Wood Preserving-Steam, Indirect Dischargers

Plant	Gravity Oil-Water Separation	Chemical Flocculation or Oil Absorptive Media	Sand Filtration	Oxidation Lagoon	Aerated Lagoon	Spray Irrigation	Holding Basin	Thermal Evaporation	Solar Evaporation Pond	Spray-Assisted Solar Evaporation	Effluent Recycle to Boiler or Condenser
139	X										
173	X	X	X				X				
267	X	X	X		X		X				
335	X	X					X				
338	X						X			X	X
339	X						X				X
529	X						X				
530	X										
547	X			X							
582	X	X									
596	X										
620	X						X				
693	X						X				
765	X	X					X				
894	X						X				
896	X						X				
898	X						X			X	
899	X	X	X				X				
901	X						X				
910	X						X				
1076	X	X					X				
1200	X		X								
1201											
589	X										
575	X										
594	X										
1203	X										
294	X	X					X				
1205	X										

SOURCE: Data collection portfolio and follow-up telephone survey.

Treated Effluent Characteristics

Treated effluent characteristics for wood preserving plants sampled during the Pretreatment Study, the verification sampling programs and the 1972 - 1980 American Wood Preservers Institute (AWPI) sampling program are presented in Tables VII-10 through 34 for traditional parameters and the toxic pollutants. All the data are presented in terms of both concentrations and waste loads, except for the AWPI data, which is presented only in terms of concentrations. The AWPI data is not presented in terms of waste loads because flow data were not available to correspond with the concentration data.

Data from four sampling and analytical programs are presented. Data for plants sampled during the 1975 Pretreatment Study represent the average of two or more grab samples collected at each plant. Data for plants sampled during the 1977 and 1978 verification sampling programs represent the average of three 24-hour composite samples collected at each point. Data for plants sampled during the 1972-1980 AWPI program represent one or more grab samples collected at each plant. For those plants where two or more grab samples were collected, the data represent an average of all the samples collected.

Treated effluent flow data for some plants may differ somewhat from the raw wastewater flow presented for the same plant during the same sampling period. This is due to either dilution by steam condensate, cooling water, boiler blowdown, etc., occurring after the raw wastewater sampling point; or where no dilution occurs, it is due to evaporative or percolation losses in the treatment system.

For the purpose of data presentation and interpretation, the plants are grouped into categories based on the type of treatment technology which was in-place at the time of sampling.

One category represents plants which have BPT technology or its equivalent in-place. BPT technology consists of primary oil-water separation, flocculation and slow sand filtration, followed by effective biological treatment. Flocculation and slow sand filtration is an optional part of BPT technology which may not be required by plants whose wastewaters do not contain high enough concentrations of emulsified oils to inhibit biological treatment. Only one of the plants in this category is a direct discharger. All of the remaining plants discharge to a POTW or to self contained systems following biological treatment. The data presented in the tables indicate that BPT technology achieves effluent PCP levels of about 1 mg/l.

A second category of plants is indirect dischargers with pretreatment technology in-place. The pretreatment technology consists of primary oil-water separation followed by flocculation and slow sand filtration. Some plants in this category achieve the 100 mg/l Oil and Grease standard without slow sand filtration. One plant replaces the flocculation/filtration system with oil absorbent media.

The data presented in the tables indicate that the pretreatment technology removes most emulsified Oil and Grease to a level of 100 mg/l or less. Removal of Oil and Grease is the key to effective pretreatment and to the control of toxic pollutants because PCP and PNAs have a much greater affinity for the oil phase than for the water phase. The data presented in the tables show that control of Oil and Grease serves as an excellent control for removal of PNAs. When Oil and Grease are removed to 100 mg/l or less, corresponding values of total PNAs are about 1 mg/l and PCP can be controlled to 15 mg/l or less.

The final category of plants for which data are presented are plants with less than the equivalent of BPT technology in-place. These plants have biological systems which do not meet the effluent limitations for BPT because of insufficient aeration and/or insufficient detention time, as compared to a properly designed plant with BPT technology. These plants were visited and sampled during the 1975 Pretreatment Study, and all of them discharge to a POTW after treatment.

Metals data are presented according to whether the plants treat with organic preservatives only, or with both organic and inorganic preservatives.

Average raw and treated effluent waste loads for traditional parameters and toxic pollutants are presented in Tables VII-35 through 47. Percent removals of pollutant waste loads are also presented in these tables.

Table VII-10. Wood Preserving Treated Effluent Traditional Parameters Data for Plants with Less Than the Equivalent of BPT Technology In-Place**

Plant	Data Source	Flow (gpd)	Production (ft^3/Day)	Concentrations (mg/l) COD				Waste Loads (lb/1,000 ft^3) COD			
				COD	Total Phenols	O & G	PCP	COD	Total Phenols	O & G	PCP
499	PS'75	< 100	1,950	10,580	5.30	1,220	57.0	<4.52	<0.0023	<0.521	<0.0244
547*	PS'75	25,000	8,000	1,980	18.9	78.2	7.20	51.6	0.493	2.04	0.188
593*	PS'75	9,000	12,300	2,220	120	116	5.50	13.6	0.729	0.706	0.0336
898*	PS'75	2,000	3,000	5,100	325	449	41.5	28.4	1.81	2.49	0.231
Waste Load Averages								<24.5	<0.759	<1.44	<0.119

* Plants used to calculate treated averages in Table VII-35.

** All four of these plants provide a minimum of biological treatment prior to discharge to a POTW.

Plant 499 provides insufficient aeration and detention time for effective biological treatment.
Plant 547 provides insufficient aeration for effective biological treatment.
Plant 593 provides insufficient aeration for effective biological treatment.
Plant 898 provides insufficient aeration and detention time for effective biological treatment.

Table VII-11. Wood Preserving Treated Effluent Traditional Parameters Data for Plants with Current Pretreatment Technology In-Place

Plant	Data Source	Flow (gpd)	Production (ft^3/Day)	Concentrations (mg/l) COD	Concentrations (mg/l) Total Phenols	Concentrations (mg/l) O & G	Concentrations (mg/l) PCP	Waste Loads (lb/1,000 ft^3) COD	Waste Loads (lb/1,000 ft^3) Total Phenols	Waste Loads (lb/1,000 ft^3) O & G	Waste Loads (lb/1,000 ft^3) PCP
173*	PS'75	3,000	3,880	4,866	0.202	339.3	15.0	31.4	0.0013	2.19	0.097
267	ESE'78	9,120	9,890	5,440	13.6	14.1	5.80	41.8	0.105	0.108	0.0446
267*	ESE'77	12,000†	5,800	4,420	64.4	49	6.12	76.3	1.11	0.846	0.106
267*	PS'75	6,000	6,600	4,315	50.8	20.0	3.20	32.7	0.385	0.152	0.0243
335*	PS'75	1,700	3,400	2,290	230.2	15.0	NA	9.55	0.960	0.0626	NA
582*	PS'75	13,750	7,500	3,030	80.2	40.0	9.00	46.2	1.23	0.612	0.138
765*	PS'75	5,000	2,700	10,513	448.0	245.2	NA	162	6.92	3.79	NA
1076	PS'75	12,000	5,500	4,644	169.7	87.8	134.0	84.5	3.09	1.60	2.44
65*	ESE'78	2,200	2,770	500	1.60	121	17.0	3.31	0.0106	0.801	0.113
65*	PS'75	5,000	5,000	528	73.7	19.67	2.71	4.40	0.615	0.164	0.0226
1078*	ESE'77	10,500**	10,900	3,164	680	40.0	NA	25.4	5.46	0.321	NA
1078*	PS'75	7,000	10,000	4,078	613.1	24.9	0.06	23.8	3.58	0.145	0.0004
Waste Load Averages								45.1	1.96	0.899	0.332

NA Not Analyzed.

* Plants used to calculate treated averages in Table VII-36.

† Variations between the raw and treated flow are due to inclusion of stormwater runoff in treated flow. These data do not alter the validity of waste loads.

** Variations between the raw and treated flow are due to flow equalization in the treatment system. These data do not alter the validity of waste loads.

PTR Phenols ave. (#/100 2 cu ft) = 2.027.

Table VII-12. AWPI Wood Preserving Treated Effluent Pentachlorophenol (PCP) Data for Plants with Current Pretreatment Technology In-Place

Plant	Data Source	Concentrations, mg/1 PCP
547	AWPI, 1980	4.84
237	AWPI, 1978	3.03
355	AWPI, 1979	10.0
593	AWPI, 1976	14.0
376	AWPI, 1974	10.3
1111	AWPI, 1972	1.03
582	AWPI, 1979	1.20
582	AWPI, 1979	13.0
589	AWPI, 1979	7.6
894	AWPI, 1980	0.9
894	AWPI, 1980	9.0
894	AWPI, 1980	0.16
901	AWPI, 1980	14.0

* Samples were collected by AWPI members and analyzed at the Mississippi State Forest Products Utilization Laboratory.

Table VII-13. Wood Preserving Treated Effluent Traditional Parameter Data for Plants With Current BPT Technology In-Place

Plant	Data Source	Flow (gpd)	Prod. (ft^3/day)	Concentrations (mg/l)				Waste Loads (lb/1,000 ft^3)			
				COD	Total Phenols	O & G	PCP	COD	Total Phenols	O & G	PCP
548**	ESE'78	36000	15500	661	0.927	52.3	2.70	12.8	0.0180	1.01	0.0.523
548**	ESE'77	14000*	8760	416	0.695	126	0.907	5.54	0.0093	1.68	0.0121
591**	ESE'78	14150††	7920	630	0.260	100	0.032	9.39	0.0039	1.49	0.0005
591**	ESE'77	9350	11300	119	0.048	39	0.21	0.821	0.0003	0.269	0.0014
897**	ESE'78	42400	18200	230	0.068	9.3	0.069	4.47	0.0013	0.181	0.0013
1100	ESE'77	66300	16300	2122	7.00	398	8.27	72.0	0.237	13.5	0.281
1111**	PS'75	25000	7000	100	0.130	< 10	NA	2.98	0.0039	<0.298	NA
Waste Load Averages								6.00	0.0061	<0.821	0.0135

NA Not Analyzed.

* Plant is a self-contained discharger. Samples were taken after Multi-Stage Biological Treatment. Historical flow data were used to calculate waste loads.

† Data not included in averaging since the treatment system was operating under upset conditions during sampling. Samples were collected from the plant to determine the effect of upset upon priority pollutant removal.

** Plants used to calculate treated averages in Table VII-37.

†† Variations between the raw and treated flow are due to inclusion of boiler blowdown and stormwater runoff in treated flow. This does not alter the validity of the waste loads.

Table VII-14. Substances Analyzed for but Not Found in Volatile Organic Analysis During 1978 Verification Sampling

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vinyl chloride
chloroethane
chloromethane
bromomethane
tribromomethane
bromodichloromethane
dibromochloromethane
carbon tetrachloride
dichlorodifluoromethane
trichlorofluoromethane
1,2-dichloroethane
1,1-dichloroethane
1,1,1-trichloroethane
1,1,2-trichloroethane
tetrachloroethane
1,1-dichloroethylene
trans 1,2-dichloroethylene
tetrachloroethylene
trichloroethylene
1,2-dichloropropane
1,3-dichloropropylene
Bis-chloromethylether
Bis-chloroethylether
2-chloroethylvinylether
acrolein
acrylonitrile

Generalized machine detection limit for these compounds is 10 ug/l.

Table VII-15. Wood Preserving Treated Effluent Volatile Organics Data for Plants with Current Pretreatment Technology In-Place†

				Concentrations (mg/l)						Waste Loads (lb/1,000 ft^3)					
Plant	Data Source	Flow (gpd)	Prod. (ft^3/day)	mecl	trclme	brdiclme	benzene	etbenzene	toluene	mecl	trclme	brdiclme	benzene	etbenzene	toluene
65*	ESE'78	2200	2770	1.90	—	—	0.003	—	—	0.0126	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
267	ESE'78	9120	9890	0.067	—	—	0.033	0.020	0.033	0.0005	<0.0001	<0.0001	0.0003	0.0002	0.0003
Waste Load Averages										0.0005	<0.0001	<0.0001	0.0003	0.0002	0.0003

* Data not included in averaging since plant uses unique methylene chloride process.

† A corresponding averages table is not presented because Plant 267 raw wasteloads are unavailable and Plant 65 uses a unique methylene chloride process.

— Hyphen denotes that parameter was analyzed for but was below detection limit.

Key to Volatile Organics Data Tables

mecl = methylene chloride
trclme = chloroform (trichloromethane)
brdiclme = bromodichloromethane
etbenzene = ethylbenzene

Table VII-16. Wood Preserving Treated Effluent Volatile Organics Data for Plants with Current BPT Technology In-Place

				Concentrations (mg/l)					Waste Loads (lb/1,000 ft^3)				
Plant	Data Source	Flow (gpd)	Prod. (ft^3/day)	mecl	trclme	benzene	etbenzene	toluene	mecl	trclme	benzene	etbenzene	toluene
548*	ESE'78	36000	15500	0.013	--	--	--	--	0.0003	<0.0001	<0.0001	<0.0001	<0.0001
591*	ESE'78	14150†	7920	0.660	0.023	0.010	--	0.140	0.0098	0.0003	0.0001	<0.0001	0.0021
897*	ESE'78	42400	18200	0.140	0.003	0.030	--	0.023	0.0027	0.0001	0.0006	<0.0001	0.0005
Waste Load Averages									0.0043	<0.0002	<0.0003	<0.0001	<0.0009

-- Hyphen denotes that parameter was analyzed for but was below detection limit.

* Plants used to calculate treated averages in Table VII-38.

† Variations between the raw and treated flow are due to inclusion of boiler blowdown and stormwater runoff in treated flow. This does not alter validity of the waste loads.

Key to Volatile Organics Data Tables

mecl = methylene chloride
trclme = chloroform (trichloromethane)
brdiclme = bromodichloromethane
etbenzene = ethylbenzene

Table VII-17. Substances Analyzed for but Not Found in Base Neutral Fractions During 1977 and 1978 Verification Sampling

2-chloronaphthalene
diethylphthalate
di-n-butylphthalate
butylbenzylphthalate
dimethylphthalate
4-chlorophenyl-phenylether
bis(2-chloroisopropyl) ether
bis(2-chloroethoxy) methane
4-bromophenyl phenylether
N-nitrosodimethylamine
N-nitrosodi-n-propylamine
N-nitrosodiphenylamine
1,2-dichlorobenzene
1,3-dichlorobenzene
1,4-dichlorobenzene
1,2,4-trichlorobenzene
hexachlorobenzene
2,6-dinitrotoluene
2,4-dinitrotoluene
benzidine
3,3'-dichlorobenzidine
nitrobenzene
hexachlorobutadiene
hexachlorocyclopentadiene
hexachloroethane
isophorone
1,2-diphenylhydrazine
2,3,7,8-tetrachlorodibenzo-p-dioxin

Generalized machine detection limit for these compounds is 10 ug/l.

Table VII-18. Wood Preserving Treated Effluent Base Neutrals Concentrations for Plants with Current Pretreatment Technology In-Place

Plant Number	Data Source	Flow (gal/day)	Prod. (ft^3/day)	Concentrations (mg/l)														
				1	2	3	4	5	6	7	8	9	11	12	13	14	15	16
65	ESE '78	2200	2770	--	--	--	--	--	--	--	0.133	--	--	--	--	--	--	--
1078	ESE '77	10500	10900	0.092	--	--	0.027	--	--	--	0.058	--	0.930	0.059	0.059	0.019	--	0.029
267	ESE '78	9120	9890	17.0	2.50	--	9.40	--	--	--	37.0	3.40	36.0	18.0	--	16.0	1.9	--
267	ESE '77	12000	5800	--	--	--	--	--	--	--	0.059	--	0.820	0.100	0.140	0.036	--	0.154

-- Hyphen denotes that parameter was analyzed for but was below detection limit.

Key to Base Neutral Data Tables

1. Fluoranthene
2. Benzo (B) Fluoranthene
3. Benzo (k) Fluoranthene
4. Pyrene
5. Benzo (A) Pyrene
6. Indeno (1, 2, 3-CD) Pyrene
7. Benzo (ghi) Perylene
8. Phenanthrene and/or Anthracene
9. Benzo (a) Anthracene
10. Dibenzo (a, h) Anthracene
11. Naphthalene
12. Acenaphthene
13. Acenaphthylene
14. Fluorene
15. Chrysene
16. Bis-2-ethyl-hexyl phthalate

Table VII-19. Wood Preserving Treated Effluent Base Neutrals Waste Loads for Plants with Current Pretreatment Technology In-Place

Plant Number	Data Source	Flow (gal/day)	Prod. (ft3/day)	Waste Loads (lb/10,000 ft^3)															
				1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
65††	ESE '78	2200	2770	<0.0001	<0.0001	<0.0001	<0.0001	0.0001	<0.0001	<0.0001	0.0009	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
1078††	ESE '77	10500*	10900	0.0007	<0.0001	<0.0001	0.0002	<0.0001	<0.0001	<0.0001	0.0005	<0.0001	<0.0001	0.0075	0.0005	0.0005	0.0002	<0.0001	0.0002
267††	ESE '77	12000†	5800	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	0.0010	<0.0001	<0.0001	0.0141	0.0017	0.0024	0.0006	<0.0001	0.0027
267**	ESE '78	9120	9890	0.131	0.0192	<0.0001	0.0723	<0.0001	<0.0001	<0.0001	0.285	0.0261	<0.0001	0.277	0.138	<0.0001	0.123	0.0146	<0.0001
Waste Load Averages				<0.0003	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	0.0008	<0.0001	<0.0001	<0.0072	<0.0008	<0.0010	<0.0003	<0.0001	<0.0010

* Variations between the raw and treated flow are due to flow equalization in the treatment system. This does not alter the validity of the waste loads.

† Variations between the raw and treated flow are due to inclusion of stormwater runoff in treated flow. This does not alter the validity of the waste loads.

** Not included in the average because of suspected analytical discrepancies.

†† Plants used to calculate treated averages in Table VII-39.

Key to Base Neutral Data Tables

1. Fluoranthene
2. Benzo (B) Fluoranthene
3. Benzo (k) Fluoranthene
4. Pyrene
5. Benzo (A) Pyrene
6. Indeno (1, 2, 3-CD) Pyrene
7. Benzo (ghi) Perylene
8. Phenanthrene and/or Anthracene
9. Benzo (a) Anthracene
10. Dibenzo (a, h) Anthracene
11. Naphthalene
12. Acenaphthene
13. Acenaphthylene
14. Fluorene
15. Chrysene
16. Bis-2-ethyl-hexyl phthalate

Table VII-20. Wood Preserving Treated Effluent Base Neutrals Concentrations for Plants with Current BPT Technology In-Place

Plant Number	Data Source	Flow (gal/day)	Prod. (ft^3/day)	Concentrations (mg/l)															
				1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
548	ESE '78	36000	15500	1.60	0.210	0.210	1.20	0.290	0.110	0.063	1.40	0.440	--	--	0.370	--	0.280	0.270	--
591	ESE '78	14150	7920	0.210	--	0.037	0.120	0.015	0.040	0.002	0.037	0.055	--	0.031	0.065	--	0.017	--	0.009
591	ESE '77	9350	11300	0.120	--	--	0.077	--	--	--	0.053	--	--	0.140	0.090	0.067	0.050	--	0.010
897	ESE '78	42400	18200	0.011	0.057	0.057	0.013	0.070	0.050	0.011	--	--	--	0.002	0.004	0.004	--	0.019	--
1100	ESE '77	66300	16300	0.106	--	--	0.079	--	--	--	0.420	0.009	--	0.033	0.203	0.190	0.100	--	0.305

-- Hyphen denotes that parameter was analyzed for but was below detection limit.

Key to Base Neutral Data Tables

1. Fluoranthene
2. Benzo (B) Fluoranthene
3. Benzo (k) Fluoranthene
4. Pyrene
5. Benzo (A) Pyrene
6. Indeno (1, 2, 3-CD) Pyrene
7. Benzo (ghi) Perylene
8. Phenanthrene and/or Anthracene
9. Benzo (a) Anthracene
10. Dibenzo (a, h) Anthracene
11. Naphthalene
12. Acenaphthene
13. Acenaphthylene
14. Fluorene
15. Chrysene
16. Bis-2-ethyl-hexyl phthalate

Table VII-21. Wood Preserving Treated Effluent Base Neutrals Waste Loads for Plants with Current BPT Technology In-Place

Plant Number	Data Source	Flow (gal/day)	Prod. (ft^3/day)	Waste Loads (lb/10,000 ft^3)															
				1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
548†	ESE '78	36000	15500	0.0310	0.0041	0.0041	0.0232	0.0056	0.0021	0.0012	0.0271	0.0085	<0.0001	<0.0001	0.0072	<0.0001	0.0054	0.0052	<0.0001
591†	ESE '78	14150**	7920	0.0031	<0.0001	0.0006	0.0018	0.0002	0.0006	<0.0001	0.0006	<0.0008	<0.0001	0.0005	0.0010	<0.0001	0.0003	<0.0001	<0.0001
591†	ESE '77	9350	11300	0.0008	<0.0001	<0.0001	0.0005	<0.0001	<0.0001	<0.0001	0.0004	<0.0001	<0.0001	0.0010	0.0006	0.0005	0.0003	<0.0001	0.0001
1100*	ESE '77	66300	16300	0.0036	<0.0001	<0.0001	0.0027	<0.0001	<0.0001	<0.0001	0.0142	0.0003	<0.0001	0.0011	0.0069	0.0064	0.0034	<0.0001	0.0103
897†	ESE '78	42400	18200	0.0002	0.0011	0.0011	0.0003	0.0014	0.0010	0.0002	<0.0001	<0.0001	<0.0001	<0.0001	0.0001	0.0001	<0.0001	0.0004	<0.0001
Waste Load Averages				0.0088	<0.0014	<0.0015	0.0032	<0.0018	<0.0010	<0.0004	<0.0071	<0.0024	<0.0001	<0.0004	0.0022	<0.0002	<0.0015	<0.0015	<0.0001

* Data not included in averaging since treatment system was operating under upset conditions during sampling.

† Plants used to calculate treated averages in Table VII-40.

** Variations between the raw and treated flow are due to inclusion of boiler blowdown and stormwater runoff in treated flow. This does not alter the validity of the waste loads.

Key to Base Neutral Data Tables

1. Fluoranthene
2. Benzo (B) Fluoranthene
3. Benzo (k) Fluoranthene
4. Pyrene
5. Benzo (A) Pyrene
6. Indeno (1, 2, 3-CD) Pyrene
7. Benzo (ghi) Perylene
8. Phenanthrene and/or Anthracene
9. Benzo (a) Anthracene
10. Dibenzo (a, h) Anthracene
11. Naphthalene
12. Acenaphthene
13. Acenaphthylene
14. Fluorene
15. Chrysene
16. Bis-2-ethyl-hexyl phthalate

Table VII-22. Toxic Pollutant Phenols Analyzed for but Not Found During 1978 Verification Sampling

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2-nitrophenol
4-nitrophenol
2,4-dichlorophenol
2,4-dinitrophenol
para-chloro-meta-cresol
4,6-dinitro-ortho-cresol

Generalized machine detection limits for these compounds is 25 ug/l.

Table VII-23. Wood Preserving Treated Effluent Toxic Pollutant Phenols Data for Plants with Current Pretreatment Technology In-Place

				Concentrations (mg/l)					Waste Loads (lb/1,000 ft^3)				
Plant Number	Data Source	Flow (gal/day)	Prod. (ft^3/day)	phen	2-clphen	2,4-dimeph	2,4,6-triclph	PCP	phen	2-clphen	2,4-dimeph	2,4,6-triclph	PCP
173†	PS '75	3000	3880	NA	NA	NA	NA	15.0	NA	NA	NA	NA	0.0967
267	ESE '78	9120	9890	16.0	--	--	--	5.80	0.123	<0.0001	<0.0001	<0.0001	0.0446
267†	ESE '77	12000**	5800	NA	NA	NA	NA	5.39	NA	NA	NA	NA	0.0930
267†	PS '75	6000	6600	NA	NA	NA	NA	3.20	NA	NA	NA	NA	0.0243
582†	PS '75	13750	7500	NA	NA	NA	NA	9.00	NA	NA	NA	NA	0.138
1076	PS '75	12000	5500	NA	NA	NA	NA	134.	NA	NA	NA	NA	2.44
							BOULTON						
65†	ESE '78	2200	2770	0.026	0.004	--	0.005	17.0	0.0002	<0.0001	<0.0001	<0.0001	0.113
65†	PS '75	5000	5000	NA	NA	NA	NA	2.71	NA	NA	NA	NA	0.0226
1078†	PS '75	7000	10000	NA	NA	NA	NA	0.055	NA	NA	NA	NA	0.0003
Waste Load Averages									0.0616	<0.0001	<0.0001	<0.0001	0.330

NA Not analyzed.
-- Hyphen denotes that parameter was analyzed for but was below detection limit.
* Data not included in averages.
† Plants used in calculating treated averages in Table VII-41.
** Variations between the raw and treated flow are due to inclusion of stormwater runoff in treated flow. This does not alter the validity of the waste loads.

Key to Volatile Organics Data Tables

phen = phenol
2-clphen = 2-chlorophenol
2,4-dimeph = 2,4-dimethylphenol
2,4,6-triclph = 2,4,6-trichlorophenol
PCP - pentachlorophenol

Table VII-24. Wood Preserving Treated Effluent Toxic Pollutant Phenols Data for Plants with Current BPT Technology In-Place

Plant Number	Data Source	Flow (gal/day)	Prod. (ft^3/day)	Concentrations (mg/l)					Waste Loads (lb/10,000 ft^3)				
				phen	2-clphen	2,4-dimeph	2,4,6-triclph	PCP	phen	2-clphen	2,4-dimeph	2,4,6-triclph	PCP
548**	ESE '78	36000	15500	--	--	0.140	--	2.70	<0.0001	<0.0001	0.0027	<0.0001	0.0523
548**	ESE '77	14000*	8760	NA	NA	NA	NA	0.907	NA	NA	NA	NA	0.0121
591**	ESE '78	14150††	7920	0.015	--	--	--	0.032	0.0002	<0.0001	<0.0001	<0.0001	0.0005
591**	ESE '77	9350	11300	NA	NA	NA	NA	0.213	NA	NA	NA	NA	0.0015
897**	ESE '78	42400	18200	0.015	--	0.005	0.005	0.069	0.0003	<0.0001	0.0001	0.0001	0.0013
1100†	ESE '77	66300	16300	NA	NA	NA	NA	8.27	NA	NA	NA	NA	0.281
Waste Load Averages									<0.0002	<0.0001	<0.0010	<0.0001	0.0135

NA Not analyzed.

-- Hyphen denotes that parameter was analyzed for but was below detection limit.

* Plant is a self-contained discharger. Samples were taken after Multi-Stage Biological Treatment. Historical flow data were used to calculate waste loads.

† Data not included in averaging since the treatment system was operating under upset conditions during sampling. Samples were collected from the plant to determine the effect of upset upon priority pollutant removal.

** Plants used in calculating treated averages in Table VII-42.

†† Variations between the raw and treated flow are due to inclusion of boiler blowdown and stormwater runoff in treated flow. This does not alter the validity of the waste loads.

Key to Volatile Organics Data Tables

phen = phenol
2-clphen = 2-chlorophenol
2,4-dimeph = 2,4-dimethylphenol
2,4,6-triclph = 2,4,6-trichlorophenol
PCP - pentachlorophenol

Table VII-25. Wood Preserving Metals Data, Organic Preservatives Only, Treated Effluent for Plants with Current Pretreatment Technology In-Place

Plant	Source	Flow (gpd)	Prod. (ft^3/day)	Effluent Concentrations (mg/l) Arsenic	Antimony	Beryllium	Cadmium	Copper	Chromium	Lead	Mercury	Nickel	Selenium	Silver	Thallium	Zinc
267	ESE '78	9120	9890	0.024	--	0.013	0.005	0.270	0.072	0.025	--	0.046	--	0.004	0.007	0.480
267	ESE '77	12000	5800	0.003	0.001	--	--	0.056	0.005	0.001	--	0.006	0.003	--	0.001	0.579

-- Hyphen denotes that parameter was analyzed for but was below detection limit.

Table VII-26. Wood Preserving Metals Data, Organic Preservatives Only, Treated Effluent for Plants with Current Pretreatment Technology In-Place

Plant	Source	Flow (gpd)	Prod. (ft^3/day)	Effluent Waste Load (lb/1,000 ft^3) Arsenic	Antimony	Beryllium	Cadmium	Copper	Chromium	Lead	Mercury	Nickel	Selenium	Silver	Thallium	Zinc
267	ESE '78	9120	9890	0.00018	<0.00001	0.00010	0.00004	0.00208	0.00055	0.00019,	<0.00001	0.00035	<0.00001	0.00003	0.00005	0.00369
267*	ESE '77	12000†	5800	0.00005	0.00002	<0.00001	<0.00001	0.00097	0.00009	0.00002	<0.00001	0.0001	0.00005	<0.00001	0.00002	0.00999
Average Waste Loads				0.00011	<0.00002	<0.00006	<0.00003	0.00153	0.00032	0.00010	<0.00001	0.00023	<0.00003	<0.00002	0.00004	0.00684

* Plant used in calculating treated averages in Table VII-43.

† Variations between the raw and treated flow are due to inclusion of stormwater runoff in treated flow. This does not alter validity of waste loads.

Table VII-27. Wood Preserving Metals Data, Organic Preservatives Only, Treated Effluent for Plants with Current BPT Technology In-Place

Plant	Source	Flow (gpd)	Prod. (ft^3/day)	Effluent Concentrations (mg/l)												
				Arsenic	Antimony	Beryllium	Cadmium	Copper	Chromium	Lead	Mercury	Nickel	Selenium	Silver	Thallium	Zinc
548	ESE '78	36000	15500	6.98	0.014	--	0.003	0.018	0.015	0.037	--	0.019	--	--	--	0.047
548	ESE '77	14000	8760	0.035	0.002	--	--	0.020	0.003	0.004	--	0.005	0.002	--	--	0.054
591	ESE '78	14150	7920	0.028	0.001	--	0.001	0.034	0.007	0.004	0.002	0.009	--	0.001	--	0.080
591	ESE '77	9350	11300	0.002	0.001	--	--	0.040	0.001	--	0.0005	0.002	0.001	--	0.002	0.145
1100*	ESE '77	66300	16300	0.227	--	--	--	0.092	0.003	0.003	--	0.057	0.003	0.001	0.001	0.252

-- Hyphen denotes that parameter was analyzed for but was below detection limit.

Table VII-28. Wood Preserving Metals Data, Organic Preservatives Only, Treated Effluent for Plants with Current BPT Technology In-Place

Plant	Source	Flow (gpd)	Prod. (ft^3/day)	Effluent Waste Load (lb/1,000 ft^3)												
				Arsenic	Antimony	Beryllium	Cadmium	Copper	Chromium	Lead	Mercury	Nickel	Selenium	Silver	Thallium	Zinc
548**	ESE '78	36000	15500	0.135*	0.00027	<0.00001	0.00006	0.00035	0.00029	0.00072	<0.00001	0.00037	<0.00001	<0.00001	<0.00001	0.00091
548**	ESE '77	14000††	8760	0.00047	0.00003	<0.00001	<0.00001	0.00027	0.00004	0.00005	<0.00001	0.00007	0.00003	<0.00001	<0.00001	0.00072
591**	ESE '78	14150***	7920	0.00042	0.00001	<0.00001	0.00001	0.00051	0.0001	0.00006	0.00003	0.0001	<0.00001	0.00001	<0.00001	0.0012
591**	ESE '77	9350	11300	0.00001	0.00001	<0.00001	<0.00001	0.00028	0.00001	<0.00001	<0.00001	0.00001	0.00001	<0.00001	0.00001	0.00100
1100†	ESE '77	66300	16300	0.00770	<0.00001	<0.00001	<0.00001	0.0031	0.0001	0.0001	<0.00001	0.0019	0.0001	0.00003	0.00003	0.00855
Average Waste Loads				0.0287	<0.00008	<0.00001	<0.00002	0.00035	0.0001	<0.00021	<0.00001	0.0001	<0.00002	<0.00001	<0.00001	0.00096

— Hyphen denotes that parameter was analyzed for but was below detection limit.

* Data not used in averaging.

† Data not included in averaging since treatment system was operating under upset conditions during sampling. Samples were collected from the plant to determine the effect of upset upon priority pollutant removal.

** Plants used in calculating treated averages in Table VII-44.

†† Plant is a self contained discharger. Samples were taken after Multi-Stage Biological Treatment. Historical flow data were used to calculate waste loads.

*** Variations between raw and treated flow are due to inclusion of boiler blowdown and stormwater runoff in treated flow. This does not alter validity of waste loads.

Table VII-29. Wood Preserving Metals Data, Organic and Inorganic Preservatives, Treated Effluent for Plants with Less Than the Equivalent of BPT Technology In-Place

Plant	Data Source	Flow (gpd)	Prod. (ft^3/day)	Effluent Concentrations (mg/l)												
				Arsenic	Antimony	Beryllium	Cadmium	Copper	Chromium	Lead	Mercury	Nickel	Selenium	Silver	Thallium	Zinc
499	PS '75	<100	1950	1.02	NA	NA	NA	4.00	1.30	NA	NA	NA	NA	NA	NA	NA

NA--Not Analyzed.

Table VII-30. Wood Preserving Metals Data, Organic and Inorganic Preservatives, Treated Effluent for Plants With Less Than the Equivalent of BPT Technology Treatment In-Place

Plant	Data Source	Flow (gpd)	Prod. (ft^3/day)	Effluent Waste Loads (lb/1,000 ft^3) Arsenic	Antimony	Beryllium	Cadmium	Copper	Chromium	Lead	Mercury	Nickel	Selenium	Silver	Thallium	Zinc
499*	PS '75	<100	1950	<0.00044	NA	NA	NA	<0.00171	<0.00056	NA	NA	NA	NA	NA	NA	NA
Average Waste Loads				<0.00044	NA	NA	NA	<0.00171	<0.00056	NA	NA	NA	NA	NA	NA	NA

NA--Not Analyzed.

* Plant used in calculating treated averages in Table VII-45.

Table VII-31. Wood Preserving Metals Data, Organic and Inorganic Preservatives, Treated Effluent for Plants with Current Pretreatment Technology In-Place

Plant	Data Source	Flow (gpd)	Prod. (ft^3/day)	Effluent Concentrations (mg/l)												
				Arsenic	Antimony	Beryllium	Cadmium	Copper	Chromium	Lead	Mercury	Nickel	Selenium	Silver	Thallium	Zinc
65	ESE '78	2200	2770	0.011	0.008	0.002	0.007	0.092	4.40	0.013	0.0001	0.018	0.039	0.001	--	31.0
65	PS '75	5000	5000	--	NA	NA	NA	0.020	6.60	NA	NA	NA	NA	NA	NA	41.1
173	PS '75	3000	3880	0.050	NA	NA	NA	0.570	0.090	NA	NA	NA	NA	NA	NA	NA
335	PS '75	1700	3400	0.730	NA	NA	NA	1.78	0.530	NA	NA	NA	NA	NA	NA	NA
582	PS '75	13750	7500	0.030	NA	NA	NA	0.150	0.010	NA	NA	NA	NA	NA	NA	0.160
1078	ESE '77	10500	10900	0.002	--	--	--	0.277	0.010	0.001	0.0012	0.150	0.001	--	--	1.37
1078	PS '75	7000	10000	--	NA	NA	NA	0.530	0.030	NA	NA	NA	NA	NA	NA	1.04

NA Not Analyzed.

-- Hyphen denotes that parameter was analyzed for but was below detection limit.

Table VII-32. Wood Preserving Metals Data, Organic and Inorganic Preservatives, Treated Effluent for Plants with Current Pretreatment Technology In-Place

Plant	Data Source	Flow (gpd)	Prod. (ft^3/day)	Effluent Waste Loads (lb/1,000 ft^3)												
				Arsenic	Antimony	Beryllium	Cadmium	Copper	Chromium	Lead	Mercury	Nickel	Selenium	Silver	Thallium	Zinc
65*	ESE '78	2200	2770	0.00007	0.00005	0.00001	0.00005	0.00061	0.0291	0.00009	<0.00001	0.00012	0.00026	0.00001	<0.00001	0.205
65*	PS '75	5000	5000	<0.00001	NA	NA	NA	0.00017	0.0550†	NA	NA	NA	NA	NA	NA	0.0343†
173	PS '75	3000	3880	0.00032	NA	NA	NA	0.00368	0.00058	NA	NA	NA	NA	NA	NA	NA
335*	PS '75	1700	3400	0.00304	NA	NA	NA	0.00742	0.00221	NA	NA	NA	NA	NA	NA	NA
582*	PS '75	13750	7500	0.00046	NA	NA	NA	0.00229	0.00015	NA	NA	NA	NA	NA	NA	0.00245
1078*	ESE '77	10500**	10900	0.00002	<0.00001	<0.00001	<0.00001	0.00223	0.00008	0.00001	0.00001	0.00121	0.00001	<0.00001	<0.00001	0.0110
1078*	PS '75	7000	10000	<0.00001	NA	NA	NA	0.00309	0.00018	NA	NA	NA	NA	NA	NA	0.00607
Average Waste Loads				<0.00056	<0.00003	<0.00001	<0.00003	0.00278	0.00538	0.00005	<0.00001	0.00067	0.00014	<0.00001	<0.00001	0.0561

* Plants used in calculating treated averages in Table VII-46.

† Not included in averages because the process involves direct metals contamination of wastewater.

** Variations between the raw and treated flow are due to flow equalization in the treatment system. This does not alter the validity of waste loads.

NA Not Analyzed.

Table VII-33. Wood Preserving Metals Data, Organic and Inorganic Preservatives, Treated Effluent for Plants with Current BPT Technology In-Place

Plant	Data Source	Flow (gpd)	Prod. (ft^3/day)	Effluent Concentrations (mg/l)												
				Arsenic	Antimony	Beryllium	Cadmium	Copper	Chromium	Lead	Mercury	Nickel	Selenium	Silver	Thallium	Zinc
897	ESE '78	66700	18200	0.083	--	--	0.005	0.058	0.031	0.009	0.0002	0.011	--	--	--	0.100

-- Hyphen denotes that parameter was analyzed for but was below detection limit.

Table VII-34. Wood Preserving Metals Data, Organic and Inorganic Preservatives, Treated Effluent for Plants with Current BPT Technology In-Place

Plant	Data Source	Flow (gpd)	Prod. (ft^3/day)	Waste Loads ($lb/1,000\ ft^3$) Arsenic	Antimony	Beryllium	Cadmium	Copper	Chromium	Lead	Mercury	Nickel	Selenium	Silver	Thallium	Zinc
897*	ESE '78	66700	18200	0.0025	<0.00001	<0.00001	0.0001	0.0018	0.00095	0.0003	0.00001	0.00034	<0.00001	<0.00001	<0.00001	0.00306
Average Waste Loads				0.0025	<0.00001	<0.00001	0.0001	0.0018	0.00095	0.0003	0.00001	0.00034	<0.00001	<0.00001	<0.00001	0.00306

* Plant used in calculating treated averages in Table VII-47.

Table VII-35. Wood Preserving Traditional Data Averages for Plants With Less Than the Equivalent of BPT Technology In-Place

	Waste Loads (lb/1,000 ft^3)			
	COD	Total Phenols	Oil & Grease	PCP
Raw*	92.8	1.77	8.71	0.498
Treated**	31.2	1.01	1.75	0.151
% Removal	66.4	42.9	79.9	69.7

* Averages calculated from data in Table V-7.

** Averages calculated from data in Table VII-10.

Table VII-36. Wood Preserving Traditional Data for Plants with Pretreatment Technology In-Place

	Waste Loads (lb/1,000 ft³)			
	COD	Total Phenols	O & G	PCP
Raw*	80.7	3.11	7.82	<0.294
Treated**	41.5	2.03	0.908	0.0716
% Removal	48.6	34.7	88.4	<75.6

* Averages calculated from Tables V-7 and V-8.

** Averages calculated from Table VII-11.

Table VII-37. Wood Preserving Traditional Data for Plants with BPT Technology In-Place

	Waste Loads (lb/1,000 ft3)			
	COD	Total Phenols	O & G	PCP
Raw*	31.3	2.41	4.32	<0.268
Treated**	6.00	0.0061	0.821	0.0135
% Removal	80.8	99.7	>81.0	<95.0

* Averages calculated from Table V-7.

** Averages calculated from Table VII-13.

Table VII-38. Wood Preserving Volatile Organic Analysis Data for Plants with BPT Technology In Place

	Waste Loads (lb/10,000 ft^3)				
	mecl	trclme	benzene	etbenzene	toluene
Raw*	0.0049	<0.0001	%0.0200	0.101	0.0237
Treated**	0.0043	<0.0002	<0.0003	<0.0001	<0.0009
% Removal	12.2		>98.5	>99.9	>96.2

* Averages calculated from data in Table V-9.

** Averages calculated from data in Table VII-16. Key to Volatile Organics Data Tables

mecl = methylene chloride

trclme = chloroform (trichloromethane)

brdiclme = bromodichoromethane

etbenzene = ethylbenzene

Table VII-39. Wood Preserving Base Neutrals Data, Averages for Plants with Current Pretreatment Technology In-Place

	Waste Loads (lb/1,000 ft^3)															
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Raw*	<0.0057	<0.0001	<0.0001	<0.0038	<0.0001	<0.0001	<0.0001	0.0324	<0.0006	<0.0001	<0.0137	<0.0158	<0.0117	<0.0116	<0.0003	<0.0062
Treated†	0.0003	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	0.0008	<0.0001	<0.0001	<0.0072	<0.0008	<0.0010	<0.0003	<0.0001	<0.0010
% Removal	<94.7			97.4				97.5	83.3		47.4	94.9	91.5	97.4	66.7	83.9

*Averages calculated from data in Table V-12.

† Averages calculated from data in Table VII-19.

Key to Base Neutral Data Tables

1. Fluoranthene
2. Benzo (B) Fluoranthene
3. Benzo (k) Fluoranthene
4. Pyrene
5. Benzo (A) Pyrene
6. Indeno (1, 2, 3-CD) Pyrene
7. Benzo (ghi) Perylene
8. Phenanthrene and/or Anthracene
9. Benzo (a) Anthracene
10. Dibenzo (a, h) Anthracene
11. Naphthalene
12. Acenaphthene
13. Acenaphthylene
14. Fluorene
15. Chrysene
16. Bis-2-ethyl-hexyl phthalate

Table VII-40. Wood Preserving Base Neutrals Data, Averages for Plants with Current BPT Technology In-Place

	Waste Loads (lb/1,000 ft^3)															
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Raw*	0.0530	<0.0091	0.0127	0.0395	<0.0105	<0.0073	<0.0015	0.121	<0.0129	<0.0005	>0.186	0.0436	0.0049	0.0344	<0.0112	<0.0002
Treated†	0.0088	<0.0014	<0.0015	0.0032	<0.0018	<0.0010	<0.0004	<0.0071	<0.0024	<0.0001	<0.0004	0.0022	<0.0002	<0.0015	<0.0015	<0.0001
% Removal	83.4	85.7	>89.7	93.0	83.9	89.6	78.9	>94.0	86.0	83.3	>99.8	95.3	>97.0	>95.9	83.1	66.7

* Averages calculated from data in Table V-12.

† Averages calculated from data in Table VII-21.

Key to Base Neutral Data Tables

1. Fluoranthene
2. Benzo (B) Fluoranthene
3. Benzo (k) Fluoranthene
4. Pyrene
5. Benzo (A) Pyrene
6. Indeno (1, 2, 3-CD) Pyrene
7. Benzo (ghi) Perylene
8. Phenanthrene and/or Anthracene
9. Benzo (a) Anthracene
10. Dibenzo (a, h) Anthracene
11. Naphthalene
12. Acenaphthene
13. Acenaphthylene
14. Fluorene
15. Chrysene
16. Bis-2-ethyl-hexyl phthalate

Table VII-41. Wood Preserving Toxic Pollutant Phenols Data for Plants with Pretreatment Technology In-Place

	Waste Loads (lb/1,000 ft^3)				
	phen	2-clph	2,4-dimeph	2,4,6-triclph	PCP
Raw*	0.0066	0.0001	0.0001	0.0001	0.419
Treated**	0.0002	0.0001	0.0001	0.0001	0.0697
% Removal	97.1				83.4

* Averages calculated from data in Table V-14.

** Averages calculated from data in Table VII-23.

<u>Key to Toxic Pollutant Phenols Data Tables</u>

phen = phenol

2-clphen = 2-chlorophenol

2,4-dimeph = 2,4-dimethylphenol

2,4,6-triclph = 2,4,6-trichlorophenol

PCP = pentachlorophenol

Table VII-42. Wood Preserving Toxic Pollutant Phenols Data For Plants With BPT Technology In-Place

	Waste Loads (lb/1,000 ft^3)				
	phen	2-clph	2,4-dimeph	2,4,6-triclph	PCP
Raw*	0.352	D0.0004	0.0445	D0.0050	0.0736
Treated**	D0.0002	D0.0001	0.0010	0.0001	0.0135
% Removal	>99.9	75.0	>97.8	98.0	97.6

* Averages calculated from data in Table V-14.

** Averages calculated from data in Table VII-24.

<u>Key to Toxic Pollutant Phenols Data Tables</u>

phen = phenol

2-clph = 2-chlorophenol

2,4-dimeph = 2,4-dimethylphenol

2,4,6-triclph = 2,4,6-trichlorophenol

PCP = pentachlorophenol

Table VII-43. Wood Preserving Metals Data, Organic Preservatives Only, Averages for Plants with Current Pretreatment Technology In-Place

	Waste Loads (lb/1,000 ft^3)												
	Arsenic	Antimony	Beryllium	Cadmium	Copper	Chromium	Lead	Mercury	Nickel	Selenium	Silver	Thallium	Zinc
Raw*	0.00003	<0.00001	<0.00001	<0.00001	0.00137	0.00001	0.00008	<0.00001	0.00005	0.00001	<0.00001	0.00001	0.00338
Treated †	0.00005	0.00002	<0.00001	<0.00001	0.00097	0.00009	0.00002	<0.00001	0.0001	0.00005	<0.00001	0.00002	0.00999
% Removal					29.2		75.0						

* Averages calculated from data in Table V-17.

† Averages calculated from data in Table VII-26.

Table VII-44. Wood Preserving Metals Data, Organic Preservatives Only, Averages for Plants with Current BPT Technology In-Place

	Waste Loads (lb/1,000 ft^3)												
	Arsenic	Antimony	Beryllium	Cadmium	Copper	Chromium	Lead	Mercury	Nickel	Selenium	Silver	Thallium	Zinc
Raw*	0.00014	0.00022	<0.00001	<0.00001	0.00048	0.00012	0.00043	<0.00001	0.00010	0.00002	<0.00001	<0.00001	0.00163
Treated†	0.0003	<0.00008	<0.00001	<0.00002	0.00035	0.0001	<0.00021	<0.00001	0.0001	<0.00002	<0.00001	<0.00001	0.00096
% Removal		>63.6			27.1	16.7	>51.2						41.1

* Averages calculated from data in Table V-17.

† Averages calculated from data in Table VII-28.

Table VII-45. Wood Preserving Metals Data, Organic and Inorganic Preservatives, Averages for Plants With Less Than Current BPT Technology In-Place

	Waste Loads (lb/1,000 ft^3)												
	Arsenic	Antimony	Beryllium	Cadmium	Copper	Chromium	Lead	Mercury	Nickel	Selenium	Silver	Thallium	Zinc
Raw*	0.00043	NA	NA	NA	0.00167	0.00053	NA	NA	NA	NA	NA	NA	NA
Treated†	0.00044	NA	NA	NA	0.00171	0.00056	NA	NA	NA	NA	NA	NA	NA
% Removal													

* Averages calculated from data in Table V-19.

† Averages calculated from data in Table VII-30.

NA Not Analyzed.

Table VII-46. Wood Preserving Metals Data, Organic and Inorganic Preservatives, Averages for Plants with Current Pretreatment Technology In-Place

Data Sources	Waste Loads (lb/1,000 ft^3)												
	Arsenic	Antimony	Beryllium	Cadmium	Copper	Chromium	Lead	Mercury	Nickel	Selenium	Silver	Thallium	Zinc
Raw*	<0.00030	<0.00005	<0.00001	<0.00002	0.0039	<0.00728	0.00003	<0.00001	0.00062	0.00019	0.00002	<0.00001	0.0601
Treated †	<0.00060	<0.00003	<0.00001	<0.00003	0.00264	0.00634	0.00005	<0.00001	0.00067	0.00014	<0.00001	<0.00001	0.0561
% Removal		40.0			32.3	<12.9				26.3	>50.0		6.7

* Averages calculated from data in Table V-19.

† Averages calculated from data in Table VII-32.

Table VII-47. Wood Preserving Metals Data, Organic and Inorganic Preservatives, Averages for Plants with Current BPT Technology In-Place

Data Sources	Waste Loads (lb/1,000 ft^3) Arsenic	Antimony	Beryllium	Cadmium	Copper	Chromium	Lead	Mercury	Nickel	Selenium	Silver	Thallium	Zinc
Raw*	0.00253	<0.00001	<0.00001	0.00002	0.0015	0.00045	0.00031	0.00003	0.00194	<0.00001	<0.00001	<0.00001	0.00233
Treated †	0.0025	<0.00001	<0.00001	0.0001	0.0018	0.00095	0.0003	0.00001	0.00034	<0.00001	<0.00001	<0.00001	0.00306
% Removal	1.2						3.2	66.7	82.5				

* Averages calculated from data in Table V-19.

† Averages calculated from data in Table VII-34.

Wood Preserving Candidate Treatment Technologies

Direct Dischargers--Candidate treatment technologies for direct dischargers are applicable only to the Steam subcategory. Previously published BPT regulations require no discharge for the Boulton subcategory, and no Boulton direct dischargers were identified.

These direct discharge candidate technologies are presented primarily for information purposes, as only one direct discharging wood preserving-steam plant was identified during the BAT review. This plant, Plant 268, discharges only during periods of heavy rainfall. The plant provides primary oil-water separation followed by chemical coagulation, sedimentation, and biological treatment, and is planning steps to eliminate the intermittent discharges of process wastewater from the plant.

Four basic treatment technologies are applicable to steaming direct dischargers:

1. BPT technology (primary oil-water separation, chemical coagulation and sedimentation or filtration, and biological treatment) treatment facilities;
2. BPT with increased biological treatment as above with the addition of activated carbon adsorption as a polishing treatment for the biological effluent;
3. BPT with increased biological treatment as in (1) above with metals removal by chromium reduction and hydroxide precipitation; and
4. BPT with increased biological treatment and metals removal as in (3) above with activated carbon adsorption as a polishing treatment for the biological effluent.

Increased biological treatment facilities can be achieved through one of two options. One option is to add an aerated lagoon followed by a facultative lagoon for additional treatment and clarification to the existing BPT biological system. The other option is to provide an activated sludge system, including equalization and secondary clarification in addition to the BPT technology.

The effluent quality of each option will be the same. The aerated lagoon option is less costly than the activated sludge system; however, it requires more land.

The candidate treatment systems selected for direct dischargers in the steam subcategory including both biological treatment options for each of the four basic treatment technologies are:

1. Candidate Treatment Technology A which represents BPT technology plus an additional aerated and facultative lagoon system for increased biological treatment, as shown in Figure VII-5.
2. Candidate Treatment Technology B which represents BPT technology plus an additional activated sludge system including equalization and clarification for increased biological treatment, as shown in Figure VII-6.
3. Candidate Treatment Technology C which represents Technology A plus activated carbon adsorption, as shown in Figure VII-7.
4. Candidate Treatment Technology D which represents Technology B plus activated carbon adsorption, as shown in Figure VII-8.
5. Candidate Treatment Technology E which represents Technology A plus metals removal, as shown in Figure VII-9.
6. Candidate Treatment Technology F which represents Technology B plus metals removal, as shown in Figure VII-10.
7. Candidate Treatment Technology G which represents Technology E plus activated carbon adsorption, as shown in Figure VII-11.
8. Candidate Treatment Technology H which represents Technology F plus activated carbon adsorption, as shown in Figure VII-12.

The representative treated waste loads for Candidate Treatment Technologies A through H are presented in Table VII-48. The waste loads for Technologies A and B were obtained from Table VII-13, with the exception of those for Oil and Grease. The Oil and Grease waste loads shown in Table VII-48 were obtained by averaging the Oil and Grease waste loads demonstrated by Plants 591 (ESE, 1977), 897 (ESE, 1978), and 1111 (PS, 1975) as shown in Table VII-13. Plants 548 (ESE, 1977 and 1978) and 591 (ESE, 1978) were not included in this average as both plants are self contained dischargers which either recycle a large portion of their treated effluent or spray irrigate their treated effluent following treatment. Neither plant met the 30-day average BPT standard for oil and grease during the stated sampling period. There is no need for these plants to optimize Oil and Grease removal because their wastewater disposal systems are apparently operating satisfactorily. Plants 591 (ESE, 1977), 897 (ESE, 1978), and 1111 (PS, 1975) demonstrate that the BPT Oil and Grease standards are achievable with a biological system.

Waste loads after carbon treatment are calculated based on the assumption that activated carbon will remove 80 percent of the COD, and 95 percent of total phenols including PCP. It should be noted that these reductions are assumptions supported only by

WOOD PRESERVING - STEAM
(DIRECT DISCHARGERS)

CANDIDATE TREATMENT TECHNOLOGY
MODEL PLANT A

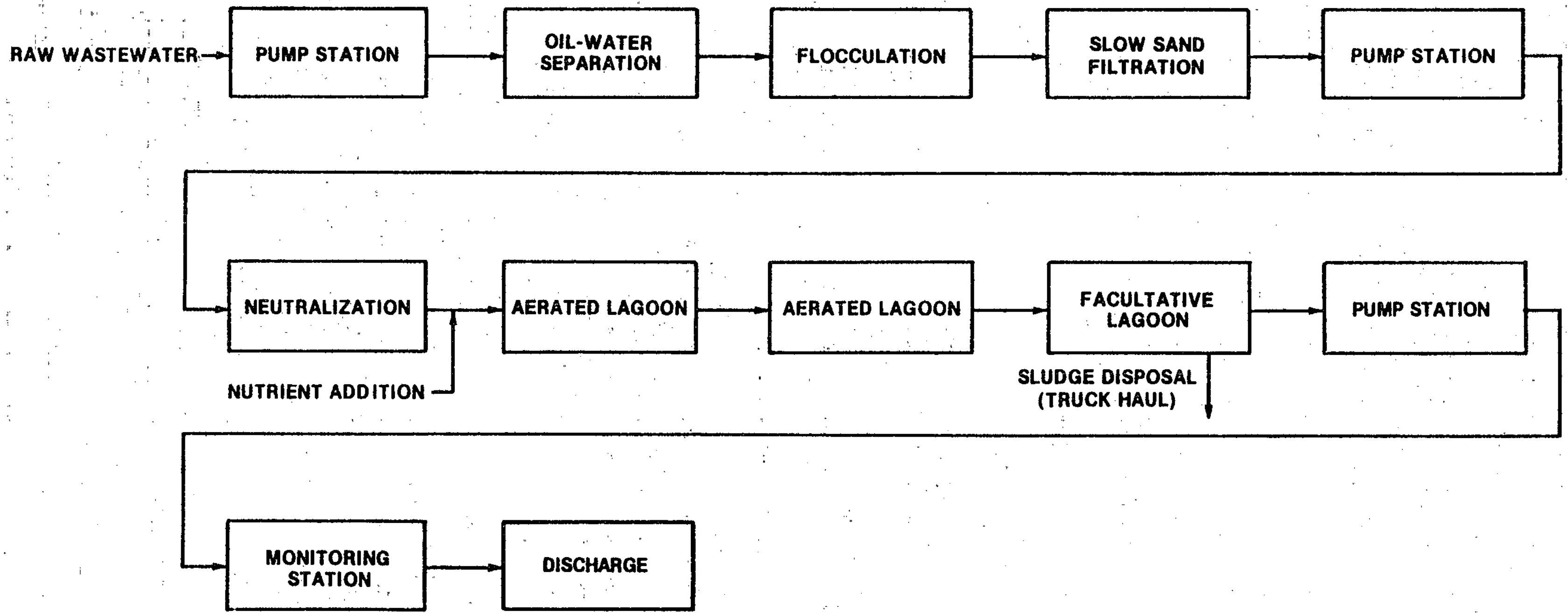


Figure VII-5

WOOD PRESERVING - STEAM
(DIRECT DISCHARGERS)

CANDIDATE TREATMENT TECHNOLOGY
MODEL PLANT B

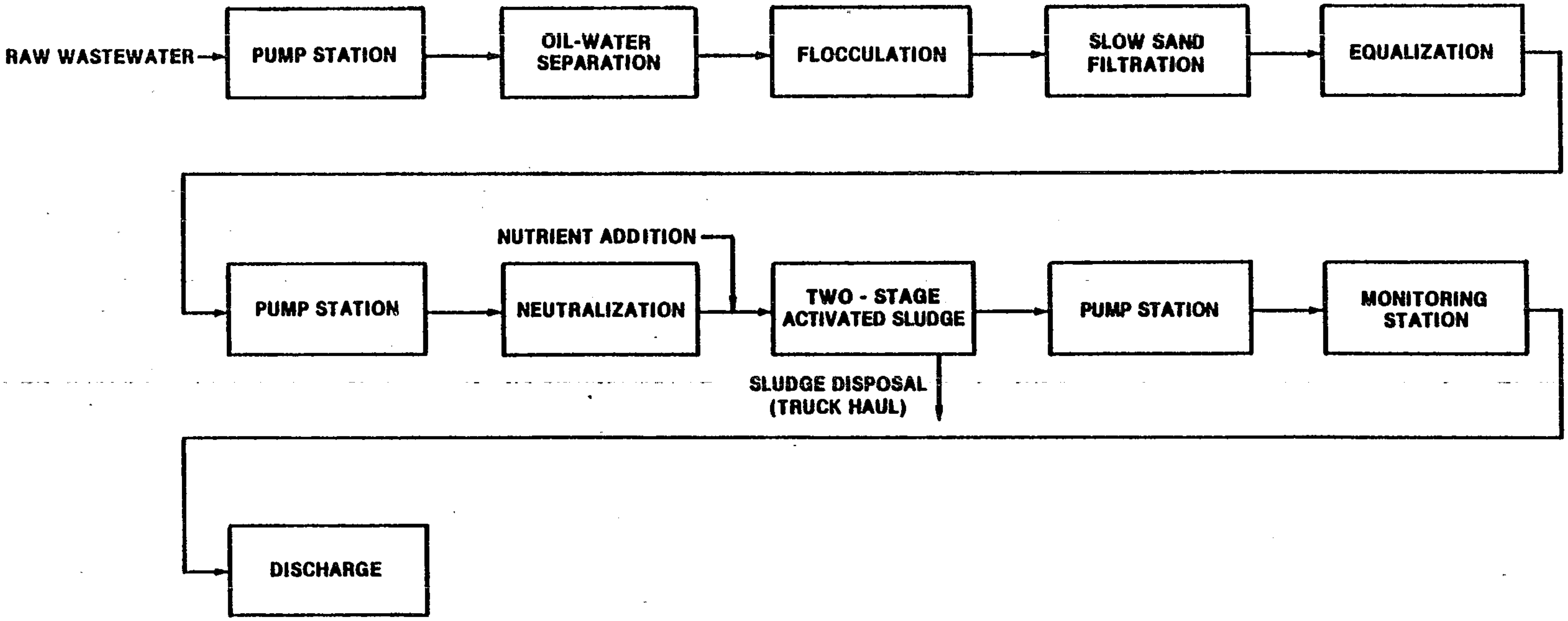


Figure VII-6

WOOD PRESERVING - STEAM
(DIRECT DISCHARGERS)

CANDIDATE TREATMENT TECHNOLOGY
MODEL PLANT C

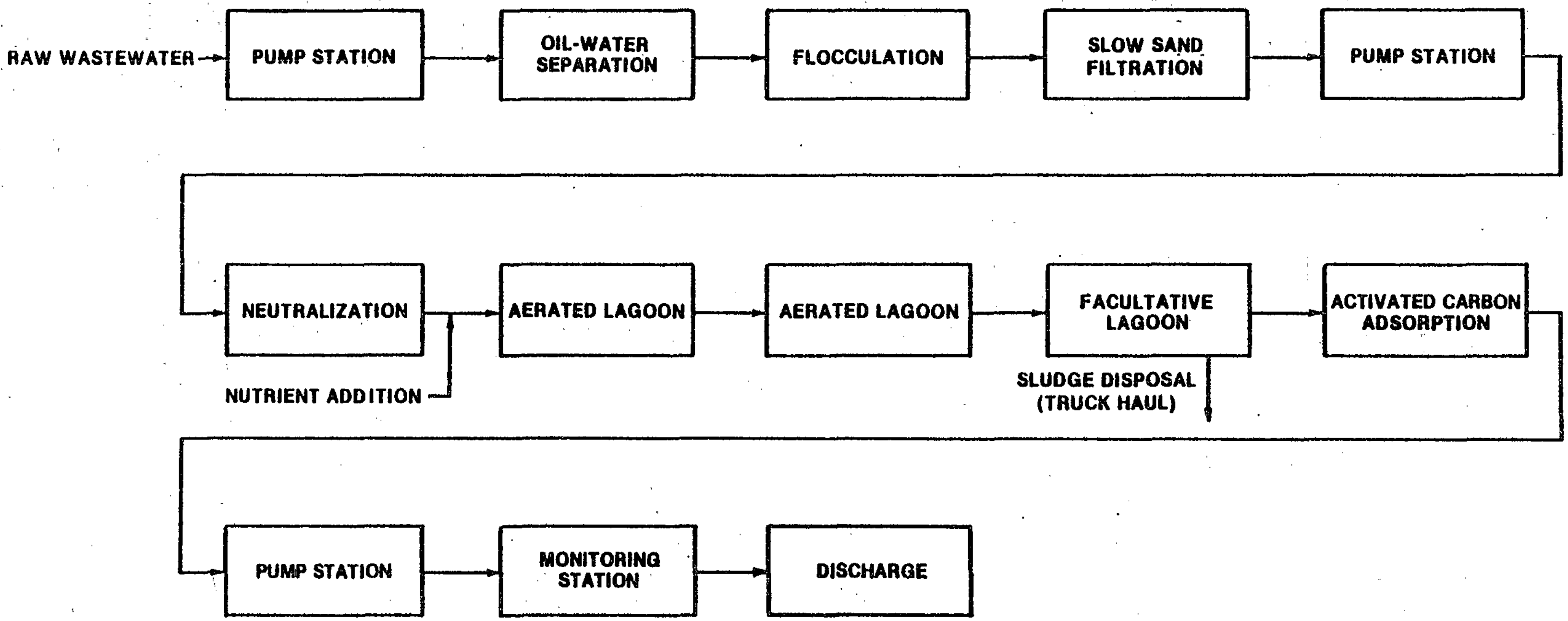


Figure VII-7

WOOD PRESERVING - STEAM
(DIRECT DISCHARGERS)

CANDIDATE TREATMENT TECHNOLOGY
MODEL PLANT D

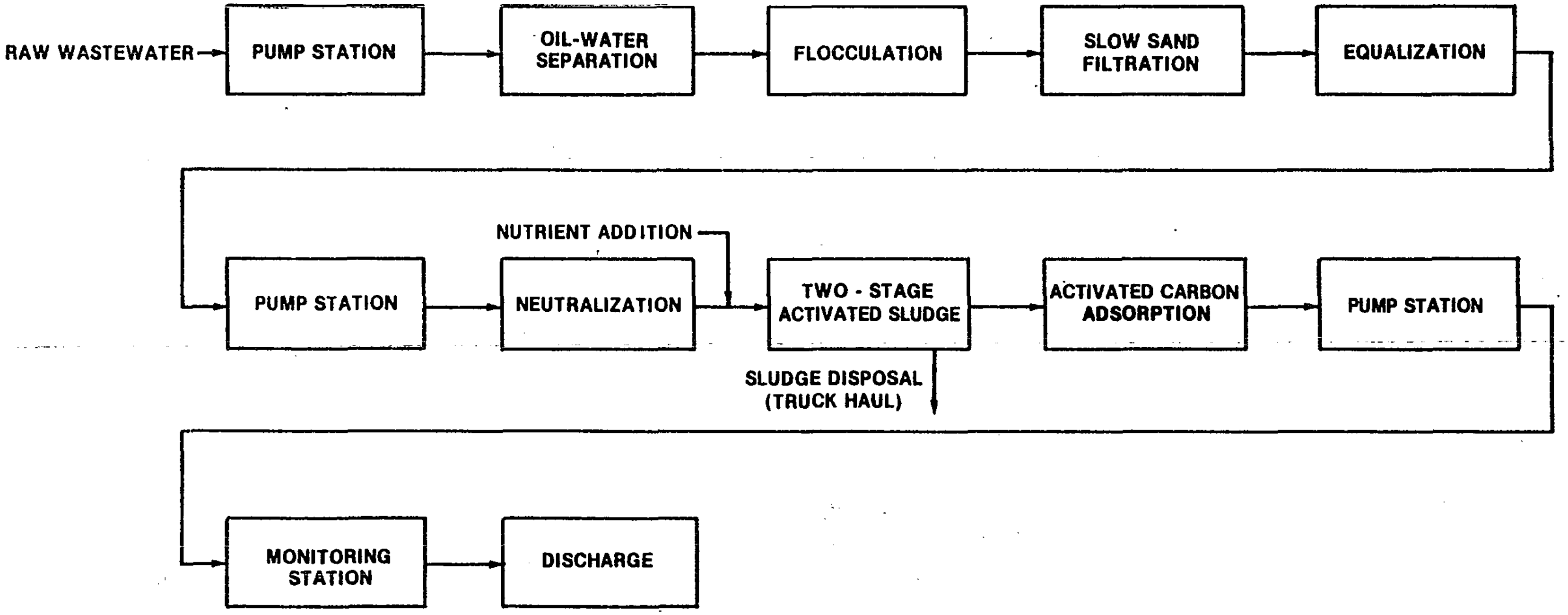


Figure VII-8

WOOD PRESERVING - STEAM
(DIRECT DISCHARGERS - OILY WASTEWATER WITH FUGITIVE METALS)

CANDIDATE TREATMENT TECHNOLOGY
MODEL PLANT E

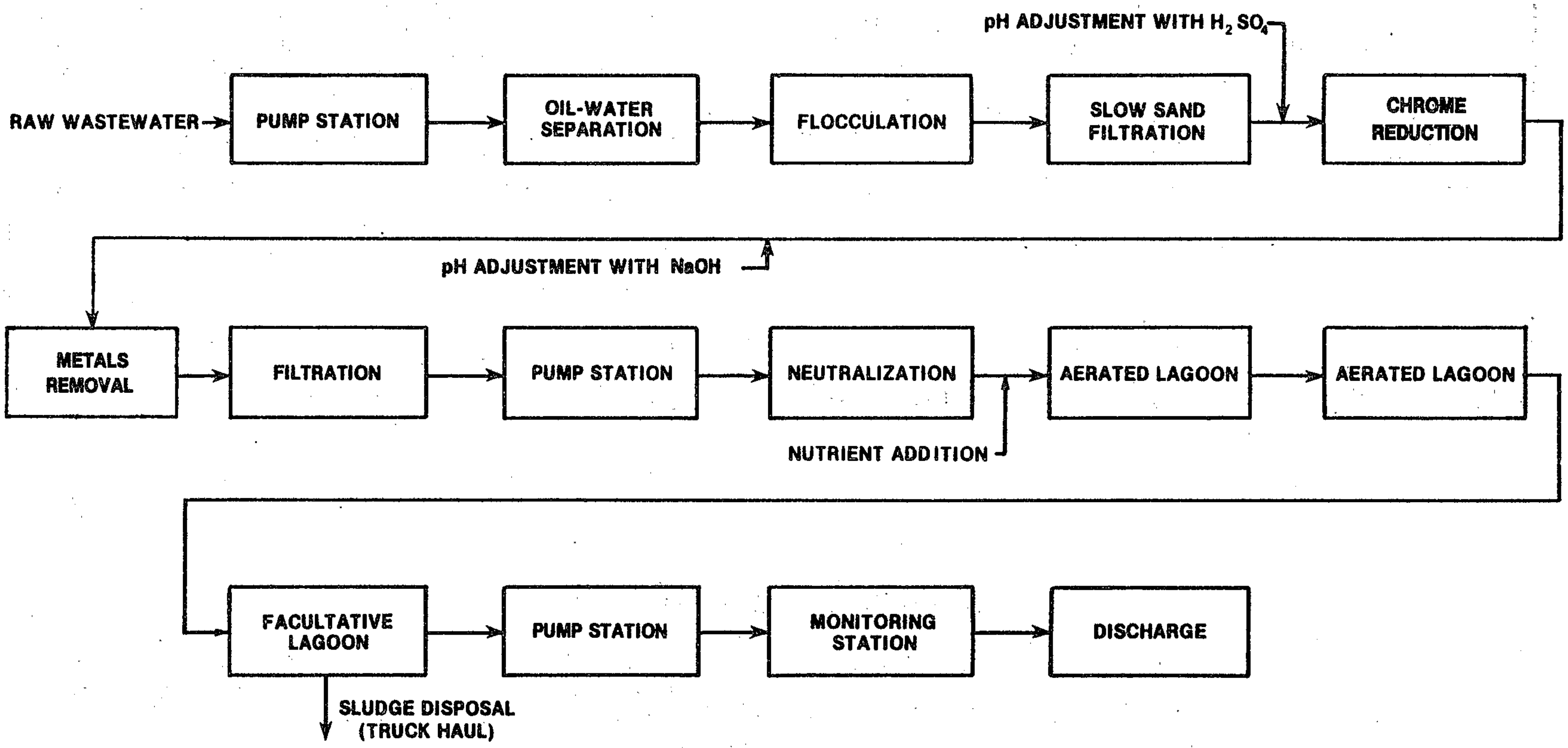


Figure VII-9

WOOD PRESERVING - STEAM
(DIRECT DISCHARGERS - OILY WASTEWATER WITH FUGITIVE METALS)

CANDIDATE TREATMENT TECHNOLOGY
MODEL PLANT F

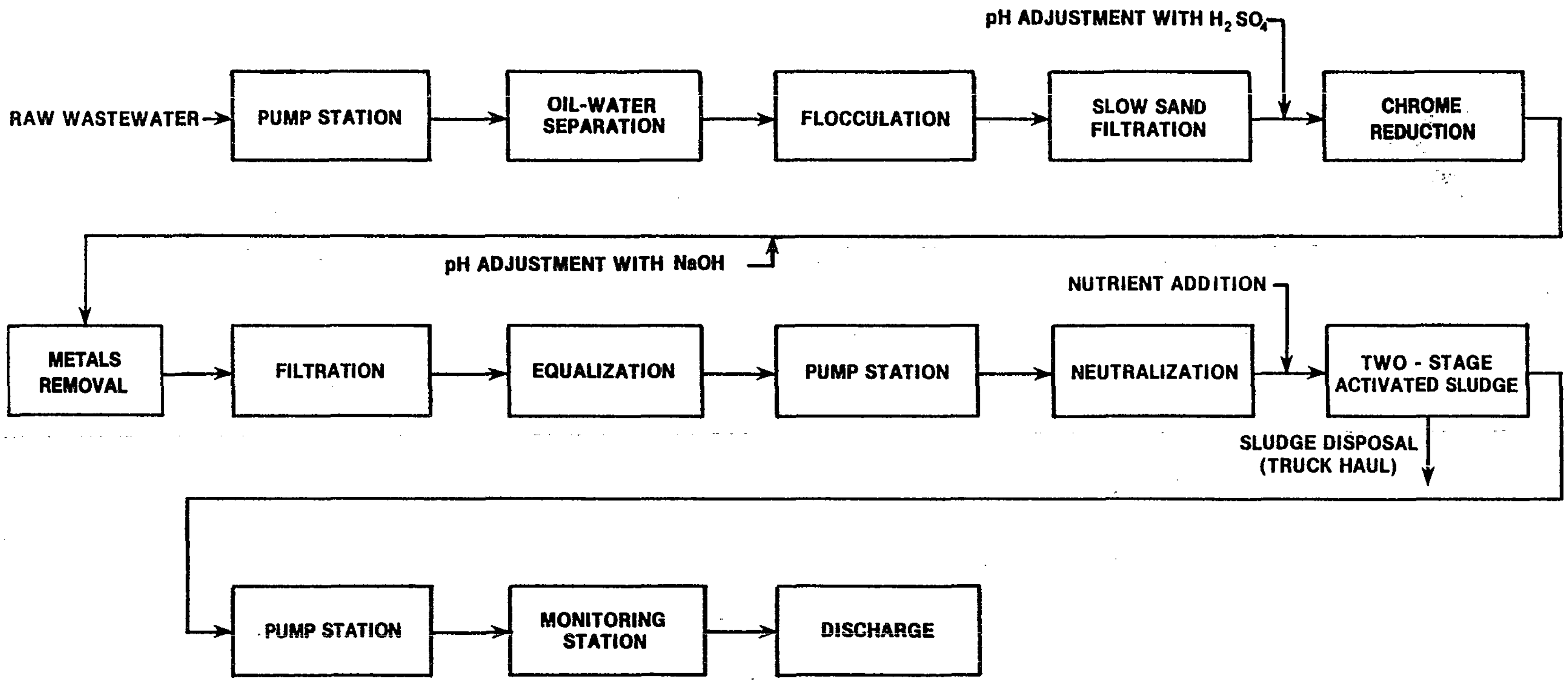


Figure VII-10

WOOD PRESERVING - STEAM
(DIRECT DISCHARGERS - OILY WASTEWATER WITH FUGITIVE METALS)

CANDIDATE TREATMENT TECHNOLOGY
MODEL PLANT G

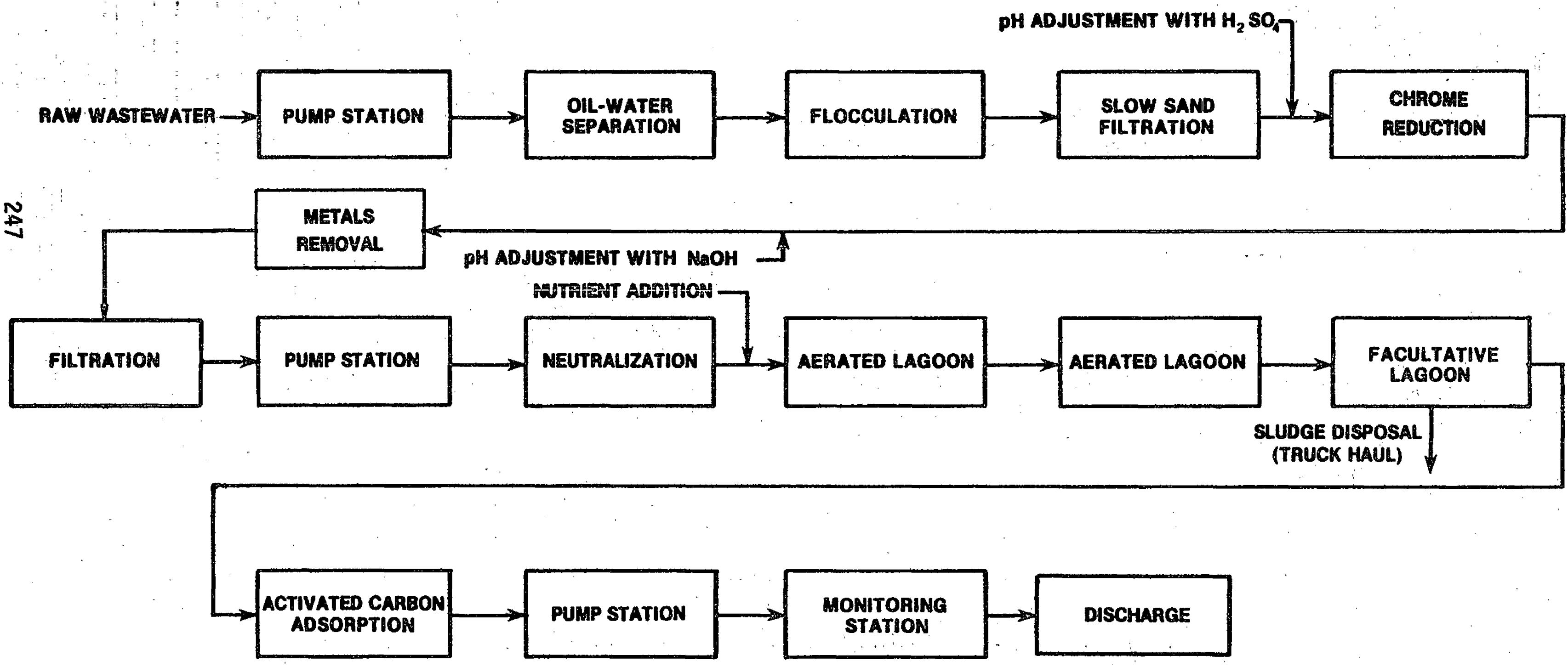


Figure VII-11

WOOD PRESERVING - STEAM
(DIRECT DISCHARGERS - OILY WASTEWATER WITH FUGITIVE METALS)

CANDIDATE TREATMENT TECHNOLOGY
MODEL PLANT H

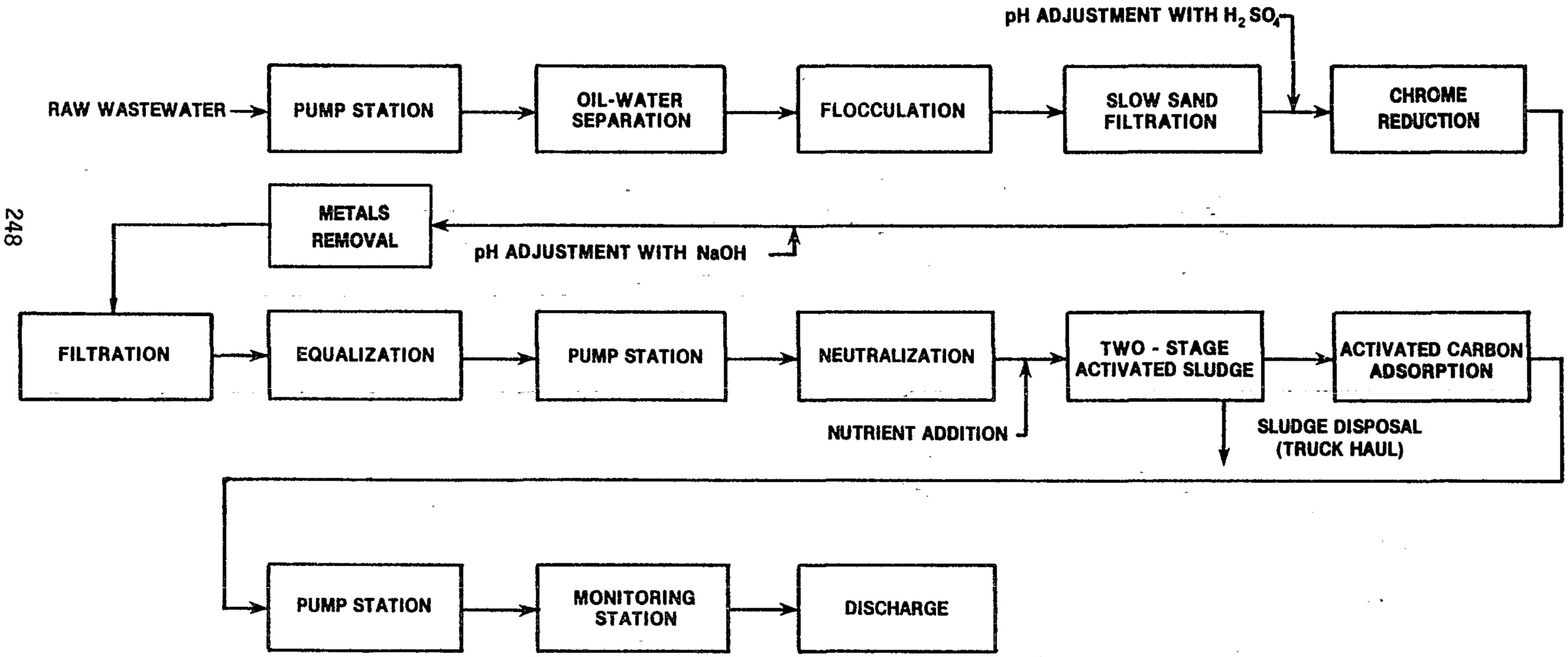


Figure VII-12

Table VII-48. Treated Effluent Loads in lb/1,000 ft^3 of Production for Candidate Treatment Technologies (Direct Dischargers)

Pollutant Parameter	Candidate Technology A or B	 C or D*	 E or F	 G or H*
COD	6.0	1.2	6.0	1.2
Oil & Grease	0.25	0.25	0.25	0.25
Total Phenols	0.0061	0.0003	0.0061	0.0003
PCP	0.014	0.0007	0.014	0.0007
VOA's	See Table VII-38	99+% removal (except methylene chloride)	See Table VII-38	99+% removal (except methylene chloride)
Base Neutrals	See Table VII-40	99+% removal	See Table VII-40	99+% removal
Toxic Pollutant Phenols	See Table VII-42	99+% removal	See Table VII-42	99+% removal
Heavy Metals	See Table VII-44 and VII-47	See Table VII-44 and VII-47	About 75% removal, copper, chrome, zinc, and arsenic*	76-98% removal of copper, chrome, zinc, and arsenic

* Expected treated effluent loads based on literature presented earlier in this section.

literature data and have not been demonstrated in the industry as there are no similar systems currently in-place.

Waste loads after metals removal are calculated based on the removals reported in the literature, as described earlier in this section. They have not been demonstrated in the industry as there are no systems currently in-place.

Direct discharging steaming plants may also achieve no discharge status through the self contained Candidate Treatment Technology N, which consists of spray evaporation and is discussed under self contained dischargers later in this section.

The costs associated with the single direct discharging wood preserving plant identified earlier to install the candidate treatment technologies are presented in Appendix A.

Indirect Dischargers--Candidate treatment technologies applicable to indirect dischargers are applicable to both Boulton and Steam subcategory plants.

Three basic treatment technologies are applicable to the indirect dischargers:

1. Pretreatment technology (primary oil separation followed by chemical flocculation and slow sand filtration).
2. Pretreatment technology with the addition of biological treatment facilities sufficient to meet BPT standards.
3. Pretreatment technology with biological treatment facilities as above with the addition of heavy metals removal by chromium reduction and hydroxide precipitation.

Biological treatment can be achieved through one of two options. One option consists of an aerated lagoon followed by a facultative lagoon for additional biological treatment and clarification. The other option consists of a single basin activated sludge system including equalization and clarification.

The effluent quality of each option will be the same. The aerated lagoon option is less costly than the activated sludge system; however, it requires more land.

The candidate treatment systems selected for indirect dischargers are:

1. Candidate Treatment Technology I which represents pretreatment technology, as shown in Figure VII-13.
2. Candidate Treatment Technology J which represents pretreatment technology plus an aerated lagoon followed

by a facultative lagoon for biological treatment, as shown in Figure VII-14.

3. Candidate Treatment Technology K which represents pretreatment technology plus an activated sludge system including equalization and clarification, as shown in Figure VII-15.

4. Candidate Treatment Technology L which represents Technology J plus metals removal, as shown in Figure VII-16.

5. Candidate Treatment Technology M which represents Technology K plus metals removal, as shown in Figure VII-17.

The representative treated waste loads for Candidate Treatment Technologies I through M are presented in Table VII-49. Treated waste loads presented for Oil and Grease, copper, chromium, and arsenic for treatment technology I are based on pretreatment standards and average wastewater flows presented in Section V. Treated waste loads for the biological systems presented in this table are based on BPT standards. The design and cost estimates, presented in Appendix A, for the indirect discharger biological systems are based on minimum biological treatment required to provide a BPT effluent quality. Cost estimates are not presented in Appendix A for pretreatment technology (Technology I) because no incremental costs of compliance will accrue for the indirect dischargers since they are currently required to meet effluent levels based on this technology. Expected treated effluent waste loads of 0.05 lb/1,000 cu ft for PCP for biological treatment systems are based on an estimate of PCP removal for plants with sufficient biological treatment to meet minimum BPT standards for regulated parameters. Table VII-10 shows that the average PCP waste load for plants with biological systems insufficient to meet BPT is 0.119 lb/1,000 cu ft. Table VII-13 shows that the average PCP waste load for plants which exceed BPT standards is 0.0135 lb/ 1,000 cu ft.

WOOD PRESERVING - STEAM, BOULTON
(INDIRECT DISCHARGERS - OILY WASTEWATER WITH FUGITIVE METALS)

CANDIDATE TREATMENT TECHNOLOGY
MODEL PLANT I

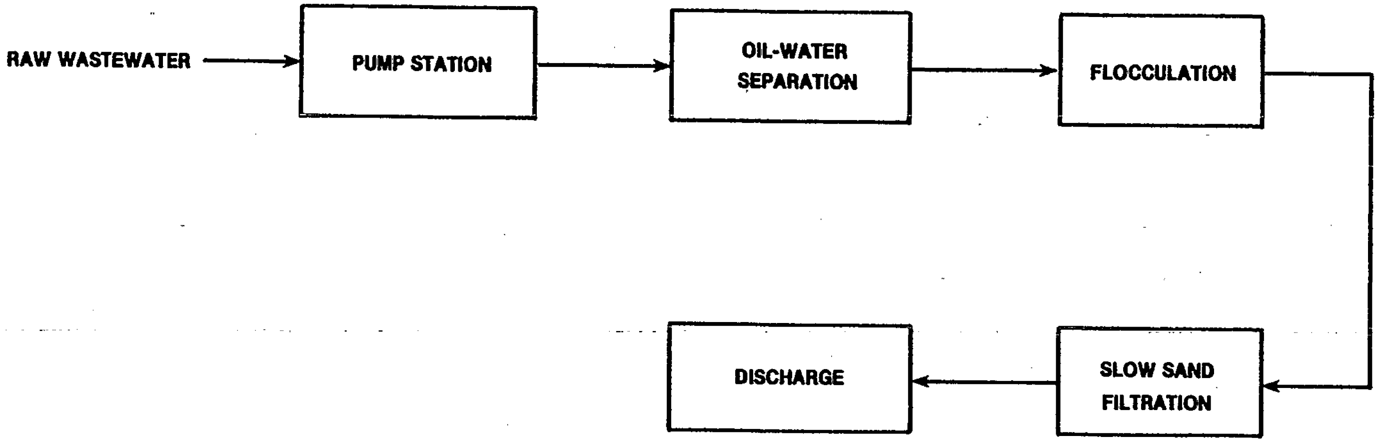


Figure VII-13

WOOD PRESERVING - STEAM, BOULTON
(INDIRECT DISCHARGERS)

CANDIDATE TREATMENT TECHNOLOGY
MODEL PLANT J

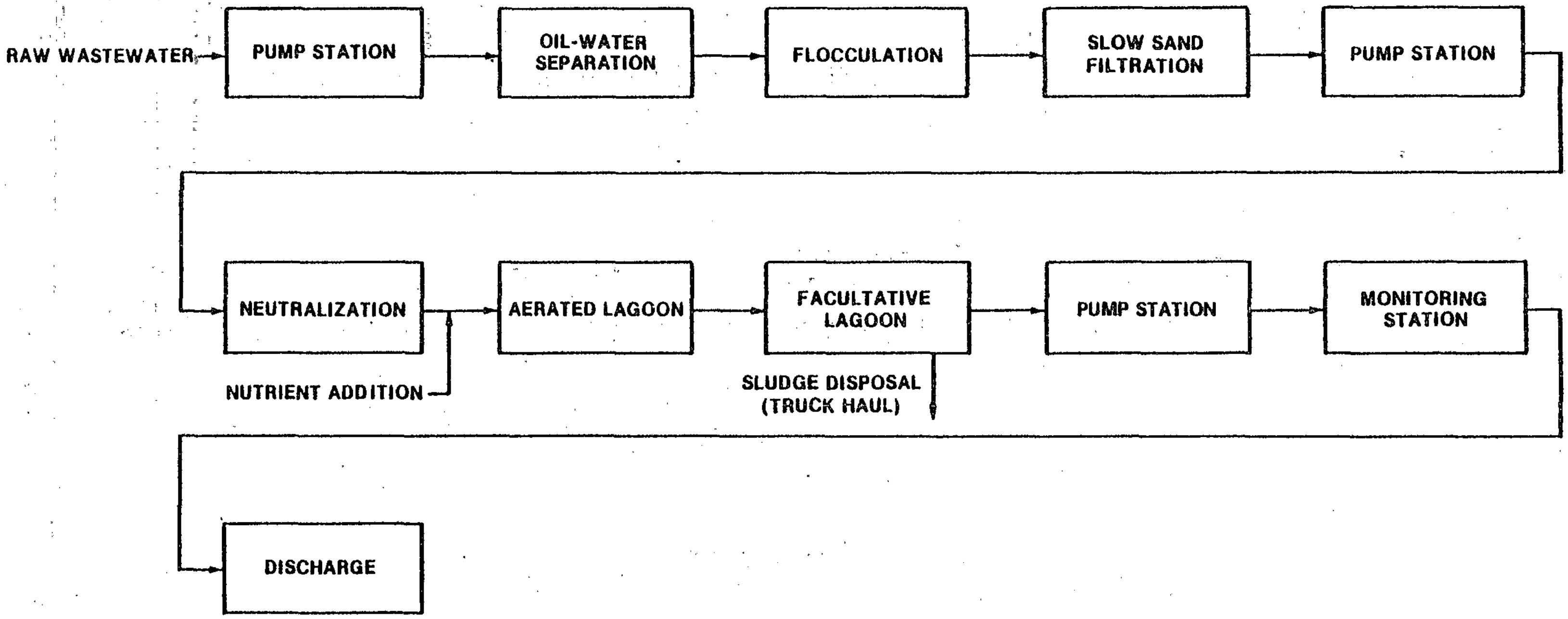


Figure VII-14

WOOD PRESERVING - STEAM, BOULTON
(INDIRECT DISCHARGERS)

CANDIDATE TREATMENT TECHNOLOGY
MODEL PLANT K

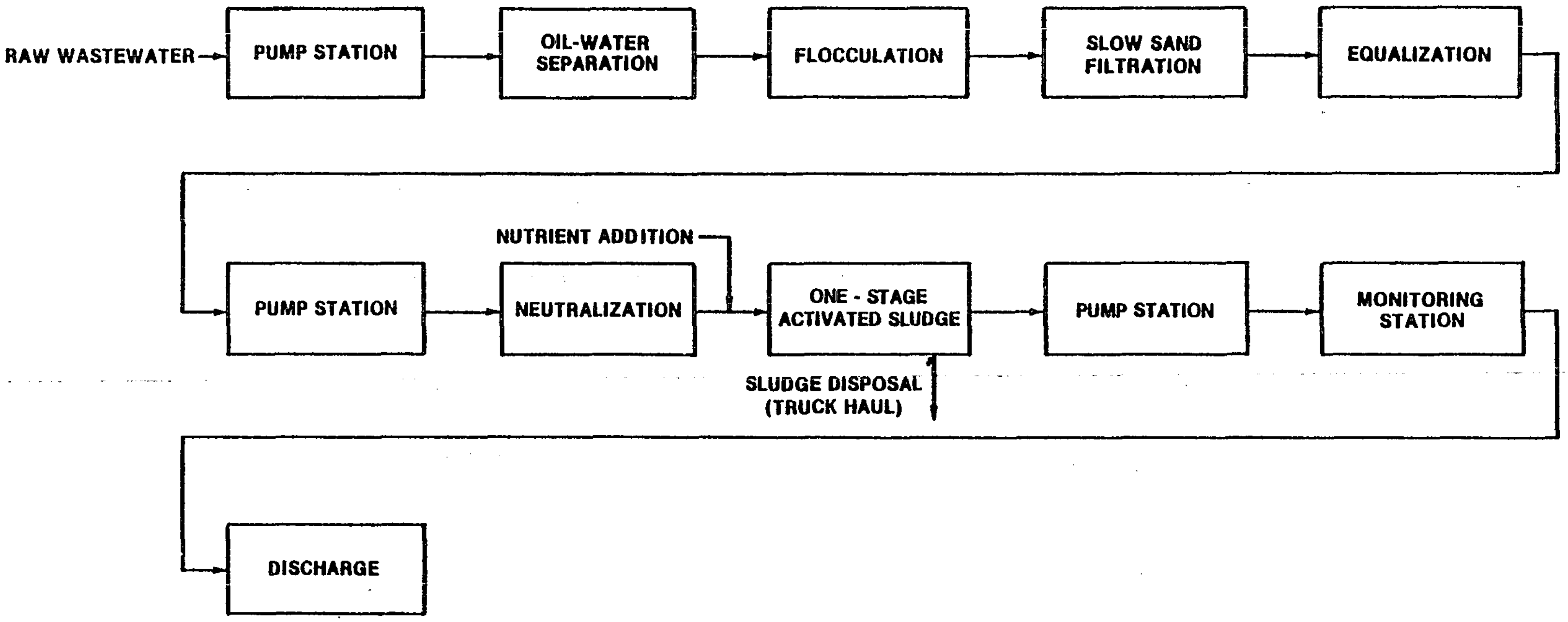


Figure VII-15

WOOD PRESERVING - STEAM , BOULTON
(INDIRECT DISCHARGERS - OILY WASTEWATER WITH FUGITIVE METALS)

CANDIDATE TREATMENT TECHNOLOGY
MODEL PLANT L

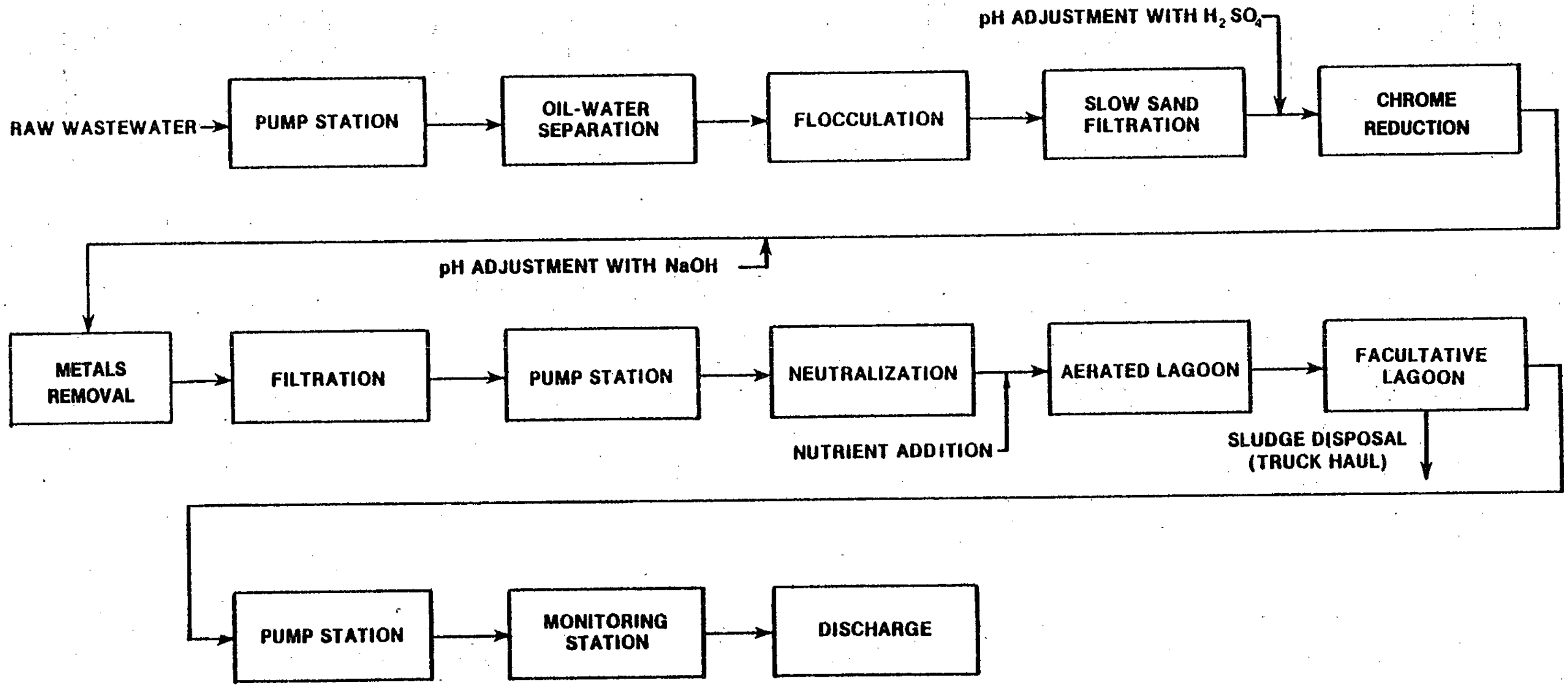


Figure VII-16

WOOD PRESERVING - STEAM, BOULTON
(INDIRECT DISCHARGERS - OILY WASTEWATER WITH FUGITIVE METALS)

CANDIDATE TREATMENT TECHNOLOGY
MODEL PLANT M

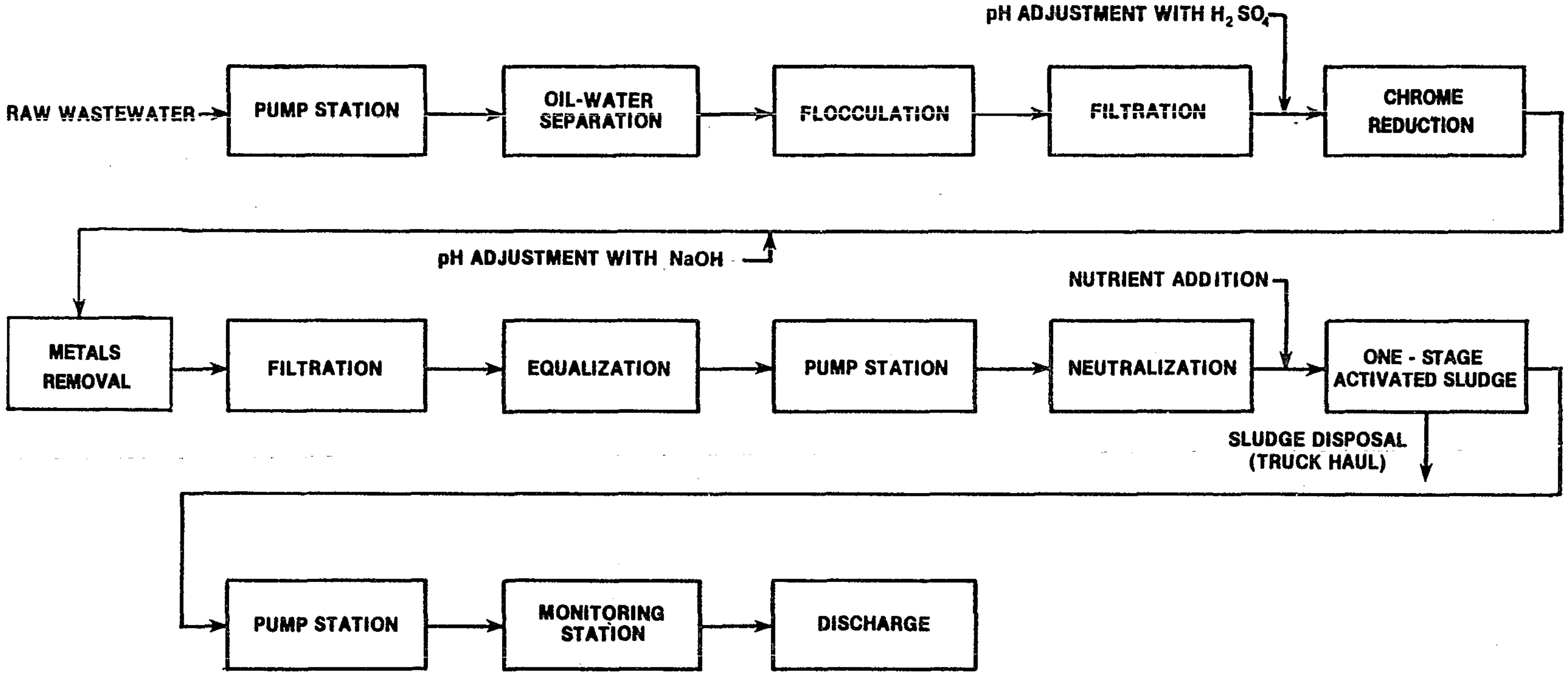


Figure VII-17

Table VII-49. Treated Effluent Loads in lb/1,000 ft^3 of Production for Candidate Treatment Technologies--Wood Preserving (Indirect Dischargers)

Pollutant Parameter	Candidate Technology I	 J or K	 L or M
COD	41.5	34.5	34.5
Oil & Grease	0.93	0.75*	0.75*
Total Phenols	2.0	0.04	0.04
PCP	0.07	0.05*	0.05*
VOAs	See Table VII-15	See Table VII-38	See Table VII-38
Base Neutrals	See Table VII-39	See Table VII-40	See Table VII-40
Toxic Pollutant Phenols	See Table VII-41	See Table VII-42	See Table VII-42
Heavy Metals	0.05 (cu) 0.04 (cr) 0.04 (as) See Table VII-43 and VII-46	See Table VII-44 and VII-47	75 percent removal, copper, chrome, zinc, and arsenic*

*Expected treated effluent loads based on literature presented earlier in this section.

Waste loads after metals removal are calculated based on the removals reported in the literature discussed earlier in this section. They have not been demonstrated in the industry because there are no systems currently in-place.

Indirect discharging Boulton and steaming plants may also achieve no discharge status through the self contained Candidate Treatment Technology N, which consists of cooling tower evaporation for Boulton plants and spray evaporation for steaming plants. Both of these technologies are discussed below.

The costs associated with all the candidate treatment technologies applicable to indirect dischargers, except pretreatment technology (Technology I), are presented in Appendix A.

Self Contained Dischargers-One primary technology applicable to Boulton plants will enable those plants to achieve no discharge status. Candidate Treatment Technology N for Boulton plants consists of primary oil separation, chemical flocculation, and slow sand filtration followed by cooling tower evaporation. This technology is shown in Figure VII-18.

One primary technology applicable to steaming plants will enable them to achieve no discharge status. Candidate Treatment Technology N for steaming plants consists of primary oil separation, chemical flocculation, and slow sand filtration followed by spray evaporation. This technology is shown in Figure VII-19. Spray evaporation technology can also be used by Boulton plants if the land is available for this system.

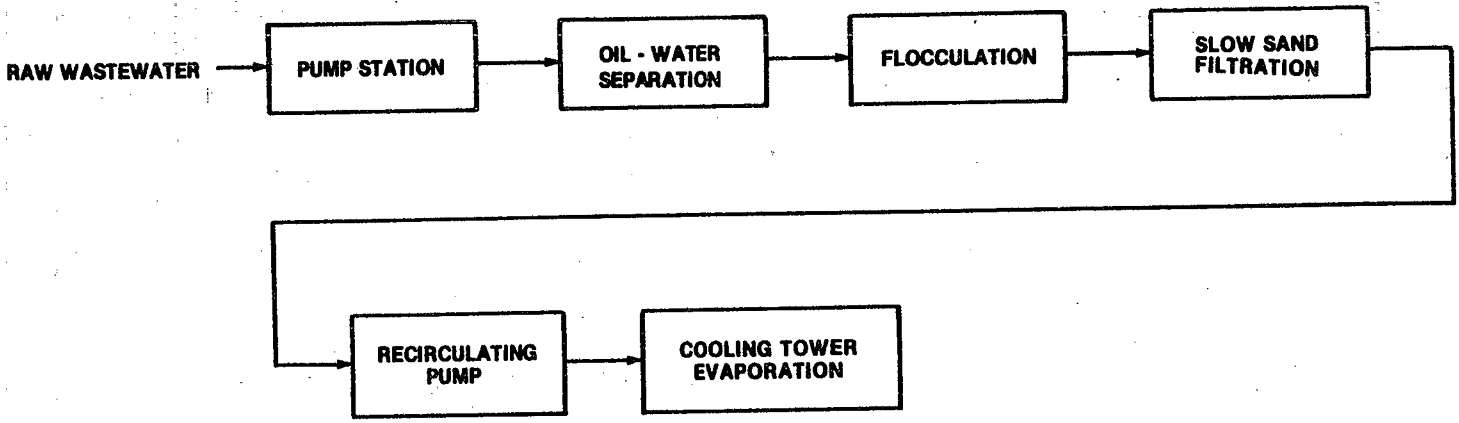
Costs for both the above technologies are presented in Appendix A.

Other Applicable Technologies--Candidate Treatment Technology O represents conversion from open to closed steaming. This is applicable to those open steaming plants wishing to reduce the flow of wastewater generated at their plants, and thus reduce the total cost and land requirements of subsequent treatment. Cost estimates for Technology O are presented in Appendix A. The plant-by-plant cost estimates presented in Appendix A were based upon the actual amount of wastewater generated by each plant and do not include the cost of Technology O, with the exception of one plant which is clearly identified in Table A-14. For this open steaming plant, wastewater generation was high enough that it was more cost-effective to convert to closed steaming prior to applying other treatment options.

Candidate Technology P entails collection and recycle of rainwater and cylinder drippings from inorganic salts plants. All plants in the Wood Preserving-Water Borne or Nonpressure subcategory are already required to achieve no discharge status.

WOOD PRESERVING - BOULTON
(SELF CONTAINED)

CANDIDATE TREATMENT TECHNOLOGY
MODEL PLANT N

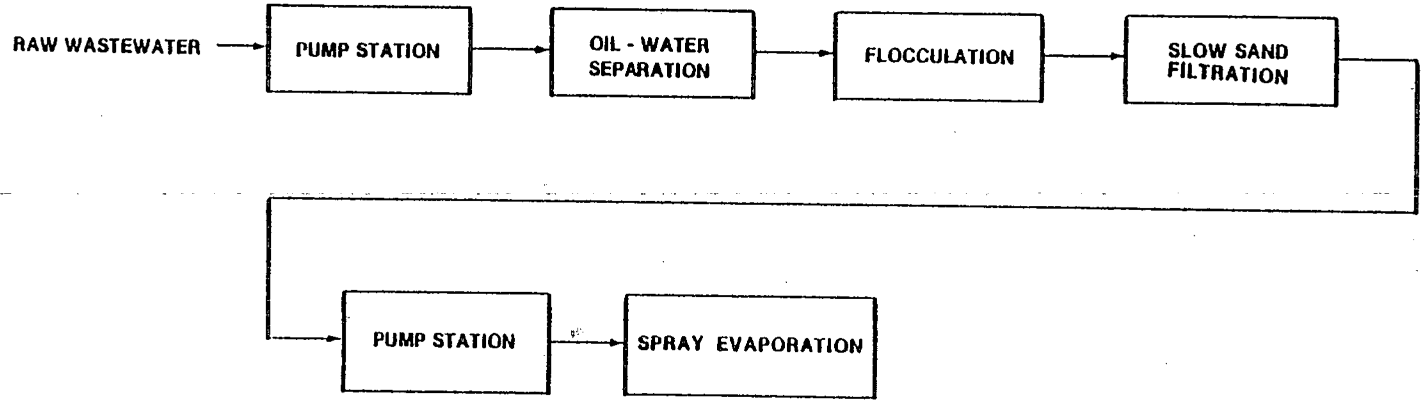


See Tables A-2 and A-3 for cost summaries

Figure VII-18

WOOD PRESERVING - STEAM
(SELF CONTAINED)

CANDIDATE TREATMENT TECHNOLOGY
MODEL PLANT N



See Tables A-4 and A-5 for cost summaries

Figure VII-19

New Source Performance Standards--Candidate Technology N for both Boulton and steaming plants can be applied to new sources. New sources have the ability to choose plant locations based on the availability of sufficient land for this option, as well as other potential no discharge options such as soil irrigation, and non-oil preservative carrier processes.

INSULATION BOARD AND WET PROCESS HARDBOARD

In-Plant Control Measures

The production of either insulation board or hardboard requires extensive amounts of process water which ultimately becomes contaminated with dissolved and suspended substances through contact with the wood and additives used as raw material. In the past, most plants used large amounts of fresh water to produce fiberboard products in what was essentially a once through process. The exclusive use of fresh water in the refining, washing, diluting, and forming of fiberboard results in only one opportunity for dissolved and suspended solids to be retained in the product, and leads to an extensive pollution problem because of the volumes of wastewater generated and the large, costly end-of-pipe treatment facilities required.

More recent practices used by most plants include the use of recycled process whitewater in place of fresh water at various points in the system. Process water can be reused for stock dilution, shower water, and pump seal water. The use of recycled process whitewater provides the opportunity for increased retention of dissolved and suspended solids in the product, results in decreased fresh water consumption, and decreased wastewater volume.

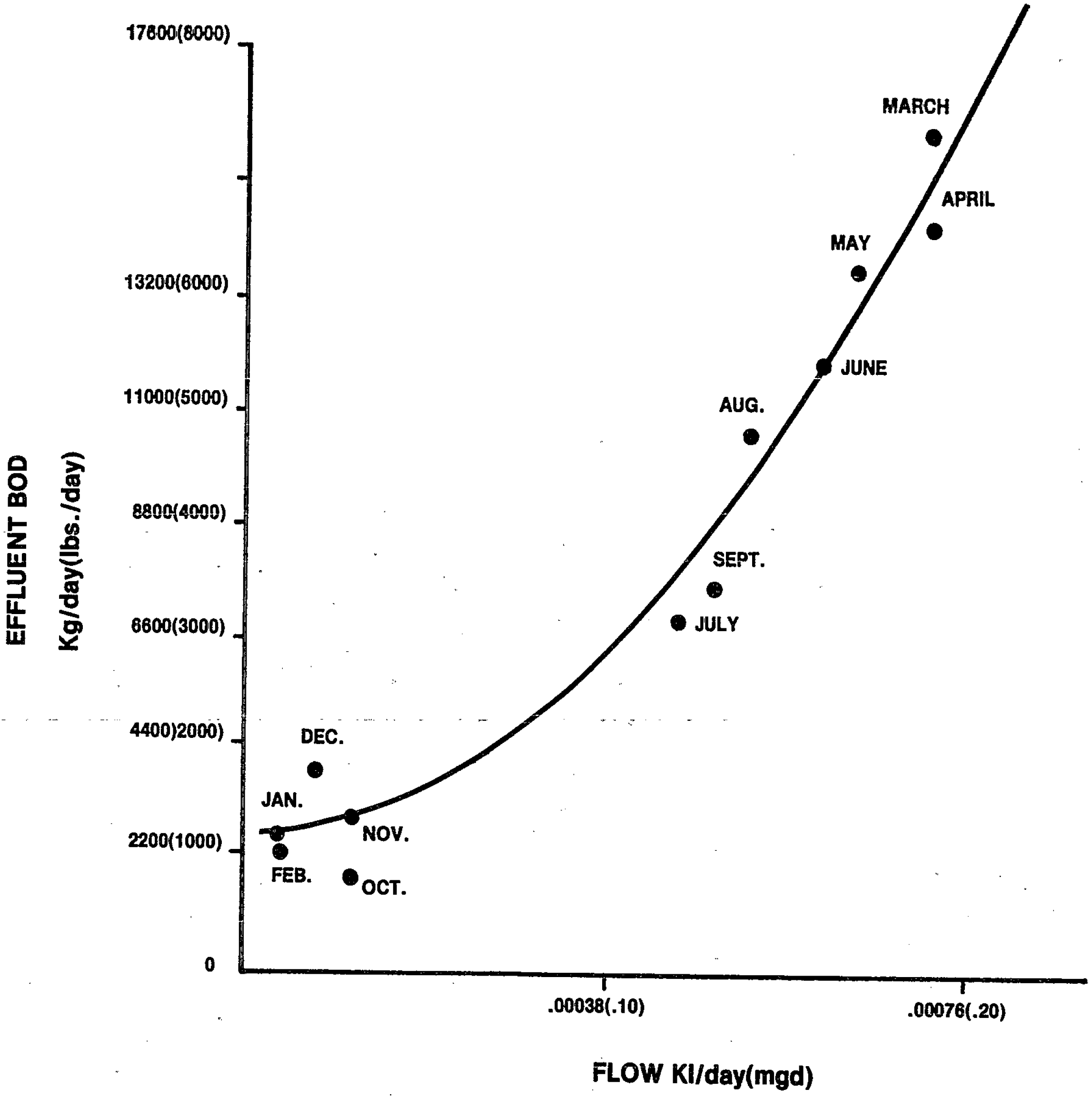
By closing the process whitewater system in a fiberboard plant, it is possible to reduce the mass discharge of suspended solids in the raw waste load. As a first approximation, the total mass discharge of suspended solids is roughly proportional to the volume of wastewater generated (Gran, 1972).

The mass discharge of BOD in the raw waste load, on the other hand, is less influenced by a moderate close up of the process whitewater system. Dissolved solids (which exert BOD) increase in the whitewater system during recycle.

Operating data are available from Plant 929, an S1S hardboard plant, which demonstrates the effect of process water system close up on BOD loads. Plant 929 began an extensive program to close its whitewater system in March 1976. The wastewater flow from the plant was reduced in steps from an average of 750,000 l/day (200,000 gpd) in March 1976, to 18,925 l/day (5,000 gpd) in June 1977. The corresponding BOD loads were reduced from 2,710 kg/ day (6,000 lb/day) to 340 kg/day (750 lb/day). Figure VII-20 illustrates the relationship between BOD load and discharge volume for the plant during the close up period. The most

PLANT 929

FLOW VS. EFFLUENT BOD



DATA ARE FROM MARCH, 1976 TO FEBRUARY 1977.

Figure VII-20

dramatic reduction in BOD load occurred in October 1976, when the plant achieved a reduction in flow of about 85 percent.

The ability of an insulation board or hardboard plant to close up its process whitewater system is highly dependent upon the type of board products produced and the raw materials used. The increased dissolved solids retained in the board tend to migrate to the board surface during drying and/or pressing, increasing the risk of spot formation on the board sheets and sticking in the press.

Decreased paintability, darker and inconsistent board color, surface defects, increased water absorption, and decreased dimensional stability are all quality problems which have been associated with the increased dissolved solids in the whitewater system as a result of close up (Coda, 1978). Some board products, particularly structural grade insulation boards and industrial grade hardboards, can tolerate a degree of quality deterioration. Excessive degradation of board quality cannot be tolerated in decorative type insulation board, finished hardboard paneling, or certain types of exterior hardboard siding.

Other problems associated with a high degree of process whitewater recycle are corrosion of pumps, plumbing, and equipment from the lowered pH of recycled whitewater; plugging of shower sprays and decreased freeness (drainage) of stock because of solids build up; and an elevation of temperature in the process whitewater system.

Raw materials are an important factor in the ability of a mill to close up. Furnish must be free of bark. Coda (1978) reports that a maximum of 1.5 percent bark can be tolerated by Plant 929, which has nearly reached completely closed status. Whole tree chips and other types of furnish which would increase the dissolved solids load cannot be tolerated in a completely closed system. Moisture content of furnish is also an important factor. One thermomechanical refining insulation board plant (Plant 2), which had achieved complete close up, attributed the availability of low moisture plywood and furniture trim furnish as a major reason for the success of its close up program. Plant 2 is no longer operating because of a management decision not related to pollution.

In order to achieve maximum closure, a plant must be willing to invest considerable capital and be prepared to accept decreased production during the period of time that optimum plant operating conditions are being developed. The primary benefit to a plant which succeeds in closing its process whitewater system is effective pollution control without reliance on expensive end-of-pipe treatment.

Some of the measures which can be used to achieve close up or maximum recycle of the process whitewater system are as follows:

1. Elimination of extraneous wastewater sources. Pump seal water can be reduced or eliminated by the use of recycled whitewater or by conversion to mechanically sealed pumps where possible. Chip wash water can be reduced by recycle following screening and sedimentation of grit. Housekeeping water use should be kept to an absolute minimum. High pressure sprays and/or dry cleaning methods should be used where possible.

2. Provision of sufficient whitewater equalization. Sufficient equalization capacity for control and containment of whitewater surges should be provided. Several plants employ large outdoor surge ponds for this purpose. Surge ponds also serve to control whitewater temperature. Several plants use heat exchangers for temperature control and provide sufficient capacity for plant start-up and shut-down.
3. The installation of cyclones following the refiner. This allows the fiber to be blown into the cyclones for steam release and cooling. No water should be added to these cyclones. The added water condenses the steam which causes higher whitewater temperatures and an additional source of water to the system.

4. Clarification of whitewater. Several plants use gravity clarifiers to remove grit and settleable solids from the whitewater system. To use forming water for showers or pump seal water, it is necessary to remove the majority of fiber. Screens or filters are available for this purpose, and in some cases a "save-all" installation may be appropriate. Save-alls are used extensively in the pulp and paper industry. They can result in fiber concentrations of less than 0.20 pound per 1,000 gallons of water, which makes the water suitable for showers and pump seals. This type of device can also dramatically reduce the suspended solids leaving the mill in the raw effluent. The hardboard process can use either a flotation-type save-all or a drum-type unit. Fiber from the save-all can be returned to the process.

5. Extraction of concentrated wastewater. The soluble sugars and other dissolved materials released into the process whitewater during refining can be extracted by efficient countercurrent washing of the stock or by using a dewatering press. The concentrated whitewater can then be evaporated for recovery of an animal feed byproduct. Use of this process allows greater recycle of the remaining whitewater, which is primarily leaner machine whitewater. Plants 673, 678 and 943 currently use stock washers to extract concentrated whitewater for subsequent evaporation to animal feed. Plant 933 has successfully demonstrated the capability of a

dewatering press for the same purpose on one of its production lines. This plant was able to completely close the remaining process whitewater system following the press. Successful application of this extraction process depends on the use of an evaporator on the concentrated whitewater, otherwise the plant has succeeded only in concentrating its wastewater, which may have adverse effects on subsequent biological treatment. The high capital expense of such systems must be at least partially amortized by byproduct sales. The economics of applying this system will vary from plant to plant, and must be evaluated on an individual basis. Some considerations will be: amount of material available for recovery; energy costs for wastewater evaporation; proximity to market; and market price.

6. Corrosion control. The corrosiveness of the recycled process whitewater can be controlled with addition of caustic soda, lime, or other basic chemicals. Most plants practice chemical pH control to some extent. Corrosion-resistant pumps, piping, and tanks can be used to replace corroded equipment or for new construction.

7. Control of press sticking. Press sticking can be mitigated by washing the surface of the press plates or cauls more frequently, or by using release agents. Lowering the temperature of the hot press may also be effective.

Two thermomechanical refining insulation board plants have achieved complete close up of process whitewater systems. Both plants produce structural grade board only. Plant 186 uses a save all device to clarify the whitewater for further reuse. Plant 2 used external surge ponds for whitewater equalization and temperature control, as well as a gravity clarifier for solids control. As previously discussed, Plant 2, which is now shut down, used locally available low moisture plywood trim as furnish which helped to maintain the water balance in the mill. Both plants indicated that extensive process experimentation and modification, during a period of one to two years, was required before the board quality/technical problems associated with the close up were resolved.

Plant 929, as previously discussed, has approached full close up. Major modifications made at this plant included:

1. Installation of cyclones following the refiner to allow process steam to escape.

2. Increased whitewater equalization.

3. Replacement of fresh water packing seals on primary grinders with steam, and replacement of pumps requiring fresh sealing water with mechanically sealed pumps.

This plant produces primarily industrial grade hardboard and has experienced some quality control problems as well as a loss in production capacity compared to its previous operations.

Another method of close up used by three plants is the recycle of treated effluent from external biological treatment systems for use as process water in the plant. Plant 919 has achieved a complete close up in this manner. Plant 537 recycles approximately 85 percent of its treated effluent, discharging the remaining 15 percent. Plant 36 recycles 28 percent of its effluent discharging the remaining 72 percent.

Although this approach may eliminate some of the problems associated with close up, such as temperature and corrosiveness of the recycled water, the problems of board quality and process control remain. The characteristics of high color and the secondary treatment solids in the recycled water also pose problems with using this method.

A review of potential in-plant process modifications for both insulation board and hardboard plants indicates that some reductions in raw waste loading can be accomplished. Specific recommendations for in-plant modifications on a plant-to-plant basis require a detailed working knowledge of each plant.

<u>End-of-Pipe Treatment</u>

<u>Screening</u>--Screens are used by many fiberboard plants to remove bark, wood chips, and foreign materials from the wastewater prior to further treatment. Screening equipment may consist of mechanically cleaned bar screens, vibrating screens, or sidehill screens. Screening serves to reduce wear and tear on processing equipment, and also to separate extraneous material from the wood fiber which is returned to the plant after primary settling in most insulation board plants.

<u>Primary Settling</u>--Most insulation board plants and many hardboard plants use gravity-type primary settling facilities to remove a major portion of the wood fibers from the raw wastewater. Primary sludge may be returned to the process for reuse, or it may be thickened and/or dewatered and disposed to a landfill. Common sludge handling devices include gravity thickeners and mechanical dewatering equipment.

Settling ponds are the most common primary settling facilities used in the industry; however, several plants are equipped with mechanical clarifiers. Suspended solids removals in primary settling facilities range from about 65 to 80 percent. Data from one plant demonstrated that 10 to 15 percent BOD removal was being achieved by the primary settling facility. One plant achieved 24 percent BOD removal in a mechanical primary settling tank through the use of polymers as a coagulant.

Biological Treatment--Wastewater generated by the insulation board and wet process hardboard subcategories is amenable to biological treatment. A discussion of this subject is presented in Appendix E.

All direct discharging plants in the insulation board and wet process hardboard subcategories of the industry apply varying degrees of biological treatment to their wastewaters. The contaminants in the wastewaters from the two subcategories are comprised mainly of soluble oxygen-demanding material leached from the wood. These materials (wood sugars, hemicellulose, lignins, etc.) are readily biodegradable. The suspended solids in the raw wastewaters are primarily wood fibers, bark particles, and small amounts of grit that easily settle in primary sedimentation basins or aerated lagoons. Because of the large raw wastewater flows and high concentrations of BOD and TSS, as described in Section V, the biological treatment systems required to treat these wastewaters must be of considerable size to be effective. Most plants in both subcategories of the industry have allocated considerable sums of money to construct and operate these treatment systems.

The biological systems in the insulation board and wet process hardboard subcategories vary from single aerated lagoons, usually followed by facultative oxidation ponds for increased solids and BOD removal, to complex contact stabilization activated sludge systems.

Spray Irrigation--Spray irrigation is a viable alternative for treatment and ultimate disposal of wastewaters generated by the insulation board and wet process hardboard subcategories. The feasibility of spray irrigation is a function of hydraulic and BOD loadings on a per unit area basis. Allowable hydraulic and BOD loadings can vary considerably from site to site depending on vegetation and soil conditions, and should be determined through site specific studies. Once the allowable BOD loading has been determined, the application of biological treatment to the wastewater for BOD reduction prior to spray irrigation may be considered as an alternative to an increase in spray field area.

There are two insulation board plants, Plants 889 and 186, which spray irrigate their wastewaters. Plant 889 applies biological treatment, consisting of an aerated lagoon followed by a clarifier, prior to spray irrigation, and thereby achieves a nondischarge status. Philipp (1971) reported on the land disposal of insulation board wastewater at Plant 186. Following in-plant filtering for fiber recovery, the wastewater was pumped to a 0.4 ha settling pond and then to two holding ponds, the first having a volume of about 100,000 cu m and the second about 378,500 cu m. All wastewater was retained from late October through April. During the period May to October, the effluent from the second holding pond was pumped to the 40.5 ha spray field.

The spray field was located on a sand of high permeability and with a depth of 2 to 4 m. A test underdrainage system was installed at a depth of 1.5 m for the purpose of collecting and testing effluent percolating into the surface aquifer from the spray field. The entire area was originally cleared and then seeded with Reed Canary grass.

The discharge from the insulation board plant averaged 22 l/sec with a BOD concentration prior to spray irrigation of 1,150 mg/l.

Although Philipp provided no data, he stated that the efficiency of the system for removing BOD, as measured from the influent to the field to the effluent of the underdrainage system, was in excess of 99 percent.

There are three hardboard plants, Plants 943, 979, and 673, which also use spray irrigation for wastewater treatment and ultimate disposal. Plant 673 applies biological treatment,consisting of an aerated lagoon system, prior to spray irrigation, whereas Plants 943 and 979 do not. Plant 673 normally spray irrigates only during dry periods and discharges directly to surface waters during wet periods when spray irrigation is not practicable. At Plant 943 an underdrainage system collects all wastewater which filters down from the spray field and directs it to two holding ponds prior to discharge to surface waters. Plant 979 achieves a nondischarge status using spray irrigation.

<u>Other Applicable Technologies-Insulation Board and Wet Process Hardboard</u>- Several additional treatment technologies were evaluated to determine their feasibility as candidate treatment technologies for BAT, NSPS, and pretreatment standards. The technologies evaluated for insulation board and wet process hardboard included:

Chemically Assisted Coagulation
Granular Media Filtration
Activated Carbon Adsorption

A discussion of each of these technologies and case studies of their application to the insulation board and wet process hardboard industries are presented in Appendix F, DISCUSSION OF POTENTIALLY APPLICABLE TECHNOLOGIES.

None of these were identified as candidate technologies because they are experimental in nature and further research is necessary to sufficiently determine the effectiveness of treatment which could be expected if these technologies were to be applied to insulation board and hardboard wastewaters.

In-Place Technology and Treated Effluent Data, Insulation Board

Plant 36 produces structural and decorative insulation board. The plant has reduced its raw waste flow from 13,250 kl/day (3.5 MGD) to less than 5,678 kl/day (1.5 MGD) by modification of the pulping process, reuse of process water, and recycle of treated effluent. The wastewater is screened for removal of gross solids. The wastewater then goes to two parallel primary clarifiers followed by an activated sludge system. Discharge from the biological system is either recycled to the plant or discharged to a creek.

In 1976, sludge resulting from primary clarification and a portion of the waste sludge from secondary clarification was gravity thickened, vacuum filtered, and reused in the process. In 1977, only sludge resulting from primary clarification was recycled. Ten percent of the primary sludge plus waste secondary sludge was thickened, vacuum filtered, and sold as a soil conditioner. In 1977, the addition of polymer in the secondary clarifier was initiated which improved the solids removal. Effluent BOD and TSS are presented in Table VII-50.

Plant 725 produces ceiling tiles and panels, sheathing, and mineral wool fiber insulation board. Process water from the insulation board plant receives primary sedimentation. Primary sludge is returned to the process. The wastewater is then either reused in the insulation board process for stock dilution and shower water, or used as makeup water for the mineral wool fiber plant. The raw wastewater from the mineral wool plant enters the treatment system, which consists of a primary clarifier, an aerated lagoon, and a secondary clarifier. Sludge from the primary and secondary clarifier is dewatered, either in a settling pond or by a vacuum filter, and hauled to a disposal site. Approximately 1,514 l/min (400 gpm) of the treated wastewater from the secondary clarifier is discharged to a POTW, while approximately 757 l/min (200 gpm) is recycled to a freshwater tank for use as makeup water in both the insulation and mineral wool fiber plants.

Plant 978 has no treatment or pretreatment facilities. Excess process wastewater, combined with pump seal water and sanitary wastewater, is discharged directly to a POTW. Plant personnel indicated in communications that suspended solids removal equipment is being considered to reduce current loads to the POTW.

Plant 360 produces structural and decorative insulation board. The plant collects its process wastewater in a whitewater storage tank, recycles a portion of the whitewater where needed, and sends the remaining portion to the treatment system which consists of an equalization tank, a floc-clarifier, and an aerated lagoon. Polymer addition in the clarifier is used to aid settling. Fiber recovered in the clarifier is recycled to the process. A portion of the clarifier overflow is recycled to the

Table VII-50. Insulation Board Mechanical Refining, Treated Effluent Characteristics*

Plant Number	Production		Flow		BOD		TSS	
	Kkg/day	(TPD)	kl/Kkg	(kgal/ton)	kg/Kkg	(lbs/ton)	kg/Kkg	(lbs/ton)
360†	201	(220)	2.96	(0.71)	1.05	(2.10)	1.15	(2.30)
	—	—	—	—	—	—	—	—
	—	—	—	—	—	—	—	—
36	606	(668)	8.18	(1.96)	0.28	(0.56)	2.64	(5.29)
	600	(661)	8.47	(2.03)	0.28	(0.56)	1.46	(2.91)
	603	(665)	7.38	(1.77)	0.28	(0.56)	2.11	(4.22)
889	246	(270)	1.02	(0.24)	0.07	(0.14)	0.16	(0.32)
	—	—	—	—	—	—	—	—
	—	—	—	—	—	—	—	—

* First row of data represents 1976 average annual daily data; second row represents 1977 average annual data; third row represents average annual daily data for two-year period of 1976 and 1977 except as noted.

† Indirect discharger.

process and the remaining wastewater enters the aerated lagoon, where it is retained about 30 days before discharge to a POTW. The treated waste loads for this plant are presented in Table VII-50.

Plant 889 is a self contained discharger and uses treated wastewater to spray irrigate a 2.3-hectare (5.6-acre) field. Whitewater enters the treatment system at two points: an aerated lagoon and an evaporation pond. Water from the evaporation pond is routed to the aerated lagoon. From the aerated lagoon, the wastewater is sent to a primary clarifier, where polymer and alum are added to assist in settling and pH adjustment. The supernatant from the clarifier is directed to a holding pond. Sludge from the clarifier is thickened in a flotation unit and hauled daily to a cinder dump. Water separated from the sludge enters the holding pond of the spray irrigation system. Effluent waste loads applied to the spray field determined from data supplied by the plant are presented in Table VII-50.

Plant 537 produces structural and decorative insulation board. Its process wastewater (combined with vacuum seal water, treated septic tank effluent, and stormwater runoff) is routed to a primary clarifier. Sludge drawn from the primary clarifier is recycled to the manufacturing process. Overflow from the clarifier goes to an aerated lagoon. Secondary clarification follows, and the waste secondary sludge is recycled to the process. The treated effluent is collected in a sump for reuse in the process. The excess treated effluent is discharged to receiving waters. The discharged waste loads are presented in Table VII-51.

Plant 108 produces approximately 55 percent insulation board and 45 percent hardboard. The plant has upgraded its wastewater treatment system by installing an oxygen-activated sludge system. Excess whitewater passes through a hydrasieve for removal of gross solids. After screening, the wastewater flows to a sump where nutrients are added. From the sump, the wastewater is pumped to a four-cell aeration basin. The aeration basin effluent flows to a clarifier where wastewater generated by paper production is introduced and the clarifier effluent is discharged to the receiving waters. Sludge removed in the clarifier is vacuum filtered and disposed of in a landfill.

In 1976, the wastewater treatment system was the same as that described above, except that a rotating biological surface (RBS) system followed screening instead of an oxygen activated sludge system.

Plant 1035 produces approximately 70 percent insulation board and 30 percent S2S hardboard. The plant has a waste stream which consists of raw process wastewater, and another waste stream which consists of lower strength miscellaneous wastewaters. The raw process wastewater is screened for removal of gross solids by a bar screen. The screened wastewater flows to a clarifier.

Table VII-51. Insulation Board Thermomechanical Refining, Treated Effluent Characteristics*

Plant Number	Production		Flow		BOD		TSS	
	Kkg/day	(TPD)	kl/Kkg	(kgal/ton)	kg/Kkg	(lbs/ton)	kg/Kkg	(lbs/ton)
537	139	(153)	1.88	(0.45)	2.03	(4.06)	1.71	(3.42)
	145	(160)	1.75	(0.419)	2.18	(4.36)	1.27	(2.54)
	145	(159)†	1.69	(0.406)	2.07	(4.14)†	1.31	(2.62)†
108**	605	(665)††	51.3	(12.3)	4.06	(8.12)	12.3	(24.5)
	--	--	--	--	--	--	--	--
	570	(628)††	22.6	(5.41)***	2.06	(4.13)***	2.24	(4.47)***
1035	359	(395)**	21.9	(5.26)	2.15	(4.31)	0.94	(1.88)
	--	--	--	--	--	--	--	--
	--	--	--	--	--	--	--	--

* First row of data represents 1976 average annual daily data; second row represents 1977 average annual daily data; third row represents average annual daily data for two-year period of 1976 and 1977 except as noted.

† Data represent period of 1/1/76 through 3/31/79.

** Data are taken before paper wastewater is added.

†† Includes both insulation board and hardboard production.

*** Data represent period of 9/21/79 through 4/30/80 when oxygen activated sludge system was in operation.

Sludge removed from the clarifier flows to a hydrasieve for screening. Screened solids are recycled to the process and the wastewater is returned to the clarifier. The clarifier effluent flows successively to two 1.5 acre settling ponds (in series), a 60-acre settling pond, a 4-acre aeration lagoon, a 2-acre aeration lagoon, and to a 1-acre aeration lagoon. Part of the effluent from the 1-acre aeration lagoon flows to a 135-acre oxidation pond, where the lower strength miscellaneous wastewater stream enters the treatment system. The remaining effluent from the 1-acre aeration lagoon flows to a 165-acre oxidation pond. The effluent from both oxidation ponds is discharged to the receiving waters. The treated effluent waste loads are presented in Table VII-51.

Plant 186, which produces decorative and mineral wool insulation board, is a self contained discharger with spray irrigation as the ultimate means of wastewater disposal. The process wastewater from the plant enters a series of three settling ponds with a total capacity of 587 million liters (155 million gallons). The ponds retain the wastewater up to a period of six months, after which it is sprayed onto a 30-hectare (80-acre) field of Reed Canary grass. The spray irrigation system operates 180 days per year at a rate of 6,435 kl/day (1.7 MGD).

Plant 2, which is now closed, produced structural insulation board. Process whitewater was completely recycled.

Plant 502 has no wastewater treatment facilities. Wastewater from the thermomechanical pulping and refining of insulation board is collected in a whitewater chest. A portion is recycled to the process and the remaining wastewater is discharged to a POTW. No monitoring practices for flow or other parameters exist.

Plant 183 uses thermomechanical pulping and refining to produce structural and decorative insulation board. The process wastewater is screened for removal of gross solids prior to being collected and is either recycled to the process or discharged with no further treatment to a POTW.

Plant 184 produces structural insulation board. There are no wastewater treatment facilities, as no process wastewater is discharged. All process whitewater is recirculated to a sump. Sump waters are screened, stored in a clarified whitewater chest, and recycled to the process.

Raw and treated effluent loads of total phenols for four insulation board plants are presented in Table VII-52. Raw and treated effluent loads of heavy metals for four insulation board plants are presented in Table VII-53.

Raw and treated waste concentrations for organic toxic pollutants for the insulation board plants that were sampled during the 1978 verification sampling program are presented in Table VII-54.

Table VII-52. Raw and Treated Effluent Loads and Percent Reduction for Total Phenols--Insulation Board*

Plant Code	Raw Waste Load†		Treated Waste Load†		% Reduction
	kg/Kkg	(lb/ton)	kg/Kkg	(lb/ton)	
36	0.00095	(0.0019)	0.00010	(0.00021)	89
	0.007	(0.014)	0.00012	(0.00025)	98
183	0.0024	(0.0048)	--	--	--
	0.009	(0.018)	--	--	--
360	0.00040	(0.00079)	0.00008	(0.00015)	81
	--	--	--	--	--
537	0.0022	(0.0045)	0.00014	(0.00029)	94
	0.0055	(0.011)	0.00065	(0.0013)	88

* First row of data represents data for 1977; second row of data represents data for 1978.

† Total phenols concentration data obtained during 1977 and 1978 verification sampling programs. Average annual daily waste flow and production data supplied by plants in response to data collection portfolio were used to calculate waste loads.

Table VII-53. Raw and Treated Effluent Loadings and Percent Reduction for Insulation Board Metals

Plant No.	Be	Cd	Cu	Pb	Ni	Zn	Sb	As	Se	Ag	Tl	Cr	Hg
360													
Raw Waste Load (kg/Kkg)	.0000042	.0000028	.0019	.000006	.0008	.003	.0000021	.000013	.000014	.0000021	.0000028	.000006	.000028
(lb/ton)	(.0000083)	(.0000056)	(.0037)	(.000011)	(.0016)	(.005	(.0000042)	(.000025)	(.000027)	(.0000042)	(.0000056)	(.000011)	(.0000042)
Treated Waste Load (kg/Kkg)	.0000021	.0000035	.0009	.000006	.0006	.0014	.000018	.000006	.000007	.0000021	.000008	.000022	.00000042
(lb/ton)	(.0000042)	(.0000069)	(.0018)	(.000011)	(.0011)	(.0028)	(.000035)	(.000011)	(.000013)	(.0000042)	(.000015)	(.000044)	(.00000083)
% Reduction	49%	+23%	51%	0%	31%	44%	+733%	56%	52%	0%	+167%	+300%	80%
183													
Raw Waste Load (kg/Kkg)	.000007	.000008	.0023	.00017	.00085	.0042	.000025	.000027	.000035	.0000049	.0000041	.00006	.000041
(lb/ton)	(.000014)	(.000016)	(.0046)	(.00034)	(.0017)	(.0084)	(.000049)	(.000054)	(.00007)	(.0000098)	(.0000082)	(.00012)	(.000082)
Treated Waste Load (kg/Kkg)	.000012	.000013	.0020	.00021	.0009	.0480	.000021	.000013	.000025	.000017	.0000041	.00020	.00013
(lb/ton)	(.000024)	(.000026)	(.0040)	(.00041)	(.0018)	(.0095)	(.000042)	(.000026)	(.000049)	(.000033)	(.0000082)	(.00040)	(.00026)
% Reduction	+71%	+62%	13%	+20%	5%	+13%	14%	52%	30%	+236%	0%	+233%	+21%
537													
Raw Waste Load (kg/Kkg)	.00001	.00001	.000041	.000027	.00025	.005	.000014	.00006	.00007	.00001	.000017	.00047	.000021
(lb/ton)	(.00002)	(.00002)	(.000062)	(.000053)	(.00049)	(.01)	(.000027)	(.00012)	(.00014)	(.00002)	(.000033)	(.00094)	(.000041)
Treated Waste Load (kg/Kkg)	.000001	.000001	.00018	.0000038	.000013	.00017	.0000028	.000006	.0000044	.0000013	.0000013	.000006	.0000019
(lb/ton)	(.0000019)	(.0000019)	(.00035)	(.0000075)	(.000026)	(.00033)	(.0000056)	(.000012)	(.0000087)	(.0000025)	(.0000025)	(.000011)	(.0000038)
% Reduction	90%	90%	+326%	85%	94%	96%	79%	90%	93%	88%	92%	98%	91%
36													
Raw Waste Load (kg/Kkg)	.0000055	.0000055	.0036	.000055	.0009	.006	.000022	.000017	.000035	.000005	.0000065	.00012	.00008
(lb/ton)	(.000011)	(.000011)	(.0072)	(.00011)	(.00018)	(.012)	(.000044)	(.000034)	(.00007)	(.000011)	(.000013)	(.00023)	(.00016)
Treated Waste Load (kg/Kkg)	.000006	.000006	.0012	.000008	.000037	.0008	.000048	.00002	.000032	.000007	.000008	.00009	.0000007
(lb/ton)	(.000011)	(.000011)	(.0023)	(.000016)	(.000074)	(.0016)	(.000095)	(.00004)	(.000063)	(.000013)	(.000016)	(.00017)	(.0000013)
% Reduction	0%	0%	68%	65%	58%	86%	+115%	+17%	10%	+18%	+23%	26%	99%

Source: 1977 Verification Sampling Program.

Only extremely low concentrations of chloroform, benzene, toluene, and phenol were found in the raw wastewaters of the three insulation board plants sampled. Chloroform, benzene, and toluene most likely originated in industrial solvents, and phenol is an expected byproduct of hydrolysis reactions which occur during refining of the wood furnish. The levels of the heavy metals and organic toxic pollutants which were found in the raw wastewaters are so low that no specific technology exists to reduce or remove these pollutants from the wastewater matrix. Biological treatment is effective in reducing most raw heavy metals concentrations as shown in Table VII-53, and in removing all of the few organic toxic pollutants present in the raw wastewater as shown in Table VII-54.

Table VII-54. Insulation Board, Organic Toxic Pollutant Data

	Average Concentration (ug/l)				
	Raw Wastewater			Treated Effluent	
Pollutant	Plant 183	Plant 36+	Plant 537	Plant 36	Plant 537*
Chloroform	20	--	--	--	--
Benzene	70	40**	--	--	--
Toluene	60	40**	--	--	--
Phenol	--	40	--	--	--

* One of three treated effluent sample contained 40 ug/l of trichlorofluoromethane.

\+ One sample of raw wastewater contained 20 ug/l of chloroform. Plant intake water contained 10 ug/l of chloroform.

** Plant intake water contained 50 ug/l and 30 ug/l of benzene and toluene, respectively.

-- Hyphen denotes that the pollutant was not found in concentrations above the detection limit for the compound.

In-Place Technology and Treated Effluent Data, Wet Process Hardboard

Plant 678 produces approximately 90 percent S1S hardboard and approximately 10 percent S2S hardboard for such uses as paneling, doorskins, siding and concrete formboard. Process wastewaters are collected in a sewer. Cooling water, pump seal water, boiler blowdown, surface runoff, and condensate from the distillation process are combined in a separate storm sewer. After screening, primary clarification, and flow equalization of each waste stream, the two streams are combined prior to biological treatment. Solids removed during screening are landfilled. Solids from primary clarification are either landfilled or dewatered and burned in mill boilers. After the two waste streams are combined, they are routed to a biological system consisting of two contact stabilization activated sludge systems operating in parallel, followed by two secondary clarifiers. The activated sludge from the secondary clarifiers is pumped to two stabilization basins, reaerated for sludge stabilization, and returned to the contact basins. Waste sludge is either recycled to the production units or landfilled.

After secondary clarification the wastewater is routed to an aerated lagoon and is discharged after approximately six days detention time to impoundment ponds. A portion of the lagoon effluent is reused as log flume make-up water. Treated effluent is discharged from the holding ponds to a creek. Effluent waste loads are presented in Table VII-55.

Plant 673, which produces approximately equal amounts of S1S and S2S hardboard, collects all process wastewaters and directs the flow in one of two streams to the wastewater treatment facility. The two streams are designated as strong and weak. The strong wastewater stream (which contains condensate from the evaporation of process whitewater for animal feed) enters two activated sludge units operating in parallel. Waste sludge is aerobically digested and pumped to two humus ponds. Water decanted from the humus ponds enters the weak wastewater system. After clarification, the strong wastewater is combined with the weak wastewater and enters the weak treatment system. The weak system consists of an aerated lagoon, an oxidation and settling pond, and two storage ponds. The wastewater is subsequently routed to either spray irrigation or discharge, depending on the season of the year. Between October 1 and May 14, the effluent from the treatment facility is usually recycled to the process or discharged to the river. From May 15 through September 30, the mill directs the treated effluent to a number of storage ponds. The stored treated effluent is either discharged to spray irrigation fields or recycled to the manufacturing process. During 1976, because of drought conditions, the plant was not allowed to discharge to the river for the major part of the year, and effluent was discharged to the irrigation field. Effluent waste loads are presented in Table VII-55.

Plant 3 produces S1S hardboard which is used for exterior siding. The process water is first screened to remove gross solids which are landfilled. The wastewater then enters two settling ponds used alternately. Sludge from these ponds is dredged as required and landfilled. The wastewater flows to the two-stage biological treatment system, consisting of an aerated lagoon and a secondary clarifier. The practice of recycling a portion of the waste sludge from the secondary clarifier is under evaluation.

Table VII-55. SlS Hardboard, Treated Effluent Characteristics (Annual Averages)*

Plant	Production		Flow		BOD		TSS	
	kkg/day	(TPD)	kl/kkg	(kgal/ton)	kg/kkg	(lbs/ton)	kg/kkg	(lbs/ton)
348	88.7	(97.5)	46.6	(11.2)†	9.00	(18.0)†	17.1	(34.1)†
	--	--	--	--	--	--	--	--
	--	--	--	--	--	--	--	--
3	194	(213)	7.38	(1.78)	5.05	(10.1)	4.05	(8.10)
	194	(213)	9.35	(2.24)	9.35	(18.7)	8.50	(17.0)
	194	(213)	8.22	(1.97)	7.20	(14.4)	6.10	(12.2)
931	117	(129)	8.84	(2.12)	6.85	(13.7)	10.1	(20.2)
	115	(127)	8.14	(1.95)	0.74	(1.49)	2.52	(5.03)
	119	(131)**	13.26	(3.18)**	0.92	(1.84)**	3.01	(6.02)**
919††	91.9	(101)	--	--	--	--	--	--
	--	--	--	--	--	--	--	--
	--	--	--	--	--	--	--	--
673	343	(377)	4.16	(1.00)	0.13	(0.26)	0.12	(0.24)
	--	--	--	--	--	--	--	--
	--	--	--	--	--	--	--	--
678	1446	(1589)	9.40	(2.26)	0.97	(1.93)	1.14	(2.27)
	--	--	--	--	--	--	--	--
	--	--	--	--	--	--	--	--
929	111	(122)	4.24	(1.02)	18.5	(36.9)	1.59	(3.18)
	111	(122)	0.62	(0.15)	5.10	(10.2)	0.59	(1.17)
207	83.2	(91.7)	17.3	(4.14)	4.71	(9.42)	11.1	(22.2)
	79.7	(87.8)	13.9	(3.32)	4.31	(8.62)	9.85	(19.7)
	81.5	(89.8)	15.1	(3.62)	4.46	(8.91)	10.4	(20.8)

* First row of data represents 1976 average annual daily data; second row represents 1977 average annual daily data; third row represents average annual daily data for two-year period of 1976 and 1977; except as noted.

† Hardboard and paper waste streams are comingled.

** Data represent period of 10/1/76 through 10/31/79 when upgraded system was in normal operation.

†† All of treated effluent is recycled.

Overflow from the clarifier enters a second stage aerated lagoon. Treated effluent from this lagoon is currently discharged to the river. Effluent waste loads are presented in Table VII-55.

Plant 348 produces S1S hardboard and specialty paper products. The wastewaters from the two processes are comingled with cooling waters and discharged to the treatment system. The plant has completed modifications to eliminate the discharge of cooling water to the process wastewater treatment system. The treatment system consists of two primary settling ponds, which can operate either in series or parallel, an aerated lagoon, and a secondary settling pond. The primary settling ponds are decanted and the sludge is pumped to a drying area and landfilled. Secondary sludge is pumped and landfilled. Effluent waste loads are presented in Table VII-55.

Plant 207 produces S1S hardboard. The cooling water is discharged directly to the river. All excess plant whitewater is processed through the treatment facility. The wastewater is first screened for removal of gross solids, the solids are returned to the process.

The wastewater then enters a primary settling pond, where it is retained for five days before entering the biological treatment system. Nutrients are added prior to an aerated lagoon. After a twenty-two-day retention period in the aerated lagoon, the wastewater enters a secondary settling pond and is discharged to the river. Sludge from the settling ponds and aerated lagoon is dredged as necessary and landfilled. Treated waste loads are presented in Table VII-55.

Plant 931, which produces S1S hardboard, significantly expanded its biological treatment system during 1976 and began normal operation in October, 1976. The treatment system consists of two pair of aerated lagoons (in series), each pair operating in parallel. Each of the aerated lagoons in the first pair has a capacity of 15 million liters (4 million gallons) and the capacity of each lagoon in the second pair is 5.7 million liters (1.5 million gallons). Nutrients are added to the lagoons. The effluent from the second pair of aerated lagoons flows to one or more of three 4.9-million-liter (1.3-million-gallon) settling ponds which operate in parallel. The number of settling ponds used depends on the settleabililty of the suspended solids which, in turn, is a function of the water temperature. During the winter months, all three ponds are placed in operation. Cooling water is combined with the effluent from the settling ponds prior to discharge to the receiving waters. Effluent waste loads are presented in Table VII-55.

Plant 919 produces S1S hardboard for use in siding and industrial furniture. The plant also operates a veneer plant. Process waters from the hardboard and veneer plant are comingled and directed to the treatment facility, which consists of two primary settling ponds in series followed by an activated sludge system.

Detention time in the primary settling ponds is approximately nine days. Solids are removed annually by decanting the basins. Nutrients are added as the wastewater enters the activated sludge system, consisting of an aeration basin and a secondary clarifier. Sludge is recycled from the clarifier to the aeration basin at approximately 568 l/min (150 gpm). Waste sludge enters a small aerobic digester and is pumped to an irrigation field. After biological treatment the treated wastewater flows into two storage basins and is recycled to the manufacturing process. Plant production data are presented in Table VII-55; no treated effluent data were available for this plant.

Plant 929 produces S1S hardboard. The treatment system consists of two settling ponds in series. Process wastewater is collected in a sump and directed to the ponds with a theoretical retention time of 10 days before discharge to receiving waters. The treated effluent waste loads are presented in Table VII-55. As previously discussed in the section concerning in-plant controls, Plant 929 has approached complete close up of its process whitewater system, achieving a daily wastewater flow of less than 18,925 l/day (5,000 gpd).

Plant 933, which produces S1S hardboard, collects all process wastewater in a system of channels, gravity sewers, and force mains. The wastewater flows into a collection and equalization tank and is pumped to a lime neutralization tank, then to a POTW.

Plant 980, which produces S2S hardboard, collects all plant wastewaters into one sewer prior to any treatment. The treatment system consists of a primary aerated equalization pond (Kinecs Air Pond), two-stage biological treatment, and secondary storage and/or settling. Wastewater is retained in the Kinecs Air Pond for approximately 2.5 days. The primary function of this system is flow and biological equalization, as no BOD or TSS reduction is achieved. After nutrient addition and pH adjustment, wastewater enters the first stage of biological treatment, which consists of two Infilco Aero Accelators. Each Aero Accelator has an aeration compartment and a clarification zone. Biological solids from the clarifier zone are recycled to the aeration compartment. Waste sludge is detained in a surge tank and spray irrigated. The wastewater is routed from the Accelators to the secondary stage of biological treatment consisting of two aerated lagoons in series. The retention time in both lagoons is approximately 2.5 days. After final biological treatment, the wastewater flows into one of two 22.7 million-liter (6 million-gallon) facultative lagoons. The lagoons are used alternately to minimize the effects of any thermal inversions. Solids are removed from each basin during the periods it is not in use. Treated effluent is discharged to the river. The effluent waste loads are presented in Table VII-56. Effluent TSS waste loads are not reported for periods including the period prior to June 16, 1977 when a nonstandard method of TSS analysis was being used.

Table VII-56. S2S Hardboard, Treated Effluent Characteristics (Annual Averages)*

Plant Number	Production kkg/day	Production (TPD)	Flow kl/kkg	Flow (kgal/ton)	BOD kg/kkg	BOD (lbs/ton)	TSS kg/kkg	TSS (lbs/ton)
980	210	(231)	18.3	(4.39)	4.44	(8.88)	--	--
	216	(238)	20.5	(4.92)	2.86	(5.73)	4.68	(9.35)
	213	(235)†	18.9	(4.52)†	3.61	(7.22)†	--	--
	214	(236)**	18.9	(4.53)**	--	--	5.00	(10.0)**
1035	359	(395)††	21.9	(5.26)	2.15	(4.31)	0.94	(1.88)
	--	--	--	--	--	--	--	--
	--	--	--	--	--	--	--	--
108	605	(665)††	51.3	(12.3)	4.06	(8.12)	12.3	(24.5)
	--	--	--	--	--	--	--	--
	570	(628)††	22.6	(5.41)***	2.06	(4.13)***	2.24	(4.47)***
1	311	(343)	25.8	(6.18)	20.8	(41.5)	43.8	(87.6)
	--	--	--	--	--	--	--	--
	--	--	--	--	--	--	--	--

* First row of data represents 1976 average annual daily data; second row represents 1977 average annual daily data; third row represents average annual daily data for two-year period of 1976 and 1977; except as noted.

† Data represent period of 1/1/76 through 2/29/80.

** Data represent period of 6/16/77 through 2/29/80 when standard TSS analyses were performed.

†† Includes both insulation board and hardboard production.

*** Data represent period of 9/21/79 through 4/30/80 when oxygen activated sludge system was in operation.

Plant 1035 produces thermomechanically pulped and refined insulation board and S2S hardboard. The hardboard is primarily used for exterior siding. Approximately 70 percent of the production is insulation board and fiberboard and 30 percent is hardboard. The wastewater from the insulation and hardboard product lines is collected in a sump, screened, and directed to a primary clarifier. Clarifier underflow is recycled to the process. The solids are pumped over a Bauer hydrosieve, recovered, and recycled to the process. Water may bypass the clarifier and flow directly to settling basins. Water then flows to a 24.3-hectare (60-acre) holding pond, used for flow equalization, and subsequently discharges to a series of four aerated lagoons. The discharge from the fourth aerated lagoon is split between two oxidation ponds. Effluent from the two oxidation ponds is comingled and discharged to the river. The treated effluent waste loads are presented in Table VII-56.

Plant 108 and its wastewater treatment system are described earlier in the discussion of the insulation board plants. Treated effluent waste loads for this treatment system are presented in Table VII-56.

Plant 1 produces approximately 20 percent S1S hardboard and approximately 80 percent S2S hardboard, which is used in tile board, furniture, and merchandising display panels. Wastewater is pumped to an effluent holding tank and then to a primary clarifier with a detention time of three hours. Sludge, consisting mainly of wood fiber, is continuously removed from the clarifier, dewatered, and either burned in a power boiler or landfilled. The water removed from the sludge is recycled back to the primary clarifier. Clarified effluent flows to the secondary treatment system consisting of a settling pond and two aerated lagoons in series. Primary treated effluent is held one day in the settling pond and then flows to the first aerated lagoon, where nutrients are added. Average theoretical detention in each basin is 17 days. The first basin was designed to maintain the totally mixed system. The water flows by gravity to the second aerated lagoon, the second half of which is a quiescent zone to allow the biological solids to settle. Treated effluent is discharged from the second aerated lagoon to receiving waters. The treated effluent waste loads are presented in Table VII-56.

A dissolved air flotation system is currently under construction at Plant 1.

Plant 979 produces approximately 40 percent S2S hardboard and 60 percent thermomechanically pulped and refined insulation board. The hardboard is used for paneling or cabinets. The insulation board is used for ceiling tiles or sheathing. Plant effluent, after screening to remove gross solids, enters a three-day detention holding pond. The wastewater then flows to two settling ponds operating in parallel. After settling, the water enters a storage pond. Discharge from the storage pond is pumped to irrigation fields. This plant does not monitor wastewater quality.

Plant 977 produces S2S hardboard, thermomechanically pulped and refined insulation board, and mineral wool fiber. Approximately equal amounts of insulation board and hardboard are produced in one manufacturing facility, and mineral wool fiber is produced at a separate manufacturing facility. Wastewaters from the mineral wool fiber plant are discharged to two settling ponds operating in parallel. The hardboard and insulation board wastewaters are combined with the settling pond effluent and discharged to a POTW.

Plant 943 produces S2S hardboard for use in building siding and thermomechanically pulped and refined insulation board. The plant uses a combination of biological and physical wastewater treatment. All wastewaters other than groundwood whitewater are discharged to a sump. The groundwood whitewater is directed either to a wood molasses plant or to a primary clarifier. Sludge from the clarifier is recycled to the plant, and the overflow wastewater is directed to the holding tank. The effluent from the holding tank is spray irrigated. Underdrainage from the spray irrigation field is collected and discharged to the river.

Raw and treated effluent loads of total phenols for seven hardboard plants are presented in Table VII-57. Raw and treated effluent loads of heavy metals for six hardboard plants are presented in Table VII-58.

Table VII-59 presents the raw and treated waste concentrations of organic toxic pollutants for two S1S hardboard plants which were sampled during the 1978 verification sampling program. Extremely low concentrations of chloroform, benzene, ethylbenzene, toluene, and phenol were found in the raw wastes of the S1S hardboard plants. All of these pollutants, with the exception of phenol, most likely originated in industrial solvents or as a result of the chlorination of incoming process water. Phenol is an expected byproduct of hydrolysis reactions which occur during refining of the wood furnish. The levels of the heavy metals and organic toxic pollutants which were found in the raw wastewaters are so low that no specific technology exists, other than biological treatment, to remove these pollutants from the wastewater matrix.

The intake water for Plant 207 contained 10 ug/l of toluene. This concentration is the analytical detection limit for this compound and, available data on potable water sources demonstrate that few surface waters are entirely free of trace organic contaminants.

Table VII-60 presents the organic toxic pollutant concentrations of the raw and treated wastes for the three S2S hardboard plants that were sampled during the 1978 verification sampling program.

Table VII-57. Raw and Treated Effluent Loads and Percent Reduction for Total Phenols--Hardboard*

Plant Code	Raw Waste Load† kg/Kkg	Raw Waste Load† (lb/ton)	Treated Waste Load† kg/Kkg	Treated Waste Load† (lb/ton)	% Reduction
207	0.005	(0.01)	0.00030	(0.00059)	94
	0.0010	(0.021)	0.00020	(0.00040)	98
673	0.01	(0.02)	0.00015	(0.0003)	98
	--	--	--	--	--
678	0.003	(0.006)	--	--	--
	--	--	--	--	--
931	0.055	(0.11)	0.00046	(0.00092)	99
	0.031	(0.062)	0.065	(0.13)	+110
933	--	--	0.003	(0.006)	--
	--	--	--	--	--
979	0.0015	(0.003)	0.0028	(0.0055)	+83
	--	--	--	--	--
1	--	--	0.0005**	(0.001)**	--
	0.10	(0.21)	0.00095	(0.0019)	99

* First row of data represents data for 1977; second row of data represents data for 1978.

† Total phenols concentration data obtained during 1977 and 1978 verification sampling programs. Average annual daily waste flow and production data supplied by plants in response to data collection portfolio were used to calculate waste loads.

** Data are 1976 historical data supplied by plant in response to data collection portfolio.

Table VII-58. Raw and Treated Effluent Loadings and Percent Reduction for Hardboard Metals

Plant No.	Be	Cd	Cu	Pb	Ni	Zn	Sb	As	Se	Ag	Tl	Cr	Hg
931													
Raw Waste Load (kg/Kkg)	.000006	.00029	.0039	.00006	.0024	.009	.0002	.000012	.000018	.000006	.000013	.00029	.000018
(lb/ton)	(.000012)	(.00057)	(.0078)	(.00012)	(.0047)	(.017)	(.00003)	(.000023)	(.000035)	(.000012)	(.000026)	(.00058)	(.000035)
Treated Waste Load (kg/Kkg)	.0000045	.0000045	.0014	.00002	.0002	.0025	.0000085	.00002	.000006	.0000005	.000007	.000006	.000018
(lb/ton)	(.000009)	(.000009)	(.0028)	(.00004)	(.0004)	(.0049)	(.00017)	(.00004)	(.000012)	(.000001)	(.000014)	(.00011)	(.000035)
% Reduction	25%	98%	64%	67%	92%	72%	96%	+73% increase	33%	92%	46%	98%	0%
980													
Raw Waste Load (kg/Kkg)	.000013	.00006	.014	.00012	.0018	.0048	.00008	.000026	.00002	.00018	.000013	.00019	.0000013
(lb/ton)	(.000025)	(.000012)	(.027)	(.00024)	(.0035)	(.0096)	(.00015)	(.000051)	(.00004)	(.00035)	(.000025)	(.00037)	(.0000025)
Treated Waste Load (kg/Kkg)	.000009	.000037	.009	.000037	.00033)	.0008)	.000009	.000024	.000019	.000085	.000013	.000043	.000037
(lb/ton)	(.000018)	(.000074)	(.017)	(.000074)	(.00066)	(.0016)	(.000018)	(.000048)	(.000037)	(.00017)	(.000025)	(.000085)	(.000074)
% Reduction	31%	38%	36%	69%	82%	83%	89%	8%	8%	53%	0%	77%	+283% increase
678													
Raw Waste Load (kg/Kkg)	.000008	.000007	.00044	.0008	.0008	.003	.00008	.000016	.00005	.000007	.000013	.0001	.0000027
(lb/ton)	(.000016)	(.000013)	(.00088)	(.0015)	(.00015)	(.005)	(.00015)	(.000032)	(.0001)	(.000013)	(.000026)	(.0019)	(.0000053)
Treated Waste Load (kg/Kkg)	.0000028	.000008	.000017	.000033	.000024	.00026	.0001	.000007	.00002	.0000033	.0000023	.000024	.0000011
(lb/ton)	(.0000056)	(.000016)	(.00033)	(.000065)	(.000047)	(.00052)	(.000020)	(.000014)	(.000039)	(.0000066)	(.0000045)	(.000047)	(.0000022)
% Reduction	65%	+14% increase	96%	96%	97%	91%	87%	56%	60%	53%	82%	76%	59%
933													
Raw Waste Load (kg/Kkg)	.000005	.000005	.0011	.00002	.00006	.024	.000024	.000014	.000024	.000005	.000005	.00009	.000011
(lb/ton)	(.00001)	(.0001)	(.0021)	(.00004)	(.00012)	(.048)	(.000048)	(.000027)	(.000048)	(.00001)	(.00001)	(.00017)	(.000021)
Treated Waste Load (kg/Kkg)													
(lb/ton)													
% Reduction													
207													
Raw Waste Load (kg/Kkg)	.000009	.000009	.009	.000035	.00006	.014	.000009	.000017	.00006	.000009	.000009	.000017	.00031
(lb/ton)	(.000017)	(.000017)	(.017)	(.000069)	(.00011)	(.027)	(.000017)	(.000034)	(.00011)	(.000017)	(.000017)	(.000034)	(.00062)
Treated Waste Load (kg/Kkg)	.000009	.000009	.004	.000026	.000035	.0066	.000009	.000017	.00047	.000009	.000009	.000035	.00007
(lb/ton)	(.000017)	(.000017)	(.0079)	(.000052)	(.000069)	(.013)	(.000017)	(.000034)	(.000093)	(.000017)	(.000017)	(.000069)	(.00014)
% Reduction	0%	0%	56%	26%	42%	53%	0%	0%	15%	0%	0%	+103% increase	77%
678													
Raw Waste Load (kg/Kkg)	.000007	.000007	.0033	.000042	.00012	.007	.0001	.000015	.000015	.000009	.000009	.006	.000022
(lb/ton)	(.000013)	(.000013)	(.0065)	(.000083)	(.00023)	(.014)	(.0002)	(.00003)	(.00003)	(.000017)	(.000017)	(.011)	(.000043)
Treated Waste Load (kg/Kkg)	.0000048	.0000048	.0000048	.000036	.00006	.0019	.000011	.0000004	.0000004	.000006	.000008	.00082	.0000004
(lb/ton)	(.0000096)	(.0000096)	(.0000096)	(.000071)	(.00011)	(.0038)	(.000023)	(.0000009)	(.0000009)	(.000011)	(.000016)	(.0016)	(.0000007)
% Reduction	31%	31%	99%	14%	50%	73%	89%	97%	97%	+547% increase	11%	86%	98%

Source: 1977 Verification Sampling.

Table VII-59. SlS Hardboard Toxic Pollutant Data, Organics

	Average Concentration (ug/l)			
	Raw Wastewater		Treated Efluent	
Parameter	Plant 207	Plant 931	Plant 207	Plant 931
Chloroform	--	20	--	--
Benzene	--	80	10	80
Ethylbenzene	20	--	--	--
Toluene	15*	70	--	70
Phenol	--**	680	--	20

* Plant 207 intake water contained 10 ug/l toluene.

** Plant 207 intake water contained 97 ug/l phenol.

-- Hyphen denotes that the concentration for the parameter is below the detection limit for the compound.

Table VII-60. S2S Hardboard Toxic Pollutant Data, Organics

	Average Concentration (ug/1)					
	Raw Wastewater			Treated Effluent		
Parameter	Plant 980	Plant 1	Plant 943	Plant 980	Plant 1	Plant 943
Chloroform	--	20	--	--	--	--
1,1,2-Trichloroethane	--	--	90	--	--	--
Benzene	--	90*	--	--	40	--
Toluene	--	60*	10	100**	30	--
Phenol	--	300	--	--	--	--

* Plant intake water was measured at 120 ug/1 benzene and 80 ug/1 toluene.

** Plant reported a minor solvent spill in final settling pond prior to sampling.

-- Hyphen denotes that the concentration for the parameter is below the detection limit for the compound.

Extremely low concentrations of chloroform, 1,1,2-trichloroethane, benzene, toluene, and phenol were found in the raw wastes of the plants sampled. All of these pollutants, with the exception of phenol, most likely originated in industrial solvents or as a result of the chlorination of incoming process water. Phenol is an expected byproduct of hydrolysis reactions which occur during refining of the wood furnish. The levels of the heavy metals and organic toxic pollutants which were found in the raw wastewaters are so low that no specific technology exists to remove these pollutants from the wastewater matrix. Biological treatment is effective in reducing most raw heavy metals concentrations as shown in Table VII-58 and in significantly reducing the concentrations of the few organic toxic pollutants found in the raw wastewater.

The treated effluent of Plant 980 contained 100 ug/l of toluene which is thought to have been caused by a minor solvent spill in the final settling pond prior to sampling.

Insulation Board Candidate Treatment Technologies

There are two basic treatment technologies applicable to insulation board plants. One technology is biological treatment. Two equivalent options for biological treatment are presented--an aerated lagoon option and an activated sludge option. Both options will result in the same degree of treatment and final effluent level. The aerated lagoon option is less costly; however, it requires more land.

The biological candidate treatment technology schemes for the insulation board subcategory are based on demonstrated performance of Plant 537, a thermomechanical refining plant. The single direct discharging mechanical refining plant, Plant 36, has raw waste loads similar to Plant 537 and based on previously presented data, is capable of achieving treatment performance equivalent to Plant 537.

Candidate Treatment Technology A includes an activated sludge system for biological treatment and secondary clarification with aerobic digestion, sludge thickening, and vacuum filtration for waste sludge conditioning and dewatering. Figure VII-21 presents a schematic of Candidate Treatment Technology A.

Candidate Treatment Technology B, as shown in Figure VII-22, includes an aerated lagoon system with a facultative lagoon for additional biological treatment and clarification. Sludge is dredged from the facultative lagoon and landfilled.

Candidate Treatment Technology C, as shown in Figure VII-23, is a self contained system utilizing spray irrigation. Biological treatment precedes spray irrigation to reduce the pollutant load on the spray field. Biological treatment of raw wastewater preceding spray irrigation is not a necessity for successful performance of this technology. The allowable loading rates of

INSULATION BOARD (MECHANICAL AND THERMOMECHANICAL REFINING)
(DIRECT DISCHARGE)

CANDIDATE TREATMENT TECHNOLOGY
MODEL PLANT A

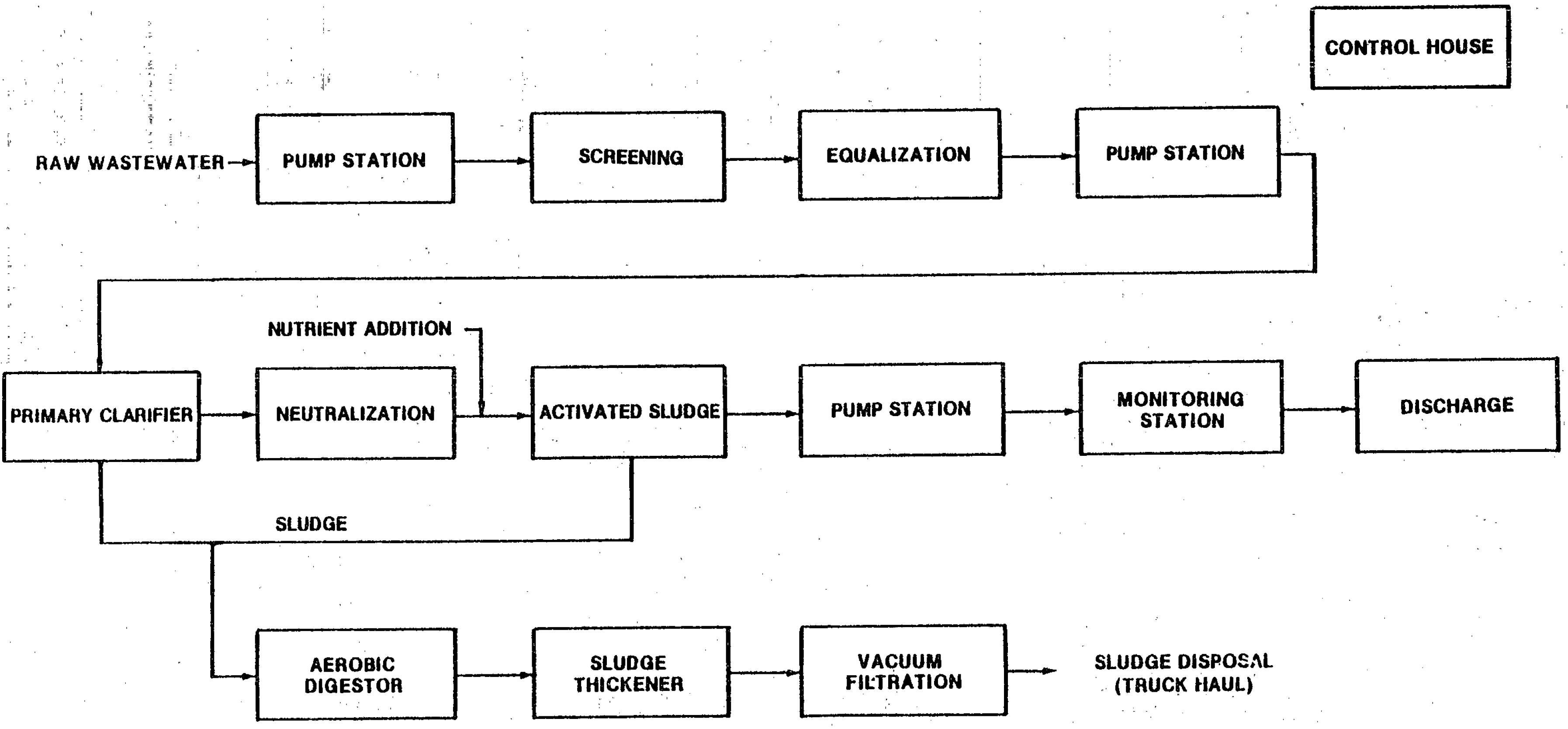


Figure VII-21

INSULATION BOARD (MECHANICAL AND THERMOMECHANICAL REFINING) (DIRECT DISCHARGE)

CANDIDATE TREATMENT TECHNOLOGY MODEL PLANT B

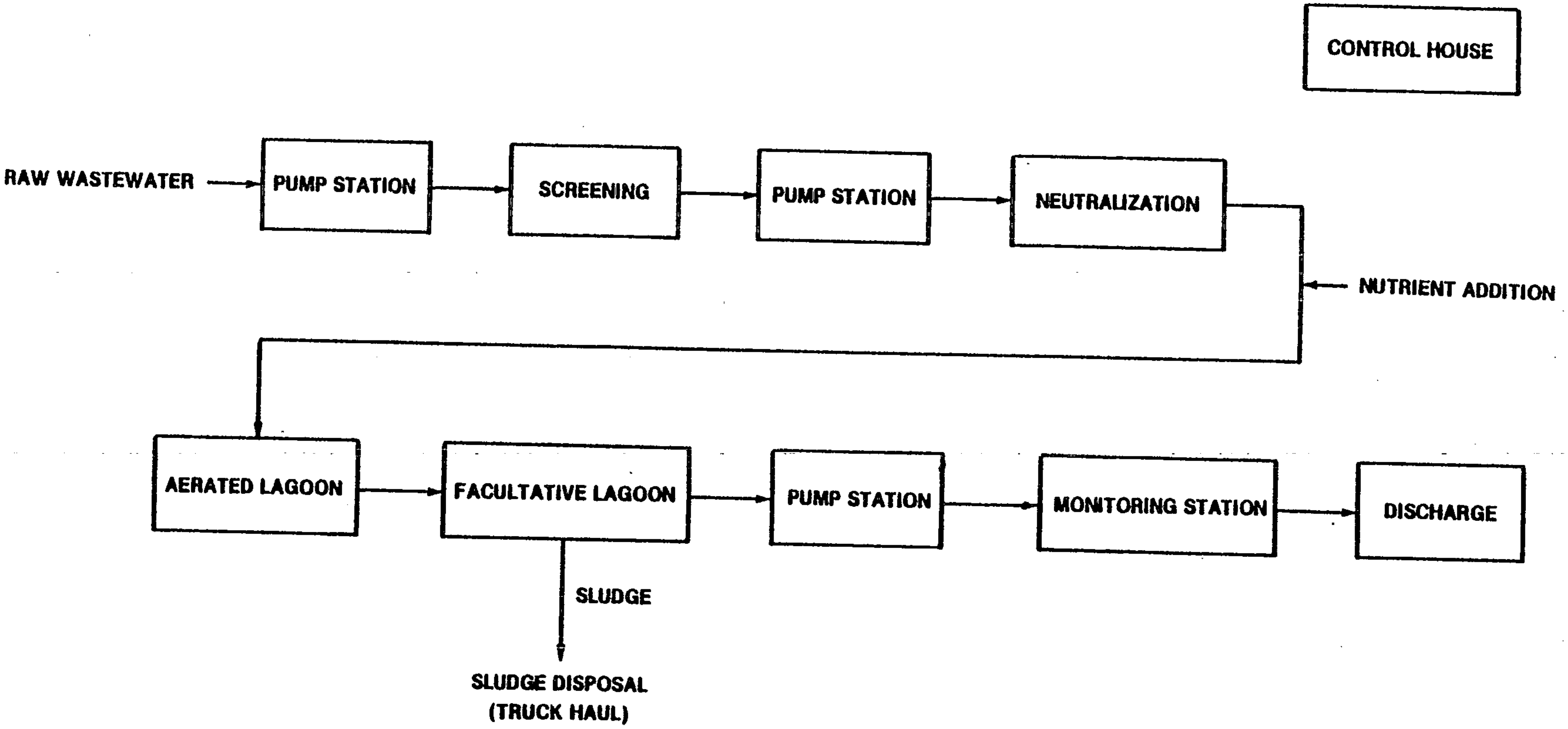
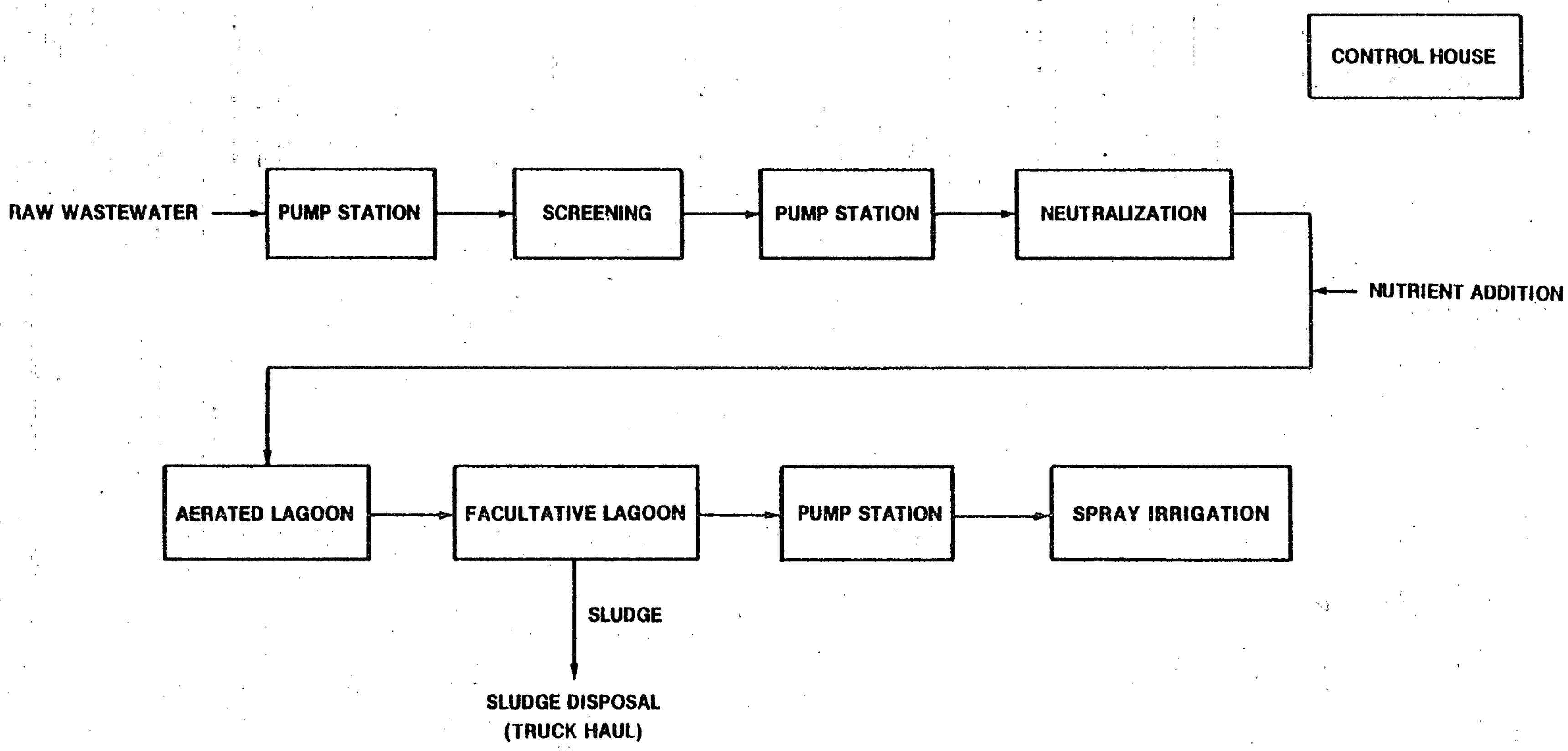


Figure VII-22

INSULATION BOARD (MECHANICAL AND THERMOMECHANICAL REFINING)
(SELF CONTAINED)

CANDIDATE TREATMENT TECHNOLOGY
MODEL PLANT C



See Tables A-6, A-7, A-8, and A-9 for cost summaries

Figure VII-23

BOD per acre of land vary considerably from soil to soil, and there are several demonstrated instances of insulation board and hardboard plants successfully spray irrigating a raw wastewater. Plants 186, 979 and 943 do not provide biological treatment prior to successful application of spray irrigation technology. Candidate Treatment Technology C is usually more land intensive than A or B.

Candidate Treatment Technology C is presented here as providing biological treatment prior to spray irrigation in order to present a conservative basis for new source performance costs and to insure that new source performance standards can be met by plants in areas where allowable BOD loading rates per acre require biological treatment. Sludge is removed from the facultative lagoon and landfilled.

Table VII-61 presents the expected treated effluent waste loads for the candidate treatment technologies for insulation board plants. These treated waste loads are based on those being achieved by thermomechanical refining Plant 537.

The battery limit costs associated with the insulation board Candidate Treatment Technology C, the NSPS technology, are presented in Appendix A. No other costs are presented for insulation board plants as both direct discharging plants which produce only insulation board already have equivalent technology in place. Cost impacts for plants which produce both insulation board and S2S hardboard are presented in the S2S hardboard discussion.

Table VII-61. Treated Effluent Waste Loads for Candidate Treatment Technologies--Insulation Board

Candidate Treatment Technology	Average Treated Effluent Waste Loads kg/Kkg (lb/ton) BOD	TSS
A, B	2.07 (4.14)	1.31 (2.62)
C	0	0

Wet Process Hardboard Candidate Treatment Technologies

There are two basic treatment technologies applicable to hardboard plants. One technology is biological treatment. As demonstrated by plants in the industry and as discussed earlier in this section, biological treatment facilities may be designed and operated to provide varying degrees of pollutant reduction. Because there are many plants that have biological systems, demonstrated performance of three of these systems (two for S1S hardboard and one for S2S hardboard plants) were used to develop three levels of biological treatment performance as a basis for the candidate biological treatment systems. Each of these candidate treatment systems described for hardboard plants will result in different final treated effluent levels.

Candidate Treatment Technology A, applicable to S1S hardboard plants and based on the biological treatment system in place at Plant 207, consists of a primary settling pond or primary clarifier, an aerated lagoon and a facultative settling lagoon. A diagram of this treatment system is presented in Figure VII-24.

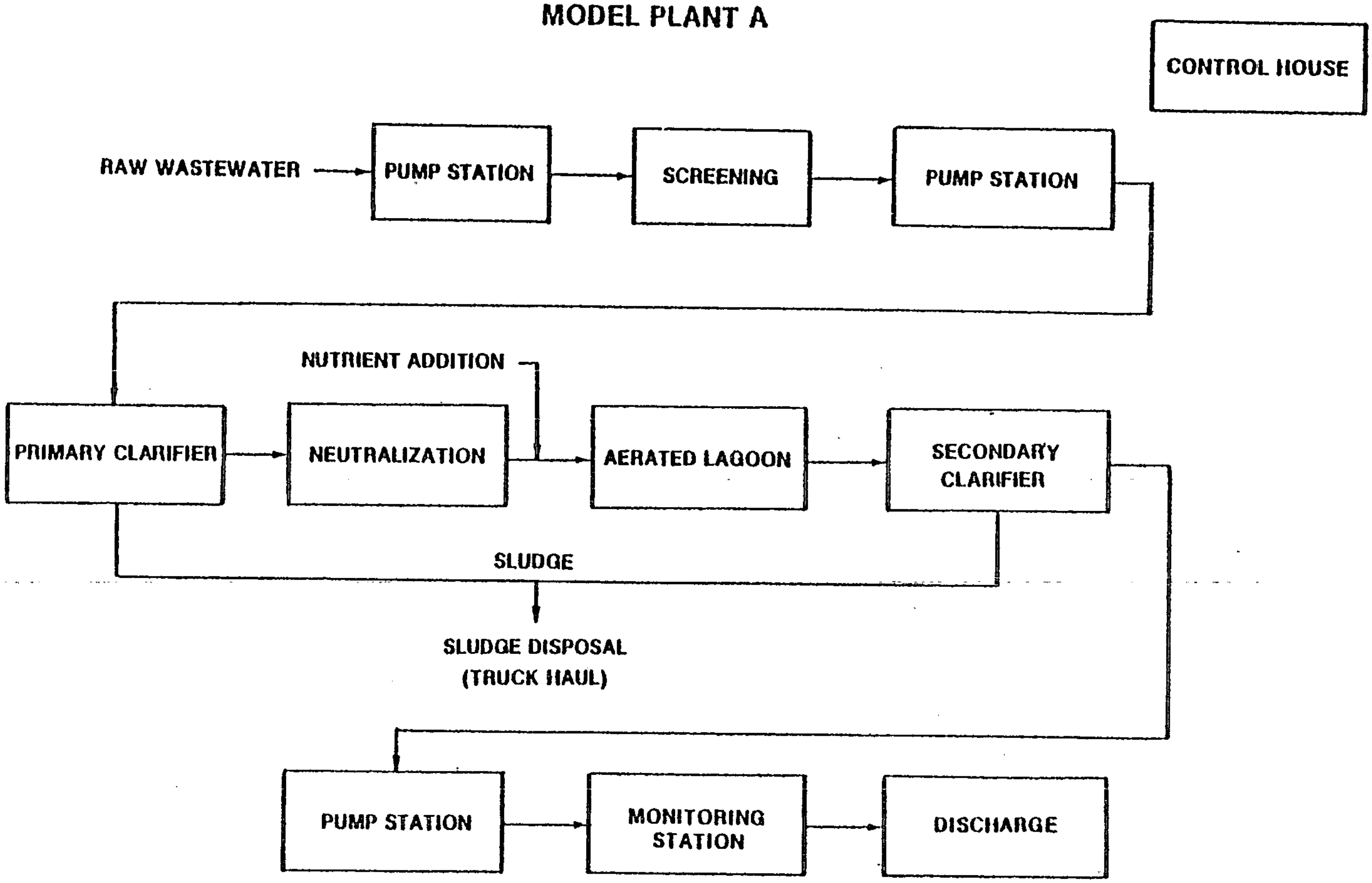
Candidate Treatment Technology B, applicable to S1S hardboard plants and based on the biological treatment system in place at Plant 931, consists of a two stage aerated lagoon system in conjunction with a facultative settling lagoon. This system provides significantly more detention time and aeration capacity per pound of raw BOD waste load than does Candidate Treatment Technology A, and thus exhibits improved performance characteristics. Figure VII-25 is a diagram of Candidate Treatment Technology B.

Candidate Treatment Technology C is applicable to S2S hardboard plants and is based on the biological treatment system in place at Plant 980, except that a primary clarifier and activated sludge system have been specified to replace the Infilco solids contact units used at this plant to provide a combination of primary settling and preliminary biological treatment. This system, which includes equalization, primary settling, activated sludge treatment followed by a two stage aerated lagoon system and a facultative lagoon for final settling, is depicted in Figure VII-26.

Candidate Treatment Technology D, applicable to S1S and S2S hardboard plants, is a no discharge spray irrigation system. For cost purposes, the spray system itself is preceded by biological treatment and sufficient holding capacity for 3 months at design flow, as well as a one mile pipeline and pumping station. A diagram of this system is presented in Figure VII-27.

HARDBOARD (S1S)
(DIRECT DISCHARGE)

CANDIDATE TREATMENT TECHNOLOGY
MODEL PLANT A



Figures VII-24

HARDBOARD (S1S)
(DIRECT DISCHARGE)

CANDIDATE TREATMENT TECHNOLOGY
MODEL PLANT B

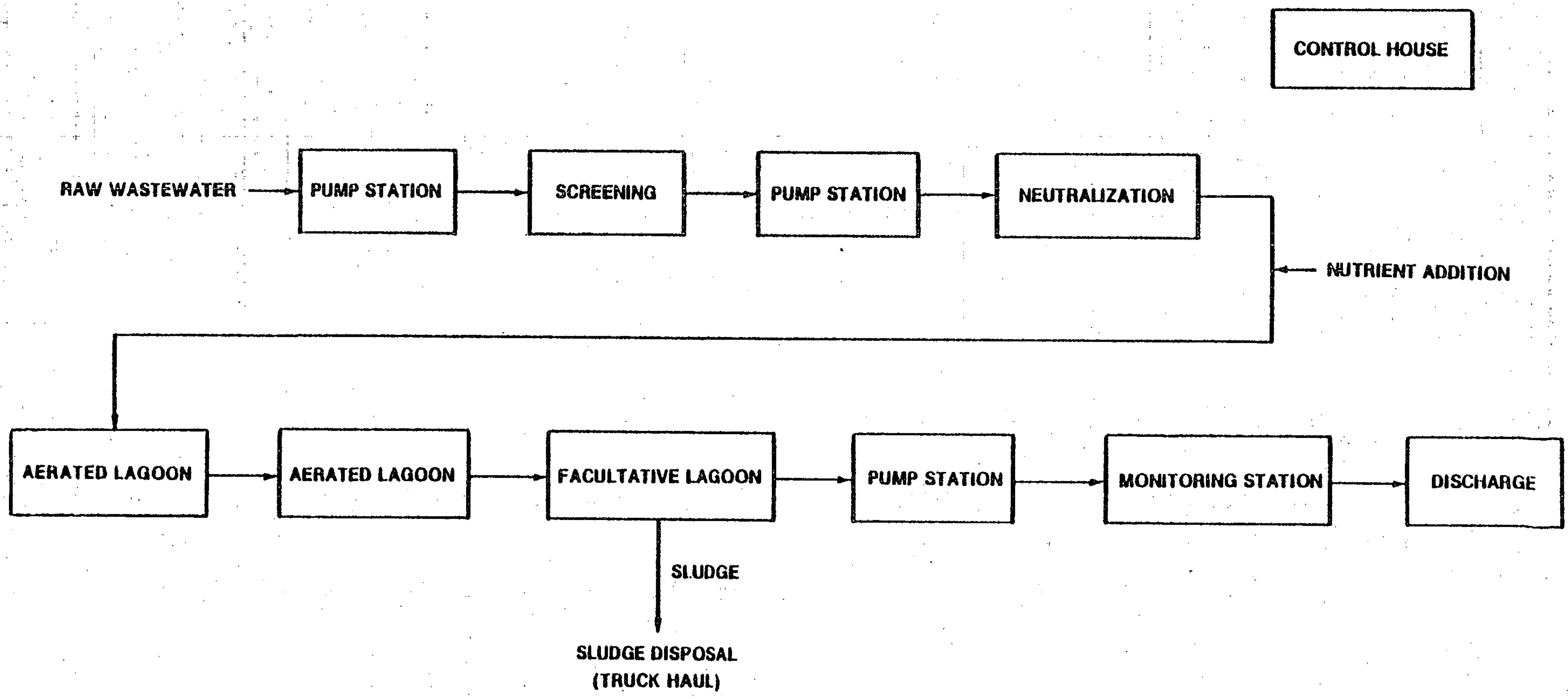


Figure VII-25

HARDBOARD (S2S)
(DIRECT DISCHARGE)

CANDIDATE TREATMENT TECHNOLOGY
MODEL PLANT C

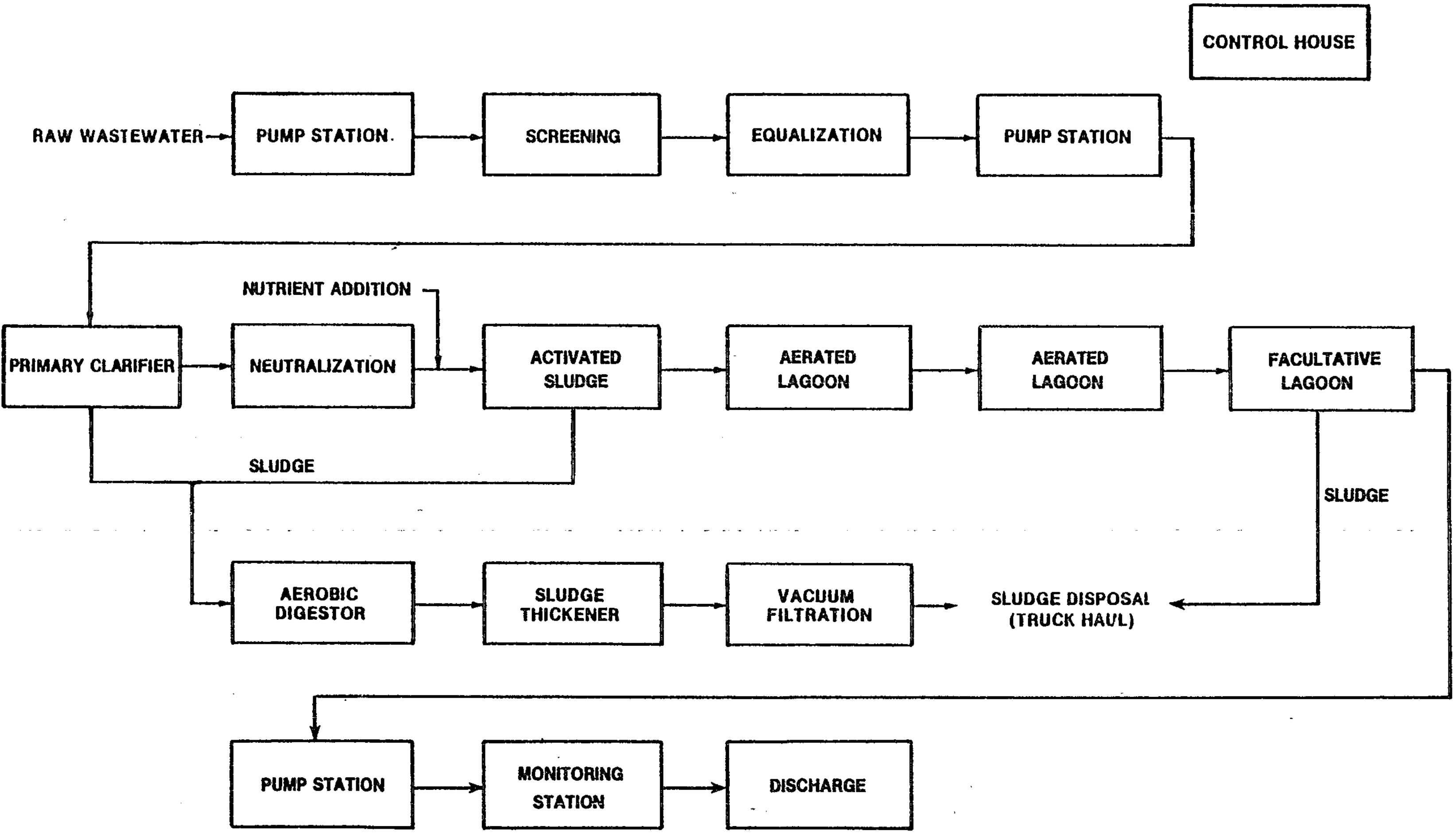
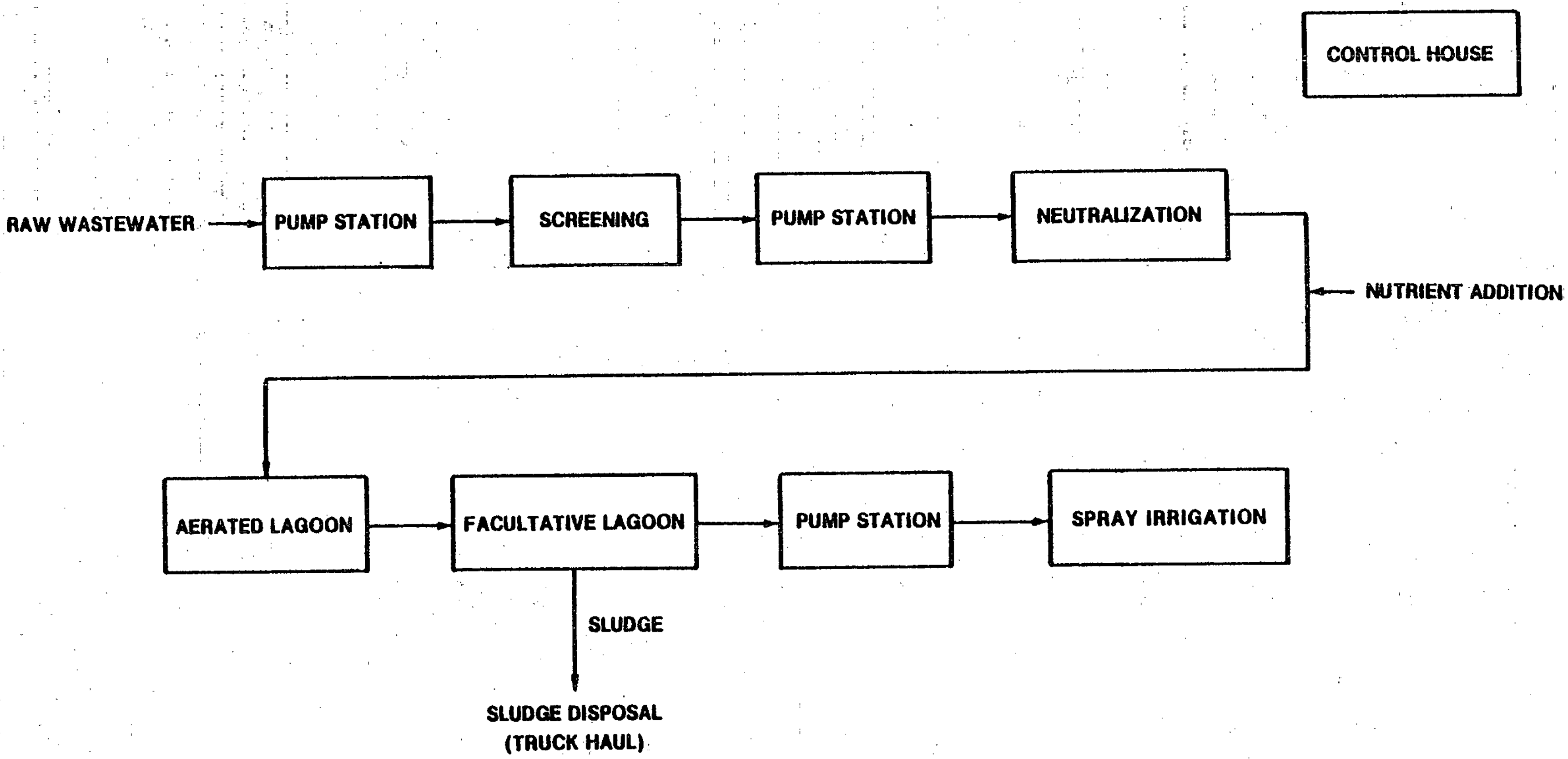


Figure VII-26

HARDBOARD (S1S AND S2S)
(SELF CONTAINED)

CANDIDATE TREATMENT TECHNOLOGY
MODEL PLANT D



See Tables A-10, A-11, and A-12 for cost summaries

Figure VII-27

Table VII-62 presents the expected treated effluent levels for these candidate treatment technologies.

Table VII-62. Treated Effluent Waste Loads for Candidate Treatment Technologies--Wet Process Hardboard

Candidate Treatment Technology	Average Treated Effluent Waste Loads kg/Kkg (lb/ton) BOD	TSS
A (S1S)	4.45 (8.91)	10.4 (20.8)
B (S1S)	0.922(1.84)	3.01 (6.02)
C (S2S)	3.61(7.22)	5.02 (10.0)
D(Both)	0	0

Cost estimates are presented in Appendix A for the self contained, NSPS Candidate Technology D only, as all direct dischargers already have treatment systems in-place.

Cost estimates are also presented in Appendix A for hardboard plants which must upgrade their treatment systems to achieve performance equivalent to Candidate Treatment Technologies A and B (for S1S) and C (for S2S).

Pretreatment Technology

No technology for pretreatment was developed for the insulation board/wet process hardboard segment because of the low levels of heavy metals and organic toxic pollutants in the raw wastewater and the lack of technology available to further reduce these levels. A plant may decide to adopt pretreatment in order to reduce its waste loads to the POTW as a matter of individual economics.

SECTION VIII

BEST PRACTICABLE CONTROL TECHNOLOGY CURRENTLY AVAILABLE

GENERAL

The effluent limitations which were required to be achieved by July 1, 1977, are based on the degree of effluent reduction attainable through the application of the best practicable control technology currently available (BPT). The best practicable control technology currently available is based upon the average of the best existing performances, in terms of treated effluent discharged, by plants of various sizes, ages and unit processes within the industry. This average is not based upon a broad range of plants within the timber products industry, but upon performance levels demonstrated by exemplary plants.

In establishing the best practicable control technology currently available effluent limitations guidelines, EPA must consider several factors, including:

1. the manufacturing processes employed by the industry;
2. the age and size of equipment and facilities involved;
3. the engineering aspects of application of various types of control techniques;
4. the cost of achieving the effluent reduction resulting from the application of the technology; and
5. non-water quality environmental impact (including energy requirements).

While best practicable control technology currently available emphasizes treatment facilities at the end of manufacturing processes, it also includes control technologies within the process itself which are considered normal practice within an industry.

A further consideration is the degree of economic and engineering reliability which must be established for the technology to be "currently available." As a result of demonstration projects, pilot plant testing, and general use, there must exist a high degree of confidence in the engineering and economic practicability of the technology at the time of commencement of construction or installation of the control facilities.

MANUFACTURING PROCESSES

As indicated in earlier sections, the differences in timber products manufacturing processes result in varying raw waste characteristics. The Agency has recognized these variations by establishing industry subcategories for the purpose of developing effluent limitations.

AGE AND SIZE OF EQUIPMENT AND FACILITIES

As discussed in Section IV of this report, the data indicate that plant age or size do not justify different effluent limitations. The data indicate that some of the oldest and smallest plants currently achieve levels of treatment equivalent to those achieved by large and new facilities.

STATUS OF BPT REGULATIONS

Wood Preserving Segment

The following BPT effluent limitations were promulgated on April 18, 1974 for the wood preserving segment of the timber products industry:

Wood Preserving-Waterborne Or Nonpressure Subcategory (formerly Wood Preserving Subcategory) -No discharge of process wastewater pollutants.

Wood Preserving--Steam Subcategory

Effluent characteristic	BPT Effluent Limitations Maximum for any 1 day	 Average of daily values for 30 consecutive days shall not exceed
	Metric units (kilograms per 1,000 m³ of product)	
COD	1,100	550
Total phenols	2.18	0.65
Oil and Grease	24.0	12.0
pH	Within the range 6.0 to 9.0	
	English units (pounds per 1,000 ft³ of product)	
COD	68.5	34.5
Total phenols	0.14	0.04
Oil and Grease	1.5	0.75
pH	Within the range 6.0 to 9.0	

Wood Preserving-Boulton Subcategory -- No discharge of process wastewater pollutants.

Insulation Board/Wet Process Hardboard Segment

Insulation Board Subcategory-On August 26, 1974, effluent guidelines and standards were proposed for the direct discharging plants of the insulation board subcategory. These proposed regulations were never promulgated. Promulgation was delayed because review of the proposed regulation indicated that additional information was needed.

Wet Process Hardboard Subcategory-Following promulgation of wet process hardboard regulations on April 18, 1974, the industry and the Agency held a series of meetings to review the information in the Record supporting these regulations. This review convinced the Agency that the existing regulations should be withdrawn. On September 28, 1977, a notice was published in the Federal Register announcing the withdrawal of 40 CFR Part 429 Subpart E-Hardboard Wet Process, best practicable control technology limitations, best available technology limitations, and new source performance standards (BPT, BAT and NSPS).

BEST PRACTICABLE CONTROL TECHNOLOGY (BPT)

Wood Preserving Segment

BPT regulations promulgated April 18, 1974 continue.

Wet Process Hardboard/Insulation Board Segment

Best practicable control technology for the wet process hardboard subcategory and the insulation board subcategory are based on demonstrated performance of existing end-of-pipe biological treatment systems. The insulation board BPT technology is defined as primary clarification, followed by secondary treatment (biological by extended aeration), secondary clarification and recycle and reuse of a portion of the treated wastewater, as practiced by Plant 537. The S1S part of the wet process hardboard subcategory BPT technology is based on primary settling, biological treatment by extended aeration, secondary settling, and discharge, as currently practiced by Plant 207. As discussed below, the only plant producing only S2S hardboard has an end-of-pipe treatment system performing at a BCT level rather than a BPT level of performance. Therefore, a BPT limitation was calculated for the S2S part of the wet process hardboard subcategory from the performance of the S1S BPT system applied to S2S raw waste loads.

The BPT limitations for the insulation board and wet process hardboard subcategories presented in this section can be achieved with the treatment systems outlined above. However, these systems are not required by the regulations. In fact, many plants in these subcategories are currently achieving BPT, or better levels of control with wastewater treatment and control systems different than those described above.

REGULATED POLLUTANTS

The pollutants controlled by the previously promulgated BPT limitations for the Wood Preserving-Steam subcategory are COD, Oil and Grease, total phenols (Standard Methods), and pH. The discharge of these pollutants, except for pH, is controlled by mass effluent limitations, i.e. in kilograms of pollutant per 1000 m^3 of production or pounds of pollutant per 1000 ft^3 of production. The existing BPT limitations for the remaining subcategories of the wood preserving segment, the Wood Preserving-Waterborne or Nonpressure and Wood Preserving-Boulton subcategories require no discharge of process wastewater pollutants. The pollutants controlled by the BPT limitations for the insulation board and wet process hardboard subcategories include BOD, TSS, and pH. The discharge of these pollutants, except for pH, is controlled by mass effluent limitations, i.e., kilograms of pollutant per 1000 kilograms of gross production or pounds of pollutant per 1000 pounds of gross production.

METHODOLOGY OF BPT DEVELOPMENT

Wood Preserving Segment

The Agency is retaining the BPT effluent limitations promulgated on April 18, 1974. A detailed discussion of the rationale for determining BPT limitations for each subcategory of the wood preserving segment is presented in the Development Document for Effluent Limitations Guidelines and New Source Performance Standards for the Plywood, Hardboard and Wood Preserving Segments of the Timber Products Industry, U.S. EPA 440/1-73/029, 1974.

All known wood preserving plants are currently in compliance with these existing BPT limitations.

Insulation Board/Wet Process Hardboard Segment

Insulation Board Subcategory-Fifteen plants fall into this subcategory, ten which produce solely insulation board, and five which produce both insulation board and S2S hardboard. Five of the fifteen plants are direct dischargers.

BOD and TSS are the major pollutants present in the wastewater. None of the 124 toxic pollutants were measured at levels that would be further reduced by practicable currently available treatment technologies.

The Agency reviewed and evaluated the treatment systems at all five direct discharging plants in order to choose a treatment technology representative of BPT. Requirements for this BPT technology were that it represent exemplary performance within the subcategory and that it be applicable to all plants within the subcategory.

Technology selected as representative of BPT technology for the insulation board subcategory is based on in-place technology at Plant 537, one of two direct dischargers that produces solely insulation board.

At Plant 537, process wastewater, septic tank effluent, and storm water runoff goes to a primary clarifier. Primary sludge is recycled to the process. Wastewater goes to an aerated lagoon, and then to a secondary clarifier. Secondary clarifier sludge also is recycled to the process. Clarifier overflow goes to a sump. A portion of the treated water is reused by the plant, and excess treated wastewater is discharged to receiving waters.

In-place technology at the remaining four direct discharging plants was not selected as representative BPT technology for the following reasons:

Plant 36 has a biological treatment system which consists of a primary clarifier followed by an activated sludge system. Although the performance of this system is exemplary, and this treatment system is applicable to other insulation board plants, Plant 36 is the only mechanical refining plant among the five insulation board direct dischargers. Mechanical refining plants usually have lower raw waste loads than do thermomechanical refining plants. The Agency decided not to base BPT treatment system performance on a system treating wastewater from a mechanical refining plant.

Plant 108 has recently constructed a pure oxygen activated sludge treatment system. Lack of operational data on this system prevents it from being considered as representative of BPT technology.

Plant 1035 has an extensive biological treatment system consisting of over 100 acres of aerated lagoons and oxidation ponds. Although this system provides excellent treatment, it is very land intensive; therefore, the Agency concluded that it is not representative of BPT technology.

Plant 943 spray irrigates primary treated wastewater on 200 acres of underdrained fields. Percolated water is collected in the underdrains and is discharged. Although this system provides a very high level of treatment, it is land intensive; for this reason, the Agency concluded that it is not representative of BPT technology.

One nondischarging plant in the subcategory, which was operating at the time of the technical study, but is no longer operating used complete recycle of process wastewater to achieve no discharge status. The Agency believes that complete recycle of process wastewater is dependent on the type of end products produced, the type of raw materials available, and on plant specific variables of process equipment. It is, therefore, not applicable to all plants in the subcategory and the Agency has not recommended this technology for BPT.

Specific engineering design criteria, based on the treatment system at Plant 537, are presented below for BPT biological treatment technology for the insulation board subcategory:

Primary and Secondary Clarifier Overflow Rate	661 gpd/sq ft
Nutrient Addition to Maintain C:N:P at	100:5:1
Aerated Lagoon Detention Time	0.0019 days/lb BOD removed
Aeration Capacity	0.066 HP/lb BOD removed

Performance data over a three-year period for Plant 537 indicate that the treatment system is performing exceptionally well, with long term average treated effluent loads of 2.07 kg/kkg (lb/1,000 lb) for BOD and 1.31 kg/kkg (lb/1,000 lb) for TSS. The BPT limitations for this subcategory were derived by multiplying the long term average performance of Plant 537 by the daily and 30-day variability factors for Plant 537 documented later in this Section.

Wet Process Hardboard Subcategory - S1S Part-Nine plants fall into this group, seven of which are direct dischargers, one of which is a indirect discharger and one of which is self contained.

BOD and TSS are the major wastewater pollutants. None of the 124 toxic pollutants were measured at levels that could be further reduced by practicable, currently available treatment technologies.

The Agency reviewed and evaluated the treatment systems at the seven direct discharging plants and the self contained plant in order to choose a treatment technology representative of BPT. Requirements for the BPT technology were that it represent exemplary performance within the S1S part of the subcategory and that it be applicable to all plants within the S1S part.

Technology selected as representative of BPT technology for the S1S part of the wet process hardboard subcategory is based on in-place technology at Plant 207.

Plant 207 produces only S1S hardboard. The treatment system consists of primary settling, about twenty two days detention in an aerated lagoon, a secondary settling pond, followed by discharge to the receiving water.

In-place technology at the remaining eight S1S hardboard plants was not selected as representative of BPT technology for the following reasons:

Plant 348 produces solely S1S hardboard. Adjacent to the hardboard plant, a plant owned by the same firm produces battery components which discharges process wastewater to the same biological treatment system treating the hardboard plant effluent. The plant was not able to separate and prorate wastewater flows from the two operations. The treatment system at this plant consists of a primary settling pond, an aerated lagoon, and a secondary settling pond. The plant is, as of Spring 1979, undertaking modifications of the treatment system in an attempt to improve its performance. To date the plant has the highest level of BOD and TSS discharge of all S1S plants. Because of poor past performance and because of the presence of battery plant effluent this plant was not considered as a BPT candidate.

Plant 3 produces primarily exterior siding grade S1S hardboard. The plant's treatment system consists of primary settling, an aerated lagoon, a secondary clarifier, followed by another aerated lagoon. Some wastewater from the final aerated lagoon is reused in the manufacturing process, and the remainder is discharged to the receiving water. The plant is considering recycling a portion of the waste sludge from the secondary clarifier. The treatment system, based on long term data analysis, discharges a greater amount of pollutants than does Plant 207. This plant also exhibited a wide swing in treatment efficiency during the two year period for which data is available, indicating that the system has not been stable during that period, and should not be considered a BPT candidate.

Two plants, 678 and 673, both of which produce some S2S hardboard as well as S1S, dispose of a significant portion of their process wastewater pollutants by an evaporation and drying process that converts wood sugars and other pulp degradation products into a by-product which is marketable as an animal feed supplement. This operation considerably reduces the raw waste load in relation to other hardboard plants.

Although both of these plants have activated sludge treatment systems with better performance characteristics than the candidate BPT system (in terms of unit discharge of pollutants) of Plant 207, the combination of evaporation and biological treatment technologies is not considered applicable to all S1S hardboard plants and therefore was not selected as a BPT candidate.

Plant 929 produces primarily industrial grade S1S hardboard. Its products are used in automobile interiors, as backing for upholstered furniture, and as TV cabinet backing: all uses where the hardboard is not visible, and not likely to be in contact with moisture. Therefore, the appearance and water absorption qualities of the board are not important criteria. The plant has for the past three years been modifying process equipment and techniques to increase recycle and minimize its volume of process wastewater. The plant has reduced its volume of process wastewater more than 90 percent and has also significantly reduced the mass of pollutants discharged in its raw waste. However, because the relatively unique product line of this plant does not have to meet stringent requirements for appearance, paintability, and water absorption, the internal recycle technology used by this plant is not applicable to all plants in the subcategory and was not chosen as a BPT candidate. This plant treats its relatively low volume of process wastewater in two large oxidation lagoons/settling ponds, which are not in themselves sufficiently effective to be considered as a BPT candidate treatment system.

Plant 931, which produces all S1S hardboard, constructed new treatment facilities which became operational during the last quarter of 1976. This treatment system consists of two parallel pairs of aerated lagoons operated in series, followed by three large settling lagoons operated in parallel. This entire system has a long detention time resulting in the best performance in terms of unit effluent pollutants discharged of any system relying primarily on end-of-pipe biological treatment and applicable to all S1S hardboard plants. Of the seven direct discharging S1S plants from which one to three years historical BOD and TSS data were available, this plant's treatment system exhibited the most consistent uniformity of discharge quality both in terms of daily and long term average discharge. This treatment system is therefore considered to be a BAT or BCT candidate, and was not considered as a BPT candidate technology.

Plant 919 produces only S1S hardboard for use in siding and industrial furniture. Process wastewater from the plant (including wastewater from an adjacent veneer plant owned by the same company) flows to two primary settling ponds followed by an activated sludge system. Following biological treatment, all the treated effluent is recycled to the plant as process make-up water.

This end-of-pipe treatment/recycle system, although quite effective for Plant 919, is not considered applicable to all S1S plants for the same reasons that Plant 929's internal-process recycle cannot be applied to other S1S plants. Therefore, the treatment system at Plant 919 was not considered as a BPT candidate.

The remaining S1S hardboard plant is Plant 933 which is an indirect discharger with no pretreatment other than neutralization.

Specific engineering design criteria, based on the treatment system at Plant 207, are presented below for BPT biological treatment technology for the S1S part of the wet process hardboard subcategory:

Primary Settling Lagoon Detention Time	5.2 days
Nutrient Addition to Maintain C:N:P at	100:5:1
Aerated Lagoon Detention Time	0.0046 days/lb BOD removed
Aeration Capacity	0.059 HP/lb BOD removed
Secondary Settling Lagoon Detention Time	2.7 days

Treated effluent performance data over a two year period for Plant 207 indicate that the treatment system is performing very adequately, with long term average treated effluent loads of 4.45 kg/kkg (lb/1000 lb) for BOD and 10.4 kg/kkg (lb/1000 lb) for TSS.

The BPT limitations for this part of the wet process hardboard subcategory were derived by multiplying the long term average performance of Plant 207 by the daily and 30-day variability factors for Plant 207 documented later in this Section.

As described in Section V, the 1976 raw waste load for Plant 207 was not used in developing the design criteria for the S1S part because a major in-plant retrofitting program, which significantly reduced the raw waste flow, was completed during the latter half of 1976. However, the daily treated effluent waste loads did not vary significantly from 1976 to 1977, and therefore, the long term average performance for this plant, in terms of treated effluent waste loads, was used in developing the BPT limitations.

<u>Wet Process Hardboard Subcategory</u> - <u>S2S Part</u>-Seven plants fall into this part of the wet process hardboard subcategory, five of which produce both insulation board and S2S hardboard. Of the plants which produce only hardboard, one plant produces approximately 80 percent S2S hardboard and 20 percent S1S hardboard. The remaining plant produces solely S2S hardboard. Five of the seven plants are direct dischargers.

BOD and TSS are the major pollutants present in the wastewater. None of the 124 toxic pollutants were measured at levels that would be further reduced by practicable, currently available treatment technologies.

The Agency reviewed and evaluated the treatment systems at all five direct discharging plants in order to choose a treatment technology representative of BPT. Requirements for this BPT technology were that it represent exemplary performance within the S2S part of the wet process hardboard subcategory and that it be applicable to all plants within the S2S part. Treatment systems at three of the plants were treating to very low effluent levels. However, two of the plants, 1035 and 943, are practicing a wastewater treatment technology application that is land intensive and not considered applicable to all plants in the subcategory.

Plant 980, the only plant which produces only S2S hardboard, has an exemplary biological treatment system in-place which is applicable to other S2S hardboard plants. The performance of this system, however, in comparison with exemplary plants in the S1S part of the subcategory, is more representative of BAT or BCT technology than it is of BPT technology. For example, the S1S part BPT treatment system demonstrates pollutant removal efficiencies of 86.1 percent for BOD and 64.6 percent for TSS. Plant 980, by comparison, is removing 94.3 percent of BOD and 91.5 percent of TSS. These removal efficiencies are more comparable to the removal efficiencies of the S1S part BCT candidate Plant 931, which removes 97.9 percent of BOD and 92.3 percent of TSS. (TSS removals are based on measured raw waste load TSS plus an additional 0.784 lb TSS per lb BOD removed to take into account biological solids generated in the treatment system. This figure is based on data supplied by the industry).

In the absence of an S2S hardboard treatment system which demonstrates technology representative of BPT, the Agency has calculated BPT for the S2S part based on the pollutant removal efficiencies demonstrated by the S1S part BPT treatment system, as applied to the long term average raw waste load generated by Plant 980, the only hardboard plant producing 100 percent S2S hardboard. Again, solids generated by biological treatment are included in this calculation. The resulting long term average treated effluent waste loads are 8.97 kg/kkg (lb/1000 lb) for BOD and 19.6 kg/kkg (lb/1000 lb) for TSS. The BPT limitations were derived by multiplying these waste loads by the daily and 30-day variability factors for Plant 980. The design of the treatment system which the Agency believes will result in BPT effluent levels is based on the system in-place at Plant 980, with reduced detention time and aeration-horsepower requirements corresponding to the reduced mass of pollutants to be removed. This system includes equalization in an aerated basin, primary settling, an activated sludge system including secondary clarification followed by an aerated lagoon system and a facultative settling lagoon for further treatment.

Specific engineering design criteria, based on the treatment system at Plant 980, are presented below for BPT biological treatment technology for the S2S part of the wet process hardboard subcategory:

Primary Clarifier Overflow Rate	400 gpd/sq ft
Nutrient Addition to Maintain C:N:P at	100:5:1
Activated Sludge System	
Detention Time	0.000053 days/lb BOD removed
Aeration	0.029 HP/lb BOD removed
Aerated Lagoon	
Detention Time	0.00028 days/lb BOD removed
Aeration Capacity	0.034 HP/lb BOD removed
Final Settling Lagoon	
Detention Time	96 hours

BPT LIMITATIONS

Presented below are the best practicable control technology limitations promulgated in this rulemaking.

Wood Preserving Segment

Wood Preserving Water Borne or Nonpressure Subcategory--No discharge of process wastewater pollutants.

Wood Preserving-Steam Subcategory

Pollutant or Pollutant Property	BPT Effluent Limitations Maximum for any one day	 Average of daily values for 30 consecutive days*
	English units (lb/1000 cubic feet of product)	
COD	68.5	34.5
Phenols	.14	.04
Oil and Grease	1.5	.75
pH	within the range of 6.0 to 9.0 at all times	
	Metric units (kg/1000 cu m of product)	
COD	1,100	550
Phenols	2.18	.65
Oil and Grease	24.0	12.0
pH	within the range of 6.0 to 9.0 at all times	

* Based on 30 observations for the 30 day period.

Wood Preserving-Boulton Subcategory--No discharge of process wastewater pollutants.

Insulation Board/Wet Process Hardboard Segment

Insulation Board Subcategory

The following limitations are applicable to plants which produce insulation board:

Pollutant or Pollutant Property	BPT Effluent Limitations Maximum for any one day	 Average of daily values for 30 consecutive days*
	kg/kkg (lb/1,000 lb) of gross production	
BOD	8.13	4.32
TSS	5.69	2.72
pH	Within the range 6.0 to 9.0 at all times	

*Based on 30 observations for the 30 day period.

Wet Process Hardboard Subcategory (S1S Part)

The following limitations are applicable to plants which produce smooth-one-side (S1S) hardboard:

Pollutant or Pollutant Property	BPT Effluent Limitations Maximum for any one day	 Average of daily values for 30 consecutive days*
	kg/kkg (lb/1,000 lb) of gross production)	
BOD	20.5	10.7
TSS	37.3	24.6
pH	Within the range 6.0 to 9.0 at all times	

*Based on 30 observations for the 30-day period.

Wet Process Hardboard Subcategory (S2S Part)

The following limitations are applicable to plants which produce smooth-two-sides hardboard:

Pollutant or Pollutant Property	BPT Effluent Limitations Maximum for any one day	 Average of daily values for 30 consecutive days*
	kg/kkg (lb/1,000 lb) of gross production)	
BOD	32.9	21.4
TSS	54.2	37.1
pH	Within the range 6.0 to 9.0 at all times	

*Based on 30 observations for the 30-day period.

The maximum average of daily values for any thirty consecutive day period should not exceed the 30 day effluent limitations shown above. As shown in the tables above, the 30-day effluent limitations are based on 30 observations for the 30-day period. The maximum for any one day should not exceed the daily maximum effluent limitations as shown above. The limitations shown above for the insulation board and wet process hardboard subcategories are in kilograms of pollutant per metric ton of gross production (pounds of pollutant per 1,000 pounds of gross production). Gross production is defined as the air dry weight of hardboard or insulation board following formation of the wet mat prior to trimming and finishing operations.

ENGINEERING ASPECTS OF CONTROL TECHNOLOGY APPLICATION

The specific level of technology defined as BPT is practicable because many plants in the wood preserving and insulation board/wet process hardboard segments of the timber products industry already practice it, and achieve effluent levels equal to or below those specified in the BPT effluent limitations. For the wood preserving segment, no plants were identified which were not meeting existing BPT limitations. For the insulation board/wet process hardboard segment, eleven of fourteen direct dischargers currently meet effluent levels proposed herein as BPT limitations. For this segment, BPT technology and effluent levels are based upon treatment systems currently in place as described by a two to three year data base of daily effluent monitoring data provided by the plants themselves.

TREATMENT VARIABILITY ESTIMATES

BPT effluent limitations guidelines for the insulation board/wet process hardboard segment of the timber industry were calculated by multiplying the long term average performance of the BPT exemplary plants by daily and 30-day performance variability factors for the exemplary BPT plants. The derivation of the BPT numerical limitations is presented in Table VIII-1. For example, in Table VIII-1 the daily variability factor for insulation board BOD is 3.92, and the long-term average is 2.07. Therefore, the BPT numerical limitation for any one day is the product,

$$(3.92)(2.07) = 8.13*$$

Similarly, the monthly variability factor from Table VIII-1 for insulation board BOD is 2.08, so the monthly numerical limitation for the average of thirty daily measurements is the product of this variability factor and the long-term mean:

$$(2.08)(2.07) = 4.32*$$

Daily variability factors were calculated using nonparametric estimates of the 99th percentile. These estimates were based on the extended (two to three year) data base available for each exemplary plant. The nonparametric estimation is a standard statistical technique that is fully documented in Appendix G, TREATMENT VARIABILITY ESTIMATES.

Thirty-day variabilities were calculated using a statistical model which accounts for the effects of seasonality and

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*The products of multiplying the variability factors by the long term average treated effluent loads may vary slightly from the BCT numerical limitations shown in Table VIII-1 due to rounding of the variability factors and the long term averages.

Table VIII-1. BPT Numerical Limitations

	Daily Variability Factors		30-Day Variability Factors		Long-Term Average Treated Effluent Waste Loads kg/kkg (lb/1000 lb)		BPT Numerical Limitations			
							Maximum For Any One Day kg/kkg (lb/1000 lb)		Average of Thirty Daily Measurements kg/kkg (lb/1000 lb)	
Subcategory	BOD5	TSS	BOD5	TSS	BOD5	TSS	BOD5	TSS	BOD5	TSS
Insulation Board	3.92	4.34	2.08	2.08	2.07	1.31	8.13	5.69	4.32	2.72
Wet-Process Hardboard										
S1S	4.61	3.59	2.40	2.37	4.45	10.4	20.5	37.3	10.7	24.6
S2S	3.67	2.77	2.39	1.90	8.97	19.6	32.9	54.2	21.4	37.1

Note: The products of multiplying the variability factors by the long-term average treated effluent loads may vary slightly from the BPT numerical limitations shown above due to rounding of the variability factors and long-term averages.

autocorrelation. This model is used to estimate the 99th percentile of the 30-day monthly averages, using the two to three year data base. Complete details of the statistical methodology used by the Agency in calculating daily and 30-day variability factors for BPT exemplary plants are contained in Appendix G, STATISTICAL METHODOLOGY FOR DETERMINING PERFORMANCE VARIABILITY OF TREATMENT SYSTEMS.

COST AND EFFLUENT REDUCTION BENEFITS-INSULATION BOARD/WET PROCESS HARDBOARD

EPA expects that the total capital investment necessary to upgrade the treatment systems of the three direct dischargers not achieving BPT effluent limitations will be $9.6 million. Operation and maintenance costs for all of these plants will increase by $3.7 million per year. Achievement of proposed BPT effluent limitations will remove approximately 2.4 million pounds per year of conventional pollutants (BOD and TSS).

NONWATER QUALITY ENVIRONMENTAL IMPACT

The primary nonwater quality impact of the BPT limitations is the waste sludge generated in the candidate treatment systems and the increased burden of the land to accept the disposal of this sludge.

In the insulation board/wet process hardboard segment of the industry, large volumes of waste sludge are generated in biological wastewater treatment systems. An estimated 500,000 cubic yards per year of such sludge is currently generated by the 26 plants in the insulation board/wet process hardboard segment. The estimated incremental increase in sludge production as a result of compliance with BPT limitations as plants upgrade their facilities is expected to be only 34,000 cubic yards per year, or about 6 percent of the total amount of sludge currently generated. Limited data from the preliminary results of a current timber industry study of Best Management Practices (BMP) suggest that significant quantities of toxic materials are not present in insulation board and hardboard sludges, and they appear to be amenable to disposal in a normal sanitary landfill.

Waste sludges from wood preserving treatment systems, although small in volume, have been shown to contain significant quantities of toxic pollutants. These sludges need special consideration insofar as land disposal is concerned.

It was not within the scope of this rulemaking to define whether waste materials from the timber products industry are to be considered hazardous according to recently promulgated Resource Conservation and Recovery Act (RCRA) regulations. Consequently, no efforts were made to fully characterize the sludge produced as a result of wastewater treatment. No sludge samples were collected during the verification sampling programs. Limited information is available, however, from the data collection portfolios, from interviews with plant personnel, and from preliminary results of a current timber industry Best Management Practice (BMP) study to estimate the quantities of sludge generated by the various candidate treatment technologies.

To date, no adverse impacts upon air quality have been identified which would restrict the adoption of any of the BPT candidate treatment technologies.

At some plants spray evaporation or cooling tower evaporation of wood preserving wastewater is used to achieve no discharge. Because the wastewater being evaporated contains volatile organic compounds there could be drift losses caused by wind.

Further, volatile organic compounds can also be stripped from wastewater by aeration, such as in activated sludge units or aerated lagoons. However, in neither case has any adverse air quality impacts been identified.

Energy Requirements

There are no additional energy requirements for the insulation board subcategory as none of the insulation board plants will be required to construct additional pollution control facilities to comply with BPT.

The current total annual energy consumption of the wet process hardboard subcategory is about 6,050,000 megawatt-hours, equivalent to about 9,961,000 barrels of oil. This energy is used not only for production processes, but also to operate in-place wastewater treatment systems.
To attain BPT, the annual energy requirements for the hardboard subcategory will increase by about 30,000 megawatt-hours, or about 49,000 barrels of oil. This additional energy requirement, which is only 0.5 percent of the current total energy consumption, is for the operation of additional pollution control equipment.

GUIDANCE TO NPDES PERMITTING PERSONNEL

Application of Insulation Board/Wet Process Hardboard BPT Effluent Limitations

1. If a plant has production in more than one subcategory, or production in both parts of a subcategory, the allowable discharge (mass) should be prorated on the percentage of the total annual production, divided by the discharging days per year, for each subcategory or part.

2. The production figure recommended for calculating these limitations is the daily average gross production of the maximum 30 consecutive days. Gross production is defined as the air dry weight of hardboard or insulation board

following formation of the wet mat prior to trimming and finishing operations.

3. Daily and 30-day effluent limitations have been derived using statistical estimates of the 99th percentile, i.e., the highest value which will not be exceeded 99 percent of the time. Conversely, large biological treatment systems can be statistically expected to violate the limitations about one percent of the time in normal operation. Enforcement personnel should consider this fact before taking enforcement action against individual plants.

SECTION IX

BEST CONVENTIONAL POLLUTANT CONTROL TECHNOLOGY

GENERAL

Section 301(b)(2)(E) of The Act requires that there be achieved, not later than July 1, 1984, effluent limitations for categories and classes of point sources, other than publicly-owned treatment works, that require the application of the best conventional pollutant control technology (BCT) for control of conventional pollutants as identified in Section 304(a)(4). The pollutants that have been defined as conventional by the Agency, at this time, are biochemical oxygen demand, suspended solids, fecal coliform, oil and grease, and pH. BAT will remain in force where toxic pollutants are present at levels where treatment and control options are available to effect reductions.

BCT requires that limitations for conventional pollutants be assessed in light of a cost reasonableness test. This cost reasonableness test is defined and described in BEST CONVENTIONAL POLLUTANT CONTROL TECHNOLOGY, 44 FR 50732, August 29, 1979. The methodology specified in the Federal Register notice for determining BCT applies when both BPT and BAT regulations for an industry are in force. The legislative language clearly indicates that final BCT effluent limitations cannot be more stringent than BAT or less stringent than BPT.

BPT and BAT regulations were not in force for either the insulation board or wet process hardboard subcategories of the timber products industry when the Act was amended in 1977. BPT and BAT regulations for the hardboard subcategory, published in 1974, were withdrawn in December 1976. Insulation board regulations, proposed in 1974, were never promulgated.

BCT limitations for the hardboard subcategory were determined from a comparison of the incremental annualized costs and incremental annualized reductions of conventional pollutants above and beyond the level of control identified as BPT.

WOOD PRESERVING SEGMENT

BCT limitations are not promulgated in this rulemaking for the wood preserving segment of the industry. The Agency reasoned that BCT limitations are not appropriate for wood preserving plants because wastewaters from each of the wood preserving subcategories contain significant amounts of toxic pollutants and because technologies for reducing toxic pollutant levels cannot be separated from technology for reducing conventional pollutant levels. No direct dischargers have been identified in the Wood Preserving-Waterborne or Nonpressure and the Wood Preserving-Boulton subcategories. Previously promulgated BAT Limitations for these subcategories require no discharge of process wastewater pollutants. These BAT limitations are being continued by this rulemaking. Only one direct discharger was identified in the Wood Preserving-Steam subcategory. Existing BAT limitations for this subcategory are being withdrawn by the Agency, because national effluent limitations are inappropriate for one plant.

INSULATION BOARD/WET PROCESS HARDBOARD SEGMENT

Upon thorough review and evaluation of the treatment systems of each direct discharging plant in this segment (previously discussed in Section VII, CONTROL AND TREATMENT TECHNOLOGY, AND Section VIII, BEST PRACTICABLE CONTROL TECHNOLOGY) the Agency selected a treatment system representative of conventional pollutant removal equal to or above and beyond that being achieved by the BPT technology, identified in Section VIII, for each subcategory. The Agency concluded that BCT limitations for the insulation board subcategory should be equal to BPT limitations. The reasons for this action are that there is no in-place treatment system in the subcategory which provides both increased pollutant removal above the BPT system and is applicable to all plants in the subcategory. The BPT/BCT treatment system is based upon in-place technology at Plant 537. For the wet process hardboard subcategory, the BCT limitations in the S1S part are based on the performance of Plant 931 and Plant 980 in the S2S part.

The test of cost reasonableness was then applied to determine whether or not the cost per pound of additional conventional pollutants (BOD and TSS) removed using these technologies were equal to or less than the $1.15/lb figure specified as reasonable for a POTW by the BCT methodology. This $1.15/lb figure is based on the maximum 30-day average pollutant load which could be discharged as calculated using the methodology presented in Appendix G.

BCT technology passed the test of reasonableness for each subcategory in this segment. Incremental costs per pound of additional conventional pollutants removed ranged from no cost for the insulation board subcategory (BCT technology for this subcategory is the same as BPT technology), to a maximum of $0.754/lb for the S1S part of the wet process hardboard subcategory, and a maximum of $0.593/lb for the S2S part.

BEST CONVENTIONAL CONTROL TECHNOLOGY (BCT)

Wood Preserving Segment

BCT limitations are not promulgated in this rulemaking for the wood preserving segment for reasons described earlier in this section.

Insulation Board/Wet Process Hardboard Segment

Insulation Board Subcategory-Section VIII, BEST PRACTICABLE CONTROL TECHNOLOGY CURRENTLY AVAILABLE, contains a detailed discussion of each treatment system in the subcategory and also details the specific engineering and design criteria for the insulation board BPT/BCT treatment system. The BPT/BCT treatment system is based upon in place technology at Plant 537. This technology consists of primary clarification, with recycle of primary sludge, extended aeration, secondary clarification, also with recycle of secondary sludge, recycle of a portion of the treated wastewater, and discharge of the remainder.

Wet Process Hardboard Subcategory - S1S Part-Technology selected as representative of BCT technology for the S1S part of the wet process hardboard subcategory is based on in-place technology at Plant 931. Plant 931, which produces all S1S hardboard, constructed new treatment facilities which became operational during the last quarter of 1976. This treatment system consists of two parallel pairs of aerated lagoons operated in series, followed by three settling lagoons operated in parallel. The settling lagoons discharge to navigable waters. This system has a very long detention time resulting in the best performance in terms of conventional pollutants discharged of any system relying primarily on end-of-pipe biological treatment which is applicable to all S1S hardboard plants. Performance data over a three-year period for Plant 931 indicate that the treatment system is performing exceptionally well, with long term treated effluent loads of 0.922 kg/kkg (lb/1000 lb) for BOD and 3.01 kg/kkg (lb/1000 lb) for TSS. The BCT limitations for the S1S part of this subcategory were derived by multiplying the long term average performance of Plant 931 by the daily and 30-day variability factors for Plant 931 documented later in this section. Specific engineering and design criteria for this BCT system include:

Nutrient Addition to Maintain C:N:P at	100:5:1
Aerated Lagoons	
Detention Time	0.0049 days/lb BOD removed
Aeration Capacity	0.04 HP/lb BOD removed
Settling Lagoons	
Detention Time	15.7 days

Wet Process Hardboard Subcategory - S2S Part-Technology selected as representative of BCT technology for the S2S part of the wet process hardboard subcategory is based on in-place treatment at Plant 980. This system includes equalization in an aerated basin, primary settling, an activated sludge system including secondary clarification, followed by an aerated lagoon system and facultative settling lagoons for additional pollutant removal. Performance data over a four-year period for Plant 980 indicate that the treatment system is discharging after treatment 3.61 kg/kkg (lb/1000 lb) for BOD and 5.02 kg/kkg (lb/1000 lb) for TSS. The BCT limitations for this subcategory were derived by multiplying the long term average performance of Plant 980 by the daily and 30-day variability factors for Plant 980 documented later in this section. Specific engineering and design criteria for this BCT system include:

Primary Clarifier Overflow Rate	400 gpd/sq ft
Nutrient Addition to Maintain C:N:P at	100:5:1
Activated Sludge System	
Detention Time	0.000053 days/lb BOD removed
Aeration	0.029 HP/lb BOD removed
Secondary Clarifier Overflow Rate:	284 gpd/sq ft
Aerated Lagoon	
Detention Time	0.00028 days/lb BOD removed
Aeration Capacity	0.034 HP/lb BOD removed
Final Settling Lagoon Detention Time	96 hours

BCT LIMITATIONS

The following limitations are applicable to plants which produce insulation board:

Pollutant or Pollutant Property	BCT Effluent Limitations Maximum for any one day	BCT Effluent Limitations Average of daily values for 30 consecutive days*
	kg/kkg (lb/1000 lb) of gross production	
BOD	8.13	4.32
TSS	5.69	2.72
pH	Within the range 6.0 to 9.0 at all times	

*Based on 30 observations for the 30-day period.

The following limitations are applicable to plants which produce smooth-one-side (S1S) hardboard:

Pollutant or Pollutant Property	BCT Effluent Limitations: Maximum for any one day	BCT Effluent Limitations: Average of daily values for 30 consecutive days*
	kg/kkg (lb/1000 lb) of gross production	
BOD	3.83	2.51
TSS	10.9	7.04
pH	Within the range 6.0 to 9.0 at all times	

*Based on 30 observations for the 30-day period.

The following limitations are applicable to plants which produce smooth-two-sides (S2S) hardboard:

Pollutant or Pollutant Property	BCT Effluent Limitations: Maximum for any one day	BCT Effluent Limitations: Average of daily values for 30 consecutive days*
	kg/kkg (lb/1000 lb) of gross production	
BOD	13.2	8.62
TSS	13.9	9.52
pH	Within the range 6.0 to 9.0 at all times	

*Based on 30 observations for the 30 day period

The maximum average of daily values for any thirty consecutive day period should not exceed the 30-day effluent limitations shown above. As shown in the tables above, the 30-day effluent limitations are based on 30 observations for the 30-day period. The maximum for any one day should not exceed the daily maximum effluent limitations as shown above. The limitations shown above for insulation board and wet process hardboard subcategories are in kilograms of pollutant per metric ton of gross production (pounds of pollutant per 1,000 pounds of gross production). Gross production is defined as the air dry weight of hardboard or insulation board following formation of the wet mat prior to trimming and finishing operations.

ENGINEERING ASPECTS OF CONTROL TECHNOLOGY APPLICATION

The technology that achieves a BCT level of control is used by many plants in the insulation board/wet process hardboard segment of the timber industry to achieve effluent levels equal to or below those specified in the BCT effluent limitations. For the insulation board/wet process hardboard segment, seven of the fourteen direct dischargers currently meet BCT effluent limitations presented herein. The BCT effluent levels are based upon treatment systems currently in place and the performance levels are supported by a two to four year data base of daily effluent monitoring data provided by the plants.

TREATMENT VARIABILITY ESTIMATES

BCT effluent guidelines limitations for the insulation board/wet process hardboard segment were calculated by multiplying the long term average treated effluent waste loads of the BCT exemplary plants by the daily and 30-day performance variability factors for the BCT exemplary plants. The derivation of the BCT numerical limitations is presented in Table IX-1. For example, in Table IX-1 the daily variability factor for insulation board BOD is 3.92, and the long term average is 2.07. Therefore, the BCT numerical limitation for any one day is the product,

$$(3.92)(2.07) = 8.11^*$$

Similarly, the monthly variability factor from Table IX-1 for insulation board BOD is 2.08, so the monthly numerical limitation for the average of thirty daily measurements is the product of this variability factor and the long term mean:

$$(2.08)(2.07) = 4.31^*$$

Daily variability factors were calculated using nonparametric estimates of the 99th percentile. These estimates were based on the extended (two to four year) data base available for each exemplary plant. The nonparametric estimation is a standard statistical technique that is explained and discussed in Appendix G, STATISTICAL METHODOLOGY FOR DETERMINING PERFORMANCE VARIABILITY OF TREATMENT SYSTEMS.

Thirty-day variabilities were calculated using a statistical model which accounts for the effects of seasonality and autocorrelation. This model is used to estimate the 99th percentile of the 30-day monthly averages, using the two to four year data base. Complete details of the statistical methodology used by the Agency in calculating daily and 30-day variability factors for BCT exemplary plants are contained in Appendix G.

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*The products of multiplying the variability factors by the long term average treated effluent loads may vary slightly from the BCT numerical limitations shown in Table IX-1 due to rounding of the variability factors and long term averages.

Table IX-1. BCT Numerical Limitations

Subcategory	Daily Variability Factors		30-Day Variability Factors		Long-Term Average Treated Effluent Waste Loads kg/kkg (lb/1000 lb)		BCT Numerical Limitations Maximum For Any One Day kg/kkg (lb/1000 lb)		BCT Numerical Limitations Average of Thirty Daily Measurements kg/kkg (lb/1000 lb)	
	BOD5	TSS	BOD5	TSS	BOD5	TSS	BOD5	TSS	BOD5	TSS
Insulation Board	3.92	4.34	2.08	2.08	2.07	1.31	8.13	5.69	4.32	2.72
Wet-Process Hardboard										
S1S	4.15	3.61	2.72	2.34	0.922	3.01	3.83	10.9	2.51	7.04
S2S	3.67	2.77	2.39	1.90	3.61	5.02	13.2	13.9	8.62	9.52

Note: The products of multiplying the variability factors by the long-term average treated effluent loads may vary slightly from the BCT numerical limitations shown above due to rounding of the variability factors and long-term averages.

COST AND EFFLUENT REDUCTION BENEFITS - INSULATION BOARD/WET PROCESS HARDBOARD

EPA expects that the total capital investment necessary to upgrade the treatment systems of the seven direct dischargers not achieving BCT effluent limitations will be $20.3 million. Operation and maintenance costs for these plants will increase by $6.3 million per year. An incremental increase in capital investment and in the operation and maintenance costs of $11 million and $2.6 million per year, respectively, will be required by the seven direct dischargers to upgrade their treatment systems from BPT to BCT. Achievement of the BCT effluent limitations will remove approximately 13 million pounds per year of conventional pollutants (BOD and TSS). This is an incremental increase of 11 million pounds per year over that removed resulting from the achievement of BPT effluent limitations. EPA believes that these effluent reduction benefits outweigh the associated costs.

NONWATER QUALITY ENVIRONMENTAL IMPACT

The primary nonwater quality impact of the BCT limitations is the waste sludge generated in the candidate treatment systems and the increased burden of the land to accept the disposal of this sludge.

In the insulation board/wet process hardboard segment of the industry, large volumes of waste sludge are generated in biological wastewater treatment systems. An estimated 500,000 cubic yards per year of such sludge is currently generated by the 26 plants in the insulation board/wet process hardboard segment. The estimated incremental increase in sludge production (from current levels of performance to BCT) as a result of compliance is expected to be 83,000 cubic yards per year, or about 16 percent of the total amount of sludge currently generated. This sludge production represents an incremental increase of 49,000 cubic yards per year over that generated as a result of BPT. Limited data from the preliminary results of a current timber industry study of Best Management Practices (BMP) suggest that significant quantities of toxic materials are not present in insulation board and hardboard sludges, and they appear to be amenable to disposal in a normal sanitary landfill.

Energy Requirements

There are no additional energy requirements for the insulation board subcategory as none of the insulation board plants will be required to construct additional pollution control facilities to comply with BCT.

The current total annual energy consumption of the wet process hardboard subcategory is about 6,050,000 megawatt-hours, equivalent to about 9,961,000 barrels of oil. This energy is used not only for production processes, but also to operate in-place wastewater treatment systems.

To comply with BCT, the hardboard subcategory will be required to consume an additional 12,000 megawatt-hours per year, or 20,000 barrels of oil per year, beyond that required to attain BPT. This represents an annual energy requirement of only 0.7 percent of the current total annual energy requirement, which is a 0.2 percent increase beyond the energy required to attain BPT. The additional energy required to attain BCT is for the operation of additional pollution control facilities.

GUIDANCE TO NPDES PERMITTING PERSONNEL

Application of Insulation Board/Wet Process Hardboard BCT Effluent Limitations

1. If a plant has production in more than one subcategory, or production in both parts of a subcategory, the allowable discharge (mass) should be prorated on the percentage of the total annual production, divided by the discharging days per year, for each subcategory or part.

2. The production figure recommended for calculating these limitations is the daily average gross production of the maximum 30 consecutive days. Gross production is defined as the air dry weight of hardboard or insulation board following formation of the wet mat prior to trimming and finishing operations.

3. Daily and 30-day effluent limitations have been derived using statistical estimates of the 99th percentile, i.e., the highest value which will not be exceeded 99 percent of the time. Conversely, large biological treatment systems can be statistically expected to violate the limitations about one percent of the time in normal operation. Enforcement personnel should consider this fact before taking enforcement action against individual plants.

SECTION X

BEST AVAILABLE TECHNOLOGY ECONOMICALLY ACHIEVABLE

GENERAL

Best available technology economically achievable (BAT) is the level of control established for toxic and nonconventional pollutants. BAT effluent limitations which must be achieved by July 1, 1984, are not based on an average of the best performance within an industrial category, but on the very best control and treatment technology employed by a specific point source within the industrial category or subcategory, or by another industry where the control and treatment technology is readily transferable. A specific finding must be made regarding the availability of control measures and practices to eliminate the discharge of toxic and nonconventional pollutants, taking into account the cost of such elimination. BAT may include process changes or internal controls, even when they are not common industry practice. BAT emphasizes internal controls, as well as control or additional treatment techniques employed at the end of the production process.

Consideration is also given to:

1. the age of the equipment and facilities involved;
2. the process employed;
3. the engineering aspects of the application of various types of control techniques;
4. process changes;
5. the cost of achieving the effluent reduction resulting from application of the technology; and,
6. nonwater quality environmental impacts (including energy requirements).

This level of technology considers those plant processes and control technologies which, at the pilot plant, semi-works, and other levels, have demonstrated both technological performances and economic viability at a level sufficient to reasonably justify investment. It is the highest degree of control technology that has been achieved or has been demonstrated to be capable of being designed for plant-scale operation up to and including "no discharge" of process wastewater pollutants. Although economic factors are considered in this development, the level of control is intended to be the top-of-the-line of current technology, subject to limitations imposed by economic and engineering feasibility. There may be some technical risk, however, with respect to performance and certainty of costs. Therefore, some process development and adaptation may be necessary for application of a technology at a specific plant site.

The statutory assessment of BAT "considers" costs, but does not require a balancing of costs against effluent reduction benefits (see Weyerhaeuser v. Costle, 11 ERC 2149 (D.C. Cir. 1978). In developing the proposed BAT, however, EPA has given substantial weight to the reasonableness of costs. The Agency has considered the volume and nature of discharges, the volume and nature of discharges expected after application of BAT, the general environmental effects of the pollutants, and the costs and economic impacts of the required pollution control levels.

Despite this expanded consideration of costs, the primary determinant of BAT is effluent reduction capability. As a result of the Clean Water Act of 1977, the achievement of BAT has become the principal national means of controlling toxic water pollution.

Wood Preserving Segment

EPA has divided the wood preserving segment of the timber industry into three subcategories of plants; plants that treat wood using nonpressure processes or which use waterborne preservatives (inorganic salts), plants that use steam conditioning to prepare wood for preservative impregnation, and plants that use the Boulton process to prepare wood for preservative impregnation. Those portions of the industry preserving with inorganics, and using the Boulton process are subject to a BAT limitation of no discharge of process wastewater pollutants promulgated in 1974.

BAT limitations for the Wood Preserving-Steam subcategory were originally promulgated in 1974. These limitations allowed a discharge of process wastewater, but established controls on COD, total phenols, oil and grease, and pH.

The technical study conducted to support the regulations presented in this document, identified only one plant in the Wood Preserving - Steam subcategory discharging process wastewater directly to the environment.

The Agency conducted an extensive mail survey, contacting about 290 wood preserving plants and received responses from 216. Telephone and personal contacts were also made with Regional EPA offices, State pollution control offices, wood preserving plants and industrial technical trade associations. The purpose of these mail, telephone, and personal contacts was to determine the discharge status, treatment and control practices, and wastewater disposal practices of wood preserving plants.

Almost all wood preserving plants in the steam subcategory have eliminated the direct discharge of process wastewater pollutants, although they were not required to by law, by the application of a variety process controls and wastewater disposal techniques. These techniques and procedures are discussed in detail in Section VII of this document.

The water conservation practice most commonly found is the use of surface condensers rather than barometric condensers. This reduces the amount of wastewater requiring treatment and/or disposal by eliminating the contamination of cooling water. Plants that did not replace barometric condensers almost without exception, recycle their barometric cooling water. Separation of steam condensate and contact process wastewater results in a significant decrease in the amount of process wastewater that must be handled.

Another option available to plants is to dry the wood raw material before going into the treating cylinder. This practice shortens or eliminates the conditioning period in the retort. Retort conditioning may or may not be needed depending on the amount of moisture in the wood at the time it goes into the retort. This method of controlling the amount of wastewater generation is not always available to wood preserving plants, the cost of maintaining inventory and the availability of a dry kiln or untreated wood storage area being the major factors in determining the feasibility of this practice.

A broad range of wastewater treatment and disposal techniques or end-of-pipe technologies are available to plants in this subcategory to achieve no discharge status. As presented in Section II, the most frequent wastewater disposal technique is containment and/or evaporation of wastewater. Evaporation can be assisted by spraying wastewater into the air, the use of heat exchangers, or the application of waste heat.

For the Wood Preserving-Waterborne or Nonpressure and the Wood Preserving-Boulton subcategories, the Agency has decided to retain existing BAT limitations which require no discharge of process wastewater pollutants. All known plants in these subcategories are already in compliance with these limitations and retention of these limitations will insure that none of the identified toxic pollutants present in wastewaters from these subcategories, as described in Sections V, VI and VII of this document, will be discharged to receiving waters.

The single Wood Preserving-Steam subcategory direct discharger is located in southern Alabama - the area of the U.S. with the most intense precipitation, in terms of a 24-hour rainfall event. The plant discharges only when precipitation events are intense and frequent. Evaporative losses from its aeration and holding lagoons are otherwise greater than the volume of process wastewater generated by the wood preserving operations.

The Agency decided that it would not be appropriate to promulgate a national BAT limitation for one direct discharging plant. This plant, located in a State with NPDES authority, will be required to control the discharge of pollutants according to the terms of the permit. The permit issuing office has this document available to assist the permit writer in developing terms when the discharge permit comes up for renewal. Existing BAT limitations for this subcategory will be withdrawn.

Insulation Board/Wet Process Hardboard

EPA has divided this segment into two subcategories. The basis for the subcategorization is differences in the raw waste load due to the process employed, and the products produced. The insulation board industry makes up one subcategory. The wet process hardboard industry, one subcategory, is divided by product produced into two parts, smooth-one-side hardboard (S1S) and smooth-two-sides hardboard (S2S).

The Agency withdrew BAT regulations, as well as BPT and NSPS regulations for the wet process hardboard subcategory in 1976.

Information presented in Sections V and VII of this document indicated that toxic pollutants, as identified by Section 307(a) of the Clean Water Act are not present in treatable amounts in wastewaters from the insulation board/wet process hardboard segment. BOD and TSS are the conventional pollutants found in high amounts.

Because toxic pollutants are not present at treatable levels in raw or treated wastewaters, the Agency has concluded that BAT limitations will not be promulgated for this segment.

Section IX of this document presents BCT limitations for the wet process hardboard/insulation board segment and the rationale for their development.

Barking Subcategory

Effluent guidelines and standards for the Barking subcategory were promulgated in 1974 (39 FR 13942 April 18, 1974). The 1974 rulemaking divided the Barking subcategory into two parts: mechanical barking, a basically dry operation using physical methods, such as blades or abrasive discs, to remove the bark, and hydraulic barking, an operation that uses water applied to the wood under high pressure to separate the bark from the wood.

The 1974 BAT regulations required mechanical barking operations and hydraulic barking operations to meet an effluent limitation requiring no discharge of process wastewater pollutants by 1983.

As part of the current study, the Agency contacted all known operators of hydraulic barking operations, State pollution control agencies, regional EPA offices and equipment manufacturers. The purpose of this survey was to: identify hydraulic barking installations, determine their process wastewater treatment and discharge status, and to determine the progress made by the industry in meeting the BAT implementation date.

Fourteen plants having hydraulic barking installations were identified. Most plants are practicing some degree of recycle of barking water, usually after clarification. The plant that was identified in 1974 as recycling about 80 percent is still at the 80 percent level of recycle, apparently unable to increase on the amount of recycle. The plant estimated that about 200,000 gallons per day of excess water is being discharged to receiving waters from the spray irrigation system.

The timber industry was surveyed to determine the most recent installation of a hydraulic barking facility and also, the possibilities of new installations. The most recent installation occurred in 1969. Information from an equipment manufacturer who supplies the equipment indicated that no recent demand exists for hydraulic barking systems. This statement can be supported by a number of considerations. Energy requirements are substantial for hydraulic barking; 750 to 2000 horsepower motors are required to develop the 1000 to 1500 pounds per square inch water pressures needed; large diameter logs, more easily barked by hydraulic barkers are less available than they were a few years ago; capital investment and maintenance requirements of hydraulic barkers are considerably higher than mechanical barkers; and, environmental control considerations such as the operation and maintenance of a biological treatment system, are more expensive and time consuming than mechanical barkers.

After review and evaluation of the above information, the Agency considered the appropriateness of the existing BAT regulation.

Because of the industry's inability to increase the amount of reuse of treated wastewater and the considerations discussed above, the Agency decided that the existing BAT, no discharge of process wastewater pollutants, for hydraulic barking operations is not appropriate and should be withdrawn.

Veneer Subcategory

BPT regulations for this subcategory promulgated in 1974, required no discharge of process wastewater pollutants for all veneer manufacturing plants, except for those plants that use direct steam conditioning of veneer logs. This exception was allowed to give plants using direct steam conditioning time to modify their operations before the BAT limitation, requiring no discharge of process wastewater pollutants, from all plants, came in force.

Review of current veneer manufacturing process water management practices determined that no known veneer manufacturing plants are discharging directly.

During the screening phase of the current BAT Review study, sampling and analysis determined that toxic pollutants, particularly heavy metals are present in wastewaters generated by veneer manufacturing facilities.

Based on the current status of process water control, and the presence of toxic pollutants in veneer wastewaters, the Agency has determined that the existing BAT limitation of no discharge of process wastewater pollutants should remain in force.

Log Washing Subcategory

BPT for this subcategory allows the discharge of process wastewater pollutants. BAT regulations published in 1974 for this subcategory requires no discharge of process wastewater pollutants.

Review of current practices in the timber industry determined that, at this time, log washing is being practiced by fewer facilities than previously reported. Plants washing logs before further processing are recycling log wash water after settling and coarse screening. The BAT Review study revealed that toxic pollutants are present in log wash water, particularly heavy metals and phenol.

Based on the current status of process water control and the presence of toxic pollutants in log wash waters, the Agency has determined that the existing BAT limitation of no discharge of process wastewater pollutants should remain in force.

SECTION XI

NEW SOURCE PERFORMANCE STANDARDS

GENERAL

The basis for new source performance standards (NSPS) under section 306 of the Act is the best available demonstrated technology (BADT). New plants have the opportunity to design the best and most efficient manufacturing processes and wastewater treatment technologies. Therefore, Congress directed EPA to consider the best demonstrated process changes, in-plant controls, and end-of-pipe treatment technologies which reduce pollution to the maximum extent feasible.

The Agency, upon thorough review and evaluation of each of the candidate treatment technologies discussed in Section VII, CONTROL AND TREATMENT TECHNOLOGY, has selected the no discharge options as the basis for NSPS for all subcategories in the wood preserving and insulation board/wet process hardboard segments of the industry. This no discharge requirement will provide the maximum feasible control for conventional, unconventional, and toxic pollutants and is based on demonstrated performance in each subcategory. Technologies required to eliminate the discharge of process wastewater pollutants for each subcategory are discussed below.

Wood Preserving-Boulton Subcategory

NSPS for this subcategory is no discharge of process wastewater pollutants. The candidate technologies for no discharge are cooling tower evaporation, spray evaporation, or spray irrigation as described in Section VII, CONTROL AND TREATMENT TECHNOLOGY. The BPT and BAT effluent limitations promulgated on April 18, 1974, are no discharge of process wastewater pollutants and all known Boulton plants are currently achieving no discharge.

Cost to new sources in the Wood Preserving - Boulton subcategory for adoption of the technologies identified above are presented in Appendix A of this document.

Wood Preserving-Steam Subcategory

NSPS for the Wood Preserving - Steam subcategory is no discharge of process wastewater pollutants. The candidate technologies for achieving no discharge are spray evaporation or spray irrigation, as described in Section VII. Although plants which utilize the Boulton process for conditioning generally produce enough waste heat to use cooling tower evaporation to achieve no discharge, plants in the Wood Preserving - Steam subcategory do not. Consequently, cooling tower evaporation is not a candidate technology for the Wood Preserving - Steam subcategory.

About ninety percent of all known Wood Preserving - Steam plants are currently achieving no discharge through the application of the technologies identified above or a combination of these technologies and treated effluent recycle.

Costs to new sources in the Wood Preserving - Steam subcategory for adoption of the spray evaporation and spray irrigation technologies are presented in Appendix A.

Insulation Board and Wet Process Hardboard Subcategories

No discharge of process wastewater pollutants was selected as NSPS for the insulation board and wet process hardboard subcategories through the application of spray irrigation technology. There are five plants in the insulation board/wet process hardboard segment which utilize spray irrigation for treatment and/or disposal of process wastewater. This technology has proven successful in this segment of the industry with and without biological treatment preceding spray irrigation as discussed in Section VII.

Although spray irrigation generally requires more land than other technologies, including large biological treatment systems, new sources have the ability to choose locations where there is available land for spray irrigation.

Costs to new sources for adoption of this technology are presented in Appendix A of this document.

SECTION XII

PRETREATMENT STANDARDS

GENERAL

Section 307(b) of the Act requires EPA to promulgate pretreatment standards for existing sources (PSES) to prevent the discharge of pollutants which pass through, interfere with, or are otherwise incompatible with the operation of publicly owned treatment works (POTW). The legislative history of the 1977 Act indicates that pretreatment standards are to be technology-based, analagous to the best available technology for removal of toxic pollutants.

One of the principal objectives of PSES is to ensure parity between the treatment of indirect discharger's and direct discharger's effluent. At a minimum, Congress intended that the pollutant reduction achieved by the combination of pretreatment and treatment at the municipal treatment works would equal the pollutant reduction achieved by a direct discharger applying BAT treatment. Consequently, where the percentage reduction by a POTW of an indirect discharger's toxic effluent is less than the percentage reduction by a comparable direct discharge BAT system, pretreatment is needed. Another objective of PSES is to ensure that toxic pollutants in POTW influents do not contaminate the POTW sludge and thereby limit POTW sludge management alternatives, including the beneficial use of sludges on agricultural lands. The general pretreatment regulations which served as the framework for these pretreatment regulations for the timber products industry, can be found at 40 CFR Part 403.

Pretreatment standards for existing sources must reflect the effluent reduction achievable through the application of the best available pretreatment technology. This includes treatment technology as employed by the industry, as well as in-plant controls considered to be normal practice within the industry.

WOOD PRESERVING

Pretreatment Standards For Existing Sources, PSES

Thirty-nine wood preserving plants discharge to POTW, 29 in the Steam subcategory and 10 in the Boulton subcategory. In 1979, these plants discharged approximately 330,000 gallons per day.

The Agency proposed, on October 31, 1979, to amend the existing PSES for the Wood Preserving-Steam and Boulton subcategories to add a no discharge requirement for pentachlorophenol (PCP). The existing PSES imposed a limitation of 100 mg/l for oil and grease and set limits on the metals copper, chromium and arsenic.

The primary reason for the no discharge of PCP proposal was the Agency's concern that PCP, a toxic pollutant, was passing through

POTW inadequately treated. Data in the Agency's possession, summarized in Table XII-1, demonstrates that at the low influent concentrations typical of a POTW receiving wood preserving wastewater, PCP is not greatly reduced by the POTW treatment processes. This conclusion is buttressed by data recently acquired from a POTW with high concentrations of PCP in its influent which demonstrates significant pass through. (See Table XII-1). Another reason for the Agency's proposed no discharge of PCP standard was that PCP was thought to have a relatively strong affinity for absorption on solid particles. If the absorbability of PCP proved to be the predominant mechanism for its removal in a POTW, accumulation of PCP in the sludge might preclude beneficial uses of such sludge.

A number of commenters critized the proposed no discharge PCP standard on economic and other grounds. Several commenters questioned the practicality of evaporative technology based on potential transfer of toxic pollutants from wastewater to the air. Although neither hard data nor information confirming such transfer was submitted, the Agency has initiated studies to gather additional information regarding this question but none is available for inclusion in this document. However, the results of that study will be considered in future reviews and reevaluations of the effluent guidelines and standards.

The Agency has decided not to promulgate the no discharge PCP standard proposed on October 31, 1979. Although PCP has been determined to pass through POTW, the Agency is troubled by the high (several million dollar) cost associated with achievement of the standard and the projected closure rate of three to five closures out of a total of twenty-four affected plants. Another factor entering into the Agency's decision is that the present oil and grease limitation 100 mg/l effectively ensures control of PCP at the level of 15 mg/l. Still another consideration is that the PCP reduction achieved by the proposed PSES would not be huge. If the amount of PCP discharged by particular wood preserving plant causes some problems, POTW's can establish more stringent controls on PCP discharge in a case-by-case basis.

In the absence of a new PSES for the Wood Preserving-Boulton and -Steam subcategories, the existing PSES will remain in force. This existing standard requires a limitation of 100 mg/l on oil and grease, as well as 5 mg/l for copper, 4 mg/l for chromium and 4 mg/l for arsenic.

The Agency's decision to retain existing PSES will also result in no costs of compliance to the wood preserving segment above and beyond those considered in promulgation of the December 1976 standard, and will therefore not result in any plant closures.

Table XII-1. Summary of Available Data--Pentachlorophenol in POTWs

	PCP Concentration (mg/l)				
POTW	Wood Preserving Plant Discharge to POTW	POTW Influent	Trickling Filter Effluent*	POTW Effluent	Data Source
Picayune, MS	2.8	<0.010	--†	<0.010	ESE, ARL, 1979**
	1.9	<0.010	--	<0.010	
Eugene, OR	Not analyzed	0.0041	--	0.0033	Buhler, 1973††
Salem, OR	Not analyzed	0.0046	--	0.0044	Buhler, 1973
Corvallis, OR	Not analyzed	0.0014	--	0.0010	Buhler, 1973
Macon, GA	14.0	0.100	--	<0.001	AWPI, 1979***
Augusta, GA	0.90	0.060	--	0.050	AWPI, 1979
	9.00	<0.001	--	0.035	
Seattle, WA	0.160	<0.001	--	<0.001	AWPI, 1979
Stockton, CA	1.2	0.020	0.072	<0.010	ESE, ARL, 1980
	15.0	<0.010	0.040	<0.010	
Stockton, CA	Not analyzed	0.42	0.16	0.15	Burns & Roe, EPA, 1980†††
	Not analyzed	0.24	0.17	0.17	
	Not analyzed	0.18	0.14	0.16	
	Not analyzed	0.64	0.44	0.27	
	Not analyzed	0.48	0.29	0.10	
	Not analyzed	0.10	0.12	0.11	

*Trickling filter effluent receives further treatment consisting of secondary sedimentation, nitrification in polishing pond system, chlorination for disinfection, and dechlorination prior to discharge to receiving water.

†Hyphen means not applicable.

**Samples collected by ESE and analyzed by Analytical Research Laboratory (ARL).

††Buhler, Rasmusson, and Nakaue, "Occurrence of Hexachlorophene and Pentachlorophenol in Sewage and Water," Environmental Science and Technology, October 1973.

***Samples collected by AWPI member plants and analyzed by the Mississippi State University Forest Products Utilization Laboratory.

†††Samples collected by Burns & Roe and analyzed by EPA Region VII.

Pretreatment Standards For New Sources, PSNS

Steam and Boulton Subcategories. Section 307(c) of the Act requires EPA to promulgate pretreatment standards for new sources (PSNS) at the same time that it promulgates NSPS. As with PSES, PSNS is intended to prevent the discharge of any pollutant which passes through or interferes with the operation of a POTW, or which limits beneficial uses of POTW sludge. New sources, however, have the opportunity to incorporate the best available demonstrated technologies including process changes, in-plant controls, and end-of-pipe treatment technologies. New sources also have the opportunity to select the location of new plant sites in such a way as to allow the installation of land intensive technologies.

The Agency proposed a PSNS for the Steam and Boulton subcategories which required no discharge of process wastewater pollutants. The rationale for this proposed standard was something like the Agency's rationale for PSES: (1) such a standard would prevent the wood preserving wastewater pollutants, PCP and heavy metals, from passing through POTW inadequately treated, (2) there existed a demonstrated and widely utilized technology in the wood preserving segment for achieving zero discharge.

After careful consideration of the comments, the Agency has decided to promulgate the no discharge PSNS as proposed. The chief factor differentiating the Agency's PSNS decision from its PSES decision is economic.

A new source has opportunities, not always available to an existing source, to install equipment, such as surface condensers, that do not result in the generation of contaminated cooling water. A new source has the opportunity, if spray evaporation or spray irrigation is selected as the wastewater disposal technique, to include land requirements in the decision making process for site selection. These wastewater treatment and disposal options are discussed in detail in Section VII - CONTROL AND TREATMENT TECHNOLOGY.

As a result of this greater flexibility, new sources are often better able to withstand the cost of pollution control technology than existing sources. The Agency's economic impact analysis of the wood preserving industry concludes that the cost of designing and installing the proper systems needed to achieve no discharge status would not hinder the addition of new capacity. Another consideration is the need to ensure that there is no bias in favor of a new source choosing indirect discharge over direct discharge because of different treatment requirements. Inasmuch as new source direct dischargers in the Boulton and steam subcategories would be required to achieve no discharge, the pretreatment limits should ensure a similiar level of treatment for pollutants which are not adequately treated by POTW.

<u>Wood Preserving-Water Borne or Nonpressure Subcategory</u>-- No discharge of process wastewater pollutants was selected as PSNS because technology for achieving no discharge is widely practiced in this subcategory. All known plants in the Wood Preserving - Water Borne or Nonpressure subcategory currently apply no discharge technology consisting of process wastewater collection for makeup of future preservative treating solutions.

Costs associated with the process wastewater collection and recycle technology are minimal, and this technology is easily incorporated into the plant design. The no discharge PSNS corresponds with BPT and BAT effluent limitations which were promulgated on April 18, 1974.

WET PROCESS HARDBOARD/INSULATION BOARD

<u>Pretreatment Standards For New and Existing Sources</u>

The conventional pollutants present in effluents from hardboard and insulation board producing facilities are treatable by biological treatment as practiced by publicly owned treatment works. Seven plants in the wet process hardboard/insulation board segment currently discharge to POTW. The Agency is not aware of any incidents where discharge from one of these plants has caused an upset, or has been otherwise incompatible with the operation of a POTW.

The Agency is promulgating pretreatment standards for new and existing sources in the wet process hardboard and the insulation board subcategories that do not establish numerical limitations on the discharge of specific pollutants but do require conformance with the general requirements of 40 CFR 403.

SECTION XIII

ACKNOWLEDGEMENTS

Mr. Richard E. Williams served as the EPA Effluent Guidelines Division Project Officer during the development of the effluent limitations guidelines and the preparation of this document. His overall guidance and coordination of the technical information was indispensible to the promulgation of this regulation.

The direction, assistance and cooperation of EPA personnel is greatly appreciated. In particular, Mr. John E. Riley, Chief, Wood and Fiber Products Branch made major contributions. Mr. Steven Schatzow, formerly Associate General Counsel, Mr. Michael Murchison and Ms. Susan Lepow of the Office of General Counsel provided positive contributions in molding the technical/legal considerations into a cohesive package.

The technical study supporting the regulation was conducted by Environmental Science and Engineering, Inc. (ESE), Gainesville, Florida. The Project Directors were Mr. John D. Crane, P.E. and Mr. Bevin A. Beaudet, P.E. Mr. Beaudet and Mr. Russell V. Bowen functioned as Project Managers during the rulemaking development program. Analytical works by ESE was managed by Mr. Stuart Whitlock and Mr. Charles Westerman. ESE staff involved in the technical study and document preparation included Ms. Patricia Markey, Ms. Jacqueline Betz, Mr. Mark Mangone, Mr. William Beckwith, Ms. Patricia McGhee, Ms Joanne Demme, Ms. Kathy Fariella, Ms. Pamela Dickinson, and Ms. Kathleen Hudek.

The contribution of Dr. Warren S. Thompson, Director, Forest Products Utilization Laboratory, Mississippi State University is greatly appreciated. Dr. Thompson served as a consultant to ESE. Dr. James T. McClave, INFO-TECH, INC., Gainesville, Florida assisted in the statistical analysis of wet process hardboard and insulation board effluent data.

The Edward C. Jordan Company, Portland, Maine and Ryckman, Edgerly, Tomlinson and Associates, St. Louis, Missouri also provided information, field sampling and analytical efforts during the project.

Cooperation and assistance provided by timber industry members through their companies and associations is greatly appreciated. Appreciation is expressed to the American Hardboard Products Association (AHA), the American Wood Preservers Institute, the American Wood Preservers Association, and the National Forest Products Association. Individuals who deserve mention are Mr. C. Curtis Peterson, AHA, Mr. C. C. Stewart, Process Design Associates, Mr. Wayne Johanson, Superwood Corporation, Mr. Thomas Marr, KOPPERS Co., Mr. Charles Best, J. H. Baxter and Sons, and Mr. Charles Burdell, ITT Rayonier, Inc.

Dale Ruhter, Harold Lester and Susan Green, Office of Analysis and Evaluation, Mark Segal and Alexandar Tarney, Monitoring and Data Support Division, and Sam Napolitano, Office of Planning and Evaluation are recognized for their assistance.

Mr. Gregory Aveni, Co-op student from Drexel University, and Mr. Jim Morrison, Co-op student from George Mason University, provided invaluable technical and editorial assistance. The performance of Ms. Carol Swann, of the Guidelines Implementation Branch, Effluent Guidelines Division is greatly appreciated. Her efforts, along with the other members of the Word Processing staff who finalized this document for publication are recognized.

SECTION XIV

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SECTION XV

GLOSSARY OF TERMS AND ABBREVIATIONS

ACA--Ammonical Copper Sulfate.

"Act"--The Federal Water Pollution Control Act Amendments of 1977.

Activated Sludge--Sludge floc produced in raw or settled wastewater by the growth of zoogleal bacteria and other organisms in the presence of dissolved oxygen and accumulated in sufficient concentration by returning floc previously formed.

Activated Sludge Process--A biological wastewater treatment process in which a mixture of wastewater and activated sludge is agitated and aerated. The activated sludge is subsequently separated from the treated wastewater (mixed liquor) by sedimentation and wasted or returned to the process as needed.

Additive--Any material introduced prior to the final consolidation of a board to improve some property of the final board or to achieve a desired effect in combination with another additive. Additives include binders and other materials. Sometimes a specific additive may perform more than one function. Fillers and preservatives are included under this term.

Aerated Lagoon--A natural or artificial wastewater treatment pond in which mechanical or diffused-air aeration is used to supplement the oxygen supply.

Aerobic--Condition in which free elemental oxygen is present.

Air-drying--Drying lumber prior to preservative impregnation by placing the lumber in stacks open to the atmosphere, in such a way as to allow good circulation of air.

Air-felting--Term applied to the forming of a fiberboard from an air suspension of wood or other cellulose fiber and to the arrangement of such fibers into a mat for board.

Anaerobic--Condition in which free elemental oxygen is absent.

Asplund Method--An attrition mill which combines the steaming and defibering in one unit in a continuous operation.

Attrition Mill--Machine which produces particles by forcing coarse material, shavings, or pieces of wood between a stationary and a rotating disk, fitted with slotted or grooved segments.

Back--The side reverse to the face of a panel, or the poorer side of a panel in any grade of plywood that has a face and back.

Bagasse--The solid matter remaining after extraction of liquids from sugar cane.

Barker--Machines which remove bark from logs. Barkers may be wet or dry, depending on whether or not water is used in the operation. There are several types of barkers including drum barkers, ring barkers, bag barkers, hydraulic barkers, and cutterhead barkers. With the exception of the hydraulic barker, all use abrasion or scraping actions to remove bark. Hydraulic barkers utilize high pressure streams of water.

Biological Wastewater Treatment--Forms of wastewater treatment in which bacterial or biochemical action is intensified to stabilize, oxidize, and nitrify the unstable organic matter present. Intermittent sand filters, contact beds, trickling filters, aeration ponds, and activated sludge processes are examples.

Blowdown--The removal of a portion of any process flow to maintain the constituents of the flow at desired levels.

BOD5 or BOD--Biochemical Oxygen Demand is a measure of biological decomposition of organic matter in a water sample. It is determined by measuring the oxygen required by microorganisms to oxidize the organic contaminants of a water sample under standard laboratory conditions. The standard conditions include incubation for five days at 20°C.

BOD7--A modification of the BOD test in which incubation is maintained for seven days. The standard test in Sweden.

Boultonizing--A conditioning process in which unseasoned wood is heated in an oily preservative under a partial vacuum to reduce its moisture content prior to injection of the preservative.

Casein--A derivative of skimmed milk used in making glue.

Caul--A steel plate or screen on which the formed mat is placed for transfer to the press, and on which the mat rests during the pressing process.

CCA-type Preservative--Any one of several inorganic salt formulations based on salts of copper, chromium, and arsenic.

Chipper--A machine which reduces logs or wood scraps to chips.

Clarifier--A unit of which the primary purpose is to reduce the amount of suspended matter in a liquid.

Closed Steaming--A method of steaming in which the steam required is generated in the retort by passing boiler steam through heating coils that are covered with water. The water used for this purpose is recycled.

cm--Centimeters.

COD--Chemical Oxygen Demand. Its determination provides a measure of the oxygen demand equivalent to that portion of matter in a sample which is susceptible to oxidation by a strong chemical oxidant.

Coil Condensate--The condensate formed in steam lines and heating coils.

Cold Pressing--See Pressing.

Composite Board--Any combination of different types of board, either with another type board or with another sheet material. The composite board may be laminated in a separate operation or at the same time as the board is pressed. Examples of composite boards include veneer-faced particle board, hardboard-faced insulation board and particle board, and metal-faced hardboard.

Conditioning--The practice of heating logs prior to cutting in order to improve the cutting properties of the wood and in some cases to facilitate debarking.

Conventional pollutants--Those pollutants identified by the Administrator of EPA as conventional pollutants under authorization of Section 304(a)(4) of the 1977 Clean Water Act. Conventional pollutants include biochemical oxygen demand, suspended solids, oil and grease, fecal coliform, and pH.

Cooling Pond--A water reservoir equipped with spray aeration equipment from which cooling water is drawn and to which it is returned.

Creosote--A complex mixture of organic materials obtained as a by-product from coking and petroleum refining operations that is used as a wood preservative.

cu m--Cubic meters.

cu ft--Cubic feet.

Curing--The physical-chemical change that takes place either to thermosetting synthetic resins (polymerization) in the hot presses or to drying oils (oxidation) used for oil-treating board. The treatment to produce that change.

Cutterhead Barker--See Barker.

Cylinder Condensate--Steam condensate that forms on the walls of the retort during steaming operations.

CZC--Chromated Zinc Chloride.

Data Collection Portfolio--Information solicited from industry under the authority of section 308 of the Act.

Decker, Deckering--A method of controlling pulp consistency in hardboard production.

Defiberization--The reduction of wood materials to fibers.

Digester--(1) Device for conditioning chips using high pressure steam, (2) A tank in which biological decomposition (digestion) of the organic matter in sludge takes place.

Disc Pulpers--Machines which produce pulp or fiber through the shredding action of rotating and stationary discs.

DO--Dissolved Oxygen is a measure of the amount of free oxygen in a water sample. It is dependent on the physical, chemical, and biochemical activities of the water sample.

Dry-felting--See Air-felting.

Dry Process--See Air-felting.

Durability--As applied to wood, its lasting qualities or permanence in service with particular reference to decay. May be related directly to an exposure condition.

FCAP--Fluor-chrom-arsenate-phenol. An inorganic waterborne wood preservative.

Fiber (Fibre)--The slender thread-like elements of wood or similar cellulosic material, which, when separated by chemical and/or mechanical means, as in pulping, can be formed into fiberboard.

Fiberboard--A sheet material manufactured from fibers of wood or other ligno-cellulosic materials with the primary bond deriving from the arrangement of the fibers and their inherent adhesive properties. Bonding agents or other materials may be added during manufacture to increase strength, resistance to moisture, fire, insects or decay, or to improve some other property of the product. Alternative spelling: fibreboard. Synonym: fibre building board.

Fiber Preparation--The reduction of wood to fiber or pulp, utilizing mechanical, thermal, or explosive methods.

Finishing--The final preparation of the product. Finishing may include redrying, trimming, sanding, sorting, molding, and storing, depending on the operation and product desired.

Fire Retardant--A formulation of inorganic salts that imparts fire resistance when injected into wood in high concentrations.

Flocculation--The agglomeration of colloidal and finely divided suspended matter.

Flotation--The raising of suspended matter to the surface of the liquid in a tank as scum--by aeration, the evolution of gas, chemicals, electrolysis, heat, or bacterial decomposition--and the subsequent removal of the scum by skimming.

F:M ratio--The ratio of organic material (food) to mixed liquor (microorganisms) in an aerated sludge aeration basin.

Formation (Forming)--The felting of wood or other cellulose fibers into a mat for fiberboard. Methods employed: air-felting and wet-felting.

FR--Federal Register.

Gal--Gallons.

GPD--Gallons per day.

GPM--Gallons per minute.

Grading--The selection and categorization of different woods as to their suitability for various uses. Criteria for selection include such features of the wood as color, defects, and grain direction.

Hardboard--A compressed fiberboard with a density greater than 0.5 g/cu m (31 lb/cu ft).

Hardboard Press--Machine which completes the reassembly of wood particles and welds them into a tough, durable, grainless board.

Hardwood--Wood from deciduous or broad-leaf trees. Hardwoods include oak, walnut, lavan, elm, cherry, hickory, pecan, maple, birch, gum, cativo, teak, rosewood, and mahogany.

Heat-treated Hardboard--Hardboard that has been subjected to special heat treatment after hot-pressing to increase strength and water resistance.

Holding Ponds--See Impoundment.

Hot Pressing--See Pressing.

Humidification--The seasoning operation to which newly pressed hardboard is subjected to prevent warpage due to excessive dryness.

Impoundment--A pond, lake, tank, basin, or other space, either natural or created in whole or in part by the building of engineering structures, which is used for storage, regulation, and control of water, including wastewater.

Insulation Board--A form of fiberboard having a density less than 0.5 g/cu m (31 lb/cu ft).

In situ--In the original location.

Kjld-N--Kjeldahl Nitrogen: Total organic nitrogen plus ammonia of a sample.

Kl/day-Thousands of liters per day.

Lagoon--A pond containing raw or partially treated wastewater in which aerobic or anaerobic stabilization occurs.

Land Spreading--See Soil Irrigation.

Leaching--Mass transfer of chemicals to water from wood which is in contact with it.

l/day--Liters per day.

Metric ton--One thousand kilograms.

MGD--Million gallons per day.

mg/l--Milligrams per liter (equal to parts per million, ppm, when the specific gravity is one).

ug/l--Micrograms per liter (equal to parts per billion, ppb, when the specific gravity is one).

Mixed Liquor--A mixture of activated sludge and organic matter under going activated sludge treatment in an aeration tank.

ml/l--Milliliters per liter.

mm--Millimeters.

Modified-closed Steaming--A method of steam conditioning in which the condensate formed during open steaming is retained in the retort until sufficient condensate accumulates to cover the coils. The remaining heat required is generated as in closed steaming.

No Discharge--The complete prevention of polluted process wastewater from entering navigable waters.

Nonconventional pollutants--Those pollutants not identified as conventional or toxic pollutants.

Nonpressure Process--A method of treating wood at atomspheric pressure in which the wood is simply soaked in hot or cold preservative.

NPDES--National Pollutant Discharge Elimination System.

Nutrients--The nutrients in contaminated water are routinely analyzed to characterize the food available for microorganisms to promote organic decomposition. They are: Ammonia Nitrogen (NH3), mg/l as N Kjeldahl Nitrogen (ON), mg/l as N Nitrate Nitrogen (NO3), mg/l as N Total Phosphate (TP), mg/l as P Ortho Phosphate (OP), mg/l as P

Oil-Recovery System--Equipment used to reclaim oil from wastewater.

Oily Preservative--Pentachlorophenol-petroleum solutions and creosote in the various forms in which it is used.

Open Steaming--A method of steam conditioning in which live steam is injected into the retort.

PCB--Polychlorinated Biphenyls.

PCP--Pentachlorophenol.

Pearl Benson Index--A measure of color-producing substances.

Pentachlorophenol--A chlorinated phenol with the formula Cl_5C_6OH and formula weight of 266.35 that is used as a wood preservative. Commercial grades of this chemical are usually adulterated with tetrachlorophenol to improve its solubility.

pH--a measure of the acidity or alkalinity of a water sample. It is equal to the negative log of the hydrogen ion concentration.

Phenol--The simplest aromatic alcohol (C_6H_5OH).

Phenolic Compounds--A wide range of organic compounds with one or more hydroxyl groups attached to the aromatic ring.

Point Source--A discrete source of pollution.

POTW--Publicly owned treatment works.

Pressure Process--A process in which wood preservatives or fire retardants are forced into wood using air or hydrostatic pressure.

Pretreatment--Any wastewater treatment processes used to partially reduce pollution load before the wastewater is delivered into a treatment facility. Usually consists of removal of coarse solids by screening or other means.

Primary Treatment--The first major treatment in a wastewater treatment works. In the classical sense, it normally consists of clarification. As used in this document, it generally refers to treatment steps preceding biological treatment.

Process Wastewater--Any water, which during manufacturing or processing, comes into direct contact with or results from the production or use of any raw material, intermediate product, finished product, by-product, or waste product.

psi--Pounds per square inch.

PVA--Polyvinyl alcohol. Binding agent applied to surface of insulation board.

PVAC--Polyvinyl acetate. Binding agent applied to surface of insulation board.

Radio Frequency Heat--Heat generated by the application of an alternating electric current, oscillating in the radio frequency range, to a dielectric material. In recent years the method has been used to cure synthetic resin glues.

Resin--Secretions of saps of certain plants or trees. It is an oxidation or polymerization product of the terpenes.

Retort--A steel vessel in which wood products are pressure impregnated with chemicals that protect the wood from biological deterioration or that impart fire resistance. Also called treating cylinder.

Roundwood--Wood that is still in the form of a log, i.e., round.

RWL--Raw Waste Load. Pollutants contained in untreated wastewater.

S1S Hardboard--Hardboard finished so as to be smooth on one side.

S2S Hardboard--Hardboard finished so as to be smooth on both sides.

Secondary Treatment--The second major step in a waste treatment system.

Sedimentation Tank--A basin or tank in which water or wastewater containing settleable solids is retained to remove by gravity a part of the suspended matter.

Settling Ponds--An impoundment for the settling out of settleable solids.

Sludge--The accumulated solids separated from liquids, such as water or wastewater, during processing.

Softwood--Wood from evergreen or needle-bearing trees.

Soil Irrigation--A method of land disposal in which wastewater is applied to a prepared field. Also referred to as soil percolation.

Solids--Various types of solids are commonly determined on water samples. These types of solids are:

Total Solids (TS)--The material left after evaporation and drying a sample at 103°-105°C.

Suspended Solids (SS)--The material removed from a sample filtered through a standard glass fiber filter. Then it is dried at 103°-105°C. Total Suspended Solids (TSS)--Same as Suspended Solids. Dissolved Solids (DS)--The difference between the total and suspended solids. Volatile Solids (VS)--The material which is lost when the sample is heated to 550°C. Settleable Solids (TSS)--The material which settles in an Immhoff cone in one hour.

Spray Evaporation--A method of wastewater disposal in which the water in a holding lagoon is sprayed into the air to expedite evaporation.

Spray Irrigation--A method of disposing of some organic wastewaters by spraying them on land, usually from pipes equipped with spray nozzles. See Soil Irrigation.

sq m--Square meter.

Steam Conditioning--A conditioning method in which unseasoned wood is subjected to an atmosphere of steam at 120°C (249°F) to reduce its moisture content and improve its permeability preparatory to preservative treatment.

Steaming--Treating wood material with steam to prepare it for preservative impregnation.

Sump--(1) A tank or pit that receives drainage and stores it temporarily, and from which the drainage is pumped or ejected; (2) A tank or pit that receives liquids.

Synthetic Resin (Thermosetting)--Artificial resin used in board manufacture as a binder. A combination of chemicals which can be polymerized, e.g., by the application of heat, into a compound which is used to produce the bond or improve the bond in a fiberboard or particle board. Types usually used in board manufacture are phenol formaldehyde, urea formaldehyde, or melamine formaldehyde.

Tempered Hardboard--Hardboard that has been specially treated in manufacture to improve its physical properties considerably. Includes, for example, oil-tempered hardboard. Synonym: superhardboard.

Tertiary Treatment--The third major step in a waste treatment facility. As used in this document, the term refers to treatment processes following biological treatment.

Thermal Conductivity--The quantity of heat which flows per unit time across unit area of the subsurface of unit thickness when the temperature of the faces differs by one degree.

Thermosetting--Adhesives which, when cured under heat or pressure, "set" or harden to form bonds of great tenacity and strength. Subsequent heating in no way softens the bonding matrix.

TOC--Total Organic Carbon is a measure of the organic contamination of a water sample. It has an empirical relationship with the biochemical and chemical oxygen demands.

T-PO4-P--Total phosphate as phosphorus. See Nutrients.

Total Phenols--Total phenols as determined by the 4-AAP analytical method of Standard Methods.

Toxic Pollutants--Those compounds listed in the 1976 Consent Decree and Section 307(a) the Water Quality Act Amendments of 1977.

Traditional Parameters--Those parameters historically of interest, e.g., BOD, COD, TSS, as compared to Toxic Pollutants.

Turbidity--(1) A condition in water or wastewater caused by the presence of suspended matter, resulting in the scattering and absorption of light rays; (2) A measure of the fine suspended matter in liquids; (3) An analytical quantity usually reported in arbitrary turbidity units determined by measurements of light diffraction.

Vacuum Water--Water extracted from wood during the vacuum period following steam conditioning.

Vapor Drying--A process in which unseasoned wood is heated in the hot vapors of an organic solvent, such as xylene, to season it prior to preservative treatment.

Vat--Large metal containers in which veneer logs are "conditioned" or heated prior to cutting. The two basic methods for heating are by direct steam contact in "steam vats" or by steam-heated water in "hot water vats."

Veneer--A thin sheet of wood of uniform thickness produced by peeling, slicing, or sawing logs, bolts, or flitches. Veneers may be categorized as either hardwood or softwood, depending on the type of woods used and the intended purpose.

Water Balance--The water gain (incoming water) of a system versus water loss (water discharged or lost).

Water-borne Preservative--Any one of several formulations of inorganic salts, the most common of which are based on copper, chromium, and arsenic.

Wet-felting--Term applied to the forming of a fiberboard from a suspension of pulp in water usually on a cylinder, deckle box, or Fourdrinier machine; the interfelting of wood fibers from a water suspension into a mat for board.

Wet Process--See Wet-felting.

Wet Scrubber--An air pollution control device which involves the wetting of particles in an air stream and the impingement of wet or dry particles on collecting surfaces, followed by flushing.

Wood Extractives--A mixture of chemical compounds, primarily carbohydrates, removed from wood during steam conditioning.

Wood Preservatives--A chemical or mixture of chemicals with fungistatic and insecticidal properties that is injected into wood to protect it from biological determination.

Zero Discharge--See No Discharge.

APPENDIX A

COSTS OF TREATMENT AND CONTROL SYSTEMS

COST INFORMATION

Cost information for the candidate treatment technologies developed in Section VII is presented in this appendix for the purpose of enabling an assessment of the economic impact on the industry. A separate economic analysis has been prepared and the results have been published in a separate document.

Two types of cost estimates are presented in this appendix. First, the total battery limit costs of the NSPS and PSNS Candidate Treatment Technologies are estimated for the model plants according to raw wastewater characteristics developed in Section V for each subcategory. These estimates include the cost of each unit process associated with the NSPS and PSNS candidate technology. As shown in Section VII, most existing plants already have substantial treatment systems in operation. These total battery limit costs, therefore, are not applicable to these plants as they do not reflect the true cost to the industry of achieving the candidate technologies. Since no technology can be assumed to be in-place for new sources, the total battery limit NSPS and PSNS cost estimates do represent the costs to the industry of achieving the NSPS and PSNS candidate technologies.

The second type of cost estimate presented is a plant-by-plant estimate of the costs of achieving the applicable candidate technologies for direct and/or indirect dischargers within each subcategory. This estimate, prepared for every affected plant in the technical data base, takes into consideration the plants' raw and treated wastewater characteristics and the treatment technology currently in-place and is a more accurate estimate of the actual cost of the candidate technologies to the industry as a whole.

It should be noted that a number of factors affect the cost of a particular facility, and that these highly variable factors may differ from those assumed herein. One of the most variable factors is the cost of land, which may range from a few hundred dollars per hectare in rural areas to millions of dollars (or total unavailability) in urban areas. Other site-specific factors which can cause variations in actual cost include local soil conditions, building codes, and labor costs.

In some cases, individual installations may use cost accounting systems which cause reported costs to differ from those in this section. For example, it is not uncommon for a portion of a manufacturing plant's administrative costs to be allocated to the waste treatment system. Such factors are not included in this document.

Table A-1 presents the cost assumptions used in developing the cost estimates described above.

Table A-1. Cost Assumptions

1. All costs are reported in June 1977 dollars.
2. Excavation costs $5.00 per cubic yard.
3. Reinforced concrete costs $210 per cubic yard.
4. Site preparation costs $2,000 per acre.
5. Contract hauling of sludge to landfill costs $25 per cubic yard.
6. Land costs $10,000 per acre except for those alternatives including spray irrigation, in which case land costs $2,000 per acre.
7. Surface dressing for lagoons costs $0.03 per square foot.
8. Fencing costs $2.00 per linear foot, installed.
9. Clay lining for lagoons costs $0.23 per square foot.
10. New carbon costs $0.40 per pound.
11. Epoxy coating costs $2.00 per square foot.
12. Electricity costs $0.05 per kilowatt-hour.
13. Phosphoric acid costs $0.25 per pound.
14. Anhydrous ammonia costs $0.18 per pound.
15. Polymer costs $0.60 per pound.
16. Sulfuric acid costs $0.06 per pound.
17. Sodium hydroxide costs $0.10 per pound.
18. Sulfur dioxide costs $0.25 per pound.
19. Average roofing costs $5.50 per square foot.
20. Engineering costs 15 percent of construction cost.
21. Contingency is 15 percent of the sum of the capital cost, land cost, and engineering cost.
22. Capital recovery is based on 20 years at 10 percent.
23. Annual insurance and taxes cost 3 percent of the sum of the capital cost plus land cost.
24. Average labor costs $20,000 per man per year, including fringe benefits and overhead.
25. Annual operating costs include amortization, operation and maintenance, energy, taxes and insurance and sludge disposal costs (hauling)

Energy Requirements of Candidate Technologies

Itemized energy costs are shown in each of the cost estimates presented in this appendix.

Total Cost of Candidate Technologies

Tables A-2 through A-5 present the total battery limit costs of NSPS and PSNS candidate technologies for the model plants in the Wood Preserving-Boulton and Steam subcategories. (The candidate technologies are the same). The design criteria for the model plants for these subcategories are presented on page 110 in Table V-21 of Section V, WASTEWATER CHARACTERISTICS. Tables A-6 through A-9 present the total battery limit costs of NSPS candidate technologies for the model plants in the insulation board subcategory. The design criteria for the mechanical and thermomechanical refining model plants in the insulation board subcategory are presented on page 122 in Tables V-24 and V-25 of

Section V, respectively. Tables A-10 through A-12 present the total battery limit costs of NSPS candidate technologies for the wet process hardboard subcategory. The model plant design criteria for the S1S and S2S parts of the wet process hardboard subcategory are presented on page 136 in Table V-31 and on page 137 in Table V-32 of Section V, respectively.

It should be noted that the battery limit costs shown for primary oil separation for new sources in the wood preserving segment, including capital, annual operating, and annual energy costs, are 50 percent of the actual values estimated during the cost analysis. This is because, as discussed in Section VII of this document, 50 percent of the total costs of this technology can be amortized through recovery of oils.

Total battery limit costs were not developed for the Wood Preserving - Water Borne or Non-Pressure subcategory PSNS candidate technology because the costs are minimal. As discussed in Section XII, PRETREATMENT STANDARDS, the PSNS candidate technology for this subcategory is process wastewater collection and recycle to achieve no discharge. Process wastewater is collected and reused to make up future preservative treating solutions. This technology is easily incorporated into the overall plant design and the costs for this technology are minimal compared to the costs of constructing and operating the preservative treatment facilities.

Costs of Compliance for Indirect Discharging Plants--Wood Preserving

Assumptions made in estimating plant-by-plant costs were: (1) technology required to achieve BPT standards, or its equivalent, should be in-place for existing direct dischargers, therefore no costs were included for primary and secondary oil separation or for an aerated lagoon of sufficient size and aeration capacity to achieve the BPT standards; (2) technology required to achieve current pretreatment standards, or its equivalent, should be in-place for existing indirect dischargers, therefore no costs were included for primary and secondary oil removal; (3) plants currently achieving no discharge through self containment (spray irrigation, evaporation, recycle, etc.) will incur no costs of compliance; and (4) the cost of converting a steam subcategory plant from open to closed steaming was estimated and included in the compliance cost only when this conversion and subsequent treatment of a reduced flow results in a lower overall cost than does treatment of the larger, open steaming flow.

Costs of compliance for individual wood preserving plants are shown in Tables A-13 through A-15.

Costs of Compliance Hardboard/Insulation Board

A plant-by-plant analysis was performed on each plant in the technical data base to determine the cost of compliance for each applicable candidate treatment technology. The individual plant's wastewater flow, raw and treated wastewater characteristics, and in-place technology were considered in determining the cost of compliance.

Table A-2. Wood Preserving-Boulton Subcategory Cost Summary for Model Plant N-1*, NSPS, PSNS Battery Limit Costs

	Capital Cost	Annual Operating Cost	Annual Energy Cost
Primary Oil Separation	$ 40,000	$ 2,500	$1,500
Flocculation and Slow-Sand Filtration	16,000	3,900	400
Pump Station	6,300	1,470	1,160
Cooling Tower Evaporation (Including Recirculation Pumps)	57,000	6,880	5,100
Engineering	17,900	--	--
Land	5,000	--	--
Contingency	21,330	--	--
Sludge Disposal	--	1,000	--
Capital Recovery	--	18,620	--
Insurance and Taxes	--	3,730	--
Labor	--	20,000	--
TOTAL	$163,530	$58,100	$8,160

*A diagram of the Candidate Treatment Technology is shown in Figure VII-18.

Table A-3. Wood Preserving-Boulton Subcategory Cost Summary for Model Plant N-2*, NSPS, PSNS Battery Limit Costs

	Capital Cost	Annual Operating Cost	Annual Energy Cost
Primary Oil Separation	$ 56,750	$ 3,000	$ 1,750
Flocculation and Slow-Sand Filtration	19,500	5,200	400
Pump Station	7,300	1,900	1,480
Cooling Tower Evaporation (Including Recirculation Pumps)	82,000	14,990	12,500
Engineering	24,830	--	--
Land	7,500	--	--
Contingency	29,680	--	--
Sludge Disposal	--	2,000	--
Capital Recovery	--	25,850	--
Insurance and Taxes	--	5,190	--
Labor	--	25,000	--
TOTAL	$227,560	$83,130	$16,130

*A diagram of the Candidate Treatment Technology is shown in Figure VII-18.

Table A-4. Wood Preserving-Steam Subcategory Cost Summary for Model Plant N-3*, NSPS, PSNS Battery Limit Costs

	Capital Cost	Annual Operating Cost	Annual Energy Cost
Primary Oil Separation	$ 40,000	$ 2,500	$1,500
Flocculation and Slow-Sand Filtration	16,000	3,900	400
Pump Station	5,790	1,290	1,020
Spray Evaporation	92,000	1,590	270
Engineering	23,070	--	--
Land	9,000	--	--
Contingency	27,880	--	--
Sludge Disposal	--	1,000	--
Capital Recovery	--	24,050	--
Insurance and Taxes	--	4,880	--
Labor	--	20,000	--
TOTAL	$213,700	$59,200	$3,200

*A diagram of the Candidate Treatment Technology is shown in Figure VII-19.

Table A-5. Wood Preserving-Steam Subcategory Cost Summary for Model Plant N-4*, NSPS, PSNS Battery Limit Costs

	Capital Cost	Annual Operating Cost	Annual Energy Cost
Primary Oil Separation	$ 56,750	$3,000	$1,750
Flocculation and Slow-Sand Filtration	19,500	5,200	400
Pump Station	6,800	1,710	1,340
Spray Evaporation	155,000	1,620	280
Engineering	35,710	--	--
Land	19,500	--	--
Contingency	43,990	--	--
Sludge Disposal	--	2,000	--
Capital Recovery	--	37,320	--
Insurance and Taxes	--	7,730	--
Labor	--	25,000	--
TOTAL	$337,250	$83,580	$3,770

*A diagram of the Candidate Treatment Technology is shown in Figure VII-19.

Table A-6. Insulation Board Mechanical Refining
Cost Summary for Model Plant C-1*, NSPS Battery Limit Costs

	Capital Cost	Operating Cost	Energy Cost
Pump Stations (3)	$ 105,000	$ 11,700	$ 3,540
Screening	16,000	1,220	--
Neutralization	11,800	3,600	140
Nutrient Addition	27,300	35,600	--
Aerated Lagoon	722,000	156,000	128,000
Facultative Lagoon	292,600	--	--
Spray Irrigation	46,400	14,800	12,500
Control House	75,680	5,980	2,950
Engineering	194,500	--	--
Land	539,900	--	--
Contingency	304,700	--	--
Sludge Disposal	--	8,000	--
Capital Recovery	--	211,000	--
Insurance and Taxes	--	55,100	--
Labor	--	40,000	--
TOTAL	$2,335,880	$543,000	$147,130

*A diagram of the Candidate Treatment Technology is shown in Figure VII-23.

Table A-7. Insulation Board Mechanical Refining
Cost Summary for Model Plant C-2*, NSPS Battery Limit Costs

	Capital Cost	Operating Cost	Energy Cost
Pump Stations (3)	$ 165,000	$ 20,100	$ 7,350
Screening	34,000	1,900	--
Neutralization	16,600	7,280	200
Nutrient Addition	39,200	82,000	--
Aerated Lagoon	1,130,000	338,000	306,000
Facultative Lagoon	425,600	--	--
Spray Irrigation	76,000	25,700	21,000
Control House	75,680	5,980	2,950
Engineering	294,300	--	--
Land	1,260,300	--	--
Contingency	527,500	--	--
Sludge Disposal	--	19,200	--
Capital Recovery	--	327,000	--
Insurance and Taxes	--	96,700	--
Labor	--	40,000	--
TOTAL	$4,044,180	$963,860	$337,500

*A diagram of the Candidate Treatment Technology is shown in Figure VII-23.

Table A-8. Insulation Board Thermomechanical Refining Cost Summary for Model Plant C-1*, NSPS Battery Limit Costs

	Capital Cost	Annual Operating Cost	Annual Energy Cost
Pump Stations (3)	$ 105,000	$ 11,700	$ 3,540
Screening	16,000	1,220	--
Neutralization	11,800	3,600	140
Nutrient Addition	43,400	104,000	--
Aerated Lagoon	1,104,000	422,000	396,000
Facultative Lagoon	292,600	--	--
Spray Irrigation	46,400	14,800	12,500
Control House	75,680	5,980	2,950
Engineering	254,200	--	--
Land	539,900	--	--
Contingency	373,400	--	--
Sludge Disposal	--	8,000	--
Capital Recovery	--	272,800	--
Insurance and Taxes	--	67,000	--
Labor	--	40,000	--
TOTAL	$2,862,380	$951,100	$415,130

*A diagram of the Candidate Treatment Technology is shown in Figure VII-23.

Table A-9. Insulation Board Thermomechanical Refining Cost Summary for Model Plant C-2*, NSPS Battery Limit Costs

	Capital Cost	Annual Operating Cost	Annual Energy Cost
Pump Stations (3)	$ 165,000	$ 20,100	$ 7,350
Screening	34,000	1,900	--
Neutralization	16,600	7,280	200
Nutrient Addition	55,300	238,000	--
Aerated Lagoon	2,206,900	1,000,000	960,000
Facultative Lagoon	425,600	--	--
Spray Irrigation	76,000	25,700	21,000
Control House	75,680	5,980	2,950
Engineering	458,300	--	--
Land	1,261,000	--	--
Contingency	716,200	--	--
Sludge Disposal	--	19,200	--
Capital Recovery	--	496,800	--
Insurance and Taxes	--	129,500	--
Labor	--	40,000	--
TOTAL	$5,490,580	$1,984,460	$991,500

*A diagram of the Candidate Treatment Technology is shown in Figure VII-23.

Table A-10. Wet Process Hardboard Subcategory (S1S Part) Cost Summary for Model Plant C-1*, NSPS Battery Limit Costs

	Capital Cost	Annual Operating Cost	Annual Energy Cost
Pump Stations (3)	$ 84,000	$ 8,700	$ 2,340
Screening	9,500	1,000	--
Neutralization	9,600	2,440	120
Nutrient Addition	27,700	36,300	--
Aerated Lagoon	726,000	168,000	138,000
Facultative Lagoon	233,400	--	--
Spray Irrigation	35,500	10,900	9,200
Control House	75,680	5,980	2,950
Engineering	180,200	--	--
Land	317,000	--	--
Contingency	254,800	--	--
Sludge Disposal	--	4,480	--
Capital Recovery	--	192,200	--
Insurance and Taxes	--	45,600	--
Labor	--	40,000	--
TOTAL	$1,953,380	$515,600	$152,610

*A diagram of the Candidate Treatment Technology is shown in Figure VII-27.

Table A-11. Wet Process Hardboard Subcategory (S1S Part) Cost Summary for Model Plant C-2*, NSPS Battery Limit Costs

	Capital Cost	Annual Operating Cost	Annual Energy Cost
Pump Stations (3)	$ 135,000	$ 15,900	$ 5,340
Screening	24,000	1,550	--
Neutralization	14,300	5,380	170
Nutrient Addition	43,300	104,800	--
Aerated Lagoon	726,000	168,000	138,000
Facultative Lagoon	364,000	--	--
Spray Irrigation	62,000	20,100	16,900
Control House	75,680	5,980	2,950
Engineering	216,600	--	--
Land	873,800	--	--
Contingency	380,200	--	--
Sludge Disposal	--	13,440	--
Capital Recovery	--	239,700	--
Insurance and Taxes	--	69,500	--
Labor	--	40,000	--
TOTAL	$2,914,880	$684,350	$163,360

*A diagram of the Candidate Treatment Technology is shown in Figure VII-27.

Table A-12. Wet Process Hardboard Subcategory (S2S Part) Cost Summary for Model Plant C*, NSPS Battery Limit Costs

	Capital Cost	Annual Operating Cost	Annual Energy Cost
Pump Stations (3)	$ 187,500	$ 23,400	$ 9,000
Screening	40,000	2,200	--
Neutralization	18,000	8,850	230
Nutrient Addition	47,500	143,000	--
Aerated Lagoon	1,535,900	584,000	576,000
Facultative Lagoon	468,400	--	--
Spray Irrigation	87,500	30,000	24,000
Control House	75,680	5,980	2,950
Engineering	369,100	--	--
Land	1,583,400	--	--
Contingency	662,000	--	--
Sludge Disposal	--	24,000	--
Capital Recovery	--	410,100	--
Insurance and Taxes	--	121,300	--
Labor	--	40,000	--
TOTAL	$5,074,980	$1,392,830	$612,180

*A diagram of the Candidate Treatment Technology is shown in Figure VII-27.

Table A-13. Wood Preserving--Steam Subcategory Costs of Compliance for Individual Plants Direct Dischargers

	Biological Treatment (Technology A or B)			Biological Treatment Plus Activated Carbon Adsorption (Technology C or D)			Spray Evaporation (Technology N)		
Plant	Capital Cost	Annual Operating Cost	Annual Energy Cost	Capital Cost	Annual Operating Cost	Annual Energy Cost	Capital Cost	Annual Operating Cost	Annual Energy Cost
268	0	0	0	68,800	30,900	1,300	176,600	36,000	200

Table A-14. Wood Preserving--Steam Subcategory Costs of Compliance for Individual Plants Indirect Dischargers

	Biological Treatment (Technology J or K)			Biological Treatment Plus Metals Removal (Technology L or M)			Spray Evaporation (Technology N)			Spray Evaporation (Technology N) Plus Conversion From Open to Closed Steaming (Technology O)		
Plant	Capital Cost	Annual Operating Cost	Annual Energy Cost	Capital Cost	Annual Operating Cost	Annual Energy Cost	Capital Cost	Annual Operating Cost	Annual Energy Cost	Capital Cost	Annual Operating Cost	Annual Energy Cost
173	65,100	25,400	2,400	167,000	52,500	3,400	119,100	29,900	300	0	0	0
267	118,000	37,100	4,000	0	0	0	198,000	40,200	300	0	0	0
335	80,800	29,400	2,900	191,900	59,000	4,000	147,900	33,700	300	0	0	0
338	83,400	30,100	3,000	0	0	0	152,500	34,300	300	0	0	0
339	68,500	33,500	5,200	0	0	0	88,600	26,000	300	0	0	0
547	79,100	38,700	6,700	0	0	0	116,400	29,900	300	0	0	0
582*	163,100	46,800	5,400	308,600	91,500	7,100	256,400	49,700	1,700	0	0	0
596	46,100	21,300	1,800	129,400	42,900	2,500	78,400	24,400	300	0	0	0
620	148,700	44,000	5,100	291,500	87,300	6,700	233,700	44,900	300	0	0	0
693*	70,300	27,200	2,700	0	0	0	133,500	31,800	300	0	0	0
765	110,200	35,900	3,900	0	0	0	188,100	38,900	300	0	0	0
894	119,400	47,800	4,200	0	0	0	208,400	53,300	1,600	0	0	0
898	42,600	9,700	1,300	0	0	0	106,100	15,900	200	0	0	0
899	210,900	66,300	6,800	369,600	116,400	8,700	296,600	65,200	1,800	0	0	0
901	75,100	28,200	2,800	0	0	0	145,600	34,700	1,400	0	0	0
910	82,200	29,900	3,000	0	0	0	149,400	33,900	300	0	0	0
1076*	128,500	39,800	4,500	0	0	0	209,900	41,600	300	0	0	0
1200	240,200	61,800	7,400	0	0	0	322,800	57,500	300	0	0	0
1201	164,600	47,300	5,600	311,300	92,400	7,300	251,400	47,200	300	0	0	0
896	0	0	0	0	0	0	0	0	0	112,200	30,800	1,100
139	46,100	21,300	1,800	0	0	0	79,100	24,500	300	0	0	0
589	72,100	27,400	2,700	177,900	57,800	3,700	132,800	31,700	300	0	0	0
575	152,000	44,700	5,200	0	0	0	239,800	45,300	1,600	0	0	0
594*	326,100	89,700	9,500	0	0	0	403,400	79,200	300	0	0	0
530	49,300	21,900	1,800	0	0	0	83,300	25,100	300	0	0	0
529	46,100	21,300	1,800	0	0	0	79,100	24,400	300	0	0	0
1203*	69,200	26,900	2,500	0	0	0	128,500	31,100	300	0	0	0
294	46,900	30,500	1,900	0	0	0	79,100	24,400	300	0	0	0
1205	46,900	30,500	1,900	0	0	0	79,100	24,400	300	0	0	0

* Identified as potential closure candidate due to the compliance costs of attaining the proposed no discharge of PCP pretreatment standard. A site specific study was conducted following the proposed pretreatment standard to refine the compliance cost analysis. This study determined that the refined compliance costs were in general agreement with the original compliance costs and were still high enough for the plant to be considered a potential closure candidate.

Table A-15. Wood Preserving--Boulton Subcategory Costs of Compliance for Individual Plants Indirect Dischargers

Plant	Biological Treatment (Technology J or K) Capital Cost	Biological Treatment (Technology J or K) Annual Operating Cost	Biological Treatment (Technology J or K) Annual Energy Cost	Biological Treatment Plus Metals Removal (Technology L or M) Capital Cost	Biological Treatment Plus Metals Removal (Technology L or M) Annual Operating Cost	Biological Treatment Plus Metals Removal (Technology L or M) Annual Energy Cost	Cooling Tower Evaporation (Technology N) Capital Cost	Cooling Tower Evaporation (Technology N) Annual Operating Cost	Cooling Tower Evaporation (Technology N) Annual Energy Cost
65*	104,000	35,100	4,100	231,000	72,900	5,400	71,900	36,800	6,500
549	976,000	203,100	21,400	0	0	0	178,200	110,100	62,000
555	0	0	0	0	0	0	110,400	55,300	18,500
577	352,000	84,300	10,000	536,100	148,700	12,400	118,500	59,900	22,000
655	238,000	61,700	7,400	406,200	116,800	9,400	103,500	51,000	15,500
743*	82,300	33,300	3,000	0	0	0	62,100	33,000	4,400
1027	173,900	48,800	5,600	322,300	96,000	7,300	92,000	44,600	11,000
1078	134,500	41,000	4,700	273,500	83,700	6,200	81,600	40,700	8,800
1110	104,000	35,100	4,100	0	0	0	71,900	36,800	6,500
1111	0	0	0	0	0	0	103,500	51,100	15,500

* Identified as potential closure candidate due to the compliance costs of attaining the proposed no discharge of PCP pretreatment standard. A site specific study was conducted following the proposed pretreatment standard to refine the compliance cost analysis. This study determined that the refined compliance costs were in general agreement with the original compliance costs and were still high enough for the plant to be considered a potential closure candidate.

Costs of Compliance for Individual Plants--Insulation Board and Hardboard

A plant-by-plant analysis was performed on each insulation board and hardboard plant to determine the cost of compliance for each applicable level of biological treatment technology discussed in Section VII. The individual plant's wastewater flow, raw and treated wastewater characteristics and in-place technology were all considered in determining cost of compliance.

Insulation Board-Mechanical Refining Plants--There is only one mechanical refining direct discharger in the insulation board subcategory. This plant exhibits exemplary treatment, therefore no cost of compliance will be incurred. The remaining plants in this subcategory are either self contained (no discharge) or indirect dischargers, and no costs of compliance will be incurred. As previously discussed in Section VII, pretreatment of raw wastewaters from this subcategory is not considered necessary due to the extremely low levels of toxic pollutant contamination.

Insulation Board-Thermomechanical Plants-There are four thermomechanical refining direct dischargers in the insulation board subcategory. Three of these exhibit exemplary treatment and no cost of compliance will be incurred. The fourth direct discharger also produces S2S hardboard and the cost analysis for this plant will be presented in the S2S hardboard discussion below.

S1S Hardboard--Of the nine S1S hardboard plants, seven are direct dischargers. Three of these plants exhibit effluent levels lower in pollutant loadings than the two candidate levels of biological treatment described in Section VII. No costs of compliance will be incurred by these plants. One plant is an indirect discharger and will not incur a cost of compliance as pretreatment of wastewaters from the S1S part of this subcategory is not considered to be necessary because of the extremely low levels of toxic pollutant contamination and lack of available technology to further reduce those levels. Another plant is self contained and, therefore, will not incur a cost of compliance. Table A-16 presents the costs of compliance for the remaining plants for each of the two candidate levels of biological treatment.

S2S Hardboard--Of the seven S2S hardboard plants, five are direct dischargers. Of the five, three plants exhibit effluent levels lower in pollutant loadings than the candidate levels of biological treatment described in Section VII. No costs of compliance will be incurred by these plants. The fourth direct discharger is currently constructing extensive treatment facilities expected to be normally operating this year. Costs of compliance for this plant are based on expected (and designed) effluent levels which will be achieved by the new system. Costs of compliance for the direct dischargers required to upgrade are presented in Table A-17 for each of the candidate levels of biological treatment. Of the remaining two plants, one is self contained (no discharge) and the other is an indirect discharger. No costs of compliance will be incurred by these plants. Pretreatment of raw wastewater from the S2S part of this subcategory is not considered necessary due to the extremely low levels of toxic pollutant contamination.

Table A-16. Wet Process Hardboard Subcategory (S1S Part) Costs of Compliance for Individual Plants Direct Dischargers

	Biological Treatment Based on Candidate Treatment Technology A (BPT)			Biological Treatment Based on Candidate Treatment Technology B (BCT)		
Plant	Capital Cost	Annual Operating Cost	Annual Energy Cost	Capital Cost	Annual Operating Cost	Annual Energy Cost
(00207)	--	--	--	1,228,000	251,000	18,000
(00348)	2,004,700	526,800	128,400	2,938,000	739,000	213,000
(00003)	285,000	84,000	1,000	1,105,300	237,000	1,000
(00929)	--	--	--	183,000	122,000	30,000
(00678)	--	--	--	599,000	173,000	41,000

Energy costs are lower for the BCT option due to technology differences between options.

Table A-17. Wet Process Hardboard Subcategory (S2S Part) Costs of Compliance for Individual Plants, Direct Dischargers

	BPT Biological Treatment Based on Performance Equivalent to S1S Subcategory BPT Plant			BCT Biological Treatment Based on Performance of Plant 980 Candidate Treatment Technology C		
	Capital Cost	Operating Cost	Energy Cost	Capital Cost	Operating Cost	Energy Cost
1	7,266,000	3,068,000	1,368,000	7,436,000	3,173,000	1,408,000
108	0	0	0	6,856,000	1,601,000	375,000

APPENDIX B-1

TOXIC OR POTENTIALLY TOXIC SUBSTANCES NAMED IN CONSENT DECREE

Acenapthene
Acrolein
Acrylonitrile
Aldrin/Dieldrin
Antimony
Arsenic
Asbestos
Benzidine
Benzene
Beryllium
Cadmium
Carbon Tetrachloride
Chlordane
Chlorinated Benzenes
Chlorinated Ethanes
Chloroalkyl Ethers
Chlorinated Naphthalene
Chlorinated Phenols
Chloroform
2-Chlorophenol
Chromium
Copper
Cyanide
DDT
Dichlorobenzenes
Dichlorobenzidine
Dichloroethylenes
2,4-Dichlorophenol
Dichloropropane and Dichloropropene
2,4-Dimethylphenol
Dinitrotoluene
1,2-Diphenylhydrazine
Endosulfan
Endrin
Ethylbenzene
Fluoranthene
Haloethers
Halomethanes
Heptachlor
Hexachlorobutadiene
Hexachlorocyclohexane
Hexachlorocyclopentadiene
Isophorone
Lead
Mercury
Napthalene
Nickel
Nitrobenzene
Nitrophenols
Nitrosamines

Pentachlorophenol
Phenol
Phthalate Esters
Polynuclear Aromatic Hydrocarbons (PNAs)
Polychlorinated Biphenyls (PCB's)
Selenium
Silver
2,3,7,8 Tetrachlorodibenzo-p-dioxin (TCDD)
Tetrachloroethylene
Thallium
Toluene
Trichloroethylene
Toxaphene
Vinyl chloride
Zinc

APPENDIX B-2

LIST OF SPECIFIC TOXIC POLLUTANTS

1. benzidine
2. 1,2,4-trichlorobenzene
3. hexachlorobenzene
4. chlorobenezene
5. bis(chloromethyl) ether
6. bis(2-chloroethyl) ether
7. 2-chloroethyl vinyl ether (mixed)
8. 1,2-dichlorobenzene
9. 1,3-dichlorobenzene
10. 1,4-dichlorobenzene
11. 3,3'-dichlorobenzidine
12. 2,4-dinitrotoluene
13. 2,6-dinitrotoluene
14. 1,2-diphenylhydrazine
15. ethylbenzene
16. 4-chlorophenyl phenyl ether
17. 4-bromophenyl phenyl ether
18. bis(2-chloroisopropyl) ether
19. bis(2-chloroethoxy) methane
20. isophorone
21. nitrobenzene
22. N-nitrosodimethylamine
23. N-nitrosodiphenylamine
24. N-nitrosodi-n-propylamine
25. bis(2-ethylhexyl) phthalate
26. butyl benzyl phthalate
27. di-n-butyl phthalate
28. diethyl phthalate
29. dimethyl phthalate
30. toluene
31. vinyl chloride (chloroethylene)
32. acrolein
33. acrylonitrile
34. acenaphthene
35. 2-chloronaphthalene
36. fluoranthene
37. naphthalene
38. 1,2-benzanthracene
39. benzo(a)pyrene(3,4-benzopyrene)
40. 3,4-benzofluoranthene
41. 11,12-benzofluoranthene
42. chrysene
43. acenaphthylene
44. anthracene
45. 1,12-benzoperylene
46. fluorene
47. phenanthrene
48. 1,2,5,6-dibenzanthracene

49. indeno (1,2,3-,cd)pyrene
50. pyrene
51. benzene
52. carbon tetrachloride (tetrachloromethane)
53. 1,2-dichloroethane
54. 1,1,1-trichloroethane
55. hexachloroethane
56. 1,1-dichloroethane
57. 1,1,2-trichloroethane
58. 1,1,2,2-tetrachloroethane
59. chloroethane
60. 1,1-dichloroethylene
61. 1,2-trans-dichloroethylene
62. 1,2-dichloropropane
63. 1,2-dichloropropylene (1,2-dichloropropene)
64. methylene chloride (dichloromethane)
65. methyl chloride (chloromethane)
66. methyl bromide (bromomethane)
67. bromoform (tribromomethane)
68. dichlorobromomethane
69. chlorodibromomethane
70. hexachlorobutadiene
71. hexachlorocyclopentadiene
72. tetrachloroethylene
73. chloroform (trichloromethane)
74. trichloroethylene
75. aldrine
76. dieldrin
77. chlordane (technical mixture and metabolites)
78. 4,4'-DDT
79. 4,4'-DDE (p,p'-DDX)
80. 4,4'-DDD (p,p'-TDE)
81. a-endosulfan-Alpha
82. b-endosulfan-Beta
83. endosulfan sulfate
84. endrin
85. endrin aldehyde
86. endrin ketone
87. heptachlor
88. heptachlor epoxide
89. a-BHC-Alpha
90. b-BHC-Beta
91. r-BHC (lindane)-Gamma
92. g-BHC-Delta
93. PCB-1242 (Arochlor 1242)
94. PCB-1254 (Arochlor 1254)
95. toxaphene
96. 2,3,7,8-tetrachlorodibenzo-p-dioxin (TCDD)
97. 2,4,6-trichlorophenol
98. parachlorometa cresol
99. 2-chlorophenol
100. 2,4-dichlorophenol
101. 2,4-dimethylphenol
102. 2-nitrophenol

103. 4-nitrophenol
104. 2,4-dinitrophenol
105. 4,6-dinitro-o-cresol
106. pentachlorophenol
107. phenol
108. cyanide (Total)
109. asbestos (Fibrous)
110. arsenic (Total)
111. antimony (Total)
112. beryllium (Total)
113. cadmium (Total)
114. chromium (Total)
115. copper (Total)
116. lead (Total)
117. mercury (Total)
118. nickel (Total)
119. selenium (Total)
120. silver (Total)
121. thallium (Total)
122. zinc (Total)

APPENDIX C

ANALYTICAL METHODS AND EXPERIMENTAL PROCEDURE

INTRODUCTION

EPA Protocols Used

The analytical effort for the Timber Products Processing Point Source Category began in November 1976 with the analyses of screening samples. The protocol available at that time was the draft "Protocol for the Measurement of Toxic Substances," U.S. EPA, Cincinnati, Ohio, October 1976.

Analyses of verification samples were conducted from February 1977 to May 1978, by which time the protocol, "Sampling and Analysis Procedures for Screening of Industrial Effluents," March 1977 (revised April 1977) was available.

Nature of the Samples

The wastewaters analyzed are characterized by BOD values as high as 7,500 mg/l, suspended solids concentrations as high as 3,000 mg/l, and Oil and Grease values as high as 10,000 mg/l. Such gross quantities of materials in the samples provided the potential for interference during workup and subsequent analysis. High concentrations of dissolved organics also imposed constraints on the achievable sensitivity.

This problem was partially circumvented by the use of smaller sample aliquots and by dilution of the resulting extract. The interference was not of consequence when analyzing classical or inorganic parameters. Clean-up procedures could be used for specific parameters, but the need for screening and verification data on a large number of compounds precludes the use of general clean-up procedures.

Overview of Methods

The toxic pollutants may be considered according to the broad classification of organics and metals. The organic toxic pollutants constitute the larger group and were analyzed according to the categories of purgeable volatiles, extractable semi-volatiles, and pesticides and PCB's. The principal analytical method for identification and quantitation of organic toxic pollutants, other than pesticides and PCB's, was repetitive scanning GC/MS.

In the screening phase, GC/MS compound identification was made in terms of the proper chromatographic retention time and comparison of the entire mass spectrum with that of an authentic standard or that from a reference work when the standard was not available or the substance was too toxic to obtain.

Compound quantitation was performed in terms of the integrated areas of individual peaks in the total ion current chromatogram compared with an external standard.

In the verification phase, compound identification was based on the following criteria: (1) appropriate retention time within a window defined as ± 1 minute that of the compound in the standard; (2) coincidence of the extracted ion current profile maxima of two (volatiles) or three (extractables) characteristic ions enumerated in the protocol; and (3) proper relative ratios of these extracted ion current profile peaks.

Toxic pollutants were quantitated with direct integration of peak areas from extracted ion current profiles and relative response factors in terms of the internal standard d10- anthracene.

An alternate GC/FID procedure (Chriswell, Chang, and Fritz, Anal. Chem., 47, 1325, (1975)) was employed for the phenols for the screening samples. In the procedure, phenol samples were steam distilled and the resultant distillate was subjected to the ion exchange separation followed by GC/FID identification and quantitation.

The use of this method was prompted because of the severe emulsion problems encountered when extracting the samples by the draft protocol method. Recovery data for the draft protocol method was unacceptable for these wastewaters and therefore this procedure was substituted.

In both screening and verification phases the pesticides and PCB's were analyzed by the use of GC/ECD. Identification was based on retention time relative to a standard injected under the same conditions. Quantitation was based on peak area for the same standard injection. The metals were done by flameless atomic absorption and all classical parameters were done by standard methods. There were slight differences between the screening method and verification method that were largely due to the evolution of the analytical protocol to its present form.

DETAILED DESCRIPTION OF ANALYTICAL METHODS

Volatile Toxic Pollutants

The purgeable volatile toxic pollutants are those compounds which possess a relatively high vapor pressure and low water solubility. These compounds are readily stripped with high efficiency from the water by bubbling an inert gas through the sample at ambient temperature.

The analytical methodology employed for the volatiles was based on the dynamic headspace technique of Bellar and Lichtenberg. This procedure consists of two steps. Volatile organics are purged from the raw-water sample onto a Tenax GC-silica gel trap with a stream of inert gas. The volatile organics are then thermally desorbed into the GC inlet for subsequent GC/MS identification and quantitation.

The purgable volatile toxic pollutants considered in the final verification phase are listed in Table C-1.

A 5 ml aliquot of the raw water sample was purged at ambient temperature with He for 12 minutes onto a 25 cm x 1/8 in. o.d. stainless steel trap containing an 18 cm bed of Tenax GC 60/80 mesh and a 5 cm bed of Davison Grade 15 silica gel 35/60 mesh. This 5 ml aliquot represented a single sample or a composite of the various volatile samples collected at the individual station.

The organics were thermally desorbed from the trap for 4 minutes at 180° with a He flow of 30 ml/min into the GC inlet. The collection of repetitively scanned mass spectra was initiated with the application of heat to the trap. The enumeration of all instrument parameters is presented in Table C-2.

The gross quantities of organics contained in many of the process waste streams necessitated preliminary screening of samples. To accomplish such screening, a 10 ml portion of the sample was extracted with a single portion of solvent and the extract was subjected to GC/FID analysis to permit the judicious selection of appropriate sample volume, i.e., less than 5 ml, for purge and trap analysis.

Although nonvolatile compounds purge poorly, significant quantities can accumulate on the analytical column from samples containing high levels of these materials. A column of 0.1 percent SP-1000 (Carbomax 20M esterified with nitroterephthalic acid) on 80/100 mesh Carbopac C was employed for the verification phase. The greater temperature stability of the SP-1000 stationary phase, as compared with the lower molecular weight Carbomax 1500, permitted column bake out at elevated temperatures for extended periods of time without adverse effects.

The purge and trap apparatus employed emphasized: (1) short-heated transfer lines, (2) low dead-volume construction, (3) manually-operated multiport valve, and (4) ready replacement of all component parts. Although the operation of the purge and trap apparatus is straightforward conceptually, cross contamination between samples and/or standards can be a serious problem. This design permitted the ready substitution of component parts with thoroughly preconditioned replacement parts when serious contamination was indicated by system blanks.

Foaming tended to be excessive with a number of the samples, particularly those analyzed neat. The brief application of localized heat to the foam trap, as foam began to accumulate, was effective in breaking the foam.

A stock standard was prepared on a weight basis by dissolving the volatile solutes in methanol. Intermediate concentrations prepared by dilution were employed to prepare aqueous standards at the 20 and 100 ppb levels. A 5 ml aliquot of these standards was analyzed in a manner identical to that employed with the samples. The attendant reconstructed total ion current chromatogram for a purgeable volatile organic standard is presented in Figure C-1.

Semivolatile Toxic Pollutants

The extractable semivolatile toxic pollutants are compounds which are readily extracted with methylene chloride. They are subjected to a solubility class separation by serial extraction of the sample with methylene chloride at pH of 11 or greater and at pH 2 or less. This provides the groups referred to as base neutrals and acidics (phenolics), respectively.

Base neutrals and phenolics were fractionated on the basis of a solubility class separation. Due to the widely varying chemical and physical properties possessed by the individual semivolatile toxic pollutants, the whole sample, i.e., suspended solids, etc., was subjected to extraction. Enumeration of the base neutrals and acidic semivolatiles is provided in Tables C-3 and C-4. A 1-liter sample was subjected to two successive extractions with three portions of methylene chloride (150, 75, and 75 ml) at pH 11 or greater and pH 2 or less to provide the base neutral and acidic fractions, respectively.

Emulsions were broken by the addition of Na_2SO_4 or methanol or simply by standing.

The extract from each fraction was dried by passage through Na2SO4, and and the volume was reduced with a Kuderna-Danish evaporator to 5 to 10 ml. The extract was further concentrated to 1 ml in the Kuderna-Danish tube under a gentle stream of organic-free nitrogen.

The solvent volume was reduced to 1.0 ml spiked with 10 ul of the d10anthracene internal standard soution of 2 ug/ul and subjected to GC/MS analysis.

The presence of gross quantities of a variety of organics in the extracts of many of the process waste streams necessitated screening of all extracts by GC/FID prior to GC/MS analysis. Sample extracts were diluted as indicated by the GC/FID scan and subjected to GC/MS analysis. A reconstructed total ion current

Table C-1. Purgeable Volatile Toxic Pollutants

chloromethane
bromomethane
chloroethane
trichlorofluoromethane
trans-1,2-dichloroethylene
1,2-dichloroethane
carbon tetrachloride
bis-chloromethyl ether (d)
trans-1,3-dichloropropene
dibromochloromethane
1,1,2-trichloroethane
2-chloroethylvinyl ether
bromoform
1,1,2,2-tetrachloroethane
toluene
ethylbenzene
dichlorodifluoromethane
vinyl chloride
methylene chloride
1,1-dichloroethylene
1,1-dichloroethane
chloroform
1,1,1-trichloroethane
bromodichloromethane
1,2-dichloropropane
trichloroethylene
cis-1,3-dichloropropene
benzene
1,1,2,2-tetrachloroethene
chlorobenzene

Table C-2. Parameters for Volatile Organic Analysis

Purge Parameters	
Gas	He 40 ml/min
Purge duration	12 min
Purge volume	5 ml
Purge temperature	Ambient
Trap	7 in Tenax GC 60/80 mesh plus 2 in Davison Grade 15 silica gel 35/60 mesh in 10 in x 1/8 in o.d. ss
Desorption temperature	180°
Desorption time	4 min
GC Parameter	
Column	8 ft x 1/8 in, nickel, 0.1% SP-1000 on Carbopac C 80/100
Carrier	He 30 ml/min
Program	50° isothermal 4 min then 8°/min to 175° isothermal 10 min
Separator	Single-stage glass jet at 185°
MS Parameters	
Instrument	Hewlett Packard 5985A
Mass Range	35-335 amu
Ionization Mode	Electron impact
Ionization Potential	70 eV
Emission Current	200 uA
Scan time	2 sec

RECONSTRUCTED TOTAL ION CURRENT CHROMATOGRAM FOR PURGEABLE VOLATILE ORGANICS STANDARD

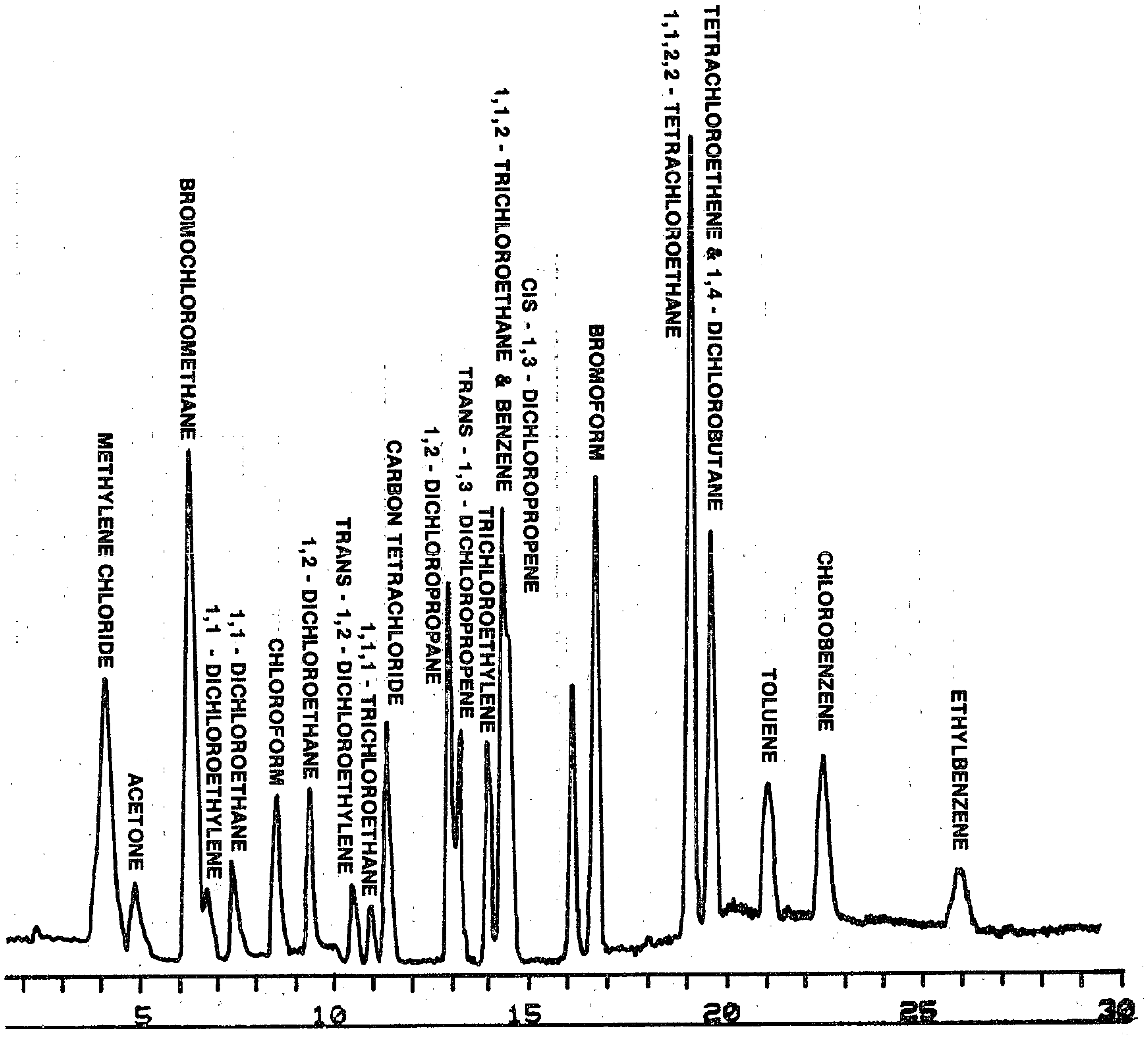


Figure C-1

Table C-3. Base Neutral Extractables

1,3-dichlorobenzene
hexachloroethane
bis(2-chloroisopropyl) ether
1,2,4-trichlorobenzene
bis(2-chloroethyl) ether
nitrobenzene
2-chloronaphthalene
acenaphthene
fluorene
1,2-diphenylhydrazine
N-nitrosodiphenylamine
4-bromophenyl phenyl ether
anthracene
diethylphthalate
pyrene
benzidine
chrysene
benzo(a)anthracene
benzo(k)fluoranthene
indeno(1,2,3-cd)pyrene
benzo(g h i)perylene
N-nitrosodi-n-propylamine
endrin aldehyde
2,3,7,8-tetrachlorodibenzo-p-dioxin
1,4-dichlorobenzene
1,2-dichlorobenzene
hexachlorobutadiene
naphthalene
hexachlorocyclopentadiene
bis(2-chloroethoxy) methane
acenaphthylene
isophorone
2,6-dinitrotoluene
2,4-dinitrotoluene
hexachlorobenzene
phenanthrene
dimethylphthalate
fluoranthene
di-n-butylphthalate
butyl benzylphthalate
bis(2-ethylhexyl)phthalate
benzo(b)fluoranthene
benzo(a)pyrene
dibenzo(a,h)anthracene
N-nitrosodimethylamine
4-chloro-phenyl phenyl ether
3,3'-dichlorobenzidine
bis(chloromethyl) ether

Table C-4. Acidic Extractables

2-chlorophenol
2-nitrophenol
phenol
2,4-dimethylphenol
2,4-dichlorophenol
2,4,6-trichlorophenol
4-chloro-m-cresol
2,4-dinitrophenol
4,6-dinitro-o-cresol
pentachlorophenol
4-nitrophenol

chromatogram for base neutrals and for phenolic standard are shown in Figures C-2 and C-3, respectively.

GC/MS instrument parameters employed for the analysis of base neutrals and phenolics are presented in Tables C-5 and C-6.

The SP-1240 DA chromatographic phase employed for the analysis phenolic extracts in the verification phase provided superior performance as compared with that achieved on Tenax GC. The SP-1240 DA phase provided improved separation, decreased tailing, decreased adsorption of nitrophenols and pentachlorophenol, and increased column life.

Emulsion formation in basic solution under the protocol conditions precluded an efficient extraction of phenolic compounds. An alternate procedure, requiring a separate portion of sample for the acidic extraction, was employed to minimize this problem in the verification phase.

A 1-liter portion of sample was adjusted to pH of 2 or less and extracted with three portions of methylene chloride (100, 75, and 75 ml). These extracts were combined and the acidic compounds were backextracted with two 100 ml portions of aqueous base (pH 12). The basic aqueous extracts were then acidified to pH of 2 or less and extracted again with two 100 ml portions of methylene chloride. The resultant extract was then processed as discussed above under protocol procedure.

PESTICIDES AND PCB's

Pesticides and PCB's were extracted and analyzed as a separate sample. These compounds were analyzed by gas chromatograph with electron capture detection (GC/ECD). Only when the compounds were present at high levels were the samples subjected to GC/MS confirmation.

The need for the increase in concentration is due to the sensitivity of the GC/MS as compared to the GC/ECD. The absolute detection limit for pesticides by GC/MS is approximately 2 parts per billion. GC/ECD detection limit varies due to the degree of chlorination, but ranges from one-half part per billion for PCB's to 50 parts per trillion for chlorinated pesticides. The implications of this fact are that all pesticides and PCB's that are reported below 2 ppb have been confirmed on two columns using GC/ECD, but not confirmed on GC/MS. Table C-7 presents the GC/ECD parameters employed for the analysis of pesticides and PCB's.

The procedure used for the analysis of pesticides and PCB's was taken from the <u>Federal Register</u>. Figure C-4 is a graphic demonstration of the step-by-step procedure used in this analysis.

RECONSTRUCTED TOTAL ION CURRENT CHROMATOGRAM FOR BASE NEUTRALS

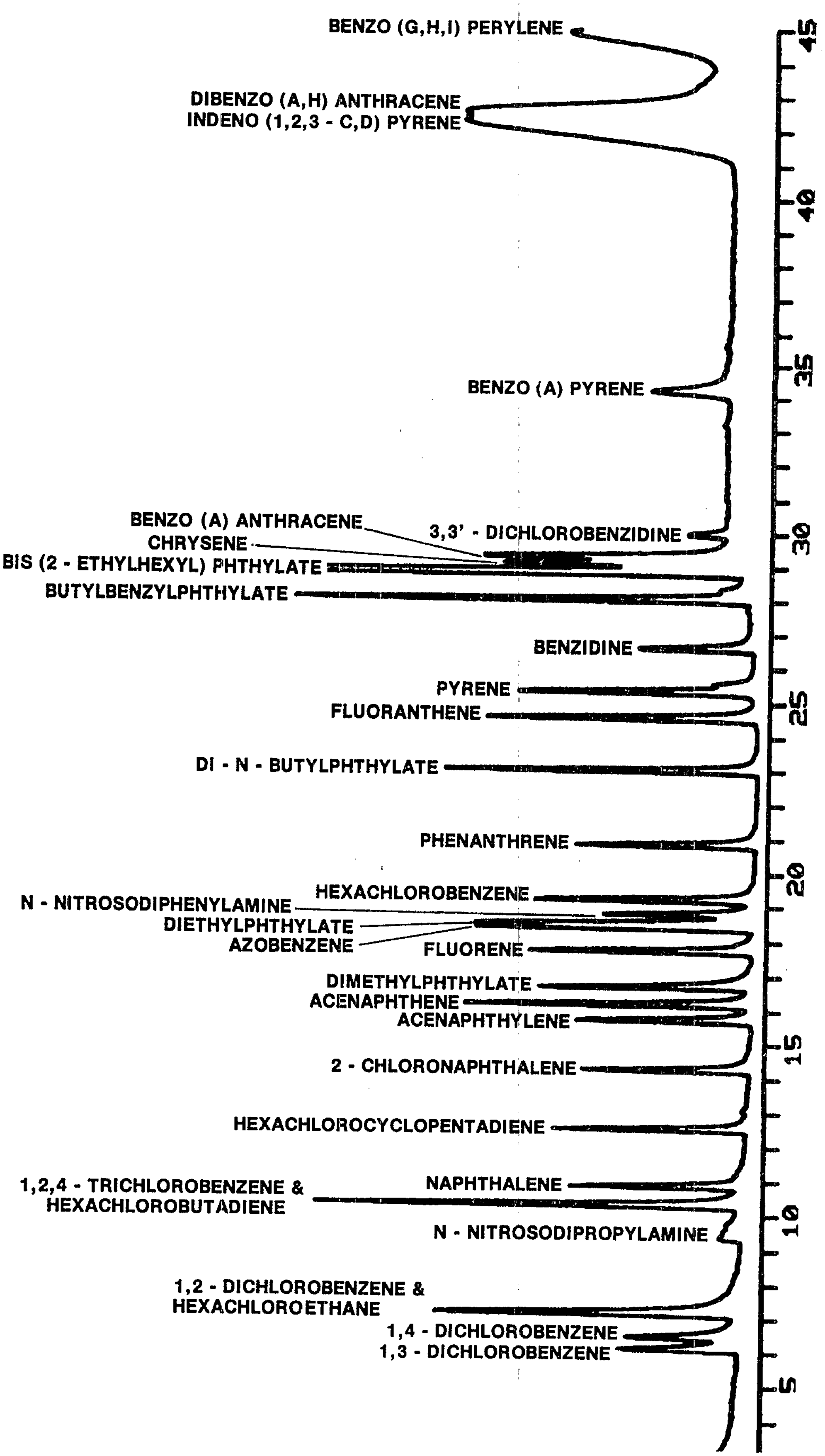


Figure C-2

RECONSTRUCTED TOTAL ION CURRENT CHROMATOGRAM FOR PHENOLIC STANDARD

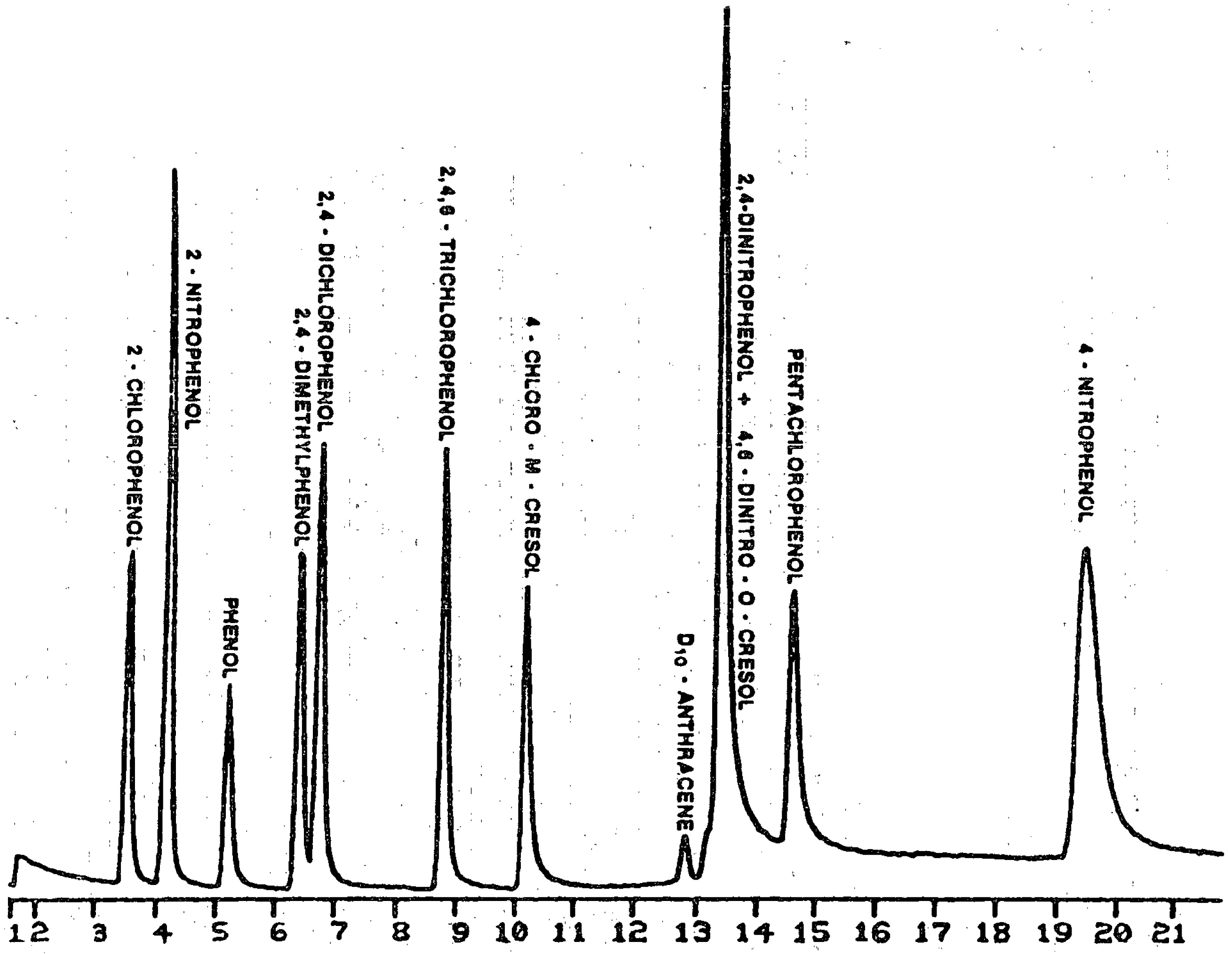


Figure C-3

Table C-5. Parameters for Base Neutral Analysis

GC Parameters	
Column	6 ft x 2 mm i.d., glass, 1% SP-2250 on 100/120 mesh Supelcoport
Carrier	He 30 ml/min
Program	50° isothermal 4 min then 8°/min to 275° for 8 min
Injector	285°
Separator	Single-stage glass jet at 275°
Injection Volume	2 ul
MS Parameters	
Instrument	Hewlett Packard 5985 A
Mass Range	35-335 amu
Ionization Mode	Electron impact
Ionization Potential	70 eV
Emission Current	200 uA
Scan time	2.4 sec

Table C-6. Parameters for Phenolic Analysis

GC Parameters	
Column	6 ft x 2 mm i.d., glass, 1% SP-1240 DA on 100/120 mesh Supelcoport
Carrier	He 30 ml/min
Program	90 to 200° at 8°/min with 16 min hold
Injector	250°
Separator	Single-stage glass jet at 250°
Injection Volume	2 ul
MS Parameters	
Instrument	Hewlett Packard 5985 A
Mass Range	35-335 amu
Ionization Mode	Electron impact
Ionization Potential	70 eV
Emission Current	200 uA
Scan time	2.4 sec

FLOW CHART FOR PESTICIDES AND PCB'S

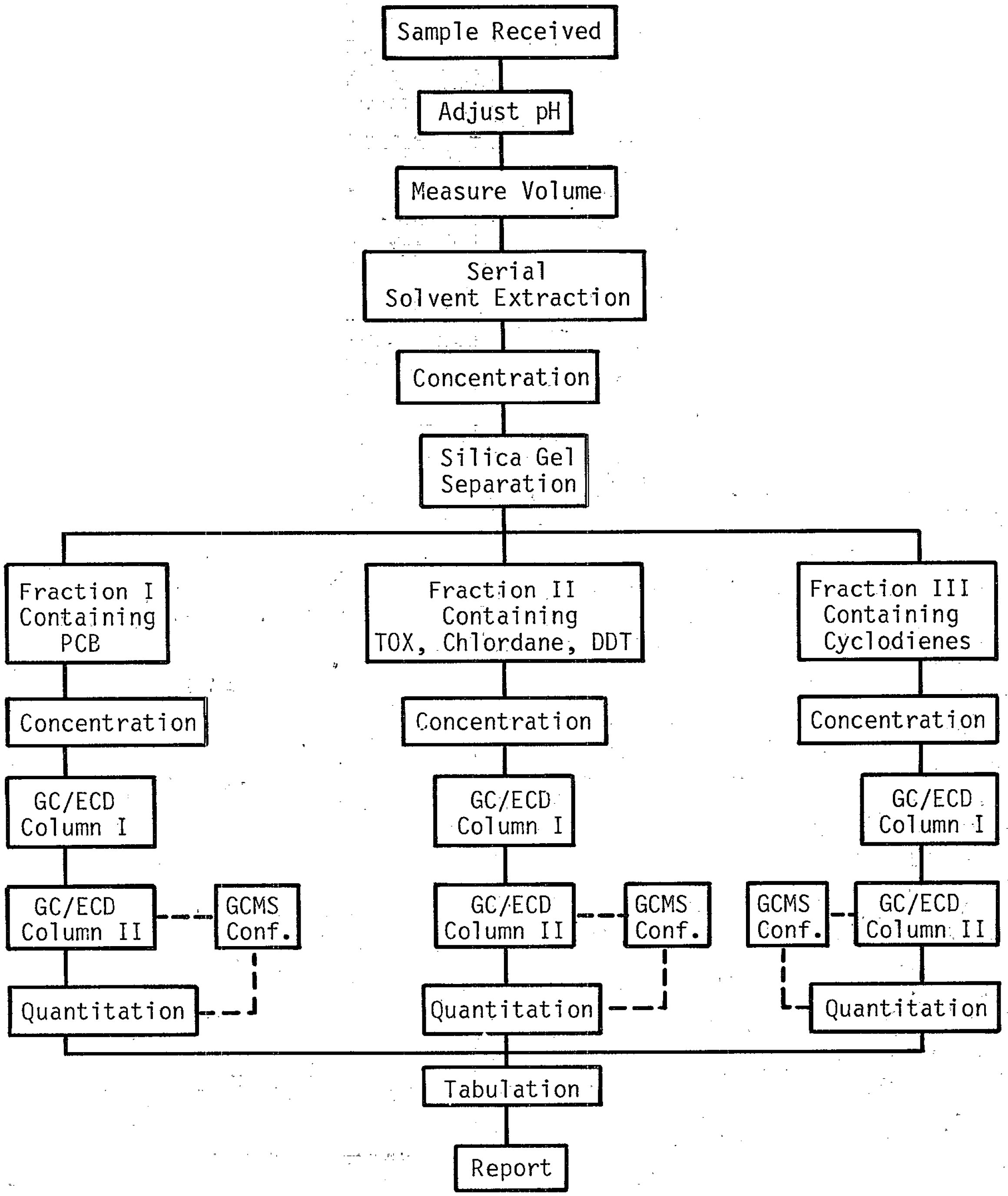


Figure C-4

The compounds of interest are listed in Table C-8 and a chromatogram of some selected representatives is shown in Figure C-5.

METALS

Metals analyzed consisted of the following:

- Beryllium
- Cadmium
- Chromium
- Copper
- Nickel
- Lead
- Zinc
- Silver
- Arsenic
- Antimony
- Selenium
- Thallium
- Mercury

With the exception of mercury, the screening metal analyses were performed by Inductively Coupled Argon Plasma at the EPA Laboratory in Chicago. Mercury samples were collected separately in 500-ml glass containers with nitric acid preservative and analyzed by the standard cold vapor technique.

Metals analysis for the verification phase were performed by atomic absorption according to the protocol method. This method entailed the complete digestion of the samples with strong acid and peroxide, then injection into a graphite furnace. Quantitation was accomplished by the standard addition method.

TRADITIONAL OR CLASSICAL PARAMETERS

The traditional parameters investigated included:

- BOD
- COD
- TSS
- TOC
- Oil and Grease
- Total Phenol
- Total Cyanide

All of these parameters were analyzed by standard methods. There were no deviations from these methods noted for any of the analyses.

The colormetric protocol method for cyanide entailed the steam distillation of cyanide from strongly acidic solution. The hydrogen cyanide gas was absorbed in a solution of sodium hydroxide, and the color was developed with addition of pyridine-pyrazolone.

Table C-7. GC/ECD Parameters for Pesticide and PCB Analysis

Column	6 ft x 1/8-in glass 1.5% OV-17/1.95% QF-1 Confirmation 6% SFc-30/4% OV210 On Supelcoport 80/100
Carrier	5% methane/Argon 50 ml/min
Program	200°C isothermal Ni63 Fc CD

Table C-8. Pesticides and PCB's

a-endosulfan
a-BHC
r-BHC
d-BHC delta
-BHC
aldrin
heptachlor
heptachlor epoxide
b-endosulfan
dieldrin
4,4'-DDE
4,4'-DDD
4,4'-DDT
endrin
endrin aldehyde
endosulfan sulfate
chlordane
toxaphene
PCB-1242
PCB-1254

PESTICIDE MIXED STANDARD

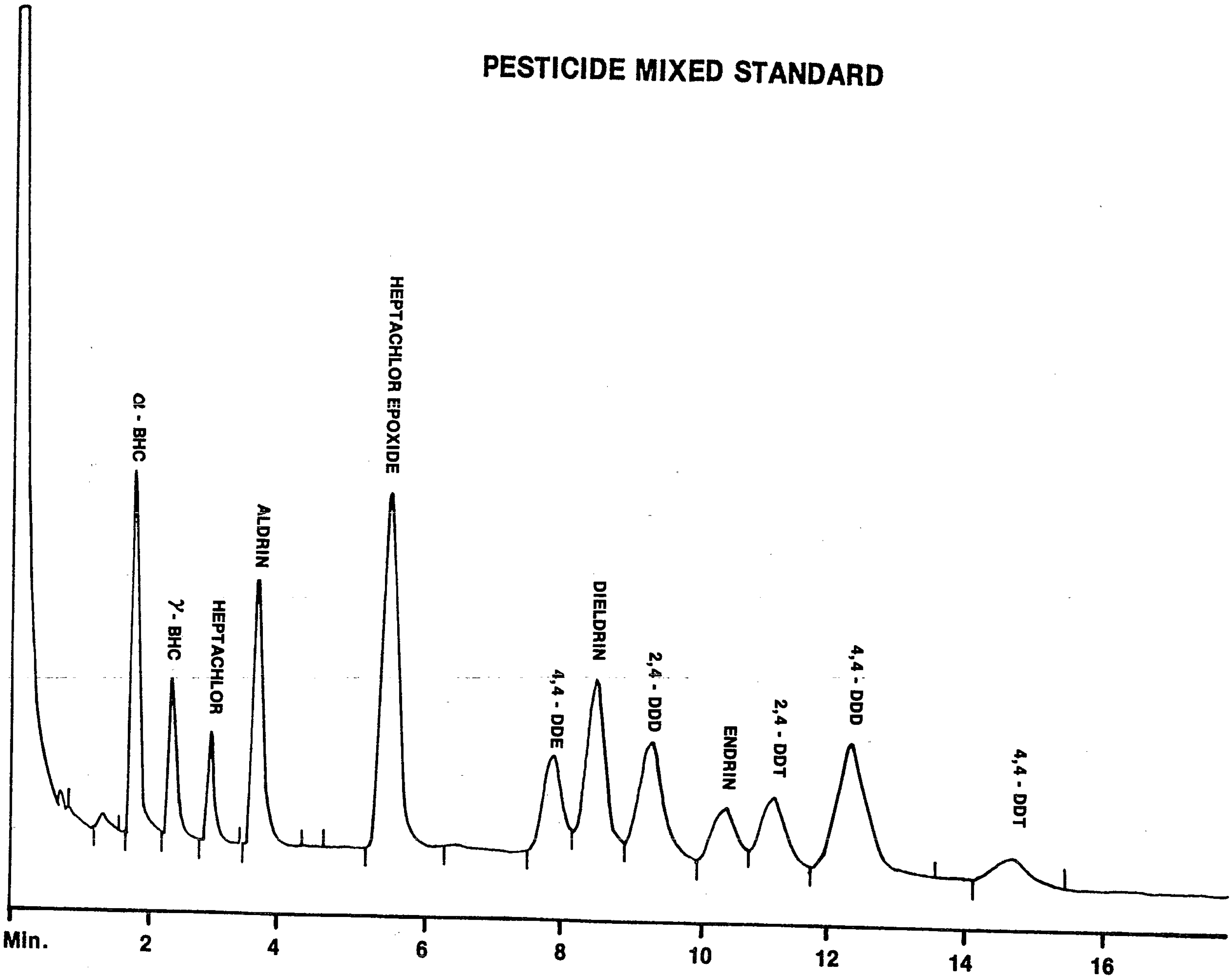


Figure C-5

APPENDIX D
CONVERSION TABLE

Multiply (English Units)		By	To Obtain (Metric Units)	
English Unit	Abbreviation	Conversion	Abbreviation	Metric Unit
acre	ac	0.405	ha	hectares
acre-feet	ac ft	1233.5	cu m	cubic meters
British Thermal Unit	BTU	0.252	kg cal	kilogram-calories
British Thermal Unit/pound	BTU/lb	0.555	kg cal/kg	kilogram calories per kilogram.
cubic feet per minute	cfm	0.028	cu m/min	cubic meters per minute
cubic feet per second	cfs	1.7	cu m/min	cubic meters per minute
cubic feet	cu ft	0.028	cu m	cubic meters
cubic feet	cu ft	28.32	l	liters
cubic inches	cu in	16.39	cu cm	cubic centimeters
degree Farenheit	°F	0.555(°F-32)*	°C	degree Centigrade
feet	ft	0.3048	m	meters
gallon	gal	3.785	l	liter
gallon per minute	gpm	0.0631	l/sec	liters per second
gallon per ton	gal/ton	4.173	l/kkg	liters per metric ton
horsepower	hp	0.7457	kw	kilowatts
inches	in	2.54	cm	centimeters
pounds per square inch	psi	0.06803	atm	atmospheres (absolute)

APPENDIX D
(continued)

Multiply (English Units)		By	To Obtain (Metric Units	
English Unit	Abbreviation	Conversion	Abbreviation	Metric Unit
million gallons per day	MGD	3.7 x 10-3	cu m/day	cubic meters per day
pounds per square inch (gauge)	psi	(0.06805 psi + 1)*	atm	atmospheres
pounds	lb	0.454	kg	kilograms
board feet	b.f.	0.0023	cu m, m3	cubic meters
ton	ton	0.907	kkg	metric ton
mile	mi	1.609	km	kilometer
square feet	ft2	.0929	m2	square meters

* Actual conversion, not a multiplier.

APPENDIX E

LITERATURE DISCUSSION OF BIOLOGICAL TREATMENT

ACTIVATED SLUDGE

Cooke and Graham (1965) performed laboratory scale studies on the biological degradation of phenolic wastes by the completed mixed activated sludge system. While many of the basic parameters needed for design were not presented, the final results were conclusive. The feed liquors contained phenolic compounds, thiocyanates, ammonia, and organic acids. Aeration varied from 8 to 50 hours. Influent concentration and percentage removal of total phenols averaged 281 mg/l and 78 percent, respectively, at a volumetric loading of 144 to 1,600 kg/100 cubic meters/day (9 to 100 lb/1,000 cubic feet/day).

Badger and Jackman (1961), studying bacteriological oxidation of total phenols in aerated reaction vessels on a continuous flow basis with a loading of approximately 1,600 to 2,400 kg/1,000 cubic meters/day (100 to 150 lb of total phenols/1,000 cubic feet/day) and MLSS of 2,000 mg/l, found that with wastes containing up to 5,000 mg/l total phenols, a two-day retention period could produce removal efficiencies in excess of 90 percent. Because the investigators were working with a coke gasification plant waste, the liquor contained thiocyanates. Higher oxidation efficiencies could be achieved with a reduction of the thiocyanate in the waste. Gas chromatography indicated no phenolic end products of degradation with original waste being a mixture of 36 percent monohydric and 64 percent polyhydric phenols.

Pruessner and Mancini (1967) obtained a 99 percent oxidation efficiency for BOD in petrochemical wastes. Similarly, Coe (1952) reported reductions of both BOD and total phenols of 95 percent from petroleum wastes in bench-scale tests of the activated sludge process. Optimum BOD loads of 2,247 kilograms/1,000 cubic meters per day (140 lb/1,000 cubic feet per day) were obtained. Coke plant effluents were successfully treated by Ludberg and Nicks (1969), although some difficulty in start-up of the activated sludge system was experienced because of the high total phenols content of the water.

The complete mixed, activated sludge process was employed to process a high phenolic wastewater from a coal-tar distilling plant in Ontario (American Wood Preservers' Association, 1960). Initial total phenols and COD concentrations of 500 and 6,000 mg/liter, respectively, were reduced in excess of 99 percent for total phenols and 90 percent for COD.

Coal gas washing liquor was successfully treated by Nakashio (1969) using activated sludge at a loading rate of 0.116 kg of total phenols/kg MLSS/day. An influent total phenols concentration of 1,200 mg/l was reduced by more than 99 percent in this year-long study. Similar total phenols removal rates were obtained by Reid and Janson (1955) in treating wastewaters generated by the washing and decarbonization of aircraft engine parts. Other examples of biological treatment of phenolic wastes include work by Putilena (1952, 1955), Meissner (1955), and Shukov, et al. (1957, 1959).

Of particular interest is a specific test on the biological treatment of coke plant wastes containing phenolic compounds and various organics. In a report of pilot and full scale studies performed by Kostenbader and Flacksteiner (1969), the complete mixed activated sludge process achieved greater than 99.8 percent oxidation efficiency of total phenols. Successful results were achieved with total phenols loadings of 0.86 kg total phenols/kg MLSS/day with an equivalent BOD loading of 2 kg BOD/kg MLSS/day. In comparison, a typical activated sludge loading is 0.4 kg BOD/kg MLSS/day. Effluent concentrations of total phenols from the pilot plant were 0.2 mg/l in contrast to influent concentrations of 3,500 mg/l. Slight variations in process efficiency were encountered with varying temperatures and loading rates. Phosphoric acid was added to achieve a phosphorus-to-total phenols ratio of 1:70. At the termination of pilot plant work, a similar large scale treatment plant processing of 424 cubic meters/day (112,000 gpd) was installed and resulted in an effluent containing less than 0.1 mg/l of total phenols.

Dust and Thompson (1972) conducted bench-scale tests of complete mixed activated sludge treatment of creosote and pentachlorophenol wastewaters using 5-liter units and detention times of 5, 10, 15, and 20 days. The operational data collected at steady-state conditions of substrate removal for the creosote waste are shown in Table E-1. A plot of these data showed that the treatability factor, K, was 0.30 days-1 (Figure E-1). The resulting design equation, with t expressed in days, is: $Le = Lo/(1 + 0.30t)$

A plot of percent COD removal versus detention time in the aerator based on the above equation, shown in Figure E-2, indicates that an oxidation efficiency of about 90 percent can be expected with a detention time of 20 days in units of this type.

Dust and Thompson (1972) also attempted to determine the degree of biodegradability of pentachlorophenol waste. Cultures of bacteria prepared from soil removed from a drainage ditch containing pentachlorophenol waste were used to inoculate the treatment units. Feed to the units contained 10 mg/liter of pentachlorophenol and 2,400 mg/liter COD. For the two 5-liter units (A and B) the feed was 500 and 1,000 ml/day and detention times were, in order, 10 and 5 days. Removal rates for pentachlorophenol and COD are given in Table E-2. For the first 20 days, Unit A removed only 35 percent of the pentachlorophenol added to the unit. However, removal increased dramatically afterward and averaged 94 percent during the remaining 10 days of the study. Unit B consistently removed over 90 percent of the pentachlorophenol added. Beginning on the 46th day and continuing through the 51st day, pentachlorophenol loading was increased at two-day intervals to a maximum of about 59 mg/liter. Removal rates for the 3 two-day periods of increased loadings were 94, 97, and 99 percent. COD removal for the two units averaged about 90 percent over the duration of the study.

Also working with the activated sludge process, Kirsh and Etzel (1972) obtained removal rates for pentachlorophenol in excess of 97 percent using an 8-hour detention time and a feed concentration of 150 mg/liter. The pentachlorophenol was supplied to the system in a mixture that included 100 mg/liter phenol. Essentially complete decomposition of the phenol was obtained, along with a 92 percent reduction in COD.

Cooper and Catchpole (1969) reported greater than 95 percent oxidation of total phenols using activated sludge units treating coke plant effluents containing phenolic compounds, thiocyanates, and sulfides. Adequate data were not available on the detailed operating parameters of the activated sludge plant.

TRICKLING FILTERS

Hsu, Yany, and Weng (1967) reported successful treatment of coke plant phenolic wastes with a trickling filter, removing over 80 percent of total phenols. It was stated that influent total phenols concentrations should not exceed 100 mg/liter.

Using a Surfpac trickling filter, Francingues (1970) was able to remove 80 to 90 percent of the influent total phenols from a wood preserving creosote wastewater at a loading rate of about 16 kg/1,000 cubic meters/day (1 pound total phenols/1,000 cubic feet/day).

Sweets, Hamdy, and Weiser (1954) studied the bacteria responsible for total phenols reductions in industrial waste and reported good total phenols removal from synthesized waste containing concentrations of 400 mg/l. Reductions of 23 to 28 percent were achieved in a single pass of the wastewater through a pilot trickling filter having a filter bed only 30 centimeters (12 inches) deep.

Waters containing total phenols concentrations of up to 7,500 mg/l were successfully treated in laboratory tests conducted by Reid and Libby (1957). Total phenols removals of 80 to 90 percent were obtained for concentrations on the order of 400 mg/l. Their work confirmed that of Ross and Shepard (1955) who found that strains of bacteria isolated from a trickling filter could survive total phenols concentrations of 1,600 mg/liter and were able to oxidize total phenols in concentrations of 450 mg/liter at better than 99 percent efficiency. Reid, Wortman, and Walker (1956) found that many pure cultures of bacteria were able to live in total phenols concentrations of up to 200 mg/l, and although the bacteria survived concentrations above 900 mg/l, some were grown in concentrations as high as 3,700 mg/l.

Harlow, Shannon, and Sercu (1961) described the operation of a commercial size trickling filter containing "Dowpac" filter medium that was used to process wastewater containing 25 mg/l total phenols and 450 to 100 mg/l BOD. Reductions of 96 percent for total phenols and 97 percent for BOD were obtained in this unit. Their results compare favorably with those reported by Montes, Allen, and Schowell (1956) who obtained BOD reductions of 90 percent in a trickling filter using a 1:2 recycle ratio, and Dickerson and Laffey (1958), who obtained total phenols and BOD reductions of 99.9 and 96.5 percent, respectively, in a trickling filter used to process refinery wastewater.

A combination biological waste treatment system employing a trickling filter and an oxidation pond was reported by Davies, Biehl, and Smith (1967). The filter, which was packed with a plastic medium, was used for a roughing treatment of 10.6 million liters (2.8 million gallons) of wastewater per day, with final treatment occurring in the oxidation pond. Removal rates of 95 percent for total phenols and 60 percent for BOD were obtained in the filter, notwithstanding the fact that the pH of the influent averaged 9.5.

A study of biological treatment of refinery wastewaters by Austin, Meehan, and Stockham (1954) employed a series of four trickling filters, with each filter operating at a different recycle ratio. The waste contained 22 to 125 mg/l of oil which adversely affected BOD removal. However, total phenols removal was unaffected by oil concentrations within the range studies.

Prather and Gaudy (1964) found that significant reductions of COD, BOD, and total phenols concentrations in refinery wastewater were achieved by simple aeration treatments. They concluded that this phenomenon accounted for the high allowable loading rates for biological treatments such as trickling filtration.

The practicality of using trickling filters for secondary treatment of wastewaters from the wood preserving industry was explored by Thompson and Dust (1972). Creosote wastewater was applied at BOD loading rates of from 400 to 3,050 kg/1,000 cu m/day (25 to 190 lb/1,000 cu ft/day) to a pilot unit containing a 6.4 meter- (21 foot-) filter bed of plastic media. The corresponding total phenols loadings were 1.6 to 54.6 kg/ 1,000 cu m/day (0.1 to 3.4 lb/1,000 cu ft/day). Raw feed-to-recycle ratios varied from 1:7 to 1:28. Daily samples were analyzed over a period of seven months that included both winter and summer operating conditions. Because of wastewater characteristics at the particular plant cooperating in the study, the following pretreatment steps were necessary: (1) equalization of wastes; (2) primary treatment by coagulation for partial solids removal; (3) dilution of the wastewater to obtain BOD loading rates commensurate with the raw flow levels provided by the equipment;

and (4) addition to the raw feed of supplementary nitrogen and phosphorus. Dilution ratios of 0 to 14 were used.

The efficiency of the system was essentially stable for BOD loadings of less than 1,200 kg/1,000 cu m/day (75 lb/1,000 cu ft/day). The best removal rate was achieved when the hydraulic application rate was 2.85 l/min/m (0.07 gpm/sq ft) of raw waste and 40.7 l/min/m (1.0 gpm/sq ft) of recycled waste. The COD, BOD, and total phenols removals obtained under these conditions are given in Table E-3. Table E-4 shows the relationship between BOD loading rate and removal efficiency. BOD removal efficiency at loading rates of 1,060 kg/1,000 cu m/day (66 lb/ 1,000 cu ft/day) was on the order of 92 percent, and was not improved at reduced loadings. Comparable values for total phenols at loading rates of 19.3 kg/1,000 cu m/day (1.2 pounds/1,000 cu ft/day) were about 97 percent.

Since total phenols concentrations were more readily reduced to levels compatible with existing standards than were BOD concentrations, the sizing of commercial units was based on BOD removal rates. Various combinations of filter-bed depths, tower diameters, and volumes of filter media that were calculated to provide a BOD removal rate of 90 percent for an influent having a BOD of 1,500 mg/l are shown in Table E-5 for a plant with a flow rate of 75,700 l/day (20,000 gpd).

STABILIZATION PONDS

The American Petroleum Institute's "Manual on Disposal of Refinery Wastes" (1960) refers to several industries that have successfully used oxidation ponds to treat phenolic wastes. Montes (1956) reported on results of field studies involving the treatment of petrochemical wastes using oxidation ponds. He obtained BOD reductions of 90 to 95 percent in ponds loaded at the rate of 84 kg of BOD per hectare per day (75 lb/acre/day).

Total phenols concentrations of 990 mg/l in coke oven effluents were reduced by about 7 mg/l in field studies of oxidation ponds conducted by Biczyski and Suschka (1967). Similar results have been reported by Skogen (1967) for a refinery waste.

The literature contains operating data on only one pond used for treating wastewater from wood preserving operations (Crane, 1971; Gaudy, et al., 1965; Gaudy, 1971). The oxidation pond is used as part of a waste treatment system by a wood preserving plant. As originally designed and operated in the early 1960's, the waste treatment system consisted of holding tanks into which water from oil-recovery system flowed. From the holding tanks the water was sprayed into a terraced hillside from which it flowed into a mixing chamber adjacent to the pond. Here it was diluted 1:1 with creek water, fertilized with ammonia and phosphates, and discharged into the pond proper. Retention time in the pond was 45 days. The quality of the effluent was quite variable, with total phenols content ranging up to 40 mg/l. In 1966, the system was modified by installing a raceway containing a surface aerator and a settling basin in a portion of the pond. The discharge from the mixing chamber now enters a raceway where it is treated with a flocculating agent. The resulting floc collects in the settling basin. Detention time is 48 hours in the raceway and 18 hours in the settling basin from which the wastewater enters the pond proper.

These modifications in effect changed the treating system from an oxidation pond to a combination aerated lagoon and polishing pond, and the effect on the quality of the effluent was dramatic. Figure E-3 shows the total phenols content at the outfall of the pond before and after installation of the aerator. As shown by these data, total phenols content decreased abruptly from an average of about 40 mg/l to 5 mg/l.

Even with the modifications described, the efficiency of the system remains seasonally dependent. Table E-6 gives total phenols and BOD values for the pond effluent by month for 1968 and 1970. The smaller fluctuations in these parameters in 1970 as compared with 1968 indicate a gradual improvement in the system.

Amberg (cir. 1964) reported on an aerated lagoon with an oxygen supply of 2,620 kg/day which (5,770 lb/day) was used to treat whitewater with a design BOD load of 2,780 kg/day (6,120 lb/day). The lagoon was uniformly mixed and had an average dissolved oxygen concentration of 2.9 mg/l.

Suspended solids increased across the lagoon as a result of biological floc formation, but could be readily removed by subsequent sedimentation. The final effluent averaged 87 mg/l suspended solids during the three days of the study.

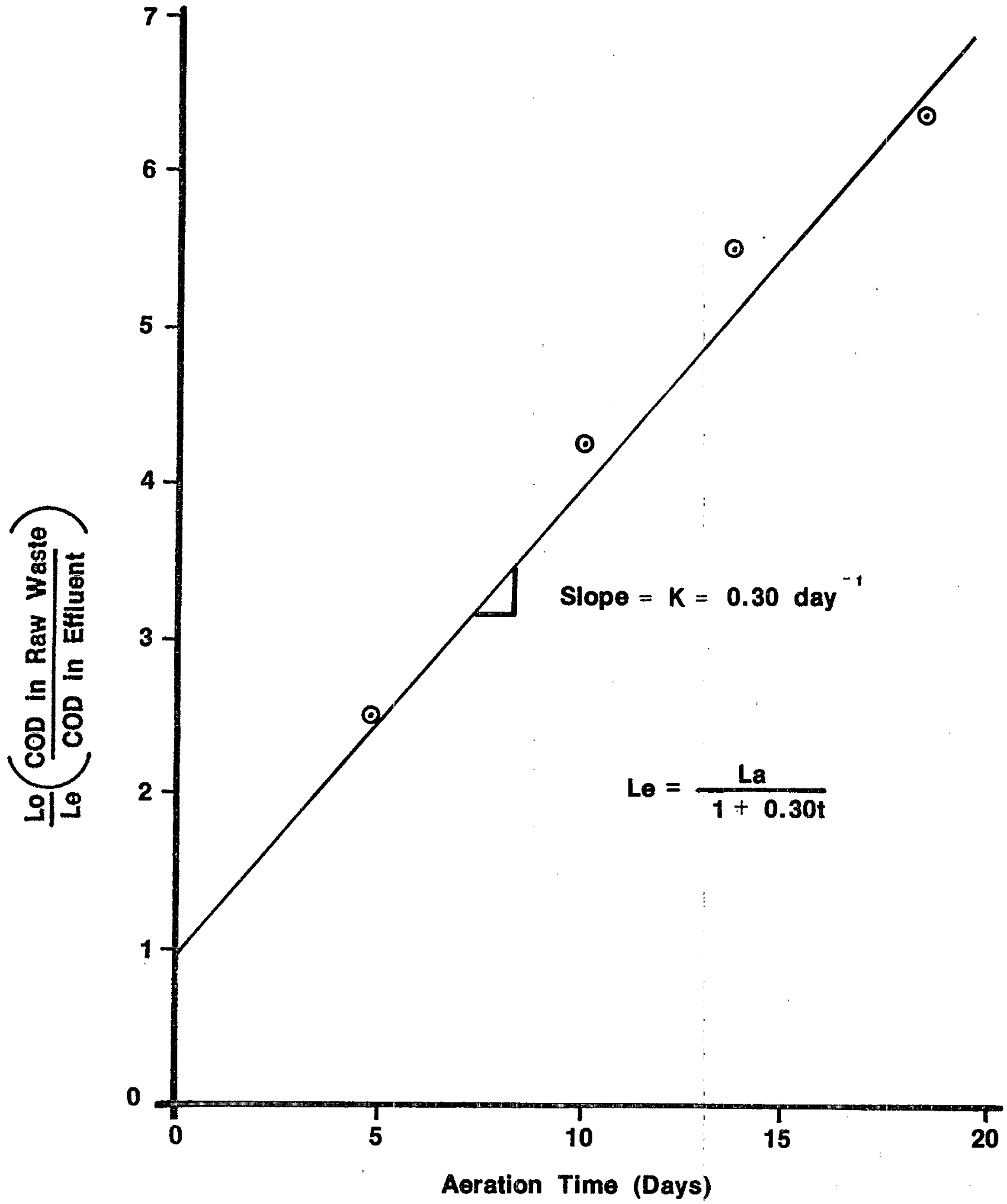
The overall plant efficiency for BOD removal was 94 percent, producing a final effluent with an average BOD concentration of 60 mg/l.

Quirk (1969) reported on a pilot plant study of aerated stabilization of boxboard wastewater. Detention times ranged from 0.5 to 0.6 day. The study indicated that full-scale performance, with nutrient addition, could achieve a 90 percent reduction of BOD with a detention time of 4 days.

Table E-1. Substrate Removal at Steady-State Conditions in Activated Sludge Units Containing Creosote Wastewater

Aeration Time, Days	5.0	10.0	14.7	20.1
COD Raw, mg/l	447	447	442	444
COD Effluent, mg/l	178	103	79	67
% COD Removal	60.1	76.9	82.2	84.8
COD Raw/COD Effluent	2.5	4.3	5.6	6.6

SOURCE: Thompson and Dust, 1972.



Determination of Reaction Rate Constant for a Creosote Wastewater

Figure E-1

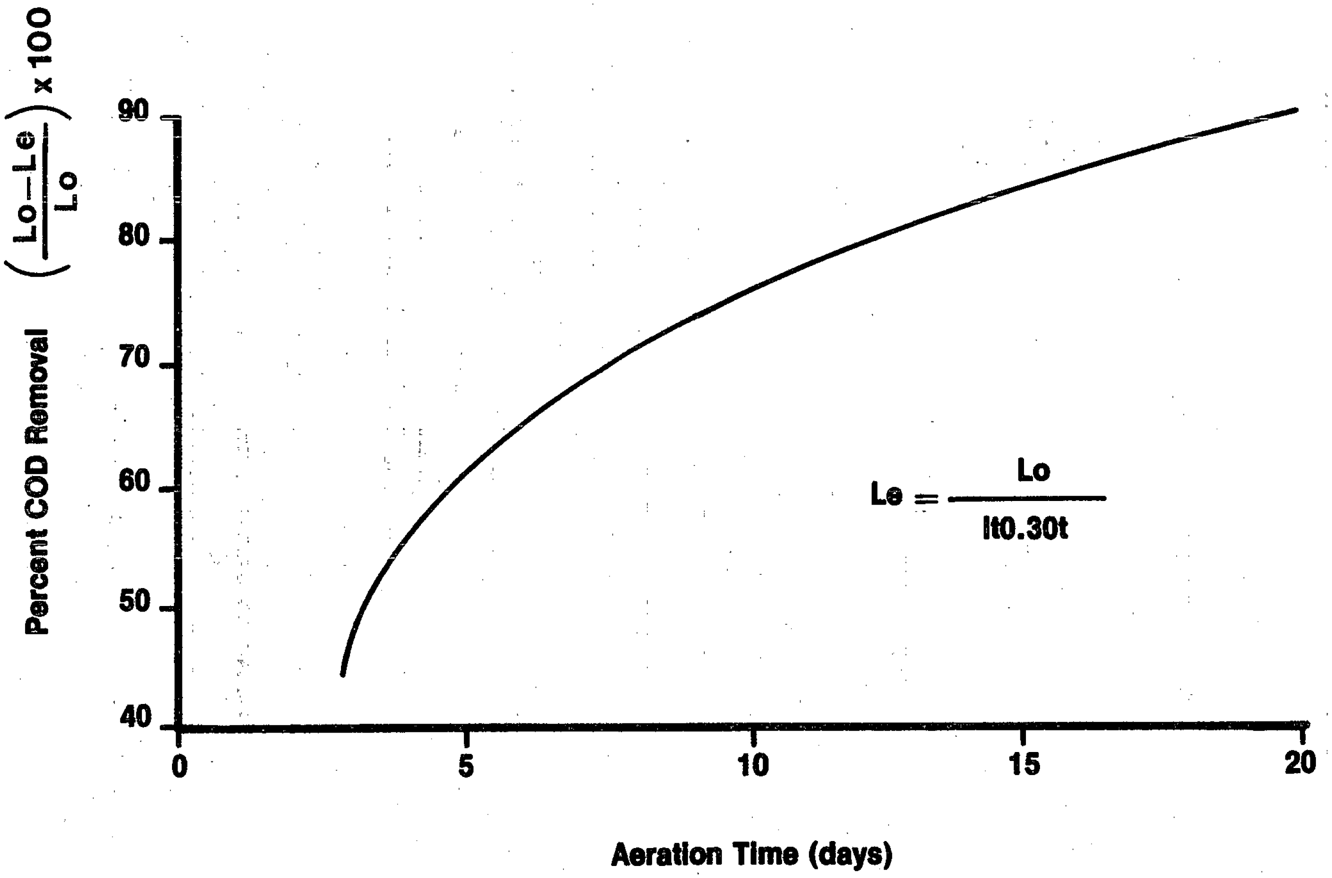


Figure E-2

COD Removal from a Creosote Wastewater by Aerated Lagoon without Sludge Return

Table E-2. Reduction in Pentachlorophenol and COD in Wastewater Treated in Activated Sludge Units

Days	Raw Waste (mg/l)	Effluent from Unit (% Removal) "A"	"B"
	COD		
1-5	2350	78	78
6-10	2181	79	79
11-15 Removal	2735	76	75
16-20	2361	82	68
21-25	2288	90	86
26-30	2490	--	84
31-35	2407	83	80
	PENTACHLOROPHENOL		
1-5	7.9	20	77
6- 10	10.2	55	95
11-15	7.4	33	94
16-20	6.6	30	79
21-25	7.0	--	87
26-30	12.5	94	94
31-35	5.8	94	91
36-40	10.3	--	91
41-45	10.0	--	96
46-47	20.0	--	95
48-49	30.0	--	97
50-51	40.0	--	99

SOURCE: Thompson and Dust, 1972.

Table E-3. BOD, COD, and Total Phenols Loading and Removal Rates for Pilot Trickling Filter Processing A Creosote Wastewater*

Measurement	Characteristics BOD	 COD	 Total Phenols
Raw Flow Rate l/min/sq m (gpm/sq ft)	2.85 (0.07)	2.85 (0.07)	2.85 (0.07)
Recycle Flow Raw l/min/sq m (gpm/sq ft)	40.7 (1.0)	40.7 (1.0)	40.7 (1.0)
Influent Concentration (mg/l)	1968	3105	31
Loading Rate gm/cu m/day	1075 (66.3)	1967 (121.3)	19.5 (1.2)
Effluent Concentration (mg/l)	137	709	1.0
Removal (%)	91.9	77.0	99+

* Based on work at the Mississippi Forest Products Laboratory as reported by Davies (1971).

Table E-4. Relationship Between BOD Loading and Treatability for Pilot Trickling Filter Processing A Creosote Wastewater

BOD Loading kg/cu m	BOD Loading (lb/cu ft/day)	Removal (%)	Treatability* Factor
373	(23)	91	0.0301
421	(26)	95	0.0383
599	(37)	92	0.0458
859	(53)	93	0.0347
1069	(66)	92	0.0312
1231	(76)	82	0.0339
1377	(85)	80	0.0286
1863	(115)	75	0.0182
2527	(156)	62	0.0130

* Based on the equation:

$$\frac{Le}{Lo} = eKD/Q0.5 \text{ (EPA, 1976)}$$

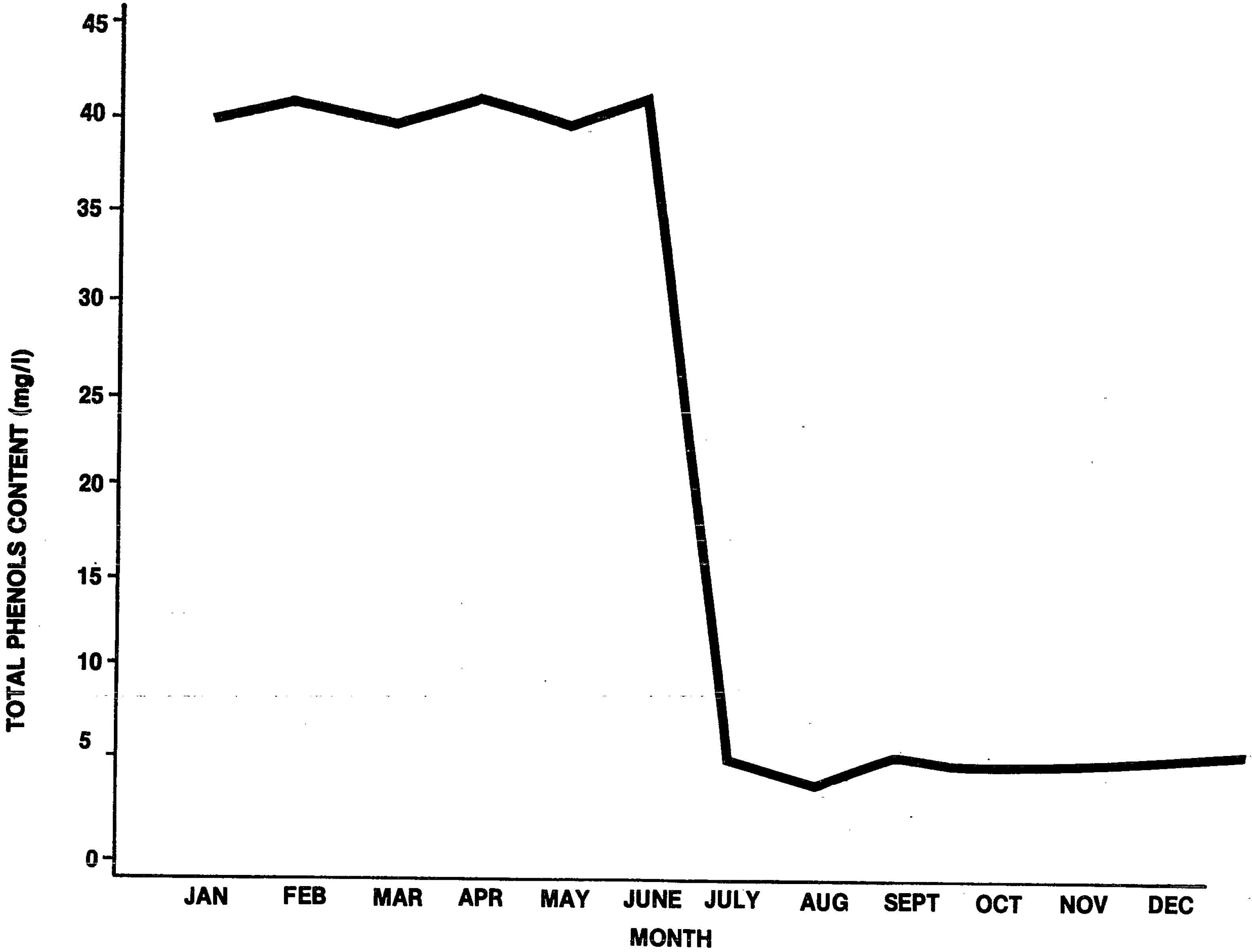
in which Le = BOD concentration of settled effluent, Lp = BOD of feed, Q2 = hydraulic application rate of raw waste in gpm/sq ft, D = depth of media in feet, and K = treatability factor (rate coefficient).

Table E-5. Sizing of Trickling Filter for a Wood Preserving Plant

NOTE: Data are based on a flow rate of 75,700 liters per day (20,000 gallons per day) with filter influent BOD of 1,500 and effluent BOD of 150 mg/l.

Depth of Filter Bed m (ft)	Raw Flow l/min/sq m (gpm/sq ft) Filter Surface	Recycle Flow l/min/sq m (gpm/sq ft) Filter Surface	Filter Surface Area sq m (sq ft)	Tower dia sq m (sq ft)	Volume of Media cu m (cu ft)
3.26 (10.7)	0.774 (0.019)	29.7 (0.73)	65.8 (708)	9.14 (30.0)	213 (7617)
3.81 (12.5)	1.059 (0.206)	29.3 (0.72)	48.3 (520)	7.83 (25.7)	183 (6529)
4.36 (14.3)	1.385 (0.034)	28.9 (0.71)	37.0 (398)	6.86 (22.5)	160 (5724)
4.91 (16.1)	1.793 (0.044)	28.5 (0.70)	29.3 (315)	6.10 (20.0)	142 (5079)
5.46 (17.9)	2.200 (0.054)	28.1 (0.69)	23.7 (255)	5.49 (18.0)	128 (4572)
5.97 (19.6)	2.648 (0.065)	27.7 (0.68)	19.5 (210)	4.97 (16.3)	116 (4156)
6.52 (21.4)	3.178 (0.078)	27.3 (0.67)	16.4 (177)	4.57 (15.0)	107 (3810)

Figure E-3



TOTAL PHENOLS CONTENT IN OXIDATION POND EFFLUENT BEFORE AND AFTER INSTALLATION IN JUNE 1966 OF AERATOR

Table E-6. Average Monthly Total Phenols and BOD Concentrations in Effluent from Oxidation Pond

Month	1968 Total Phenols	1968 BOD	1970 Total Phenols	1970 BOD
January	26	290	7	95
February	27	235	9	140
March	25	190	6	155
April	11	150	3	95
May	6	100	1	80
June	5	70	1	60
July	7	90	1	35
August	7	70	1	45
September	7	110	1	25
October	16	150	--	--
November	7	155	--	--
December	11	205	--	--

SOURCE: Crane, 1971; Gaudy, et al., 1965; Gaudy, 1971.

APPENDIX F.

DISCUSSION OF POTENTIALLY APPLICABLE TECHNOLOGIES

WOOD PRESERVING

Tertiary Metals Removal

The most difficult ion to reduce to acceptable concentrations levels is arsenic. Treatment of water containing arsenic with lime generally removes only about 85 percent of the metal. Removal rates in the range of 94 to 98 percent have been reported for filtration through ferric hydroxide. However, none of these methods is entirely satisfactory, particularly for arsenic concentrations above 20 mg/liter.

A detailed treatise on treatment technology for wastewater containing heavy metals was recently published in book form (Patterson, 1975). Methods of treatment for arsenic presented by the author are shown in Table F-1.

Chemical precipitation and filtration employing ferric compounds and sulfides were at least as effective as lime precipitation, which, as indicated above, has been employed to a limited extent by the wood preserving industry. However, with one or two possible exceptions, none of the methods is as effective as the combination physical-chemical method described in the EPA report discussed above (Technology Transfer, January 1977), particularly when initial concentration is taken into account. Chemical oxidation of arsenate to arsenite prior to coagulation treatment was reported to improve arsenic removal. Incomplete removal of the metal by coagulation treatments was believed by the author to be caused by the formation of a stable complex with the precipitating metal. More complete removal of arsenite was assumed to indicate that arsenate forms the more stable complexes.

Among other methods of chemical precipitation, use of thioacetamide and dibromo-oxine is mentioned in the literature (Cadman, 1974). "Complete" recovery of chromium and zinc is claimed for the first-named chemical, and "100-percent" recovery of copper, zinc, and chromium is reported for dibromo-oxine.

Considering cost, no more efficient chemical method of removing hexavalent chromium and copper from solution than the standard method (reduction of chromium to trivalent form followed by lime precipitation of both metals) is revealed by the literature. However, to meet increasingly stringent effluent standards, some industries have turned to an ion exchange technique.

Cadman (1974) has reported excellent results in removing metals from wastewater using ion exchange. The resin, Chelex-100, removed "essentially" 100 percent of the zinc, copper, and chromium in his tests. Chitosan, Amberlite, and Permutit-S1005 were also reported to be highly effective. The Permutit resin removed 100 percent of the copper and zinc but only 10 percent of the chromium.

Membrane Systems

This term refers to both ultrafiltration and reverse osmosis (RO). The main difference between these two membrane systems involves the difference in pore size of the membrane. The ultrafiltration membrane, with the larger pore openings, separates substances from wastewater mainly because the physical size and shape of the molecules of the substances do not allow them to pass through the membrane. Ultrafiltration is employed primarily to remove suspended solids and emulsified materials in wastewater, although some dissolved substances of large molecular size will also be removed. The RO membrane, with smaller pore openings, relies on both physical separation, as utilized in ultrafiltration, and a particle charge repulsion mechanism. RO removes all or part of the dissolved substances, depending upon the molecular species involved, and virtually all of the suspended substances. Both technologies are currently used as part of the wastewater treatment system of many diverse industries (Lin and Lawson, 1973; Goldsmith, et al., 1973; Stadnisky, 1974) and have potential application in the Wood Preserving Industry for oil removal.

Ultrafiltration treatment of oily waste basically involves passing the waste under a pressure of 2.1 to 3.6 atm (30 to 50 psi) over a membrane cast onto the inside of a porous fiberglass tube. The water phase of the waste is forced through the membrane and discarded, reused, or further processed by other means. The oil and other solids not in solution remain in the tube. The process in effect concentrates the waste. Volume reductions on the order of 90 to 96 percent have been reported (Goldsmith, et al., 1973; Stadnisky, 1974).

Results obtained in pilot- and full-scale operations of ultrafiltration systems have been mixed. Goldsmith, et al., (1973), operated a pilot unit continuously (24 hours per day) for six weeks processing waste emulsions containing 1 to 3 percent oil. The permeate from the system, which was 95 percent of the original volume, contained 212 mg/liter ether extractables--primarily water-soluble surfactants. A 15,140-l/day (4,000 gpd) system installed, based on the pilot plant data, produced a permeate containing 25 mg/liter ether extractables. No significant reduction in flux rate with time was observed in either the pilot- or full-scale operation.

Ultrafiltration tests of a pentachlorophenol wastewater were conducted by Abcor, Inc., in cooperation with the Mississippi Forest Products Laboratory (1974). The samples contained 2,160 mg/liter oil and had a total solids concentration of 3,900 mg/liter. Flow rate through the system was 95 l/min (25 gpm) at a pressure of 3.3 atm (48 psi). A 26-fold volumetric concentration, representing a volume reduction of 96.2 percent, was achieved. Two membrane types were tested. Both showed a flux decline on the order of 55 to 60 percent with increasing volumetric concentration. A detergent flush of the system was found to be necessary at the end of each run to restore the normal flux values of 35 l/sq m/day (35 gal/sq ft/day). Oil content of the permeate was 55 mg/liter. While this value represents a reduction of over 97 percent, it does not meet the requirements for stream discharge. COD was reduced 73 percent.

The principal of reverse osmosis (RO) is similar to that of ultrafiltration. However, higher hydraulic pressures, 27.2 to 40.8 atm (400 to 600 psi), are employed and the membranes are semipermeable and are manufactured to achieve rejection of various molecular sizes. Efficiency varies, but rejection of various salts in excess of 99 percent has been reported (Merten and Bray, 1966). For organic chemicals, rejection appears to be a function of molecular size and shape. Increases in chain length and branching are reported to increase rejection (Durvel and Helfgott, 1975). Total phenols are removed to the extent of only about 20 percent by cellulose acetate membranes, while polyethylenimine membranes increase this percentage to 70 but achieve a lower flux rate (Fang and Chian, 1975). In case studies that have been cited, RO was found to be competitive with conventional waste treatment systems only when extremely high levels of treatment were required (Kremen, 1975).

Removals of 83 percent TOC and 96 percent TDS were reported for RO in which cellulose acetate membranes at 40.8 atm (600 psi) were used (Boen and Jahannsen, 1974). Flux rates in this work of 129 to 136 l/sq m/day (34 to 36 gal/sq ft/day) were achieved. However, in other work, pretreatment by carbon adsorption or sand filtration was found to be necessary to prevent membrane fouling (Rozelle, 1973). Work by the Institute of Paper Chemistry (Morris, et al., 1972) indicates that membrane fouling by suspended solids or large molecular weight organics can be controlled in part by appropriate pretreatment, periodic pressure pulsations, and washing of the membrane surfaces. In this and other work (Wiley, et al., 1972), it was concluded that RO is effective in concentrating dilute papermill waste and produces a clarified water that can be recycled for process purposes.

Recycling of process wastewater, following ultrafiltration and RO treatment, was being attempted by Pacific Wood Treating Corporation, Ridgefield, Washington. The concentrated waste is incinerated and the permeate from the system is used for boiler feed water. The system, which cost approximately $200,000 began operation in 1977. An evaluation of the effectiveness of the system will be made under an EPA grant.

Data on the use of RO with wood preserving wastewater were provided by the cooperative work between Abcor, Inc., and the Mississippi Forest Products Laboratory referred to above (1974). In this work, the permeate from the ultrafiltration (UF) system was processed further in an RO unit. Severe pressure drop across the system indicated that fouling of the membranes occurred. However, module rejection remained consistent throughout the run. Permeate from the system had an oil content of 17 mg/liter, down from 55 mg/liter, and the COD was reduced by 73 percent. Total oil removal and COD reductions in the UF and RO systems were 99 percent and 92 percent, respectively.

Adsorption on Synthetic Adsorbents

Polymeric adsorbents have been recommended for use under conditions similar to those where carbon adsorption is indicated (Stevens and Kerner, 1975). Advantages cited for these materials include efficient removal of both polar and nonpolar molecules from wastewater, ability to tailor-make an adsorbent for a particular contaminant, small energy inputs for regeneration compared to carbon, and lower cost compared to carbon where carbon depletion rates are greater than 2.3 kg per 3,785 liters (5 pounds per 1,000 gallons). Data on efficiency of polymeric adsorbents were not presented.

Clay minerals, such as attapulgite clay, have been recommended for use in removing certain organics and heavy metals from wastewater (Morton and Sawyer, 1976).

Oxidation by Chlorine

The use of chlorine and hypochlorites as a treatment to oxidize phenol-based chemicals in wastewater is widely covered in the literature. A review of this literature, with emphasis on the employment of chlorine in treating wood preserving wastewaters, was presented in a recent EPA document (1973).

The continued use of chlorine as an oxidizing agent for phenols is in question for at least two reasons. There is, first of all, a concern over recent supply problems and the increasing cost of the chemical (Rosfjord, et al., 1976). Secondly, chlorine treatments of phenolic wastes form mono-, di-, and trichlorophenols which persist unless sufficient dosages are used to rupture the benzene ring (EPA, 1973). It is probably true that low-level chlorine treatments of these waters are worse than no treatment at all because of the formation of such compounds.

For these and possibly other reasons, attention has been focused on other oxidizing agents equally as capable as chlorine of oxidizing phenolic compounds without creating these additional problems.

Oxidation by Potassium Permanganate

This is a strong oxidizing agent that is being marketed as a replacement for phenol. One vendor (Carus Chemical Company, 1971) claims that the chemical "cleaves the aromatic carbon ring of the phenol and destroys it" and then degrades the aliphatic chain thus created to innocuous compounds. Stoicheometrically, 7.13 kg of $KMnO_4$ are required to oxidize one kilogram of phenol. According to Rosfjord, et al. (1976), however, ring cleavage occurs at ratios of about 7 to 1. A higher ratio is required to reduce the residual organics to CO_2 and H_2O.

As in the case of chlorine (EPA, 1973), the presence of oxidizable materials other than phenol in wastewater greatly increases the amount of $KMnO_4$ required to oxidize a given amount of phenol. In the trade literature cited above, it was stated that $10 worth of $KMnO_4$ was required to treat 3,785 liters (1,000 gallons) of foundry waste containing 60 to 100 mg/liter of total phenols. Eighty milligrams per liter of total phenols in 3,785 liters (1,000 gallons) is equivalent to 0.3 kg (0.67 pounds). At a 7:1 ratio, the treatment should have cost $2.35.

The actual ratio was 30:1 and the cost was about $15 per 0.454 kilograms (one pound) of total phenols removed. The latter figure agrees with one vendor's data, which indicated a cost of $0.15 per mg/liter of total phenols per 3,785 liters (1,000 gallons) of wastewater.

Limited studies conducted by the Mississippi Forest Products Laboratory revealed no cost advantage of $KMnO_4$ over chlorine in treating wood preserving wastewater. The high content of oxidizable materials other than phenol in this type of waste consumes so much of the chemical that massive doses are required to eliminate phenolic compounds.

Oxidation by Hydrogen Peroxide

This is a powerful oxidizing agent, the efficacy of which is apparently enhanced by the presence of ferrous sulfate which acts as a catalyst. Reductions in total phenols content of 99.9 percent (in wastewater containing 500 mg/liter) have been reported for H_2O_2 when applied in a 2:1 ratio (Anonymous, 1975). A reaction time of 5 minutes was required. Ferrous sulfate concentrations of 0.1 to 0.3 percent were used. COD concentration was reduced to 760 mg/liter from 1,105 mg/liter.

According to Eisenhauer (1964), the reaction involves the intermediate formation of catechol and hydroquinone, which are oxidized by the ferric ion to quinones. As is the case with other oxidizing agents, the degree of substitution on the phenol molecule affects the rate of reaction. Substituents in the _ortho_ and _para_ positions reduced the reaction rate the most, and complete substitution (e.g., pentachlorophenol) prevented the reaction from taking place. Solution pH had a significant effect on the efficiency of the treatment. Optimum pH was in the range of 3.0 to 4.0, with efficiency decreasing rapidly at both higher and lower values.

Treatments of industrial wastes were reported by Eisenhauer to require higher levels of H_2O_2 than simple phenol solutions because of the presence of other oxidizable materials. In fact, the required ratio of H_2O_2 to total phenols varied directly with COD above the level contributed by the total phenols itself. At all ratios studied with industrial wastes, total phenols levels dropped rapidly during the early part of the reaction period, then remained unchanged thereafter. For some types of wastes, the addition of high concentrations of H_2O_2, up to molar ratios of 16:1, did not cause significant further decreases in total phenols content. Similar results have been reported for wood preserving wastewater treated with chlorine (EPA, 1973). Prechlorination of wastes with high COD contents reduced the amount of H_2O_2 required in some cases, but not in others.

Hydrogen peroxide (H_2O_2) has not been used on a commercial scale to treat wastewater from the wood preserving industry or, based on the available literature, wastewaters from related industries. The cost of the chemical is such that a relatively high phenol removal efficiency must ensue to justify its use. The available evidence suggests that, in common with other oxidizing compounds, organics other than phenol consume so much of the reagent as to render the treatment impractical. Its use in a tertiary treating capacity may be practical, depending upon the residual COD of the treated effluent.

Oxidation by Ozone

Ozone has been studied extensively as a possible treatment for industrial wastewaters (Evans, 1972; Eisenhauer, 1970; Niegowski, 1956). No practical success has attended these efforts. The literature reveals only one example in the U.S. of the application of ozone to treat an industrial waste. Boeing Corporation is reported to have operated a 6.8 kg/hour ozonator to treat cyanide and phenolic wastes (McLain, 1973). Worldwide, the situation is similar. The literature mentions a plant in France and one in Canada, both of which use ozone to treat cyanide and phenolic wastes from biologically treated effluents. Conversely, there have been numerous pilot plant studies of the application of ozone for industrial wastes, and ozone is widely used in Europe, especially France, to treat domestic water supplies. Pilot studies to assess the feasibility of using ozone to treat domestic wastes have been sponsored by EPA (Wynn, et al., 1973).

The problem is one of economics. Eisenhauer (1970) concluded from his work that the ozonization of phenol to CO_2 and H_2 cannot be achieved economically. By contrast, Niegowski (1953) reported that in pilot plant tests of ozone, chlorine, and chlorine dioxide, ozone was demonstrated to be the most economical treatment for total phenols.

No example of the use of ozone to treat timber products wastewater appears in the literature. However, one wood preserving plant installed a small ozone generator and directed the gas into a large lagoon. The treatment had no measurable effect on wastewater quality.

INSULATION BOARD AND HARDBOARD

Chemically-Assisted Coagulation

Chemically-assisted clarification, as defined in this document, is the use of coagulants or coagulant aids to increase the settleability of biological suspended solids in the clarifier of the biological treatment system. This technology is particularly applicable to the fiberboard industry, as this industry relies heavily on biological treatment for end-of-pipe pollution control.

The mechanisms by which a coagulant aids the precipitation of colloidal matter, such as biological suspended solids, are discussed at length in an AWWA Committee Report (1971), "State of the Art of Coagulation." The chemicals generally used to increase removals of fine and colloidal particles in conjunction with this technology are the metal salts of aluminum and iron, as well as synthetic organic polymers.

When metal salts are used, hydrolysis products are formed which desta bilize colloidal particles by a complex series of chemical and physical interactions. Polyelectrolytes are extended-chain polymers of high molecular weight. Particles are adsorbed at sites along the chains of these polymers which interlock to form a physical bridge, thereby destabilizing the sorbed particles.

Chemically-assisted coagulation may be used as an additional treatment process applied to the effluent of the secondary clarifier of the biological treatment system. This requires separate mixing, flocculation, and settling facilities, and a considerable capital investment. A recent study performed for the EPA (E.C. Jordan Co., 1977) on chemically assisted clarification (CAC) demonstrated that increased suspended solids removal may be obtained when applying CAC as an integral part of the biological system. The advantage to this application is that capital and operating costs are kept at a minimum. Mixing takes place using the natural turbulence inherent in the latter stages of the biological system, and settling occurs in the biological secondary clarifier.

Insulation board Plant 36 and S1S hardboard Plant 931 reported the use of polyelectrolytes to increase solids removal in the biological secondary clarifiers of their respective treatment systems. Plant 931 adds the polyelectrolyte at the influent weir of the final settling pond; little mixing is achieved by application of the polymer at this point. The annual average daily TSS effluent concentration of this plant for the last four months of 1976 (following completion of upgraded treatment facilities) was about 488 mg/l. This represents an 81 percent reduction in TSS in the total system.

Plant 36 adds polyelectrolyte in the aeration basin of the activated sludge unit, achieving better mixing than Plant 931.

The annual average daily TSS concentration of the final effluent is about 320 mg/l, which represents a 93 percent reduction in TSS. Both plants noted increased TSS removals using the polyelectrolyte, however, no comparable data are available to quantify the amount of TSS reduction due to polymer addition.

Selection of the proper coagulant, point of addition, and optimum dose for this technology can be approximated in the laboratory using jar test procedures. Since the capital cost is minimum, in-plant studies can be easily conducted to optimize operating characteristics for maximum effectiveness.

Granular Media Filtration

Granular media filtration as a tertiary process for control of biological suspended solids, is receiving growing attention in the pulp and paper, food processing, textile, and oil refining industries. It is a physical/electrical/chemical process consisting of: (1) transport of the particles from the suspension to the media; and (2) contact with and adhesion to the media or other solids previously absorbed on the media.

There are currently no hardboard or insulation board plants using granular filtration; however, several applications of this technology exist in the pulp and paper industry.

The National Council for Air and Stream Improvement conducted a pilot study to investigate the effectiveness of three manufactured granular media filters in removing suspended solids, BOD, and turbidity from papermaking secondary effluents (NCASI, 1973). The three filter systems were studied for TSS and BOD removals when filtering the effluent from an integrated bleached kraft mill and a boxboard mill. The report summarized the study findings by stating that all three units could reduce suspended solids concentrations and turbidity by 25 to 50 percent when chemicals were not used. Reductions of greater than 90 percent were possible with chemical addition.

A recent study performed for EPA on the Direct Filtration and Chemically Assisted Clarification of Biologically Treated Pulp and Paper Industry Wastewater concluded that, based on actual plant operating data, direct filtration systems can be designed with chemical addition to achieve, on average, at least 50 percent reduction in filter effluent TSS concentration, with maximum removals of 80 to 90 percent.

It should be noted that influent suspended solids characteristics are an important factor in determining filter performance. Biological treated effluent from the insulation board and hardboard industries differs greatly from that of the pulp and paper industry. Pilot plant studies are needed to properly design a wastewater filter for any specific application. Actual plant operating data will also be required to effectively estimate actual TSS removals for the insulation board and hardboard industries.

Activated Carbon Adsorption

Several activated carbon isotherms were performed on the treated effluents of two hardboard plants to determine the feasibility of carbon adsorption as a tertiary treatment for this industry. Although the carbon was quite effective at reducing the influent COD to one-half or less of its original concentration, the carbon dosage required for this purpose and the rigorous pretreatment requirements were so high as to rule out activated carbon as a technically feasible tertiary treatment.

Table F-1. Summary of Arsenic Treatment Methods and Removals Achieved*

Treatment	Initial Arsenic (mg/l)	Final Arsenic (mg/l)	Percent Removal
Charcoal Filtration	0.2	0.06	70
Lime Softening	0.2	0.03	85
Precipitation with Lime plus Iron	--	0.05	--
Precipitation with Alum	0.35		85-92
Precipitation with Ferric Sulfate	0.31-0.35	0.003-0.006	98-99
Precipitation with Ferric Sulfate	25.0	5	80
Precipitation with Ferric Chloride	3.0	0.05	98
Precipitation with Ferric Chloride	0.58-0.90	0.0-0.13	81-100
Precipitation with Ferric Hydroxide	362.0	15-20	94-96
Ferric Sulfide Filter Bed	0.8	0.05	94
Precipitation with Sulfide	--	0.05	--
Precipitation with Sulfide	132.0	26.4	80

* Adopted from Patterson, 1975.

APPENDIX G

STATISTICAL METHODOLOGY FOR DETERMINING PERFORMANCE VARIABILITY OF TREATMENT SYSTEMS

Effluent limitations guidelines for the hardboard and insulation board segment were determined by analysis of long term, historical monitoring data for those biological treatment systems selected as representative of BPT or BCT for each subcategory. The long term pollutant wasteload averages for these treatment systems were presented in Section VII, Control and Treatment Technology, of this document. Treatment systems do not perform continuously at their long term average performance level. It is necessary, therefore, to consider the variability of such systems in relation to long term average performance in order to develop effluent limitations.

This section presents the results of a statistical variability analysis performed on the effluent data from representative treatment systems in order to determine their maximum daily and maximum 30-day effluent variabilities.

Effluent limitations presented in Sections VIII and IX of this document were calculated by multiplying a representative plant's long term average wasteloads by its respective daily and 30-day variability factors. The purpose of this appendix is to describe the methodology used to determine appropriate variability factors used to calculate the effluent limitations guidelines.

METHODOLOGY USED TO DEVELOP VARIABILITY FACTORS FOR EFFLUENT LIMITATIONS PROPOSED ON OCTOBER 31, 1979

Hardboard and insulation board plants, identified as representative of BPT and BCT systems for each subcategory, all provided available monitoring data for calendar years 1976 and 1977. One plant provided an additional four months of data for 1978.

The data provided included daily gross production figures and the plant's monitoring results for its treated effluent wastestream. The only wastewater parameters reported by the plants with sufficient frequency for variability analysis were BOD and TSS. The variability analysis was limited to treated effluent streams, as it is the variability of these streams that must be taken into consideration in the development of numerical effluent limitations guidelines.

Table G-1 presents the number of observations in each data set used for the variability analysis. For Plant 931, the variability analysis was performed using a data base of October 1, 1976 through December 31, 1977. During 1976, the wastewater treatment system was expanded and the new system did not begin normal operation until the beginning of October 1976. Consequently, the data reported for the period prior to October 1976 were excluded from the analysis.

The long term data base provided by Plant 980 was for the period of January 1, 1976 through April 30, 1978; however, a nonstandard method of TSS analysis was used by the plant prior to June 16, 1977. Therefore, the data base used for the TSS variability analysis was for the period of June 16, 1977 through April 30, 1978, and the data base for the BOD variability analysis was for the longer period of January 1, 1976 through April 30, 1978.

A statistical analysis was performed on the data base from each plant to determine the daily and 30-day effluent variability factors associated with the biological treatment systems of the plants. The units used were lbs/day for both BOD and TSS throughout the analysis. The purpose of the analysis was to estimate the 99th percentile of the effluent loadings.

Two basic approaches were considered for estimating the 99th percentile of a set of data. The 99th percentile is defined as that value which exceeds 99 percent of the values in the population from which the data were drawn.

The first approach consists of fitting a specific distributional model to the data. For example, the normal or mound-shaped distribution may be used, or the log-normal distribution, which hypothesizes that the logarithms of the data follow a normal distribution. Once the model is fit to the data, the 99th percentile can be determined mathematically. For example, if the normal model is used, the 99th percentile is the value 2.33 standard deviations above the mean. This approach is called the parametric approach, because it requires that a specific distribution with fixed parameters be used.

The second approach is nonparametric, since it requires no particular distributional model. Assuming the data are drawn from some unknown distribution at random, it is possible to calculate the probability that the 99th percentile is greater than the largest measurement in the data set, the second largest, the third largest, etc. This calculation uses only the fact that each measurement is assumed to have a .01 probability of exceeding the 99th percentile, and a .99 chance of falling below it; the particular form of the distribution is not required in this calculation.

To assist in deciding whether to take the parametric or the nonparametric approach, goodness-of-fit tests were conducted on the daily readings of BOD and TSS for the 1976 and the 1977 data. Two of the more powerful tests of goodness of fit, the Kolmogorov-Smirnov and Anderson-Darling tests, were used to determine whether or not the normal distribution, logarithmic normal distribution, or three parameter logarithmic normal distribution provided an adequate fit to the data.

The results of the tests indicated a consistent lack of fit at the 5 percent level of significance using the Kolmogorov-Smirnov and Anderson-Darling tests. Consequently, the use of the normal or lognormal distribution for estimating the 99th percentile was ruled out and the nonparametric approach was adopted.

Daily Variability Factors

The daily maximum variability factor is defined as the estimate of the 99th percentile of the distribution of daily pollutant discharge divided by the long term mean. Thus, given a set of n daily observations, the daily variability factor is

$$\frac{U_{.99}}{\overline{X}}$$

where $\overline{X}$ is the arithmetic average of the daily observations, and $U_{.99}$ is an estimate of the true 99th percentile, $K_{.99}$.

The value for $U_{.99}$ was obtained as the rth largest (where $r \leq n$) sample value, denoted by $X(r)$, chosen so the probability that $X(\overline{r})$ is greater than or equal to $K_{.99}$ was at least 0.50. As described above, the value of r for which this criterion was satisfied was determined by nonparametric methods (see e.g., J.D. Gibbons, Non-Parametric Statistical Inference, McGraw-Hill, 1971). An estimate chosen in this manner is referred to as a nonparametric 50 percent tolerance level estimate for the 99th percentile. The daily variability factors calculated by the above described method are shown in Table G-2.

30-Day Variability Factors

The monthly variability factors were also determined using a nonparametric analysis.

It is assumed that the daily variable X has a distribution F with mean μ and variance σ^2. Even if we made the nonparametric assumption that the form of F is unknown, the monthly means would be approximately normally distributed with mean μ and variance $\sigma^2/30$. This formula assumes that 30 observations are available during the monthly period. This approach is nonparametric or distribution free in the sense that no restrictive assumption is made regarding the form of F. If there are n daily measurements, then

$$\overline{X} = \frac{\sum_{i=1}^{n} X_i}{n}$$

where X is the daily BOD or TSS in pounds per day, and

$$S^2 = \frac{\sum_{i=1}^{n} (X_i - \bar{X})^2}{n-1}$$

estimates μ and σ^2, respectively. Therefore, the 99th percentile estimate is:

$$\bar{X} + 2.33\ S/\sqrt{30}$$

and the monthly variability factor is:

$$VF_1 = \frac{\bar{X} + 2.33\ S/\sqrt{30}}{\bar{X}}$$

Thus, the normal model for the monthly mean was used, since sample means are approximately normally distributed even when the raw data is not (e.g., see McClave & Dietrich, Statistics, Dellen, 1979).

These results of the analysis of 30-day variability factors are shown in Table G-3.

INDUSTRY COMMENT ON STATISTICAL METHODOLOGY USED TO DEVELOP EFFLUENT LIMITATIONS PROPOSED ON OCTOBER 31, 1979

Several industry participants commented on the above described statistical methodology used to calculate performance variability factors. The comments received can be summarized as follows: (1) the Agency's data base was criticized as being limited in that it contained too few data points to provide more than a rough estimation of long term averages; (2) the nonparametric statistical methodology was criticized because it assumes that data consist of independent observations, when in fact the data are time and temperature (seasonally) dependent; (3) it was stated that the Agency incorrectly relied upon the assumption that the monthly means are normally distributed in their analysis of 30-day variability factors, resulting in the BPT and BCT model plants' failure to achieve the proposed limitations with frequency consistent with the limitations being established at the 99th percentile.

REVISED STATISTICAL METHODOLOGY

As a result of continuing efforts to improve its statistical methods and in response to industry comment, the Agency conducted a thorough re-evaluation of the variability analysis used to determine the proposed timber limitations.

Extended data bases, in most cases representing 1 year or more of additional treated effluent and production data, were requested from each of the treatment systems used to determine the proposed effluent limitations for the wet process hardboard and insulation board subcategories. All but one plant provided this requested data. The S1S hardboard BPT model treatment plant did not provide the requested data on the basis that it was unrepresentative of normal treatment system operation because of a 1978 flood which washed out a solids settling lagoon.

Analyses were conducted using the original data base for Plant 207 (1/1/76 to 12/31/77) and extended data bases for Plants 537 (1/1/76 to 3/31/79), 931 (10/1/76 to 10/31/79), and 980 (1/1/76 to 2/29/80 for BOD and 6/16/77 to 2/29/80 for TSS).

The objectives of the re-evaluation were to:

1. Evaluate the effects of autocorrelation ("nonindependence") on the proposed daily and monthly variability factors;
2. Evaluate the effects of seasonality and temperature dependence of pollution load on the proposed daily and monthly variability factors;
3. Propose statistical techniques to account for autocorrelation and seasonality in the data, and compare daily and monthly 99th percentile estimates obtained using these methods to the 99th percentile estimates used to calculate the proposed limitations; and
4. Evaluate the daily and monthly variability factors for the companies' extended data bases, i.e., data collected since the analyses which generated the variability factors used to develop proposed limitations.

This discussion will focus on presentation of results of the analyses conducted to accomplish the above objectives. To facilitate the presentation of results, most statistical details will be placed in the Theoretical Supplement to Appendix G.

Daily Variability Factors

To review briefly the method of calculating the nonparametric tolerance level estimate, the daily data are first ranked from lowest to highest numerical value. The probability that the largest value exceeds the true 99th percentile of the distribution is calculated using the binomial distribution. This probability, based on a total of n measurements, is

$$\begin{aligned} &P\ [\text{largest of } n \text{ measurements exceeds the true 99th percentile}] \\ &= 1 - P\ [\text{all } n \text{ measurements are less than the 99th percentile}] \\ &= 1 - (.99)^n \end{aligned}$$

Similarly,

P [second largest of n measurements exceeds the 99th percentile]

$$= 1 - (.99)^n - n\,(.99)^{n-1}\,(.01)$$

and, in general,

P [kth largest of n measurements exceeds the 99th percentile]

$$= 1 - \sum_{j=0}^{k-1} \binom{n}{j} (.99)^{n-j} (.01)^j$$

The measurement taken to be the nonparametric estimate of the 99th percentile is the smallest measurement which causes the above probability to exceed 0.50. Thus, the estimator is said to represent an upper 50 percent tolerance level for the 99th percentile. This procedure will produce estimates which have the interpretation that in a large number of random samples each consisting of n observations, approximately 50 percent of the estimates will exceed the 99th percentile.

The nonparametric technique makes no assumption about the distribution of the data, but the observations are assumed to be independent. As will be demonstrated, there is evidence that the daily pollution load data is autocorrelated (i.e., correlated over time), so that this assumption may not be satisfied. One objective of the re-evaluation is to analyze the effect of this autocorrelation on the nonparametric tolerance level estimate of the 99th percentile.

The first step in the analysis is to obtain a description of the data base and to estimate the autocorrelation, or degree of dependence, of the data. Preliminary analysis of the data revealed little or no correlation between pollution load and available production information. All data are therefore analyzed in pounds per day. Table G-4 lists the number of daily values used in the analysis, the arithmetic mean, standard deviation, and the minimum and maximum values for each of the four plants.

Lagged autocorrelations measure the correlation between the pollution load on one day with that on previous days, and they therefore measure the time dependence of the data. The Lag 1 autocorrelation measures the correlation between today's and yesterday's load, the Lag 2 autocorrelation measures dependence between today's and 2 day's ago, etc. Like ordinary correlations (product-moment) between variables, autocorrelations range from -1 to +1, with negative values indicating negative time dependence, values near zero little or no time dependence, and positive values indicating positive time dependence between the loads at the specified time lag.

Table G-5 lists the autocorrelations for the pollution load data up to Lag 7 (1 week). These autocorrelations are computed for daily values after subtracting the monthly mean from each measurement. The monthly mean is subtracted to account for seasonal effects. Also given in Table G-5 are the number of pairs of data values which were available to compute each autocorrelation. This number varies considerably because daily data were not available every day for any one of the plants. Plant 980 comes closest to having daily data, and the size of this data base makes it the best of the four for statistical analysis. In contrast, Plant 207 is primarily weekly data, so that very few contiguous days' data (as few as four pairs) are available for several lag autocorrelations.

The autocorrelations in Table G-5 leave little doubt that the pollution loads are time dependent. In every case, the Lag 1 autocorrelation is positive and relatively large, implying that a high load on one day is likely to be followed on the next day by another high value. The physical explanation of this positive autocorrelation is probably related to the long detention time in the aeration and settling ponds of the treatment systems.

Assuming, then, that the data are positively autocorrelated, the binomial formula used to compute the tolerance probabilities does not yield exact values. Instead, they are approximations, and some indication of how well they approximate the exact probabilities should be given. Although no direct analogy to the binomial formula has been found for dependent data, there are methods available to measure the effect of dependence on the standard error of the <u>sample percentile</u> estimator of the 99th percentile. The standard error of an estimator is a measure of its variability (standard deviation) in repeated usage and therefore measures the potential error of estimation.

The sample percentile estimates of the 99th percentile of the pollution loads are given in Table G-6, with the standard errors of these values given under four different assumptions: independence, "weak" dependence, "moderate" dependence, and "strong" dependence. The model which was used to express the various levels of dependence is the <u>first order autoregressive</u> model. This model relates the present daily value, Z_t, to yesterday's value, Z_{t-1}, by the equation:

$$Z_t = \phi Z_{t-1} + \epsilon_t$$

where ϵ_t is random error, uncorrelated over time, and ϕ is a constant which determines the strength of dependence. Data from Table G-5 demonstrates that the first order autocorrelation is generally significant for all plants while no other autocorrelations are significant for all plants, suggesting the appropriateness of using a first order autoregressive model. The autoregressive model implies that the daily values are dependent, with the dependence growing steadily weaker as the time between the daily measurements increases, an implication which is generally supported by the autocorrelations of the data (see Table G-5). The assumption of independence corresponds to $\phi = 0$, "weak" dependence to $\phi = .2$, "moderate" dependence to $\phi = .5$, and "strong" dependence to $\phi = .8$. Further statistical definitions and details are given in the Theoretical Supplement to Appendix G.

Inspection of Table G-6 reveals that the standard errors increase as the assumed level of dependence increases, but the increase is moderate when compared to the absolute value of the load estimates, i.e., the increase in relative standard error is generally less than 10 percent of the estimated percentile. The variability factors under the various time-dependence conditions are given in Table G-7. The variability factors from the Development Document supporting the proposed regulations (1979) are shown, along with those obtained by using the sample percentile estimates plus two standard errors. The 1979 Development Document variability factors are based upon 50 percent tolerance interval estimates of the 99th percentile, while those presented in this appendix under the assumption of time dependence are upper 95 percent confidence level estimates of the 99 percentile. Even with the more conservative approach used in the time-dependent case, the uniformity of the variability factors in Table G-7 clearly indicates that the estimators of the 99th percentile are relatively insensitive to autocorrelation of the data. In fact, the 50 percent tolerance interval value appears to yield variability factors which are conservatively high, even when the data are time dependent. Thus, the daily variability factors established in the 1979 Development Document are reliable estimates which are minimally affected by the autocorrelation of the data.

Monthly Variability Factors

In the 1979 Development Document, monthly variability factors were derived using a probabilistic result known as the Central Limit Theorem. This theorem assures the approximate normality of the distribution of the monthly means regardless of the underlying distribution of the data, assuming that the number of observations comprising the mean is sufficiently large. Most textbooks use sample sizes of 25 or 30 as a minimum, although as few as 10 to 15 may be sufficient if the underlying distribution is not excessively skewed.

The limitations presented in the 1979 Development Document were based on the assumption of 30 daily measurements per month*, a point which was overlooked or misunderstood in industry's review of the document, since they incorrectly applied the 30-day limitation to monthly means based upon varying sample sizes. However, even if the monthly

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*The 30-day 99th percentile estimator was defined as $\bar{X} + 2.33\ s/\sqrt{30}$.

limitation were to be adjusted for the actual number of daily measurements, the number of exceedances (monthly means which exceed the limitation) would be greater than expected. This fact is probably attributable to the dependence in the data. Seasonality and autocorrelation are two main sources of dependence, and in this section, a method of establishing monthly limitations which take these factors into account is developed.

The method of developing limitations which take autocorrelation and seasonality into account is to construct a statistical model which explicitly contains these components. Although most of the statistical details will be presented in the Theoretical Supplement to Appendix G, it is useful to understand the basic concept of the model. The daily pollution load model consists of three basic components:

Daily Load = [Long Term Mean] + [Month Effect (Random)]
+ [Day Effect (Random and Autocorrelated)].

Thus, each daily value consists of a fixed mean value with two random components added to the mean: a monthly effect and a daily effect, with the latter assumed to be autocorrelated. The differences between this model and the one used in the 1979 Development Document are the addition of the Month Effect as a random component and the specification that Daily Effects are autocorrelated. The intent is that the Month Effect accounts for the seasonality of the data, while the autocorrelated Daily Effects account for the time dependence of the data.

In Table G-8, the 99th percentile estimates derived using this model are presented for each of the four plants.

For purposes of comparison, the 99th percentile estimates are given, assuming independent, weakly dependent, moderately dependent, and strongly dependent Daily Effect. A conclusion which becomes clear on studying this table is that the effect of daily autocorrelation on the monthly 99th percentile estimate appears to be minimal; that is, the estimate does not change significantly as the strength of the autocorrelation increases. The reason is that the Month Effect dominates the Daily Effect, probably due to seasonality of the data.

The assumption of moderate dependence is based upon analysis of the daily autocorrelation (detailed in the Theoretical Supplement to Appendix G), which reveals that this level of dependence provides the best description of the autocorrelation observed in the data. That is, based on the available data, the first order autoregressive model with $\emptyset = .5$ provides a good fit. Since Table G-8 revealed that the strength of dependence plays a relatively unimportant role in determining the monthly variability factors, there is little justification for attempting to find a more exact value for $\emptyset$ for each plant.

The monthly variability factors are shown in Table G-9, assuming 30 daily values and moderate dependence. The variability factors from the 1979 Development Document are also given; recall they were also based on 30 daily values. Note that the variability factors which take seasonality and autocorrelation into account are larger than the ones given in the 1979 Development Document, primarily due to the inclusion of a term (Month Effect) which allows for seasonal variability of the data.

In summary, the revised model provides a means of deriving monthly variability factors which take into account the seasonality and autocorrelation of the data. Even with minor deviations from normality, the use of 2.33 standard deviations provides a liberal limitation for the monthly means.

MODIFICATIONS TO VARIABILITY FACTORS AS A RESULT OF STATISTICAL RE-EVALUATION

The daily variability factors derived in the 1979 Development Document are relatively insensitive to autocorrelation in the data. Additionally, since they are based upon the larger observed pollutant loads, seasonality is automatically factored into their calculation. Thus, EPA has decided that no change will be made in the method used to calculate the daily limitations. These daily limitations have been recalculated to reflect the additional data received, however.

The monthly limitation proposed in the 1979 Development Document did not take autocorrelation and seasonality into account. The random effects model presented here was constructed to remedy this. The results of the analyses using this model support an increase in the 30-day limitation. While the BOD variability factors for the four plants used in this analysis range from 1.34 to 1.44 in the 1979 Development Document, they range from 2.08 to 2.72 when the random effects model is used. Similarly, the TSS variability factors range from 1.33 to 1.46 in the 1979 Development Document and from 1.90 to 2.37 when the seasonal and autocorrelation adjustments are made. Whereas more monthly exceedances (i.e., monthly means which exceed the limitation) than expected occur when the 1979 Development Document variability factors are used, very few exceedances occur using the new variability factors. Thus, EPA has increased the monthly limitations to levels consistent with those developed using the revised model.

THEORETICAL SUPPLEMENT

Given a set of N <u>ordered</u> values $X_{(1)}, X_{(2)}, \ldots, X_{(N)}$ on the random variable X, the <u>99th percentile</u> is defined (Bahadur, 1966) to be

$$
\begin{aligned}
Q_N &= X_{(.99N)} \text{ if } .99N \text{ is an integer} \\
&= X_{([.99N]+1)} \text{ if } .99N \text{ is not an integer}
\end{aligned}
$$

where [.99N] is the largest integer contained in (.99)N. For example, if N = 100, Q_N is the 99th ordered daily value, since .99N = 99. But if N is 101, .99N = 99.99 so that [.99N] + 1 = 100. Thus, Q_N is the 100th ordered observation. Note that this sample percentile estimate differs in definition from the 50 percent tolerance level estimate (Section 1), with the latter generally more conservative.

If Q is the true 99th percentile of the distribution, then it has been shown (Bahadur, 1966) that if the daily values are <u>independent</u>,

$$\sqrt{N}(Q_N - Q) \xrightarrow{D} N\left(0, \frac{pq}{f^2(Q)}\right) \qquad (1)$$

where $\xrightarrow{D}$ denotes "has an asymptotic distribution," the probability p that a randomly selected observation is less than the 99th percentile is .99, the probability q that a randomly selected observation exceeds the 99th percentile is .01, and f(Q) is the probability density function of X evaluated at Q, the true 99th percentile. Thus, the distribution of Q_N can be approximated by the normal with mean Q and variance $pq/Nf^2(Q)$ when N is large. The problem with applying this result is that the density f must be known to estimate the standard error, which requires specification of a parametric distribution for X. However, tolerance interval probabilities can be calculated for independent observations using the binomial formula given in Appendix G, and these require no specification of the probability distribution of X. Thus, even though the tolerance interval method tends to produce conservatively high estimates of Q, it is preferable to using Q_N when the distribution of X is in doubt.

The tolerance level method requires that the daily observations be independent. Since no analagous nonparametric method exists for dependent time series, the parametric method should be used to assess the 99th percentile estimator. Chanda (1976) and Sen (1971) have shown that under certain rather unrestrictive conditions on the structure of dependence,

$$\sqrt{N}(Q_N - Q) \xrightarrow{D} N(0, \frac{\sum_{-\infty}^{\infty} \gamma_\nu}{f^2(Q)}) \tag{2}$$

where $\gamma_\nu = P(X_t \leq Q, X_{t+\nu} \leq Q) - p^2$. To see that this distribution reduces to (1) in the independent case, note that

$$\gamma_\nu = P(X_t \leq Q)\ P(X_{t+\nu} \leq Q) - p^2$$
$$= p^2 - p^2 = 0 \qquad \text{if } \nu \neq 0$$

and

$$\gamma_0 = P(X_t \leq Q) - p^2$$
$$= p - p^2 = p(1-p) = pq$$

When the data are dependent, both $\sum_{-\infty}^{\infty} \gamma_\nu$ and f(Q) must be estimated. Since the log transform appears to be more symmetrically distributed than the raw data, the lognormal distribution was used to develop an estimate of the standard error of the 99th percentile for comparison with the 50 percent tolerance level estimator. Thus,

$$f(Q) = (\sqrt{2\Pi}\sigma Q)^{-1} \exp[\frac{-1}{2} \frac{(\log Q-\mu)^2}{\sigma^2}] \tag{3}$$

where μ and σ are the mean and standard deviation, respectively, of the log transform of X, which will be denoted by Y [i.e., Y = log(X)].

The estimation of f(Q) is accomplished by estimating μ by the logarithmic mean, say $\bar{y}$, σ by the logarithmic standard deviation, S_y, and Q by Q_N. Substituting into (3),

$$\hat{f}(Q_N) = (\sqrt{2\Pi} S_y\ Q_N)^{-1} \exp[\frac{-1}{2} \frac{(\log Q_N - \bar{y})^2}{S_y{}^2}]$$

is an estimator for f(Q).

In order to estimate $\sum_{-\infty}^{\infty} \gamma_\nu$, note that

$$= P[X_t \leq Q, X_{t+\nu} \leq Q] - p^2$$

$$= P[Y_t \leq \log(Q), Y_{t+\nu} \leq \log(Q)] - p^2$$

$$= F_{\mu,\sigma,\rho}[\log(Q), \log(Q)] - p^2$$

where $F_{\mu,\sigma,\rho}$ is the bivariate normal distribution with mean μ, standard deviation σ, and correlation coefficient ρ. By again substituting the estimates $\overline{y}$ and S_y for μ and σ, and Q_N for Q, an estimate of γ_ν is obtained for various correlation coefficients:

$$\hat{\gamma}_\nu = F_{\overline{y}, S_y, \rho}[\log(Q_N), \log(Q_N)] - p^2$$

Subsequently, $\sum_{-\infty}^{\infty} \gamma_\nu$ can be estimated by $\sum_{-K}^{K} \hat{\gamma}_\nu$

where K is chosen so that the addition of subsequent terms adds less than 10^{-6} to the summation.

Finally, an estimation of the standard error of the sample 99th percentile Q_N for the dependent case is

$$\text{Estimated Standard Error } (Q_N) = \hat{\sigma}_{Q_N} = \left\{ \frac{\sum_{-K}^{K} \gamma_\nu}{N \ \hat{f}^2(Q_N)} \right\}^{1/2}$$

These estimated standard errors are given in Table G-6 for the case of $\rho = 0, .2, .5,$ and $.8$, referred to in the report as independence, weak dependence, moderate dependence, and strong dependence, respectively.

The next step is to obtain an estimate of the limitations and variability factors. To estimate the 99th percentile, the approximate upper 95 percent confidence level for Q is estimated, i.e.,

$$L = Q_N + 2\hat{\sigma}_{Q_N}$$

This represents an extremely conservative estimator as compared to the 50 percent tolerance level estimator, since it will provide an estimate which exceeds the true 99th percentile approximately 95 percent of the time in repeated, independent usage, while the tolerance level estimator will exceed the true 99th percentile approximately 50 percent of the time in repeated, independent usage.

The variability factor is then defined by

$$V.F. = \frac{L}{X}$$

where X is the long-term mean of the data. When these variability factors are compared in Table G-7 to those from the 1979 Development Document, a reassuring consistency is observed. A study of this table indicates that the Development Document values, derived using the tolerance interval method, are approximately the same as those which use the sample percentiles and take daily data dependence into account.* This fact indicates that the tolerance interval method is insensitive to departures from independence, even when a more conservative confidence level of 95 percent is employed, and that the variability factors derived using the 50 percent tolerance level estimator remain very reasonable.

NOTE: Although the method of estimating the 99th percentile developed in this Appendix is referred to as "parametric", the estimator itself is nonparametric, since the sample percentile Q_N does not involve the distributional form of the daily values. However, the standard error of Q_N does explicitly involve the distribution, making the calculation of a confidence bound for Q a parametric operation.

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*As expected, the values for the more conservative percentile estimates, at 95 percent confidence, usually exceed the tolerance interval estimate, at 50 percent confidence. However, the difference is generally relatively small. In one case, Plant 207 BOD, the tolerance interval estimate exceeds the percentile estimate assuming weakly or moderately dependent daily values, probably due to the relatively small sample size (133).

CENTRAL LIMIT THEOREM

The Central Limit Theorem states that the asymptotic distribution of $\sqrt{n}(\bar{X}-\mu)$ is approximately normal with mean 0 and variance σ^2, where $\bar{X}$ is the sample mean based on n independent observations, and μ and σ^2 are the mean and variance, respectively, of the distribution from which the observations were selected. This Theorem continues to hold for dependent observations (Fuller, 1976) from a stationary process, with the modification that the variance is

$$\sigma^2 \sum_{\nu=-\infty}^{\infty} \rho_\nu$$

where ρ_ν is the autocorrelation between X_t and $X_{t+\nu}$, two observations separated by ν time units. The only assumption in either case is that the mean μ and variance σ^2 (or $\sigma^2 \sum_{-\infty}^{\infty} \rho_\nu$) must be finite, an unrestrictive assumption which holds for most data.

The most common application of this Theorem is to use the normal distribution with mean μ and variance σ^2/n to approximate the distribution of $\bar{X}$, the sample mean. The approximation improves as the sample size, n, is increased. It can be quite good for very small samples if the underlying distribution of the data is symmetric and unimodal, and quite bad for relatively large samples if the data are skewed or bimodal. It is generally accepted that a sample size of 25 to 30 is sufficient for the normal approximation to be adequate for means from almost all distributions.

An important point to note is that the sample size plays an explicit role in the variance of the sample mean. That is,

$$\mathrm{Var}(\bar{X}) = \sigma^2/n$$

This point was apparently overlooked in industry's response to the 1979 Development Document, because all the monthly means were grouped into a single plot, and compared to the same limitation (which was based on 30 sample measurements per month).

MONTHLY RANDOM EFFECTS MODEL

The intent of this section is to provide the statistical details for the model used in Appendix G of the report to derive the 30-day variability factors.

The model used is a random effects model, which may be written as follows:

$$X_{it} = \mu + M_i + Z_{it}$$

where X_{it} is the observable daily pollution load, μ is the expected value of X_{it} (the "long term" mean), M_i is a random effect associated with the i^{th} month, and Z_{it} is a random effect associated with the t^{th} day in the i^{th} month. It is assumed that:

$$E(M_i) = E(Z_{it}) = 0$$

$$Var(M_i) = \sigma_m^2, \quad Var(Z_{it}) = \sigma^2$$

and

$$Cov(M_i, M_j) = 0, \quad Cov(M_i, Z_{it}) = 0$$

In addition, the daily effects are assumed to be autocorrelated, with a first order autoregressive model used to describe the autocorrelation:

$$Z_{it} = \emptyset Z_{i,t-1} + \epsilon_{it}$$

where $\emptyset$ is a correlation parameter ($-1 < \emptyset < 1$) and ϵ_{it} is white noise, i.e., uncorrelated and satisfying the conditions

$$E(\epsilon_{it}) = 0,$$

$$Var(\epsilon_{it}) = \sigma_\epsilon^2$$

The autoregressive model is a time series model, i.e., a model which describes a random phenomenon observed over time. The model implies that the daily values are dependent, or autocorrelated, with the strength of the dependence greatest between consecutive daily values. The autoregressive model also implies that the dependence between daily observations weakens as the number of days between observations increases. Positive values of the parameter indicate positive dependence, the usual case in practical time series applications, and the strength of the dependence increases as the value of $\emptyset$ approaches one.

In Table G-5 the first seven autocorrelations for the daily effects associated with the various data series were presented. In Figures G-1 to G-6 graphs of the first 50 autocorrelations for plants 537, 931, and 980 for BOD and TSS are presented. Although the estimates are based on data which were not collected every day, there are sufficient data available for three of the plants (all but Plant 207) to see that the autoregressive model is a reasonable one. The autocorrelations for Plant 537 appear to have a 7 day cyclical pattern, possibly implying a more complex model, but the data are insufficient to identify and estimate such a model. No distributional assumptions on M_i or Z_{it} are necessary at this stage.

Before developing estimators of the random effects model parameters, some discussion of its motivation is warranted. A more familiar model which has been proposed to account for seasonality is:

$$X_{it} = f(t) + Z_{it}$$

where $E(X_{it}) = f(t)$ is a deterministic function of time which models the seasonality of the data, and Z_{it} is the random daily effect, as before.

Examples of seasonal functions, $f(t)$, are trigonometric functions, or dummy variables to account for monthly effects. Although such a model might provide a good fit to the data, the implication of using the model is that seasonal limitations are to be established, as opposed to a single limitation applicable to all the seasons. That is, if the mean of the daily values is modeled with a deterministic seasonal component, the monthly limitations and variability factors will also vary seasonally.*

Since the objective is to develop a uniform limitation, the seasonal component is modeled as a random component, so that the seasonal variability is explicitly considered and included in the monthly limitations. Note that the variance of an individual daily value is

$$\mathrm{Var}(X_{it}) = \sigma_m^2 + \sigma^2$$

while that for a monthly mean value based on d daily values,

$$X_i = \sum_{t=1}^{d} X_{it}/d = \mu + M_i + \frac{\sum_{t=1}^{d} Z_{it}}{d} \qquad (1)$$

is

$$\begin{aligned} \mathrm{Var}(X_i) &= \sigma_m^2 + \frac{\sigma^2}{d^2} \sum_{s=1}^{d} \sum_{t=1}^{d} \mathrm{Corr}(Z_{is}, Z_{it}) \\ &= \sigma_m^2 + \frac{\sigma^2}{d^2} \sum_{s=1}^{d} \sum_{t=1}^{d} \phi^{|t-s|} \\ &= \sigma_m^2 + \frac{\sigma^2}{d} \left[\frac{1+\phi}{1-\phi} - \frac{2\phi(1-\phi^d)}{d(1-\phi)}\right] \qquad (2) \end{aligned}$$

---

*When fixed effect models were fit to these data, a significant year-month interaction was found in every case, indicating that the seasonal effect is inconsistent from year to year. This further supports the use of a random effects model.

where for an autoregressive model $\mathrm{Corr}(Z_{is},Z_{it}) = \phi^{|t-s|}$, and it has been assumed that the d daily values occur on contiguous days. The variance will be somewhat smaller if the daily values are not contiguous, so that (2) represents a conservatively high variance in this case. Note that if the daily values are independent ($\phi=0$), the variance is $\sigma_m^2 + \sigma^2/d$, the usual variance of a sample mean in a random effects model.

The variance parameters of the random effects model, σ_m^2 and σ^2, must be estimated from the data in order to develop the limitations. The Analysis of Variance Sums of Squares are used for this purpose in the independent errors case, and they can be adapted for use with dependent errors.

First, the Sum of Squares for Months (SSM) is given by the formula

$$SSM = \sum_{i=1}^{m} \sum_{t=1}^{d_i} (\overline{X}_i - \overline{X})^2 = \sum_{i=1}^{m} d_i (\overline{X}_i - \overline{X})^2 \qquad (3)$$

where m is the number of months during which data are available, and d_i is the number of days on which data are observed in the i^{th} month. Also, $\overline{X}_i$ is the i^{th} monthly mean and $\overline{X}$ is the mean of all available data. Substituting (1) into (3),

$$SSM = \sum_{i=1}^{m} d_i (M_i - \overline{M})^2 + \sum_{i=1}^{m} d_i (\overline{Z}_i - \overline{Z})^2 + \sum_{i=1}^{m} \sum_{j=1}^{m} d_i d_j (M_i - \overline{M})(\overline{Z}_i - \overline{Z}) \qquad (4)$$

where

$$\overline{M} = \frac{\sum_{i=1}^{m} M_i}{m}$$

$$\overline{Z} = \frac{\sum_{i=1}^{m} \sum_{t=1}^{d_i} Z_{it}}{N}$$

and

$$N = \sum_{i=1}^{m} d_i$$

is the total sample size.

Now the expected value of SSM is

$$E(SSM) = E[\sum_{i=1}^{m} d_i (M_i - \overline{M})^2] + E[\sum_{i=1}^{m} d_i (\overline{Z}_i - \overline{Z})^2] \qquad (5)$$

since the expected value of the cross product is zero. The components of (5) are

$$E[\sum_{i=1}^{m} d_i (M_i - \overline{M})^2] = \sum_{i=1}^{m} d_i [E(M_i^2)$$

$$+ E(\frac{(\sum_{j=1}^{m} M_j)^2}{m^2}) - 2E(\frac{M_i \sum_{j=1}^{m} M_j}{m})]$$

$$= N[\sigma_m^2 + \frac{\sigma_m^2}{m} - \frac{2\sigma_m^2}{m}] \qquad (6)$$

$$= \frac{N(m-1)}{m} \sigma_m^2$$

and

$$E[\sum_{i=1}^{m} d_i (\overline{Z}_i - \overline{Z})^2]$$

$$= \sum_{i=1}^{m} d_i \; E\left\{\frac{\sum_{t=1}^{d_i} Z_{it}}{d_i^2}\right\}^2 + \frac{E(\sum_{j=1}^{m} \sum_{t=1}^{d_i} Z_{jt})^2}{N^2} \qquad (7)$$

$$-2 \; \frac{E(\sum_{t=1}^{d_i} Z_{it} \sum_{j=1}^{m} \sum_{t=1}^{d_i} Z_{jt})}{d_i N}$$

$$= \sigma^2 [\sum_{i=1}^{m} \frac{1}{d_i} \sum_{s=1}^{d_i} \sum_{t=1}^{d_i} \emptyset^{|D_s - D_t|} - \frac{1}{N} \sum_{s=1}^{N} \sum_{t=1}^{N} \emptyset^{|D_s - D_t|}]$$

where $|D_s - D_t|$ is the absolute difference of the number of days separating the daily values at times s and t, i.e., the time period between the pair of daily values being correlated.

Substituting (6) and (7) into (5),

$$E(SSM) = \frac{(m-1)N}{m}\sigma_m^2 + \left[\sum_{i=1}^{m} \frac{1}{d_i} \sum_{s=1}^{d_i} \sum_{t=1}^{d_i} \emptyset^{|D_s - D_t|} - \frac{1}{N} \sum_{s=1}^{N} \sum_{t=1}^{N} \emptyset^{|D_s - D_t|}\right]\sigma^2 \qquad (8)$$

Note that in the case of independence $(\emptyset=0)$, and a balanced design $(N=md)$, equation (8) reduces to

$$E(SSM) = (m-1)(d\sigma_m^2 + \sigma^2)$$

which is the correct expected sum of squares for the usual random effects model with independent error structure. See Mendenhall (1968) for a discussion of the random effects (nested) model with independent error structure.

Similarly, for the Sum of Squares for Error (or "Days", in this case),

$$SSE = \sum_{i=1}^{m} \sum_{t=1}^{d_i} (X_{it} - \bar{X}_i)^2$$

$$= \sum_{i=1}^{m} \sum_{t=1}^{d_i} \left[(\mu + M_i + Z_{it}) - \left(\mu + M_i + \frac{\sum_{t=1}^{d_i} Z_{it}}{d_i}\right)\right]^2$$

$$= \sum_{i=1}^{m} \sum_{t=1}^{d_i} (Z_{it} - \bar{Z}_i)^2$$

Then

$$E(SSE) = \sum_{i=1}^{m} \sum_{t=1}^{d_i} E(Z_{it} - \bar{Z}_i)^2$$

$$= \sigma^2 \sum_{i=1}^{m} \sum_{t=1}^{d_i} [1 - \frac{1}{d_i} \sum_{s=1}^{d_i} \sum_{t=1}^{d_i} \phi^{|D_s - D_t|}]$$

$$= [N - \sum_{i=1}^{m} \frac{1}{d_i} \sum_{s=1}^{d_i} \sum_{t=1}^{d_i} \phi^{|D_s - D_t|}] \sigma^2$$

In the case of independence and balance, (9) reduces to

$$E(SSE) = m(d-1)\sigma^2$$

which agrees with the usual result.

Writing

$$C_1 = \frac{(m-1)N}{m}$$

$$C_2 = \sum_{i=1}^{m} \frac{1}{d_i} \sum_{s=1}^{d_i} \sum_{t=1}^{d_i} \phi^{|D_s - D_t|} - \frac{1}{N} \sum_{s=1}^{N} \sum_{t=1}^{N} \phi^{|D_s - D_t|}$$

and

$$C_3 = N - \sum_{i=1}^{m} \frac{1}{d_i} \sum_{s=1}^{d_i} \sum_{t=1}^{d_i} \phi^{|D_s - D_t|}$$

it has been shown in (8) and (9) that

$$E(SSM) = C_1\sigma_m^2 + C_2\sigma^2$$

$$E(SSE) = C_3\sigma^2$$

Given an estimate of ϕ, the values of C_1, C_2, and C_3 can be calculated, and then estimates of σ_m^2 and σ^2 can be calculated using the observed SSM and SSE as follows:

$$\hat{\sigma}^2 = \frac{SSE}{C_3}$$

$$\hat{\sigma}_m^2 = \frac{SSM - C_2\hat{\sigma}^2}{C_1}$$

In Table G-10, the values of $\hat{\sigma}_m^2$ and $\hat{\sigma}^2$ are given for each plant, with $\phi = .5$. Note that $\hat{\sigma}_m^2$ is generally of the same order as $\hat{\sigma}^2$, indicating that much seasonal variability is present in these data.

The most important function of the model is its use in establishing a monthly limitation. The variance of the monthly mean based on d daily values now can be estimated from equation (2) by

$$\widehat{Var}(\bar{X}_i) = \hat{\sigma}_m^2 + \frac{\hat{\sigma}^2}{d}\left[\frac{1+\phi}{1-\phi} - \frac{2\phi(1-\phi^d)}{d(1-\phi)}\right]$$

To derive the limitations and variability factors in the report, a value of $\phi = .5$ was used. This estimate is based on the daily residual autocorrelations shown in Figures G-1 to G-6, which are relatively consistent with such a model. A more exact estimator of ϕ was not derived because of the many missing daily values in each series of data, and because the effect of the value of ϕ on the limitations was very minimal, especially when compared to the effect of seasonality (as measured by σ^2). The autocorrelations were also analyzed using the model identification algorithm developed by McClave (1978), and the first order autoregressive model was supported.

The 99th percentile of the monthly mean is estimated

$$L = \bar{X} + 2.33\sqrt{\widehat{Var}(\bar{X}_i)}$$

and the variability factor by

$$VF = \frac{L}{\bar{X}}$$

where $\bar{X}$ is the mean of all the daily values, i.e., the "long term" mean.

The validity of the limitation and variability factor as 99th percentile estimators depends on the normality of the two random quantities in $\bar{X}_i$: M_i and $\bar{Z}_i$. The approximate normality of $\bar{Z}_i$ follows from the Central Limit Theorem for reasonably large d, but the normality of M_i must be assumed. On a hueristic level, this may be a reasonable assumption even if the data themselves are skewed, since the distribution of the daily random component, Z_{it}, may be skewed, while that of

M_i is approximately normal. Unfortunately, the present data are insufficient to test the hypothesis of M_i's normality.*

---

*Such a test is difficult in any case, since M is not an observable random variable.

Table G-1. Number of Observations in Data Set, as Presented in 1979 Development Document

Plant	BOD			TSS		
	1976	1977	1976 & 1977	1976	1977	1976 & 1977
537	139	135	274	139	134	273
207	52	81	133	96	122	218
931	205	203	254*	205	203	254*
980	361	356	834†	360	356	311**

*Data represents period of 10/1/76 through 12/31/77 when upgraded system was in working operation.
†Data represents period of 1/1/76 through 4/30/78.
**Data represents period of 6/16/77 through 4/30/78 when standard TSS analyses were performed.

Table G-2. Non-Parametric Daily Variability Factors for Insulation Board and Hardboard Plants, as Presented in 1979 Development Document

	BOD			TSS		
Plant	1976	1977	1976 & 1977	1976	1977	1976 & 1977
931	4.7	5.64	5.58*	4.1	4.49	4.56*
537	7.3	3.72	3.93	5.6	6.32	4.22
207	†	4.87	4.61	3.3	4.24	3.59
980	3.6	3.89	4.06**	3.3	6.79††	6.79††

*Data represents period of 10/1/76 through 12/31/77 when upgraded treatment system was under normal operation.

†Insufficient data to obtain a 50 percent confidence estimate for the 99th percentile.

**Data represents period of 1/1/76 through 4/30/78.

††Data represents period of 6/16/77 through 4/30/78 when standard TSS analyses were performed.

Table G-3. Non-Parametric 30-Day Variability Factors for Insulation Board and Hardboard Plants, as Presented in 1979 Development Document

	BOD			TSS		
Plant	1976	1977	1976 & 1977	1976	1977	1976 & 1977
537	1.45	1.67	1.40	1.41	1.76	1.41
207	1.34	1.34	1.34	1.33	1.33	1.33
931	1.48	1.54	1.44	1.42	1.44	1.39
980	1.31	1.40	1.35*	1.27	1.72	1.46†

*Data represents period of 1/1/76 through 4/30/78.

†Data represents period of 6/16/77 through 4/30/78 when standard TSS analyses were performed.

Table G-4. Descriptive Statistics of Extended Data Base

Plant	Long-Term Avg. Production (tons/day)	Pollutant	Sample Size	Arithmetic Mean (lbs/day)	Standard Deviation (lbs/day)	Minimum (lbs/day)	Maximum (lbs/day)
207 1/1/76 to 12/31/77	89.8	BOD	133	800.0	640.9	40.8	3685.0
		TSS	218	1868.2	1449.8	18.0	7345.0
537 1/1/76 to 3/31/79	159.3	BOD	445	659.9	594.4	7.0	4565.0
		TSS	447	417.0	387.3	6.0	2916.0
931 10/1/76 to 10/31/79	130.9	BOD	627	241.5	223.8	6.0	1274.0
		TSS	627	788.3	630.6	15.0	3663.0
980* 1/1/76 to 2/29/80	234.7	BOD	1359	1694.3	1352.8	30.0	13541.6
		TSS	838	2367.8	1873.5	125.4	34273.5

*TSS data base period is 6/16/77 to 2/29/80 which represents the period of time when standard TSS analyses were performed. Long-term average production from this period is 236 tons/day.

Table G-5. Autocorrelations

Plant	Lag	BOD N	BOD Auto-correlation	TSS N	TSS Auto-correlation
207	1	4	.18	49	.09
	2	48	.03	76	.25
	3	7	.49	52	.28
	4	4	.24	59	.51
	5	39	.23	63	.10
	6	4	.18	72	.01
	7	75	-.12	112	-.05
537	1	150	.44	150	.41
	2	145	-.03	146	-.02
	3	137	-.25	139	-.18
	4	131	.01	132	-.23
	5	137	.06	138	-.08
	6	144	-.04	145	-.06
	7	379	.08	384	.09
931	1	464	.43	464	.45
	2	305	.03	305	.03
	3	146	-.30	146	-.24
	4	146	.20	146	.20
	5	304	.18	304	.07
	6	462	.07	462	.08
	7	609	-.06	609	.05
980	1	1333	.61	819	.51
	2	1314	.41	802	.29
	3	1302	.32	790	.02
	4	1289	.16	779	-.04
	5	1281	.11	770	-.07
	6	1273	.08	761	-.06
	7	1264	-.01	753	-.07

Table G-6. Daily 99th Percentile Estimates and Standard Errors

			Standard Error of the 99th Percentile Estimate			
				Dependent Observations (lbs/day)		
Plant	Pollutant	99th Percentile Estimate (lbs/day)	Independent Observations (lbs/day)	Weak	Moderate	Strong
207	BOD	2896.7	295.6	302.1	340.9	502.3
	TSS	6580.8	407.5	416.5	469.9	692.3
537	BOD	2575.0	124.7	127.5	143.9	211.9
	TSS	1742.0	97.7	99.8	112.6	165.9
931	BOD	1000.0	52.2	53.4	60.2	88.8
	TSS	2785.0	107.2	109.6	123.6	182.2
980	BOD	5990.5	170.5	174.3	196.6	289.7
	TSS	6355.0	218.7	223.6	252.3	371.6

Table G-7. Daily Variability Factors

				Upper Confidence Limit (95 percent) for the New Variability Factor†			
				Independent Observations (lbs/day)	Dependent Observations (lbs/day)		
Plant	Pollutant	Daily Variability Factor*			Weak	Moderate	Strong
207	BOD	4.61**		4.36	4.38	4.47	4.88
	TSS	3.59**		3.96	3.97	4.03	4.26
537	BOD	3.93**	3.92††	4.28	4.29	4.34	4.54
	TSS	4.22**	4.34††	4.65	4.66	4.72	4.97
931	BOD	5.58**	4.15††	4.57	4.58	4.64	4.88
	TSS	4.56**	3.61††	3.80	3.81	3.85	3.99
980	BOD	4.06**	3.67††	3.74	3.74	3.77	3.88
	TSS	6.79**	2.77††	2.87	2.87	2.90	3.00

*Based on 50 percent tolerance level estimates of the 99th percentile.

†Based on the upper 95 percent confidence limit for the 99th percentile. All variability factors, except Plant 207, are based on extended data bases.

**Based on original data base, as presented in 1979 Development Document.

††Based on extended data base, calculated using the same methodology as described in the 1979 Development Document.

Table G-8. 99th Percentile Estimate for 30-Day Average Based on Arithmetic Mean

Number of Observations in Monthly Mean (m)	BOD				TSS			
	Independent Observations (lbs/day)	Dependent Observations (lbs/day)			Independent Observations (lbs/day)	Dependent Observations (lbs/day)		
		Weak	Moderate	Strong		Weak	Moderate	Strong
PLANT 207								
30	1913.9	1917.4	1919.2	1906.9	4414.3	4418.9	4424.5	4413.8
PLANT 537								
30	1373.7	1374.2	1375.7	1359.6	865.7	866.2	867.4	856.5
PLANT 931								
30	658.2	657.6	657.4	657.3	1845.2	1842.8	1841.8	1841.6
PLANT 980								
30	4051.1	4049.2	4044.0	4025.6	4537.0	4526.3	4495.6	4391.4

Table G-9. Thirty Day Variability Factors

	BOD		TSS	
Plant	1979 Development Document	Random Effects Model	1979 Development Document	Random Effects Model
207	1.34	2.40	1.33	2.37
537	1.40	2.08	1.41	2.08
931	1.44	2.72	1.39	2.34
980	1.35	2.39	1.46	1.90

Table G-10. Estimates of the Variances for the Random Effects Model

Plant	Pollutant	Raw Data Monthly Variance ($\hat{\sigma}_m^2$)	 Daily Variance ($\hat{\sigma}^2$)
207	BOD	210,924	207,529
	TSS	1,104,187	1,041,546
537	BOD	66,796	288,561
	TSS	25,376	125,371
931	BOD	29,853	21,031
	TSS	183,462	219,328
980	BOD	929,068	920,109
	TSS	548,184	2,988,834

All values are computed assuming $\emptyset = 0.5$ (Moderate Dependence).

FIGURE G-1

(BOD) DAILY EFFECT AUTOCORRELATION
PLANT 537

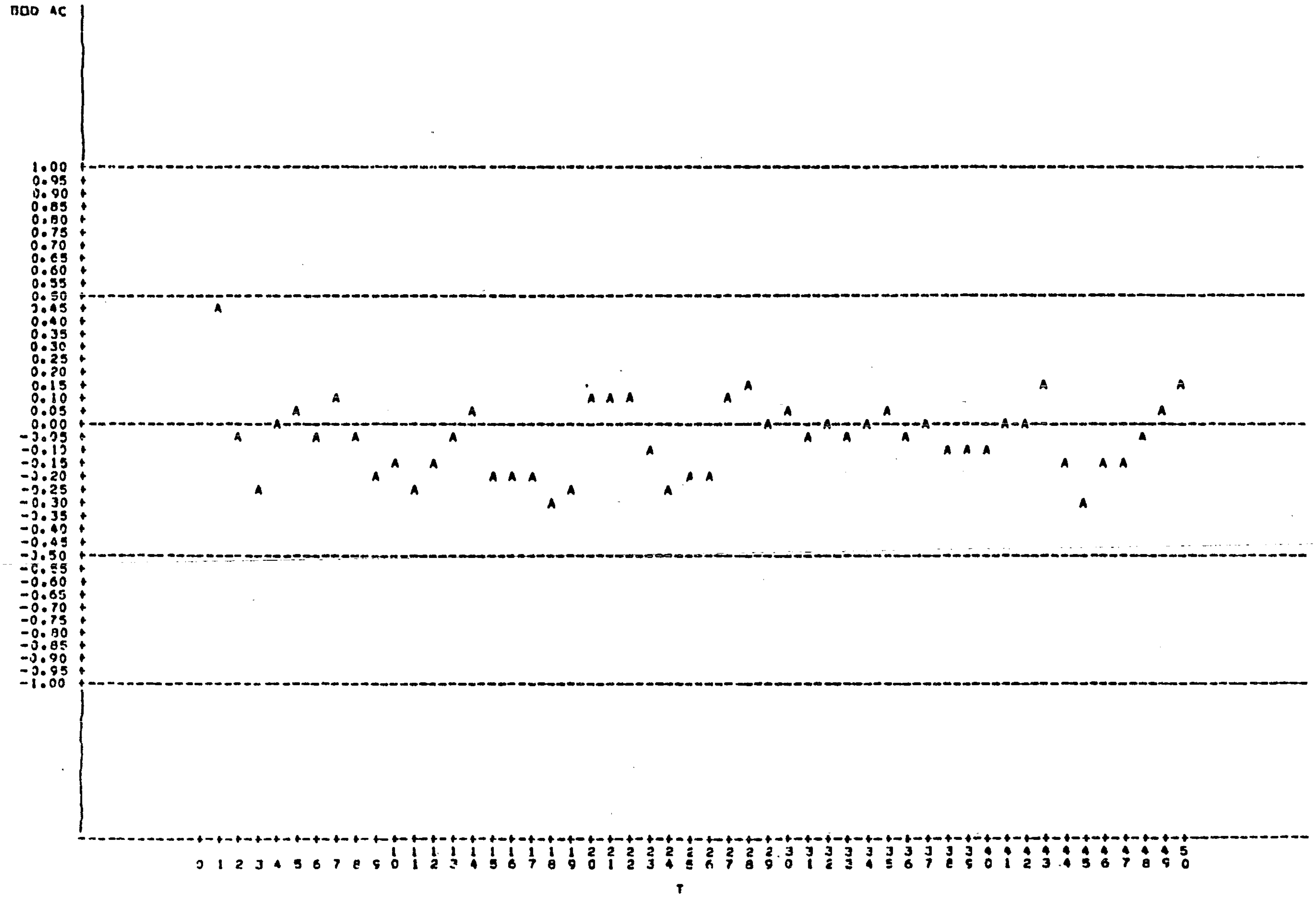


FIGURE G-2

(TSS) DAILY EFFECT AUTOCORRELATION
PLANT 537

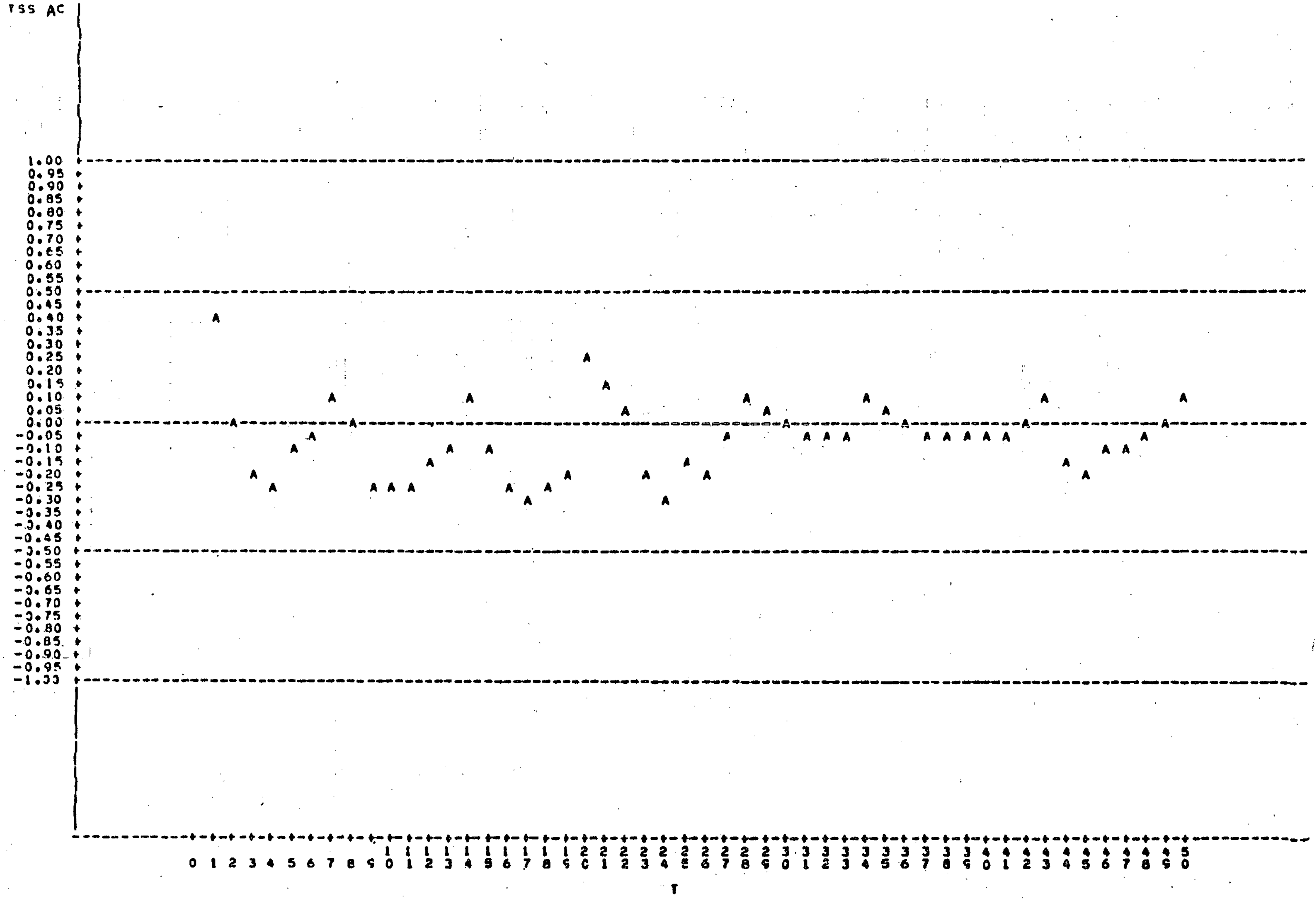


FIGURE G-3

(BOD) DAILY EFFECT AUTOCORRELATION
PLANT 931

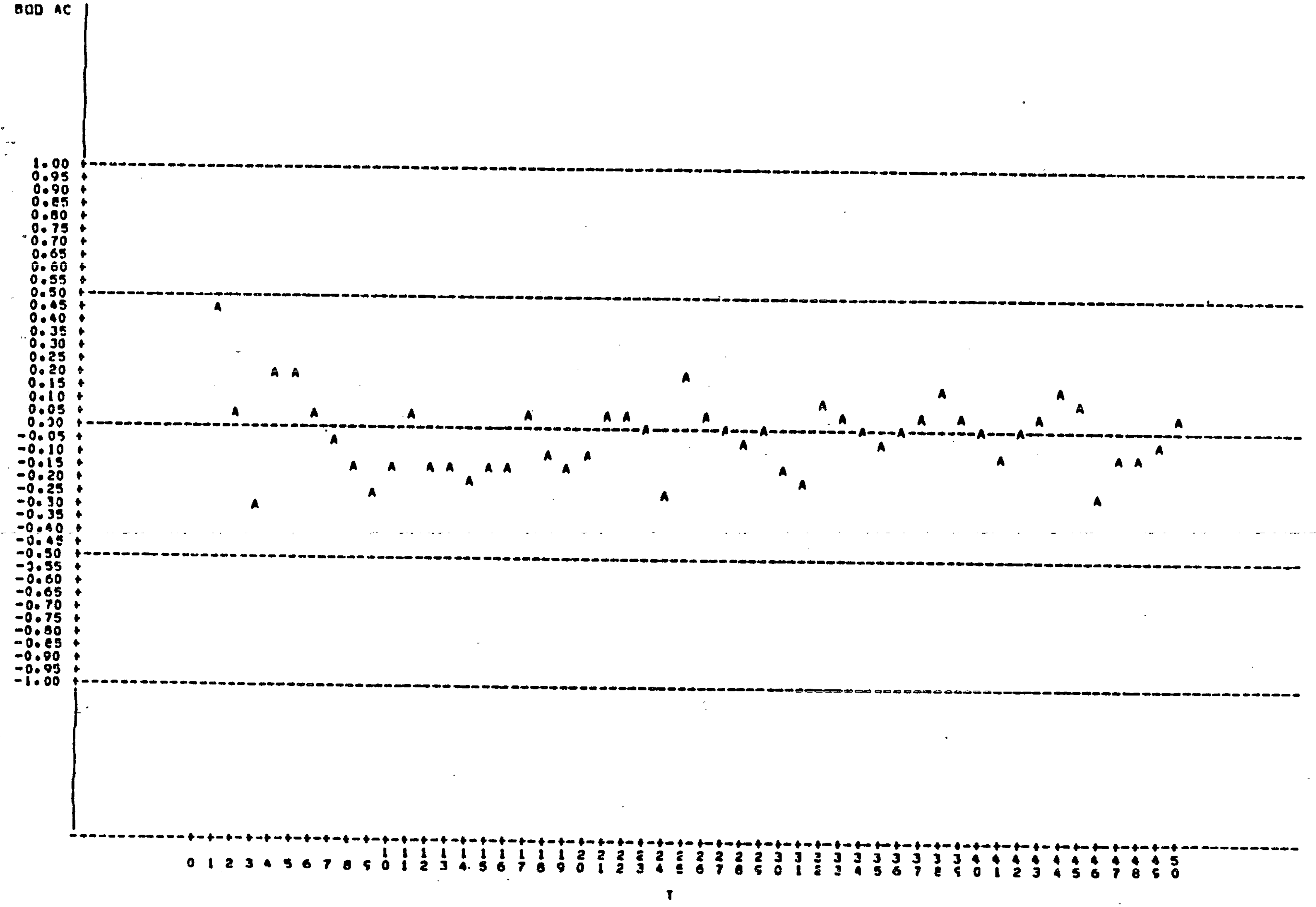


FIGURE G-4

(TSS) DAILY EFFECT AUTOCORRELATION
PLANT 931

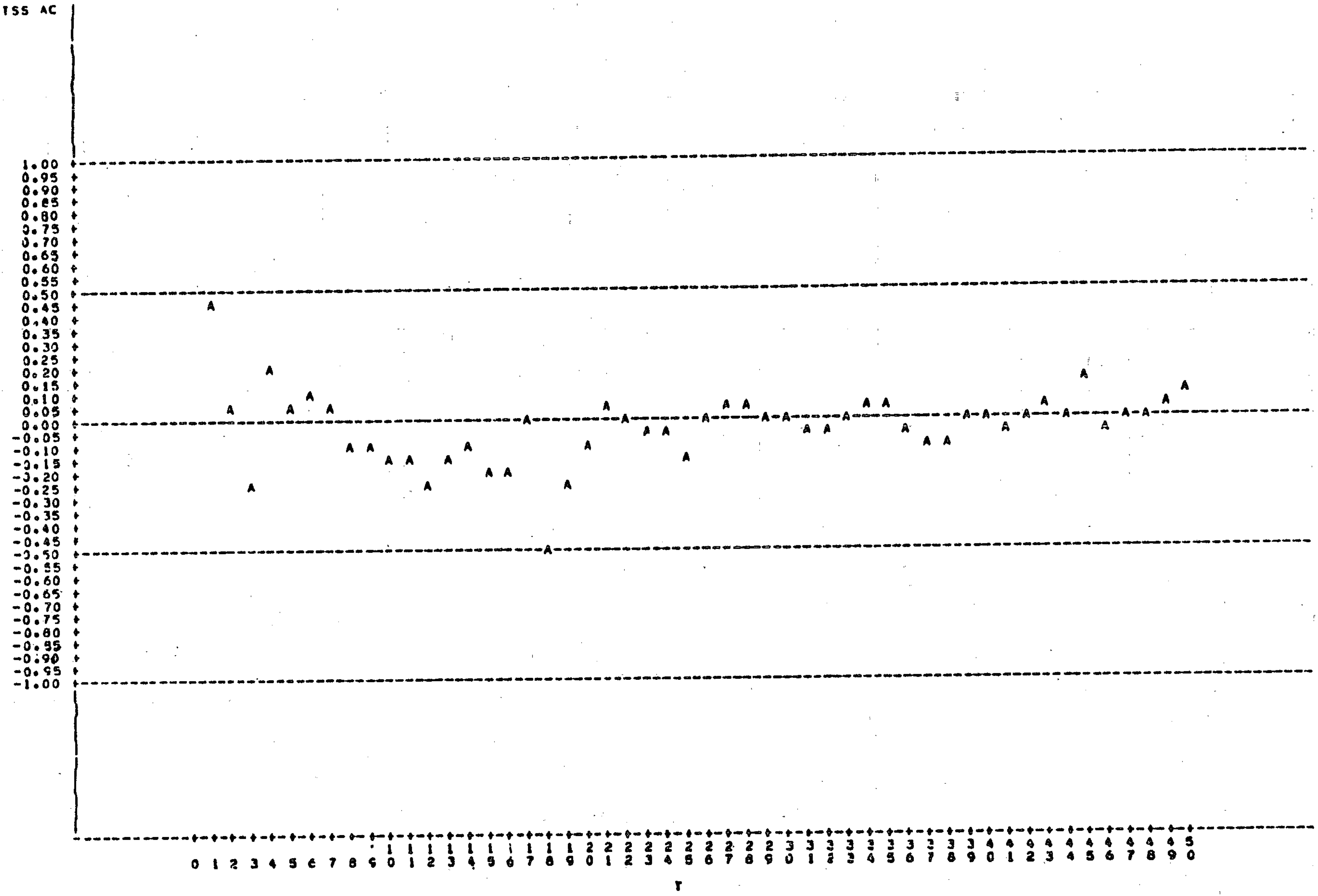


FIGURE G-5

(BOD) DAILY EFFECT AUTOCORRELATION
PLANT 980

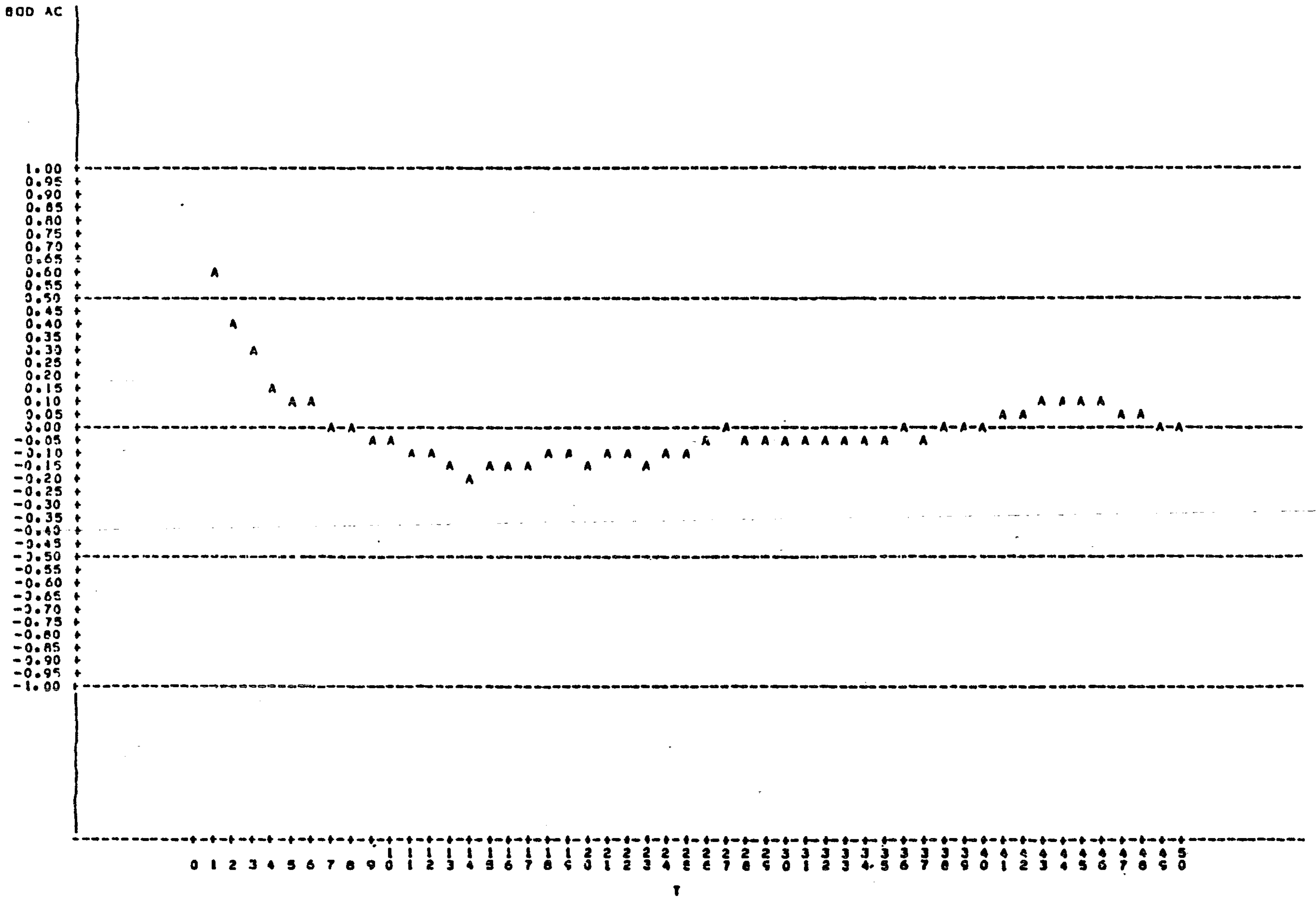
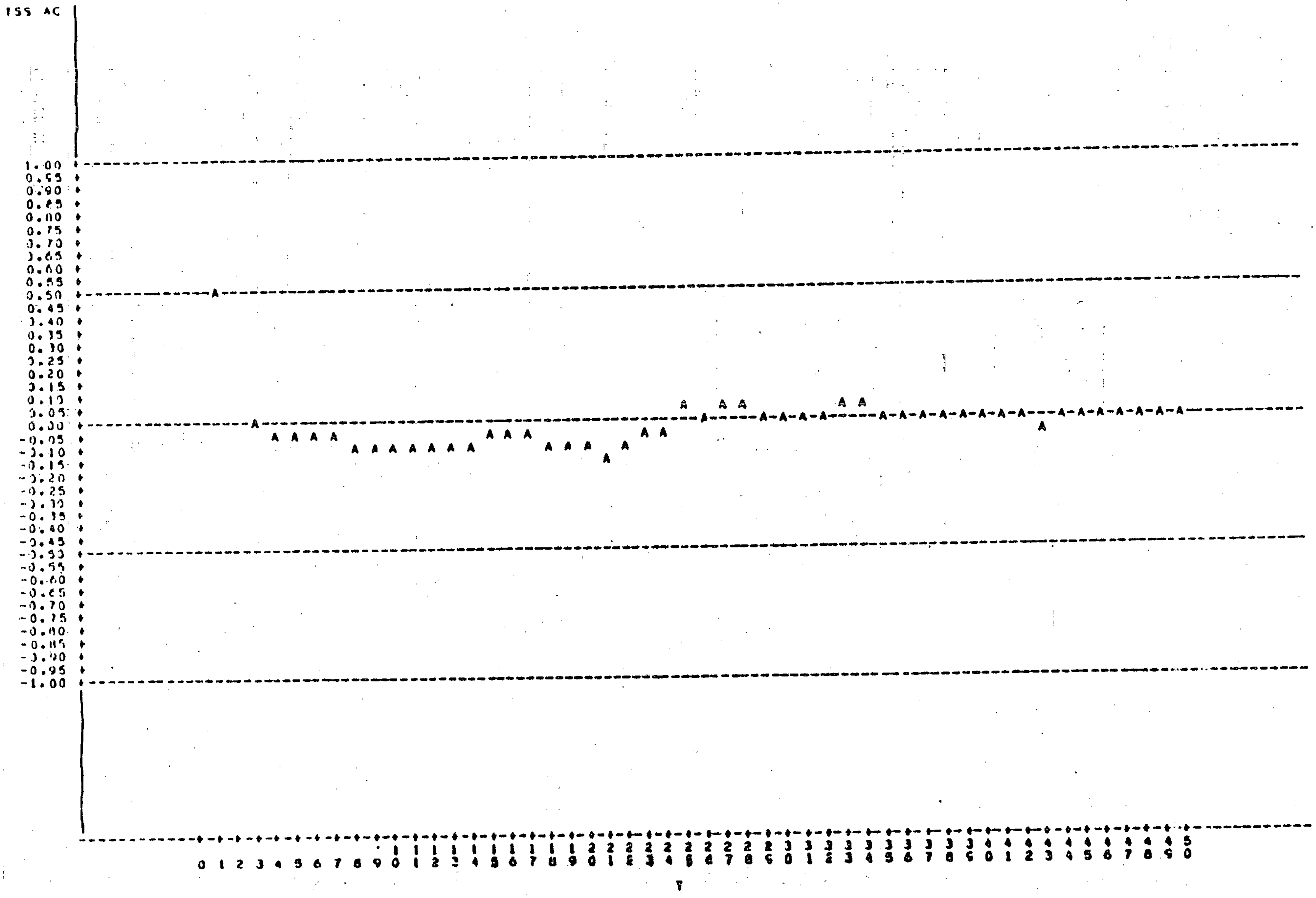


FIGURE G-6

(TSS) DAILY EFFECT AUTOCORRELATION
PLANT 980



APPENDIX H

RESPONSIBLE PERSON

Name ______________________

Title ______________________

Address ______________________

____

Signature ______________________

PRELIMINARY DEFINITIONS AND INSTRUCTIONS

For the purpose of this survey, the following definitions apply:

Process Wastewater may be defined as any spent water which results from or has had contact with the manufacturing process. It includes any water for which there is a reasonable possibility of contamination from the process or from raw material-intermediate product-final product storage, transportation, handling, processing, cleaning, or fire control. Cooling water and storm waters are considered to be process wastewaters where they can be contaminated by the process, as in the case of barometric condenser water and runoff from storage piles.

Non-Process Wastewater is that wastewater which is not contaminated by the process or related materials. Examples of non-process wastewater include boiler blowdown, surface condenser cooling water, sanitary sewage, and storm water which is not contaminated by the process.

A Direct Discharger is considered to be a plant, a manufacturing process, or an operation which releases treated or untreated process wastewater into navigable waterways, waters of the contiguous zone, or the oceans.

The fact that a plant may release process wastewater into a ditch, culvert, pipe, stream bed, fissure, or similar conveyance located on plant property does not exclude the plant from being a direct discharger if the wastewater so released eventually enters navigable waters.

<u>An Indirect Discharger</u> is considered to be a plant, a manufacturing process, or an operation which releases process wastewater, treated or untreated, to a publicly owned treatment works (POTW).

<u>A Self-Contained Discharger</u> is considered to be a plant, a manufacturing process, or an operation which releases process wastewater, treated or untreated, to disposal by spreading on the land, to containment in evaporation ponds, to a deep aquifer by subsurface injection, to application on solid waste material which is subsequently burned or disposed of in a landfill, or other method which does not result in discharge to navigable waters, water of the contiguous zone, oceans, or a POTW.

<u>Navigable Waters</u> are considered to be any surface water bodies not totally contained on the property of the discharger.

<u>Historical Data</u> is effluent quality data, relating to treated or untreated wastewater collected for a period of 30 days or longer. Requests for historical data in this portfolio are for the most recent 12-month period, or 30 days to 12 months if less than 12 months are available.

According to the definitions above, does operation of your plant or manufacturing process result in the release of any process wastewater?

Yes________ No________

If Yes, according to the definitions above, is your plant or manufacturing operation a direct, indirect, or self-contained discharger?

Direct________ Indirect________ Self-Contained________

If direct, do you release effluent into the ocean?

Yes________ No________

If your plant is a direct discharger, do you have an NPDES discharge permit issued by a state and/or regional EPA office?

Yes________ No________

If yes, enclose a copy of the permit. Also identify municipal, county, or regional regulations which control discharge from your plant, if any. Then complete Parts One, Two, Three, Four, and Five and return.

If your plant is a direct discharger and does not have an NPDES discharge permit, do you have an application for such a permit pending before a state and/or regional EPA office?

Yes_______ No_______

If Yes, provide the location of the state and/or regional EPA office where the application is on file.____

____

If your plant is a direct discharger and does not have an NPDES discharge permit, do you have historical data on the quantity and/or quality of your raw process wastewater.and/or your treated process wastewater?

Yes_______ No_______

If your plant is an indirect discharger, do you pretreat the raw wastewater prior to discharge into the sewer?

Yes_______ No_______

If your plant is an indirect discharger, do you have historical data on the quantity and quality of your raw process wastewater and your treated process wastewater?

Yes_______ No_______

Indirect dischargers: Identify the names, location, and local government office responsible for the publicly owned treatment works to which you discharge.

____

____

____

____

Indirect dischargers: Identify specific pretreatment requirements (other than federal) or limits upon pollutant parameters imposed by the POTW system to which you discharge.

____

____

____

____

If your plant is a self-contained discharger, indicate method of effluent release.

____Land disposal
____Containment in evaporation ponds
____Subsurface injection
____Spray on solid waste and incinerate
____Spray on solid waste and landfill
____Other (Specify)________________________________

If your plant is a self-contained discharger, do you pretreat the raw wastewater prior to effluent release to disposal?

Yes ________ No ________

If your plant is a self-contained discharger, do you have historical data on the quantity and/or quality of your raw process wastewater and/or your treated process wastewater?

Yes ________ No ________

Self-contained dischargers: Identify specific requirements, conditions, or limits upon pollutant parameters imposed upon your effluent disposal system by local or state pollution control authorities. Also identify the local or state regulating office or authority.

____

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____

The person who should be contacted concerning your response to this letter is:

Name ____
Title ____
Address ____
____
Telephone ____

PART ONE

SUBCATEGORIZATION CHECKLIST

The following is a list of manufacturing processes or operations which are associated with the Timber Products Processing Category. Please identify those processes or operations which occur to your plant by placing an "X" in the appropriate space. Check all appropriate responses.

______ Timber Harvesting Operations
    ______ Logging camps
    ______ Transportation of logs by truck
    ______ Transportation of logs by rail
    ______ Transportation of logs by ship or barge
    ______ Transportation by log rafts floating directly in the water
    ______ Other (specify) ____________________________________

____ Raw Materials Storage
    ______ Log storage by dry land deck
    ______ Log storage by wet land deck
    ______ Log storage, pond (self contained)
    ______ Log storage, pond (flow-through)
    ______ Log storage in estuary, river, or other large publicly-owned body of water
    ______ Fractionated wood (chip piles, etc.)
    ______ Other (specify) ____________________________________

_____Barking Operations

_____Mechanical debarkers

_____Hydraulic debarkers

_____Other (specify)_____________________________

_____Log Washing

Describe the process used.______________________

____

____

_____Sawmills and Planning Mills

_____General lumber production

_____Hardwood dimension and flooring

_____Specialty sawmills (specify)__________________

_____Millwork

Describe the type of millwork performed.___________

____

____

_____Veneer Production

_____Hardwood veneer

_____Softwood veneer

_____Steam or hot water conditioning of logs in preparation for veneering

_____Other (specify)_____________________________

_____Plywood Production

_____Softwood plywood

_____Hardwood plywood

_____Softwood core with hardwood face

_____Hardboard or particleboard core with hardwood face

_____Other (specify)_____________________________

_____Wood Container Production

_____Nailed wooden boxes

_____Wireboard boxes and crates

_____Veneer and plywood containers

_____Cooperage

_____Other (specify)_____________________________

_____Structural Wood Members and Wood Laminates

_____Mechanical fasteners used

_____Nonwater soluble adhesives used

_____Water soluble adhesives used

_____Other (specify)_____________________________

_____Finishing Operations (followng edging or trimming)

_____Kiln drying

_____Planning

_____Dipping

_____End coating

_____Moisture proofing
_____Staining or painting
_____Machining, general
_____Fabrication using water soluble adhesives
_____Fabrication using nonwater soluble adhesives
_____Molded wood products
_____Other (specify)__________________________

_____Wood Preserving
_____Steam conditioning
_____Boultonizing Process
_____FCAP treatment
_____Vapor drying methods
_____Creosote treatment
_____Pentachlorophenol treatment
_____Treatment with CCA, ACA, ACC, CZC, or other salts
_____Fire retardants
_____Other (specify)__________________________

_____Hardboard Production (density greater than 31 lbs/cf)
_____Dry felting - dry pressing
_____Dry felting - wet pressing
_____Wet felting - wet pressing
_____Wet felting - dry pressing
_____Other (specify)__________________________

_____Insulation Board Production (density less than 31 lbs/cf)
_____Mechanical pulping and refining only
_____Thermo-mechanical (steam) pulping and refining
_____Chemical or semichemical pulping
_____Hardboard production at the same facility
_____Other (specify)__________________________

_____Particleboard or Flakeboard Production
_____Mat formed
_____Extruded
_____Other (specify)__________________________

_____Wood Furniture and Fixture Production
_____With water wash spray booths
_____With on-site laundry facilities
_____Without either of the above
_____Other (specify)__________________________

_____Manufacturing operations related to, but not included in the timber products processing category
_____Pulp and paper production
_____Charcoal production
_____Gum and wood chemicals manufacture
_____Production of wood preserving chemicals
_____Other (specify)__________________________
____

PART TWO

DESCRIPTION OF PLANT OPERATIONS

(This information is required for each process identified in Part One, Subcategorization Checklist, as pertaining to your plant. List answers by number on a separate sheet.)

1. List the date the plant was built and the date major process equipment was installed. Also list the dates of any rebuilds, renovations, or modification of major process eqipment or expansions.

2. Give the location of the plant.

3. List the design capacity for each process or product produced (including byproducts, if any). State the basis used in reporting the design capacity. If the basis is other than in weight or mass units (pounds, tons, kilograms), indicate the density of the finished product (use Attachment I).

4. Provide the approximate tons/day of raw materials and additives. State whether the tons/day are reported on a dry or wet basis. If a wet basis is used, estimate the percent moisture contained in the raw material. For wood, specify the type (softwood or hardwood), species, and form (roundwood, chips, veneer, etc.). For mineral or

If your plant produces a product or conducts a manufacturing process or operation which is not listed above, please identify.

____

____

____

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chemical additives, give sufficient information to completely identify the material (i.e., phenolic resin, 10 tons/day), point of addition, and reason for use. For solutions, state the volume and concentration (i.e., ferric chloride, 1 percent solution, 500 gallongs/day). For trade name chemicals or additives, state trade name, amount used per day, point of addition, and reason for use (use Attachment II).

5. Provide a schmatic diagram of the process or operation. Indicate on this diagram, a pencil drawing will be sufficient, showing a thru e:
   a. Each point where materials and additives listed in 4 above, enter the process.
   b. The location of each point where fresh water from an external source is applied to the process and the approximate flow rate of this water.
   c. Each process wastewater stream with approximate flow rates and destinations.
   d. Each process water recycle stream. Be sure to indicate the source, destination, and approximate flow rates of each recycle stream.
   e. The point where any nonprocess wastewater stream is mixed with any process wastewater stream. Also indicate the source and approximate flow rate of this commingled nonprocess wastewater.

6. For each external source of fresh water applied to the system, list the source (municipal, river, wells or property, etc.) of this water and the quality, if known. If any external water source requires treatment prior to application to the system, describe the water treatment system. If the water treatment system results in the production of a waste stream or sludge, estimate the flow rate or volume and the quality of this waste stream.

7. List all solid waste produced by the process, the source of the wastes, approximate tons/day, and the method of solid waste disposal.

8. For each process wastewater stream indicated in 5.c above, state whether the approximate flow rate provided is constant or fluctuates during plant operation. Estimate the range of variation in any fluctuating wastewater stream and explain what causes the variation.

PART THREE

WASTEWATER CHARACTERIZATION AND TREAMENT OR PRETREATMENT SYSTEM INFORMATION

(This information is required for each process identified in Part One, Subcategorization Checklist, as pertaining to your plant. List answers by number on a separate sheet.)

1. Describe the wastewater treatment or pretreatment facilities for each process. The following information is requested:
   a. Type, size, and design basis (both hydraulic and pollutant loading) for each unit in the system (i.e., aerated lagoon, 15,000 ft^3, 1.0 mgd, and 30 lb BOD/ft^3/day peak flow; 0.5 mgd, and 15 lb BOD$_5$/ft^3/day normal flow) (see Attachment III).
   b. A schematic diagram of the wastewater treatment r pretreatment facilities. Identify all wastewater streams treated by each unit. Indicate on this diagram sampling points for which historical data are available.
   c. Amount of waste sludge produced, in pounds and cubic yards per day, week, or month. State method of sludge disposal. If sludge transported off the premises for disposal, indicate the distance to disposal site. Include sludge disposal costs, in detail. Estimate the annual energy requirements of KWH, or other standard energy units of the wastewater treatment or pretreatment system. If this information is unavailable, list the total installed horsepower for effluent treatment or pretreatment systems.

2. Report the monthly production of each product produced during the most recent 12-month period for which this data is available. If daily or weekly production figures are kept include them. State basis used for all production figures (please indicate if you want this information kept confidential.) (Use Attachment IV).

3. For the same 12-month period for which production data is provided, provide the daily monitoring data for the raw process wastewater and the treated final effluent from the plant. Parameters of interest are flow rate, BOD$_5$, COD, TOC, TSS, phenol, heavy metals, and any of the toxic substances listed in Part Four of this letter for which data are available. If the combined raw process wastewater reported contains nonprocess wastewater, estimate the flow rate and BOD$_5$, COD, TOC, TSS, phenol, and toxic substance concentrations of this nonprocess wastewater. Also, complete Attachments V and VI.

4. For the 12-month period used in reporting 2 and 3 above, report (or estimate) the total energy requirements of the production process. Report <u>all</u> energy requirements in KWH, gallons of fuel oil (state type of oil), SCF of natural gas (state heating value/CF) solid fuel, etc.

5. Describe the type and frequency of sampling conducted to obtain the data in Items 3 and 4 [i.e., weekly grab samples, daily flow proportioned samples, weekly time composites (1 hour duration, samples, ????)] that sampling points are marked on the diagram of the treatment system. State the methods used to analyze the reported data, give references for Standard Methods, and describe any nonstandard methods. State whether or not acclimated seed is used in BOD analyses.

6. If air pollution abatement equipment in your plant results in the production of wastewater, estimate flow rate, BOD_5, COD, TOC, TSS, phenols, and toxic substances in this wastewater stream.

7. Describe and fully explain any in-process technology used to reduce pollution discharges for liquid and solid waste (e.g., housekeeping practices, water streams recycled, conversion of wastes into by-products).

8. Describe any methods or devices used to reduce or contain leaks of process water and spills during the manufacturing process. If a major leak or overflow occurs in the process, what is the fate of the resulting wastewater? Do you have a spill prevention and control plant (SPCC) on file? If so, please furnish a copy, including logs or descriptions of past spill occurrences and the actions taken.

9. Discuss seasonality effects on operations, waste load generation, treatment effectiveness, etc. Provide documentation, if available.

10. Are you conducting, or have you conducted in the past 3 years, any of the following for water pollution abatement.

	Yes	No
a. Pilot Studies	______	______
b. Process Modifications	______	______
c. Treatment System Improvements	______	______
d. Grants	______	______

If answer is yes to any of the above, give details.

____

____

____

____

____

11. Are additional end of pipe treatment modules or modifications being planned in order to enable your plant to meet July 1, 1977 (BPT) guidelines? If so, give details and estimated costs. Report only those facilities which are planned to be on-line by July 1977.

Yes________ No________

PART FOUR

TOXIC CHEMICAL CHECKLIST

The following is a list of pollutants identified by the EPA as potentially toxic compounds. Indicate by placing an "X" in the appropriate space which, if any, of these pollutants, to your knowledge, are used or generated in your plant. For each of the pollutants identified as used or generated in your plant, also provide the following information (use Attachment VII).

1. The quantity and frequency of use.

2. Identify the process or operation in which the substance is used or generated.

3. Whether it is known if the substance is discharged from the plant (this includes direct and indirect discharges).

4. The quantity of each substance discharged as liquid, gaseous, or solid waste, if known.

5. The frequency with which such discharges occur, i.e., continuously or intermittently (weekly, hourly, etc.), if known.

6. The sampling or monitoring program for each pollutant, if any.

It should be noted that many plants may be using quantities of the listed chemicals as additives, cleaning solution, or solvents which are purchased and referred to by a trade name. All trade name chemicals used in the plant should be surveyed to determine if they contain substances listed below. List all wood preservative, fire retardants, fungicides, and mildewcides used in the plant. List by generic name (creosote, CCA, etc.), if known. If generic name is unknown, list by trade name.

______Acenaphthene
______Acrolein
______Acrylonitrile
______Benzene
______Benzidine
______Carbon Tetrachloride (Tetrachloromethane)
______Chlorobenzene
______1,2,4-trichlorobenzene
______Hexachlorobenzene
______1,2-dichloroethane
______1,1,1-trichloroethane
______Hexachloroethane
______1,1-dichloroethane
______1,1,2-trichloroethane

______1,1,2,2-tetrachloroethane

______Chloroethane

______Bis(chloromethyl) Ether

______Bis(2-chloroethyl) Ether

______2-chloroethyl Vinyl Ether (Mixed)

______2-chloronaphthalene

______2,4,6-trichlorophenol

______Panachlorometa Cresol

______Chloroform (Trichloromethane)

______2-chlorophenol

______1,2-dichlorobenzene

______1,3-dichlorobenzene

______1,4-dichlorobenzene

______3,3'-dichlorobenzidine

______1,1-dichloroethylene

______1-2,-trans-dichloroethylene

______2,4-dichlorophenol

______1,2-dichloropropane

______1,3-dichloropropylene (1,3-dichloropropene)

______2,4-dimethylphenol

______2,4-dinitrotoluene

______2,6-dinitrotoluene

______1,2-diphenylhydrazine

______Ethylbenzene

______Fluroanthene

______4-chlorophenyl Phenyl Ether

______4-bromophenyl Phenyl Ether

______Bis(2-chloroisopropyl) Ether

______Bis(2-chloroethoxy) Methane

______Methylene Chloride (Dichloromethane)

______Methyl Chloride (Chloromethane)

______Methyl Bromide (Bromomethane)

______Bromoform (Tribromomethane)

______Dichlorobromomethane

______Trichlorofluoromethane

______Dichlorodifluoromethane

______Chlorodibromomethane

______Hexachlorobutadiene

______Hexachlorocyclopentadiene

______Isophorone

______Naphthalene

______Nitrobenzene

______2-nitrophenol

______4-nitrophenol

______2,4-dinitrophenol

______4,6-dinitro-o-cresol

______N-nitrosodimethylamine

______N-nitrosodiphenylamine

______N-nitrosodi-n-propylamine

______Pentachlorophenol

______Dieldrin
______Chlordane (Technical Mixture and Metabolites)
______4,4'-DDT
______4,4'-DDE(p,p'-DDX)
______4,4'-DDD(p,p'-TDE)
______alph-Endosulfan
______beta-Endosulfan
______Endosulfan Sulfate
______Endrin
______Endrin Aldehyde
______Heptachlor
______Heptachlor Expoxide
______alpha-BHC
______beta-BHC
______gamma-BHC (Lindane)
______delta-BHC
______PCB-1242 (Arochlor 1242)
______PCB-2154 (Arochlor 1254)
______Toxaphene
______Antimony (Total)
______Arsenic (Total)
______Asbestos (Fibrous)
______Beryllium (Total)
______Cadmium (Total)
______Chromium (Total)

______Phenol
______Bis(2-ethylhexyl) Phthalate
______Butyl Benzyl Phthalate
______Di-n-butyl Phthalate
______Diethyl Phthalate
______Dimethyl Phthalate
______1,2-benzanthracene
______Benzo (a)pyrene (3,4-benzopyrene)
______3,4-benzofluoranthene
______11,12-benzofluoranthene
______Chrysene
______Acenaphthylene
______Anthracene
______1,12-benzoperylene
______Fluroene
______Phenanthrene
______1,2:5,6-dibenzanthracene
______Indeno(1,2,3-C,D)pyrene
______Pyrene
______2,3,7,8-tetrachlorodibenzo-p-dioxin (TCDD)
______Tetrachloroethylene
______Toluene
______Trichloroethylene
______Vinyl Chloride (Chloroethylene)
______Aldrin

______Copper (Total)

______Cyanide (Total)

______Lead (Total)

______Mercury (Total)

______Nickel (Total)

______Selenium (Total)

______Silver (Total)

______Thallium (Total)

______Zinc (Total)

ATTACHMENT I
PART TWO
QUESTION 3.

PRODUCT OR PROCESS	DESIGN CAPACITY	UNITS OF CAPACITY	MOISTURE CONTENT	DENSITY (if Applicable)	UNITS OF DENSITY
GENERAL LUMBER					
HARDWOOD DIMENSION AND FLOORING					
SPECIALTY SAWMILLS					
MILLWORK					
VENEER					
PLYWOOD					
WOOD CONTAINERS					
STRUCTURAL MEMBERS AND LAMINATES					
WOOD PRESERVING					
HARDBOARD					
INSULATION BOARD					
PARTICLEBOARD					
WOOD FURNITURE					

ATTACHMENT II
PART TWO
QUESTION 3.

PRODUCT OR PROCESS	RAW MATERIALS	% MOISTURE	ADDITIVES	COMMENT
GENERAL LUMBER				
HARDWOOD DIMENSION AND FLOORING				
SPECIALTY SAWMILLS				
MILLWORK				
VENEER				
PLYWOOD				
WOOD CONTAINERS				
STRUCTURAL MEMBERS AND LAMINATES				
WOOD PRESERVING				
HARDBOARD				
INSULATION BOARD				
PARTICLEBAORD				
WOOD FURNITURE				

ATTACHMENT III
PART THREE
QUESTION 1.

WASTEWATER TREATMENT PROCESS	DESIGN BASIS AND SIZE	YEAR CONSTRUCTED
SCREENING		
FILTRATION		
BIOLOGICAL		
ANAEROBIC		
AEROBIC		
ACTIVATED SLUDGE		
TRICKLING FILTER		
EVAPORATION		
SPRAY IRRIGATION		
OTHER		

ATTACHMENT IV
PART THREE
QUESTION 2.

MONTHLY PRODUCTION
(Indicate Month in Parentheses)

PRODUCT	Month 1 ( )	Month 2 ( )	Month 3 ( )	Month 4 ( )	Month 5 ( )	Month 6 ( )	Month 7 ( )	Month 8 ( )	Month 9 ( )	Month 10 ( )	Month 11 ( )	Month 12 ( )	Units of Production
GENERAL LUMBER													
HARDWOOD DIMENSION AND FLOORING													
SPECIALTY SAWMILLS													
MILLWORK													
VENEER													
PLYWOOD													
WOOD CONTAINERS													
WOOD PRESERVING													
HARDBOARD													
INSULATION BOARD													
PARTICLEBOARD													
WOOD FURNITURE													

ATTACHMENT IV
PART THREE
QUESTION 3.

TREATED PROCESS WASTE LOADS DISCHARGED

Corporation ____________________
Plant ____________________
Discharge Point ____________________
Do you post-chlorinate this effluent? Yes_____ No_____ If yes, do you chlorinate?_____(A) Full-time _____(B) Part-time
Time period represented ____________________

Parameter (Provide Information Available)	Daily			Calendar Monthly Averages		Remarks
	Minimum	Long Term Average	Maximum	Minimum	Maximum	
Flow (MGD)						
ph (ph Units)						
Temperature (°C)--Wastewater						
Temperature (°C)--Ambient Air						
BOD5 (lbs/day)						
COD (lbs/day)						
TOC (lbs/day)						
TSS (lbs/day)						
TDS (lbs/day)						
NH3 as N (lbs/day)						
TKN as N (lbs/day)						
Phenol (lbs/day)						
Significant Metals (Identify)						
____________ (lbs/day)						
____________ (lbs/day)						
____________ (lbs/day)						
____________ (lbs/day)						
Others (Identify)						
____________ (lbs/day)						
____________ (lbs/day)						
____________ (lbs/day)						

ATTACHMENT IV
PART THREE
QUESTION 2.

WASTE LOADS TO TREATMENT FACILITIES

Corporation ______________________________

Plant ______________________________

Wastewater Source(s) ______________________________

Time Period Represented ______________________________

Parameter (Provide Information Available)	Daily			Calendar Monthly Averages		Remarks
	Minimum	Long Term Average	Maximum	Minimum	Maximum	
Flow (MGD)						
ph (ph Units)						
Temperature (°C)--Wastewater						
Temperature (°C)--Ambient Air						
BOD5 (lbs/day)						
COD (lbs/day)						
TOC (lbs/day)						
TSS (lbs/day)						
TDS (lbs/day)						
NH3 as N (lbs/day)						
TKN as N (lbs/day)						
Phenol (lbs/day)						
Significant Metals (Identify)						
____________ (lbs/day)						
____________ (lbs/day)						
____________ (lbs/day)						
____________ (lbs/day)						
Others (Identify)						
____________ (lbs/day)						
____________ (lbs/day)						
____________ (lbs/day)						

*U.S GOVERNMENT PRINTING OFFICE 1993 715 003/87041