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Water

EPA

Economic Impact Analysis of Proposed Effluent Limitations Guidelines, New Source Performance Standards and Pre-Treatment Standards for the Gum and Wood Chemicals Manufacturing Point Source Category

ECONOMIC IMPACT ANALYSIS OF PROPOSED EFFLUENT LIMITATIONS GUIDELINES, NEW SOURCE PERFORMANCE STANDARDS AND PRE-TREATMENT STANDARDS FOR THE GUM AND WOOD CHEMICALS MANUFACTURING POINT SOURCE CATEGORY

Prepared for

U.S. Environmental Protection Agency
Office of Water Planning and Standards
Washington, D. C. 20460

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68-01-4698

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PREFACE

This document is a contractor's study prepared for the Office of Water Planning and Standards of the Environmental Protection Agency (EPA). The purpose of this study is to analyze the economic impact which could result from the application of effluent standards and limitations issued under Section 301, 304, 306, and 307 of the Clean Water Act to the Gum and Wood Chemical Manufacturing Industry.

The study supplements the technical study (EPA Development Document) supporting the issuance of these regulations. The Development Document surveys existing and potential waste treatment control methods and technology within particular industrial source categories and supports certain standards and limitations based upon an analysis of the feasibility of these standards in accordance with the requirements of the Clean Water Act. Presented in the Development Document are the investment and operating costs associated with various control and treatment technologies. The attached document supplements this analysis by estimating the broader economic effects which might result from the application of various control methods and technologies. This study investigates the effect in terms of product price increases, effects upon employment and the continued viability of affected plants, effects upon foreign trade and other competitive effects.

The study has been prepared with the supervision and review of the Office of Water Planning and Standards of EPA. This report was submitted in fulfillment of Contract No. 68-01-4698 by Arthur D. Little, Incorporated and completed in November 1979.

This report is being released and circulated at approximately the same time as publication in the Federal Register of a notice of proposed rule making. The study is not an official EPA publication. It will be considered along with the information contained in the Development Document and any comments received by EPA on either document before or during final rule making proceedings necessary to establish final regulations. Prior to final promulgation of regulations, the accompanying study shall have standing in any EPA proceeding or court proceeding only to the extent that it represents the views of the contractor who studied the subject industry. It cannot be cited, referenced, or represented in any respect in any such proceeding as a statement on EPA's views regarding the Gum and Wood Chemical Manufacturing Industry.

EXECUTIVE SUMMARY

The Gum and Wood Chemicals industry includes products that either are extracted from trees or are derivatives of products extracted from trees. They include gum and wood chemicals--the traditional "naval stores" industry--as well as sulfate pulping chemical, by products, essential oils, rosin derivatives and turpentine derivates.

1. Sulfate turpentine and fractionation products
2. Wood rosin, turpentines, and pine oil
3. Tall oil fractionation products
4. Rosin derivatives
5. Gum rosin and turpentine
6. Essential oils
7. Charcoal briquettes

Subcategories 5, 6, and 7 have been excluded under paragraph 8 of the Settlement Agreement since the plants producing these products do not discharge process wastewater or very small quantities.

The 1977 estimated shipment value is approximately $300 million. Tall oil fractionation products is the largest single segment accounting for approximately $165 million. Wood rosin, turpentines and pine oil is the second largest accounting for approximately $66 million. Rosin derivatives is third accounting for about $50 million and gum turpentine and rosin, and sulfate turpentine each account for about $10 million.

The historical growth in sales for this industry has been modest and future growth is likely to be limited by the supply of raw materials.

Over the period of 1968 through 1978, the industry sales volume has increased marginally (3-5%/yr.) on a declining production volume (-1%/yr.). Current dollar growth has been due to higher selling prices and a general industry trend to upgrade the value of products sold. Future growth is not expected to exceed a 1-2% real growth. All of this growth is expected to be realized by the Sulfate Turpentine, Tall Oil and Rosin Derivatives subcategories while the Wood Rosin and Gum Rosin subcategories will continue to decline in real growth. Prices should be firm in the future since available supplies of raw materials- particularly crude sulfate turpentine and crude tall oil- are now and will be in tight supply. The availability of these feedstocks is determined by growth of the pulp and paper industry particularly in the soft wood pulping process.

Many products produced by this industry are totally substitutable by products derived from petrochemical feedstocks. In key end use application these competitive products have equal or superior performance characteristics which has created significant competitive pricing pressures in this industry. Even with a short supply of raw materials, the pricing environment created by a shortage of raw materials will likely only result in a recapture of higher raw material costs and not result in higher margins. Those producers which are subsidiaries of pulp and paper companies will be in the strongest competitive position in the future.

Since many of the participants in this industry are small business centers within large corporations, financial statements specific to gum and wood chemicals are not available. An estimated average industry income statement suggests that 1977 before-tax profitability of between

4 and 14 percent was realized. This performance is about equal to or slightly lower than the performance of the Total Chemicals and Allied Products industry. It is believed that the sulfate turpentine and fractionations subcategory is the most profitable followed by Rosin Derivatives, Tall Oil Fractionation, and Wood Rosin in that order. The profitability of each company in this industry is largely dependent on the mix of subcategories in which it is engaged and the degree of product upgrading (higher priced product development) carried on by the company. Most of the major firms in this industry upgrade at least 40% of their production volume.

Capacity utilization in the industry is low. Most segments are currently operating well below 70% capacity utilization even though this number is difficult to define. Capacity for upgraded products is flexible since much of the chemical processing is carried out in a batch process rather than a continuous process. The average age of equipment in this industry is high compared to the chemical industry in general. Little new capacity has been added in the past 5 years and little is expected over the next 5.

The gum and wood chemicals category consists of seven subcategories and includes approximately 114 plants. Three of the subcategories represent about 91 plants that either do not discharge process wastewater or only discharge small amounts of process wastewater. These three subcategories have been excluded under paragraph 8 of the Settlement Agreement. In addition, three of the plants in the remaining four subcategories do not discharge wastewater and are also excluded.

The four remaining subcategories consists of 20 plants that discharge process whatsoever. There are 8 direct dischargers and 12 indirect dischargers in this industry. Four of the 12 indirect dischargers dispose of their wastewater through an adjacent pulp and paper mill's treatment system and two combine their wastewater with pulp and paper mill's wastewater prior to discharges to a POTW.

Only one producer in this industry is not covered by BPT regulation. The annualized cost of compliance for this sulfate turpentine plant was estimated to be approximately $180,000 and would necessitate a capital investment of about $160,000. The economic impact associated with these costs is expected to be low and not result in competitive shifts, community effects or international trade balance impacts.

Four options were considered for setting BAT regulations, and three options were considered for setting PSES regulations. Table 1 summarizes the economic impacts associated with each technological option. Option 1 would perpetuate existing BPT regulations. Option 2, metals control at-the-source, would impact only 7 of the 20 industry producers and would lead to a low economic impact. No plant closures, community effects or balance of trade impacts are expected. The effluent control costs would likely result in a small reduction of plant profitability. The total capital investment required under Option 2 is $484,000 and the annual operating costs are $916,400.

Option 3, end-of-pipe metals control, would impact 8 of the 20 industry producers and would impact two of these producers significantly more than others. We expect that one of the two producers would likely close down resulting in a loss of 150 jobs. The displaced employees could not easily be absorbed resulting in substantial community effects. There would be no significant impact on supply or on the balance of trade in this industry. The total industry capital investment required under Option 3 is $939,300 and annual operating costs are $2,678,400.

Option 4 - metals control at-the-source plus activated carbon absorption - would impact 8 of the 20 plants in the industry. All plants impacted are direct dischargers which would be economically disadvantaged versus indirect dischargers. Four of the 8 plants would experience a high economic impact and two of these plants would likely close down. This would result in the loss of between 350-400 jobs and would lead to significant community impacts, but would not disrupt industry supply or result in balance of trade impacts. The total industry capital investment required under Option 4 is $15,699,100 and the annual operating costs are $4,523,700.

The four options considered for new source performance standards and the two options considered for pretreatment standards for new sources were judged to have a low impact on the industry. The capital investment required under these options were less than 10% for all options (most being less than 2%) and the annual operating costs were less than 20% (most being less than 10%) of projected plant profits. It was judged that these costs would not preclude new plant construction as needed but would likely result in slowing new plant construction activity.

TABLE 1

ECONOMIC IMPACT SUMMARY
GUM AND WOOD CHEMICALS

PLANT	TYPE OF DISCHARGE	BUSINESS SUBCATEGORIES	OPTION 2	OPTION 3	OPTION 4
121	Direct	A, D	Low	High	High
333	Direct	C	None	None	High
600	Direct	B	None	None	High
800	Direct	A, C, D	None	None	Moderate/Low
948	Direct	C, D	Low	Low	Moderate/High
698	Direct	B, D	Low	Low	Low
416	Direct	C	None	None	Moderate/Low
693	Direct	C	None	None	High
686	Indirect	C, D	Low	Moderate	--
168	Indirect	A, C. D	None	None	--
087	Indirect	A	Low	Low	--
355	Indirect	C	None	None	--
266	Indirect	A	None	Low	--
090	Indirect	E	Low	Low	--
151	Indirect	A, B, D	Low	Low	--
607	Indirect	A, B, D	None	None	--
641	Indirect	C	None	None	--
111	Indirect	C, D	None	None	--
532	Indirect	C	None	None	--
346	Indirect	C	None	None	--

Key:
- None = No cost to meet effluent limitations
- Low = Cost <20% of before-tax profits and <5% of sales
- Moderate = Cost >20% but <50% of before-tax profits and <5% of sales
- High = Cost >50% of before-tax profits and >5% of sales

Note: Option 1 results in no impact for any producer.

I. INTRODUCTION

Section 301 (b) (1) (A) of the Clean Water Act (the Federal Water Pollution Control Act Amendments of 1972, as amended by P. L. 95-217, the Clean Water Act of 1977) requires existing industrial dischargers to waters of the U.S. to achieve by July 1, 1977, effluent limitations requiring the application of the best practicable control technology currently available (BPT). By July 1, 1984, these same dischargers are required to achieve effluent limitations requiring the application of the best available technology economically achievable (BAT) and the best conventional pollutant control technology (BCT) pursuant to Sections 301 (b) (2) (A), (b) (2) (C), (b) (2) (E). Additionally, new industrial dischargers are required to comply with New Source Performance Standards (NSPS) under Section 306 of the Clean Water Act (the Act), and new and existing industrial dischargers to Publicly Owned Treatment Works (POTW's) are subject to Pretreatment Standards under Sections 307 (b) and 307 (c) of the Act.

The purpose of this study is to assess the economic impacts of these requirements on the Gum and Wood Chemical Manufacturing Point Source Category.

A. Scope of this Report

The analysis of the economic impact of the seven effluent limitation options on the Gum and Wood Chemical Manufacturing Industry is developed primarily on a microeconomic basis. While an overall industry analysis (e.g. macroeconomic basis) is presented, it is primarily an aggregate of individual plant impacts.

Although the Gum and Wood Chemicals industry can be subdivided into seven subcategories, only four of these will be discussed in this report. These are:

1. Sulfate Turpentine
2. Wood Rosin, Turpentine, and Pine Oil,
3. Tall Oil Fractionation Products, and,
4. Rosin Derivatives.

Three other subcategories-Charcoal, Gum Rosin and Turpentine, and Essential Oils-were excluded from this analysis because the plants in these subcatetories either do not discharge process wastewater or only discharge negligable amounts of process wastewater as compared with other plants in this industry.

This report depicts the Gum and Wood Chemical's structure, financial characteristics, supply and demand relationship, domestic and international competitive environment, market characteristics, proposed effluent limitations costs, and the analysis of their resulting economic impacts. Also included is a description of the methodology used to determine these impacts. Specific impacts discussed are:

(1) price increases,
(2) profitability,
(3) industry growth,
(4) plant closures,
(5) production changes,
(6) employment,
(7) consolidation trends,
(8) balance of trade effects, and,
(9) community and other dislocational effects.

B. Organization of this Report

This report is organized into six sections, of which sections 3 through 5 deal specifically with the industry, and sections 1, 2, and 6 deal with this report and/or the analytical methodology. Section 1 defines the overall scope of this study; section 2 details the study methodology; and section 3 subcategorizes the industry structure, and discusses the characteristics of each of the four subcategories covered in this study. Major areas addressed in each subcategory are: Major products, supply characteristics and demand characteristics. Section 4 details the proposed effluent control costs, by control option, for existing plants and new direct and indirect discharge plants. Section 5 estimates the impact of these costs on the plants operating in this industry and section 6 addresses the assumptions made and limitations of this analysis.

C. Data Sources

The data sources supporting this assessment are the Development Document for the Gum and Wood Chemical Manufacturing industry provided by the EPA, publically available financial reports, studies and surveys, and the results of EPA's survey of three major participants in this industry. Supplementing this data were articles drawn from public documents (e.g. Chemical Week, the Wall Street Journal, Naval Stores Review, etc.) which reported on various current and potential future developments in this industry.

II. METHODOLOGY

A. Industry Structure and Subcategorization

The Gum and Wood Chemicals industry consists of seven subcategories and includes approximately 114 plants. These subcategories are defined by the raw materials used and processes employed rather than by markets served or "typical" plants since most plants have discrete manufacturing facilities for different raw materials used, most plants produce products intended for many diverse markets, and there is no "typical" plant in this industry.

The Gum and Wood Chemicals industry, as defined in this report, is actually a grouping of several closely related industries. Crude sulfate turpentine and tall oil are produced as by-products of the pulp and paper industry. The fractionation of tall oil into rosin and fatty acids is part of the traditional naval stores industry, as is production of gum turpentine, gum rosin, wood turpentine, wood rosin, and wood pine oil. Production of rosin derivatives is closely associated with the plastics industry while production of turpentine derivatives is associated with several related organic chemical industries. Essential oils are grouped with miscellaneous chemical preparations.

Major manufacturing routes for these products are shown in Figure 1-1. This exhibit demonstrates the close interrelations between the pulp, chemical, and plastics industries. For example, sulfate turpentine, a by-product of the pulp industry, competes directly against gum and wood turpentine, both products of the naval stores industry. In contrast, tall oil, which is also a by-product of the pulp industry, serves as an important raw material for the traditional naval stores industry.

Defining subcategories within this industry is a difficult process. In addition to complex supply and demand relationships among various products, the degree of forward and backward product integration observed varies by company. One firm, for example, may be involved in kraft pulping and tall oil fractionation, while another purchases crude tall oil for fractionation and further rosin modification. The degree of participation in various levels of product refinement is shown for selected companies in Table 1-3.

For the purpose of this report, the industry has been divided into subcategories on the basis of processes rather than by markets or "typical" plants to allow congruence with the Technical Document treatment cost data. Although we feel that these subcategories represent the best póssible compromise, they do cause some difficulties in that they do not correspond to SIC groupings, and thus to readily available government statistics.

B. Financial Profile of the Industry

1. Size of the Industry

The estimated shipment value of primary products produced by the Gum and Wood Chemicals industry in 1977 was slightly under $300 million, excluding the value of gum turpentine and gum rosin. Not included in this estimate is the value of rosin derivatives produced at plants engaged in primary product production which could add an estimated $100 million to the industry size estimate. The production volume and estimated value of shipments by product are provided in Table II-B-1.

2. Financial Performance

The financial status of this industry is difficult to characterize precisely since most of the participants are small business activities of much larger corporations. However, an estimate of the average industry income statement was prepared from several sources and is shown in Table II-B-3. This statement suggests that the average profitability is probably less than that of the Total Chemical Industry. Specific profitability estimates for each subcategory were prepared using a similar format and based on a judgment as to whether the subcategory profitability was higher or lower than the estimated industry average.

C. Model Plants

Since there are only 20 plants discharging in this industry, the analysis of the proposed effluent limitation control costs and industry economic impact analysis was done on a plant by plant basis. Therefore, no model plants were proposed or characterized.

D. Pricing Patterns

Pricing patterns within an industry subcategory are critical to an understanding of who will bear the economic impact of proposed effluent limitations. In markets where prices are depressed (i.e., soft), participants bear some or all of the costs incurred until supply and demand forces allow cost recapture through higher than "normal" prices. In markets where prices are strong, consumers of the products bear most or all of the costs incurred through higher prices. To determine the cost pass-through capability, historical price changes were compared with demand fluctuations to estimate a maximum % price increase limit beyond which significant demand shifts could be expected. A detailed analysis of price elasticity was not performed. It is believed that, during periods of reasonable supply/demand balance, price increases up to 5% could be uniformly brought to the market without disturbing the current and future demand for specific gum and wood chemical products. Beyond 5%, an analysis of demand elasticity would be required to estimate the impact on producers of such an action. While many products in this industry are currently supply limited, it is also felt that most products have a fairly high demand elasticity co-efficient and large price increases would result in significantly curtailed demand in a very short period of time.

E. Waste Treatment Technological Options and Costs

Several options for each regulatory alternative were considered in this analysis to aid developing the proposed regulations for BPT, BAT, NSPS, PSES and PSNS. Independent assessments were done for each of four industrial subcategories.

1. BPT Limitations

Three options were considered for setting BPT limitations. Option I was not to regulate. Option II was to perpetuate existing BPT regulations, and Option III was to regulate based on performance of the treatment systems in place in the industry. The potential effluent reduction and costs associated with each technology are estimated in the EPA Development Document for those plants not yet complying with these standards.

2. BAT Limitations

Four technological options were considered for setting BAT limitations. Option 1 would perpetuate the existing BPT regulations. Option II would add at-the-source metals removal. Option III would require BPT control plus metals removal end-of-pipe and Option IV would require activated carbon treatment with Option II are in the EPA Development Document.

3. NSPS Limitations

Four control options for NSPS were considered for setting NSPS limitations. Option 1 would require only existing BPT limitations. Option II would require

BPT limitations plus at-the-source metals removal. Option III would require BPT limitations plus end-of-pipe metals removal. Option IV would require activated carbon columns in addition to Option II. The costs associated with each of these options are estimated in the EPA Development Document for a "typical" (i.e. slightly "above average") new plant in might reasonably experience new plant construction.

4. PSES Limitations

Three control options were considered for setting PSES limitations. Option I was not to regulate. Option II would require at-the-source metals removal, and Option III would require end-of-pipe metals removal prior to discharge into municipal sewer systems. The potential effluent reduction and costs associated with each of these options are estimated in the EPA Development Document for each existing indirect discharger in this industry.

5. PSNS Limitations

Three control options were considered for setting PSNS limitations. Option I was not to regulate. Option II would require at-the-source metals removal and Option III would require end-of-pipe metals removal prior to discharge into municipal sewer systems. The costs associated with each of these options are estimated in the EPA Development Document for a "typical" (i.e. slightly "above average") new plant in the two subcategories which might reasonably experience new plant construction.

F. Analysis of Economic Impacts

1. Profitability

Basic to the Economic Impact Analysis is an estimate of the profitability for each plant in this industry. Based on factors such as the product mix produced in each plant, estimated production volume, average market prices for these products and average estimated cost of production, a pre-tax profit margin for each plant was estimated. After-tax profitability was not estimated since participants in this industry are typically business activities of much larger corporations and allocation of corporate overhead and interest charges would affect the actual tax rate applicable to each plant in a manner which cannot be estimated without detailed financial data and knowledge of corporate policy in these areas.

2. Economic Impact Assessment

The methodology used in the economic analysis employs estimation of the before tax profit reduction expected for plants currently operating in this industry assuming no cost pass through. Compliance costs as a percentage of before tax profits was chosen as the lay measure of the expected economic impact.

When cost pass-through was not ignored, the compliance cost as a % of plant production value was estimated and used as a reference point to qualitatively judge the possibility of recovering all or part of the compliance costs. For plants with compliance costs less than 20% of before-tax profits and 5% of production value, a negligible or slight economic impact was expected. For plants with compliance costs more than 20% but less than 50% of before-tax profits and less than 5% of production value, a moderate economic impact was expected. For plants with compliance costs more than 50% of before-tax profits and more than 5% of sales, a high economic impact was expected.

3. Differential Impacts

Competition takes place in specific markets rather than at specific plants. A plant which includes production of a group of products which results in high plant compliance costs is at a significant disadvantage to those, with a different mix of products, which have low compliance costs. Therefore, a second line of analysis involved analyzing only those plants producing products in a specific subcategory to determine which if any might be disadvantaged relative to the remaining producers. No attempt was made to examine the possibility of reallocating the compliance costs to other products produced at a potentially disadvantaged plant to maintain an overall competitive balance within an industry subcategory.

4. Plant Closures and Production Effects

The decision criteria for plant closures are based on compliance costs as a % of profits and as a % of value of production. Plants are projected to close if compliance costs are more than 50% of before-tax profits and more than 5% of sales.

5. Employment Impact Analysis

For those plants which are projected to close, it was assumed that those employed at that plant would be discharged and not transferred to other plants owned by the corporation making the closure decision.

6. Community Effects Analysis

Plants located in or near substantial industrial areas were judged not likely to inflict significant imbalances on the surrounding community upon closure.

7. Other Effects

Other effects of effluent limitation compliance costs (such as Balance of Trade Effects) were determined judgmentally based on historical importance of imports and exports and the expected potential of non-domestic producers to supply U.S. requirements at lower prices.

TABLE II-B-1

PRELIMINARY ESTIMATE OF THE VALUE OF 1977 INDUSTRY SHIPMENTS BY PRODUCT

	Production	Average Price	Shipment Value ($M)
GUM			
Turpentine	871 K. gal.[a]	$1.32/gal	1.25
Rosin	32 M lb.[a]	0.24/lb	7.68
WOOD			
Turpentine	2,986 K. gal.	1.20/gal.[b]	3.58
Rosin	265 M lb.	0.20/lb.	53.00
PINE OIL	9,489 K. gal.	1.05/gal.[b]	9.96
SULFATE TURPENTINE	20,255 K. gal.	0.50/gal.	10.13
FRACTIONATION			
Fatty Acids	375 M lb.	0.25/lb.	93.75
Rosin	410 M lb.	0.18/lb	73.80
		Total	$302.58

(a) K = thousand; M = Million
(b) No published price data are readily available; these are estimated prices.

Source: Arthur D. Little, Inc.

TABLE II-B-3

INCOME STATEMENT RATIOS

	Chemicals & Allied Products[a]	Gum & Wood Chemicals[b]
Net Sales & Receipts	100.0%	100%
--Depreciation	3.8	6[c]
--Materials Costs	85.9	53
--Labor Costs		17
--Fuel & Energy Costs		5
--Other Operating Costs		5-15
Income from Operations Before Taxes	10.3	4-14
--Income Taxes	4.0	2-5
Income after Taxes	6.3	2-9

a. Average ratios for 1977 from "Quarterly Financial Report", 4th quarter, 1977.

b. Arthur D. Little, Inc. estimates based on data from the 1972 Census of Manufacturers and the 1976 Annual Survey of Manufacturers for SIC 2861.

c. Six percent is the maximum estimate; the actual value is probably much lower because of the age of most of the equipment. Investment is new plants and equipment represented 3% of sales during this period.

III. Industry Characterization

A. Overview

The industry reviewed in this report deals with products that either are extracted from trees or are derivatives of products extracted from trees. They include gum and wood chemicals--the traditional "naval stores" industry, as well as sulfate wood chemicals, essential oils, rosin derivatives and turpentine derivates.

The following industry segments will be discussed in this report:

A. Sulfate turpentine and fractionation products

B. Wood rosin, turpentines, and pine oil

C. Tall oil fractionation products

D. Rosin derivatives

E. Gum rosin and turpentine

While subcategory E - Gum Rosin and Turpentine has been excluded under paragraph 8 of the Settlement Agreement, products produced in this segment do compete with products produced in other subcategories and therefore will be discussed.

1. Industry Size and Growth

The size and preliminary estimated values of industry shipments by product are provided in Table III-1. The growth rates predicted for each industry segment are shown in Table III-2.

2. Industry Structure

The gum and wood chemicals industry, as defined in this report, is actually a grouping of several closely related industries. Crude sulfate turpentine and tall oil are produced as by-products of the pulp and paper industry. The fractionation of tall oil into rosin and fatty acids is

TABLE III-1

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SULFATE TURPENTINE	20,255 K gal.	0.50/gal.	10.13
FRACTIONATION			
Fatty Acids	375 M lb.	0.25/lb.	93.75
Rosin	410 M lb.	0.18/lb	73.80
		Total	$302.58

(a) K = thousand; M = Million
(b) No published price data are readily available; these are estimated prices.

Source: Arthur D. Little, Inc.

TABLE III-2

GROWTH RATES BY INDUSTRY SEGMENT

Segment	Average Historic Growth Rate: 1968-1978 (%/yr)	Predicted Future Growth Rate: 1978-1988
A. Sulfate turpentine and fractionation products.	0	0-2%/yr.
B. Wood rosin, turpentime and pine oil	(6 -9)	Continued decline
C. Tall oil fractionation products	1	2 - 3%/yr.
D. Rosin derivatives	NA	0 - 2%/yr.
E. Gum rosin and turpentine	(13)	Continued decline

Source: Arthur D. Little, Inc.

part of the traditional naval stores industry as is production of gum turpentine and gum rosin. Production of rosin derivatives is closely associated with the plastics industry; production of turpentine derivatives, with several related organic chemicals industries.

Major manufacturing routes for these products are shown in Figure III-1. This exhibit demonstrates the close interrelations between the pulp, chemical, and plastics industries. For example, sulfate turpentine, a by-product of the pulp industry, competes directly against gum and wood turpentine, both products of the naval stores industry. In contrast, tall oil, which is also a by-product of the naval stores industry, serves as an important raw material for the traditional naval stores industry.

Defining subcategories within this industry is a difficult process. In addition to complex supply and demand relationships among various products, the degree of forward and backward product integration observed varies by company. One firm, for example, may be involved in kraft pulping and tall oil fractionation, while another purchases crude tall oil for fractionation and further rosin modification. The degree of participation in various levels of product refinement is shown for selected companies in Table III-3.

For the purpose of this report, the industry has been divided into subcategories on the basis of processes rather than by markets or "typical" plants to allow congruence with the Development Document treatment cost data. Although we feel these subcategories represent the best possible compromise, they do cause some difficulties in that they do not correspond to SIC groupings, and thus to readily available government statistics.

3. Historical Development of the Industry

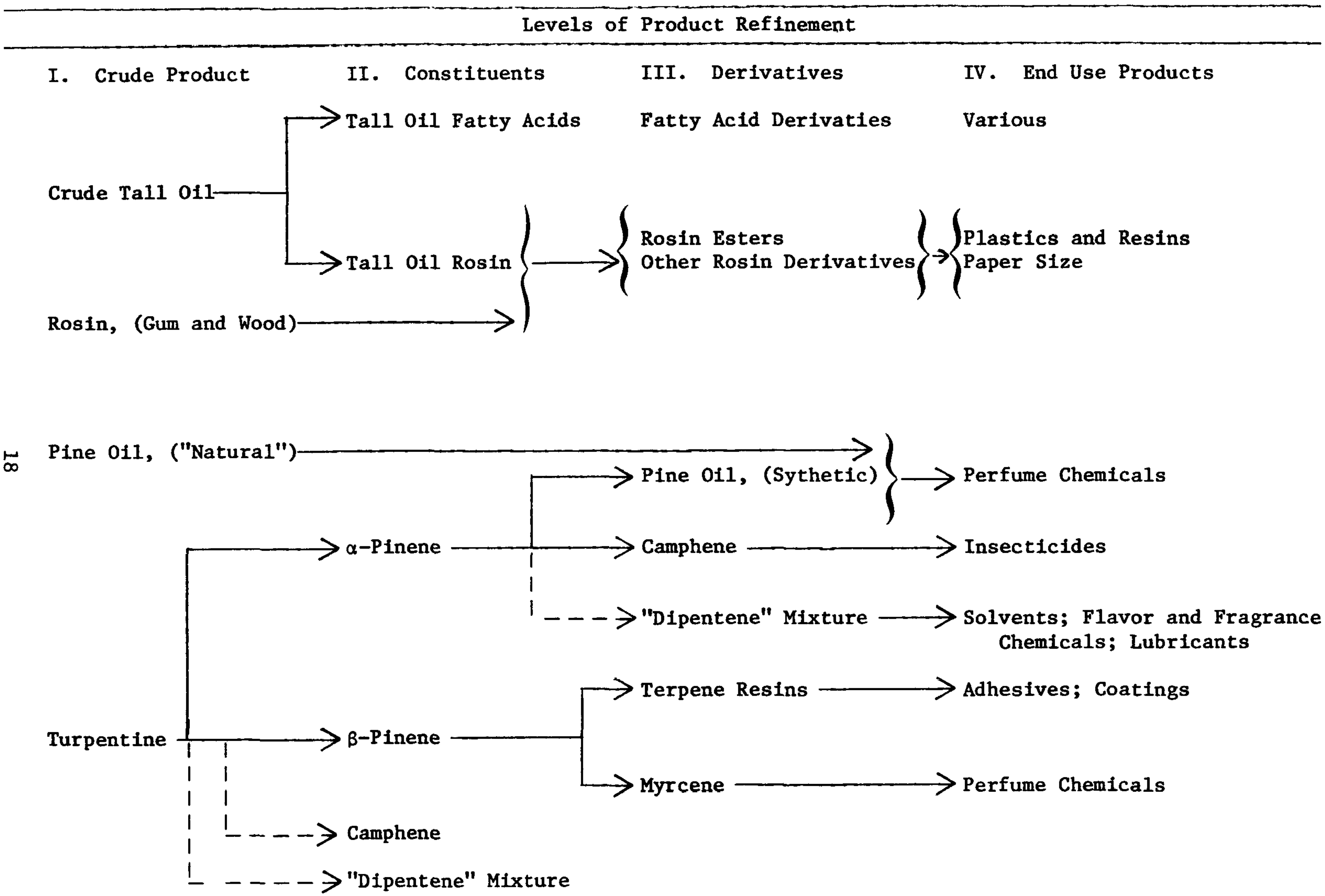
Wood-derived products have been of major interest and importance since early civilization. Theophrastus (ca. 300 BC) describes in detail various techniques for gathering oleoresins from pines in his "Enquiry into plants." Pitch was a highly valued product in the ancient power centers of Greece, Macedonia, Asia Minor, and Egypt.

The original naval stores industry, called as such, had its origins with European shipbuilders of the late 16th Century. Initially the term "naval stores" designated the pitch and tar derived from destructive distillation of the Scotch pine. These commodities were indispensable in the production and maintenance of wooden sailing vessels. With the advent of iron and steel sailing vessels, the maritime application of naval stores disappeared and the industry channeled its efforts toward the refinement and production of turpentines, rosins, and pine oil, which were beginning to become commercially important. Although these products are not related to the maritime industries, the old term "naval stores" has been carried over to encompass them.

In the Middle Ages, the original naval stores industry was centered in the Baltic States (predominantly Sweden). At that time, the industry was concerned with gum chemicals. By the end of the 17th Century (to the alarm of European maritime nations, who feared shortages and monopolies on naval stores products and their potentially devastating effect on the maritime economy), Sweden had succeeded in completely dominating the industry.

FIGURE III-1

MAJOR MANUFACTURING ROUTES



A. Dashed lines indicate that the product is produced as a by-product of the primary reaction(s).

Source: Arthur D. Little, Inc.

Table III-3

PRODUCT LINES OF SELECTED INDUSTRY PARTICIPANTS

LEVELS OF PRODUCT REFINEMENT	Arizona Chemical Co.(a)	Crosby Chemical, Inc.	Crown Zellerbach Corp.	Emery (b) Industries, Inc.	Hercules, Inc.	International Flavors & Fragrances, Inc.	Reichhold Chemicals, Inc.	SCM Corp.(c)	Stinson Lumber Co.	Sylvachem(c) Corp.	Union Camp Corp.	Weyerhaeuser Company.
I. CRUDE PRODUCT:												
Tall Oil	x		x								x	x
Turpentine			x		x		x				x	x
Rosin, (Gum or Wood)	x				x		x				x	
Pine Oil, ("Natural")	x	x			x		x		x			
II. CONSTITUENTS:												
Tall Oil Rosin	x				x		x			x	x	
Tall Oil Fatty Acids	x	x		x	.x		x			x	x	
α-Pinene	x	x			x		x		x		x	
β-Pinene	x	x			x		x		x		x	
III. DERIVATIVES:												
Fatty Acid Derivatives				x								
Rosin Esters	x	x			x		x				x	
Other Rosin Derivatives		x			x						x	
Pine Oil, (Synthetic)		x									x	
Camphene					x		x	x				
"Dipentene" Mixture	x	x					x	x	x		x	
Terpene Resins	x	x			x		x					
Myrcene						x					x	
IV. END USE PRODUCTS:												
Paper Size		x			x		x					
Plastics and Resins							x	x			x	
Flavor and Fragrance Chemicals	x				x	x	x	x			x	
Insecticides					x							
Adhesives	x				x							

(a) Arizona Chemicals is jointly owned by International Paper Co., (a participant in the Kraft sulfate pulping industry), and American Cyanamid Co., (a manufacturer of resins and paper sizes).

(b) Emery participates in a joint venture with Monsanto to fractionate crude tall oil at a plant in Nitro, W.Va.; Monsanto uses the rosin output from this operation.

(c) Sylvachem is jointly owned by SCM and St. Regis Paper Co., (a participant in the Kraft sulfate pulping industry).

Source: Arthur D. Little, Inc.

Spurred by opposition to this monopoly, development of the industry in North America began shortly after its discovery in 1492. The use of native pine tree pitch for naval stores was documented in 1528 by the Narvaez expedition to Florida. Commercial production of crude turpentine was initiated in Nova Scotia in 1606. In 1608, prompted by European demand and some sponsorship, the first export market for pine pitch and tar began in Virginia. Production of crude turpentine and pitch shifted from Nova Scotia to New England and then began to drift southward, when it was discovered that the longleaf pines of the Carolinas gave better yield than the pitch pines of New England. The use of longleaf pines for gum (oleoresin) exudates was established in North Carolina in the 17th Century, peaking in 1880, a year in which more than 1500 gum mills were operating there. With the commencement of the lumbering industry in North Carolina came the discovery of the slash pine, a more desirable species for gum collecting than the longleaf species. Copious yields can be attained from this species within 15-25 years, while for the longleaf variety the trees cannot be profitably tapped before reaching 25-45 years.

For a short period, South Carolina led the gum industry in production, having an abundance of both the longleaf and the slash pines. But, because of wholesale clear cutting of virgin stands without reseeding, the industry continued its southward migration. The naval stores industry began in Georgia in 1875 and by 1880, Georgia was its leading producer. In the early 1920's, the Department of Agriculture noted the continued devastation of virgin pine forests and predicted that the industry would die within ten years.

Commercial production by the wood chemicals industry was established in 1909. Production of these chemicals is somewhat less complicated and less labor-intensive than production of gum chemicals. The raw materials for the wood chemicals industry are 20- to 30-years old stumps and other residual woods from the cutting of southeastern pine forests. The resinous chemicals in these pines is extracted with a solvent, and the solvent extract is then separated by fractionation.

As techniques for extraction of wood chemicals from pine stumps were refined and further developed the gum chemical industry continued to decline. From 1950 to 1968, the wood chemicals industry was the leading producer of naval stores. However, in 1968 the sulfate chemicals industry, an offshoot of the kraft paper process, surpassed the wood chemicals industry to become the leading source of wood derived chemicals.

In this most recent industry, turpentine is recovered directly during the pulping process, while rosin is obtained by fractionation of a kraft process by-product known as "tall oil." The term "tall oil," derived from the Swedish word "tallolja," translates as pine oil. However, in the United States such a literal translation would cause confusion with the essential oil known as pine oil, thus the simple transliteration to tall oil. Today, sulfate turpentine represents 86% of all turpentine produced in the United States; tall oil rosin, 60% of all rosin.

4. Potential Changes within the Industry

Two factors may combine in the future to change the gum and wood chemicals industry. Recently, research has shown that paraquat treatment of pine trees increases the yield of oleoresin by 2 to 5 times over the untreated tree yield. (Since oleoresin contains both rosin and turpentine, a paraquat-treated tree could be expected to increase its yield of both these products.) This opportunity for increased production of oleoresin, combined with rising petrochemical prices, presents the possibility of oleoresin substitution for petroleum in the production of several important derivatives. It has been estimated that petrochemical prices would have to increase to roughly three times their current level to make substitution of oleoresins economically feasible.

Oleoresin is a hydrocarbon and it is technically feasible to derive compounds from it that are identical with those derived from petroleum. Some potential markets, thought to be suitable for oleoresin substitution, include polyurethane foam, synthetic lubricants, and mellitic acids. In addition, turpentine could easily be burned as a fuel. (Turpentine releases slightly more energy per gallon than gasoline; a private research organization has allegedly developed a process to produce motor fuel from turpentine, claiming that the fuel offers high gas mileage.)

5. Financial Profile

Since many of the participants in this industry are small business centers within large corporations, financial statements specific to gum and wood chemicals are not available. However, an estimate of an average industry income statement is shown in Table III-4. Note that depending on the level of general administrative costs, profitability could vary widely from company to company. It is thought that some of the small, backwoods gum and wood producers make essentially no company profit, while the owners work for wages.

Financial summaries of four companies are included in Table III-5. Even among these large companies, 1977 profitability varied from 2.0% (for Reichhold) to 10.6% (for Union Camp).

6. Employment and Wages

In 1976, the Gum and Wood Chemicals industry (SIC 2861) (including charcoal production), employed 4700 people and had an annual payroll of $56.1 million. This level of employment represents a decrease of more than 20% since the 1972 Census of Manufacturing was taken, at which time the industry employed 5900 people at an annual payroll of $47.6 million. There were 139 facilities reporting under SIC 2861 in 1972; 50% of these were located in the South. Seventy-one percent of the 1972 establishments employed less than 20 people; only 11% employed 100 or more people.

TABLE III-4

INCOME STATEMENT RATIOS

	Chemicals & Allied Products[a]	Gum & Wood Chemicals[b]
Net Sales & Receipts	100.0%	100%
--Depreciation	3.8	6[c]
--Materials Costs	85.9	53
--Labor Costs		17
--Fuel & Energy Costs		5
--Other Operating Costs		5-15
Income from Operations Before Taxes	10.3	4-14
--Income Taxes	4.0	2-5
Income after Taxes	6.3	2-9

a. Average ratios for 1977 from "Quarterly Financial Report", 4th quarter, 1977.

b. Arthur D. Little, Inc. estimates based on data from the 1972 Census of Manufacturers and the 1976 Annual Survey of Manufacturers for SIC 2861.

c. Six percent is the maximum estimate; the actual value is probably much lower because of the age of most of the equipment. Investment is new plants and equipment represented 3% of sales during this period.

TABLE III-5

MAJOR PARTICIPANTS IN NAVAL STORES INDUSTRIES:
1977 FINANCIAL SUMMARIES
($000)

	Company			
	Hercules	Reichhold	Union Camp	Westvaco
Net Sales	1697,800	673,942	1081,653	1000,622
Net Income	57,900	13,711	114,664	61,944
Income/Sales	3.4%	2.0%	10.6%	6.2%
Total Assets	1477,543	387,636	1130,061	885,710
Return on Assets	3.9%	3.5%	10.1%	7.0%
Shareholder's Equity	757,570	191,080	722,981	162,605
Return on Shareholder's Equity	7.6%	7.2%	16.7%	13.8%
Number of Employees	24,002	6,546	15,013	15,850

Source: 1977 Annual Reports

B. Sulfate Turpentine and Fractionation Products (Subcategory A)

Sulfate turpentine is produced as a by-product of the kraft or sulfate pulping process. During the kraft process, available species of pine trees are cut, debarked, chipped, and subjected to cooking with sulfate white liquor, a mixture of sodium hydroxide, sodium sulfide, and sodium carbonate. The wood is digested, releasing the cellulose fibers or pulp from the other wood constituents. Turpentine, contained in the oleoresin of the pine tree's sapwood and heartwood, is volatilized during the kraft process and recovered by condensation of the vapors.

Crude sulfate turpentine, collected during the pulping operations, contains sulfur compounds that give it an extremely disagreeable odor. In order to make a product of marketable grade, suitable for use as a chemical raw material, it is necessary to remove most of the sulfur compounds as well as the small amounts of pine oil and other terpenes which may be present in the crude. This refining process includes distillation to strip the odor-causing mercaptans from the turpentine, followed by fractionation to separate the turpentine into its major components: alpha-pinene and beta-pinene. Minor components, also recovered during the fractionation process, include limonene, camphene, dipentine, and pine oil. These turpentine fractionation products may be subsequently altered through various chemical reactions to produce marketable end products.

This report will include only establishments engaged in refining and fractionating crude turpentine into its components. The recovery of crude sulfate turpentine at the pulp mill is an integral part of the kraft pulping process and is reported under the Standard Industrial

Codes (SIC) 2611, 2621, or 2631, (depending on whether the pulp mill is a separate operation, combined with paper mills, or combined with paperboard mills). The pulp mill recovery process is not included in the scope of this report.

1. Supply Characteristics

1.1 Producers

The eight U.S. plants producing refined sulfate turpentine and turpentine fractionation products are shown in Table III-B.1. All but one of these operations (Stimson Lumber Company's Washington plant) are located in the Southeast region of the United States.

The combined capacity within the industry is unknown; however, it is likely that most, if not all, of these plants are operating below capacity. The pulp and paper industry is currently undergoing a recession and the pulping operation's by-products, including crude turpentine, are in short supply. Only an estimated 25 million gallons of crude turpentine was collected by pulp mills during the 1977 crop year and made available to turpentine producers. This amount represents roughly one-third of the crude turpentine that could be collected if the pulp mills were operating at full capacity and efficiently collecting all the turpentine vapors released during the pulping process.[1]

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[1] The known capacity for softwood kraft pulping within the pulp industry is currently 60,000 tons per day. This indicates a capacity for crude turpentine of 270 to 360 thousand gallons per day, or approximately 80 million gallons per year.

(Arthur D. Little, Inc., estimates)

TABLE III-B-1

PRODUCERS OF SULFATE TURPENTINE AND FRACTIONATION PRODUCTS

Company	Plant Location
Arizona Chemical Co.	Panama City, FL
Crosby Chemicals, Inc.	Picayune, MS
Hercules, Inc.	Brunswick, GA
Reichhold Chemicals, Inc.	Oakdale, LA
Reichhold Chemicals, Inc.	Pensacola, FL
SCM Corp.	Jacksonville, FL
Stimson Lumber Co.	Anacortes, WA
Union Camp Corp.	Jacksonville, FL

Source: Arthur D. Little, Inc.

1.2 Integration and Capital Requirements

Varying degrees of forward integration are observed within the sulfate turpentine segment of the gum and wood chemicals industry. One firm, Stimson Lumber Company, sells alpha-pinene and beta-pinene; others (e.g., SCM Corp.), market predominantly turpentine derivatives, such as flavor, fragrance, and other fine chemicals. Most of the companies appear to be making some effort to move further forward into higher value-added specialty chemicals.

Backward integration by turpentine refiners into the operation of pulp mills is not found within the industry, although informal supply agreements may often occur. Arizona Chemical Co. is partially controlled by International Paper Co., which operates fourteen kraft pulp mills, and SCM Corp. is involved in a joint venture with St. Regis Paper Co., which also owns four kraft mills. It is uncertain how much advantage, if any, these associations give Arizona and SCM over other refiners in the procurement of raw material.

Capital investment levels within the industry are moderate; the estimated ratio of capital investment to sales is 1.2 to 1.0. Both capital intensity and the level of research and development spending increase with greater forward integration.

New equipment purchases, usually representing from 10% to 15% of total capital investment, are necessary roughly every five years within this segment to allow the firms to keep pace with new product developments.

1.3 Estimated Profitability

Profitability within the sulfate turpentine segment (expressed as income after taxes as a percent of sales), tends toward the high end of the 2% to 9% range estimated for the gum and wood chemicals industry as a whole. This segment is able to obtain slightly higher profits than the industry average by integrating forward, away from more price-sensitive commodity products. There is reason to believe that opportunity exists for individual producers to further upgrade their product line if they come under pressure for better profit margins.

1.4 Other Supply Characteristics

The overriding factor influencing producers of sulfate turpentine and derivatives is their dependence on kraft pulp mill operations for raw material. Because of this dependence, the turpentine industry has located almost exclusively in the Southeastern United States, near the softwood pulp mills. The availability of crude sulfate turpentine has also influenced the growth of the industry; currently most plants are operating below capacity, and no major capacity additions or market entries are anticipated in the near future.

The industry is not highly labor-intensive; however, the ratio of skilled to nonskilled labor is relatively high. Many companies find it necessary to employ large R&D staffs to compete in the specialty chemical markets.

2. Demand Characteristics

2.1 Market Size and Share

The sulfate turpentine industry grew rapidly during the 1950's and 1960's. However, as Table III-B-2 shows, production reached a peak level

TABLE III-B-2

SULFATE TURPENTINE'S SHARE OF THE TOTAL U.S. TURPENTINE MARKET

Year Ending March 31	Sulfate Turpentine Production (000 gals)	Total U.S. Turpentine Production (000 gals)	Sulfate Turpentine's Market Share (%)
1954	8,200	26,900	30
1955	11,600	30,900	38
1956	15,150	32,750	46
1957	15,250	32,250	47
1958	15,600	31,350	50
1959	15,750	30,400	52
1960	17,670	31,840	55
1961	16,150	30,270	53
1962	16,642	31,856	52
1963	17,418	32,653	53
1964	18,777	33,677	56
1965	20,104	33,955	59
1966	21,033	35,033	60
1967	21,338	33,275	64
1968	20,987	31,397	67
1969	23,658	32,609	73
1970	23,975	30,869	78
1971	22,768	28,790	79
1972	22,745	28,433	80
1973	23,206	28,303	82
1974	22,019	26,532	83
1975	20,458	24,352	84
1976	19,274	22,380	86
1977	20,255	24,112	84
1978 (preliminary)	20,608	23,878	86

Source: Arthur D. Little, Inc., based on U.S. Department of Agriculture reports

of 24 thousand barrels in 1970 and has declined slightly since that time. The decline is attributed to the recent recession in the paper industry and to the increased use of hardwood and waste fiber in kraft pulping processes.[1] Nevertheless, sulfate turpentine's share of the total turpentine market (on a production basis) has continued to increase since 1970 and now stands at 86%.

Growth in sulfate turpentine production has been accompanied by a decline in the production of gum and wood turpentine. Table III-B-3 compares production figures for the three types of turpentine. Apparent U.S. consumption of turpentine is also provided, although the breakout of consumption between the different turpentine types is not available.

Production statistics for α-pinene and β-pinene are provided in Table III-B-4. Information is not readily available on the consumption level of these products within the Untied States. However, it is reasonable to assume that essentially all of the production shown in Table III-B-4 was subsequently converted to various chemical derivatives. The large difference between "sales" and "production" figures is an indication of the sizeable quantity of these products consumed in-house.

2.2 Major End Uses

Most of the turpentine produced in the United States today is consumed in the manufacture of chemicals, as shown in Table III-B-5, which lists the reported industrial consumption of all types of turpentine by

(1) Oleoresin, which contains both turpentine and rosin, is found only in softwood trees (i.e., pine). Increased use of hardwood species and of waste or recycled fibers from which the oleoresin has already been removed, decreases the pulp industry's yield of crude turpentine and rosin.

TABLE III-B-3

U. S. TURPENTINE PRODUCTION AND APPARENT CONSUMPTION
(thousand gallons)

Year Ending March 31	Production: Gum	Wood	Sulfate	Total	Imports	Exports	Apparent U.S. Consumption	Percent Change in Apparent Consumption From Previous Year
1954	8,900	9,650	8,200	26,900[a]	1,150	4,400	25,250	-
1955	8,800	10,400	11,600	30,900[a]	750	5,800	26,900	6.5
1956	7,450	10,050	15,150	32,750[a]	900	5,100	28,750	6.9
1957	7,200	9,750	15,250	32,250[a]	1,150	6,250	28,000	- 2.6
1958	6,450	9,300	15,600	31,350	700	4,000	28,250	0.9
1959	6,000	8,650	15,750	30,400	1,100	3,650	28,700	1.6
1960	5,370	8,800	17,670	31,840	770	3,100	26,440	- 7.9
1961	5,970	8,150	16,150	30,270	710	4,090	26,100	- 1.3
1962	7,641	7,574	16,642	31,856	761	4,111	27,297	4.6
1963	7,605	7,631	17,418	32,653	646	5,019	29,320	7.4
1964	7,026	7,874	18,777	33,677	NA	8,164	27,352	- 6.7
1965	5,979	7,873	20,104	33,955	1,155	4,245	33,806	23.6
1966	5,569	8,432	21,033	35,033	901	2,256	33,385	- 1.2
1967	4,211	7,727	21,338	33,275	890	1,823	32,483	- 2.7
1968	3,387	7,024	20,987	31,397	1,040	1,641	32,540	0.2
1969	2,521	6,430	23,658	32,609	1,137	2,039	32,639	0.3
1970	1,750	5,144	23,975	30.869	1,153	1,749	30,518	- 6.5
1971	1,292	4,731	22,768	28,790	1,207	1,983	27,003	-11.5
1972	1,418	4,270	22,745	28,433	1,133	2,079	27,496	1.8
1973	1,328	3,769	23,206	28,303	2,114	2,003[b]	28,052[b]	2.0
1974	1,071	3,443	22,019	26,532	1,682	1,536	27,094	- 3.4
1975	781	3,113	20,458	24,352	1,487	816	26,524	- 2.1
1976	1,035	2,071	19,274	22,380	2,932	210	22,960	-13.4
1977	871	2,986	20,255	24,112	814	1,013	23,203	1.1
1978 (preliminary)	727	2,544	20,608	23,878	397	972	25,152	8.4

[a] Includes some destructively distilled turpentine, not reported after 1957.

[b] Unrevised

Source: Naval Stores Annual Summary, U.S. Department of Agriculture, Crop Reporting Board

TABLE III-B-4

PRODUCTION AND SALES OF PINENE

	Production (000 lb)	Sales: Quantity (000 lb)	Sales: Value ($000)	Sales: Unit Value ($/lb)
1972				
α- Pinene	-	19,814	2,106	0.11
β- Pinene	38,095	29,180	4,638	0.16
1973[(a)]	85,102	51,767	6,251	0.12
1974	76,857	28,494	5,340	0.19
1975	70,215	18,422	4,305	0.23
1976				
α- Pinene	-	5,300	724	0.14
β- Pinene	25,366	2,757	828	0.30

(a) Combined α- and β-Pinene production and sales figures were reported in 1973-1975.

Source: "Synthetic Organic Chemicals, U.S. International Trade Commission publication

TABLE III-B-5

TURPENTINE CONSUMPTION
(Millions of Gallons)

Crop Year Beginning April 1	Reported Industrial Consumption					Apparent Consumption[a]
	Chemicals	Elastomers	Paint, Varnish and Lacquer	Other	Total	
1940	2.0	0.01	2.6	1.1	5.7	23.1
1941	2.8	0.01	3.2	1.3	7.3	25.2
1942	2.7	0.01	1.4	1.1	5.3	19.8
1943	6.9	0.01	1.2	1.3	9.4	23.6
1944	7.2	0.03	1.0	1.2	9.5	25.7
1945	6.2	0.03	0.9	1.1	8.2	25.6
1946	5.3	0.02	0.8	0.8	7.0	24.2
1947	5.7	0.02	0.8	0.6	7.0	23.3
1948	4.0	0.01	0.7	0.5	5.2	26.0
1949	4.6	0.01	0.6	0.4	5.6	17.8
1950	6.5	0.01	0.7	0.4	7.6	29.8
1951	10.4	0.01	0.6	0.5	11.5	26.4
1952	8.2	0.02	0.5	0.5	9.2	23.4
1953	9.4	0.02	0.5	0.4	10.3	25.2
1954	11.0	0.01	0.4	0.2	11.6	26.9
1955	16.0	0.01	0.4	0.3	16.8	28.8
1956	15.9	0.01	0.4	0.3	16.5	27.9
1957	18.9	0.02	0.3	0.1	19.4	28.3
1958	20.4	0.02	0.3	0.1	20.8	28.8
1959	20.3	0.02	0.2	0.1	20.7	26.4

TABLE III-B-5 (Continued)

TURPENTINE CONSUMPTION
(Millions of Gallons)

Crop Year Beginning April 1	Reported Industrial Consumption					Apparent Consumption[a]
	Chemicals	Elastomers	Paint, Varnish, and Lacquer	Other	Total	
1960	18.5	0.04	0.2	0.1	18.8	26.1
1961	18.1	0.03	0.2	0.1	18.5	27.3
1962	20.0	0.04	0.2	0.1	20.4	29.3
1963	20.6	0.04	0.2	0.2	21.0	27.4
1964	24.3	0.04	0.2	0.2	24.7	33.8
1965	26.2		0.2	0.4	26.8	33.4
1966	27.4		0.2	0.2	27.9	32.5
1967	28.2		0.2	0.2	28.6	32.5
1968	29.8		0.1	0.2	30.1	32.6
1969	29.7		0.1	0.2	29.9	30.5
1970	26.5		0.1	0.3	26.8	27.0
1971	27.0		0.1	0.1	27.2	27.5
1972	23.1		0.1	0.2	23.4	25.6
1973	21.9		neg.	0.2	22.2	27.1
1974	21.6		neg.	0.4	22.0	26.5
1975	17.5		neg.	0.2	17.7	23.0
1976	23.8		neg.	0.2	24.0	23.2
1977	23.2		neg.	0.4	23.6	25.2

(a) The difference between apparent consumption and reported industrial consumption is due primarily to retail sales of turpentine for use as a paint thinner.

Source: U.S. Department of Agriculture publications.

industry. The decline of turpentine as an ingredient in industrial paint, varnish, and lacquer, is attributed to increased substitution of mineral spirits in these applications.

An estimated 40% of the U.S. turpentine production is used in the manufacture of pine oil. Other major end use product categories for turpentine are shown in Table III-B-6, which represents a composite of the use patterns for all three types of turpentine. In the specific case of sulfate turpentine, slightly higher percentages are used in chemical manufacturing. The market for retail turpentine and solvent is supplied more heavily by gum and wood turpentine.

Pine oil is used as a solvent and bactericide in soaps and other disinfecting compounds. It also serves as a solvent for chlorinated phenols used in the treatment of lumber, and as a preservative for casein and other proteins in adhesives and water paints. Some pine oil fractions are used as odorants in commercial cleaning compounds. Terpineol-rich fractions are used in the manufacture of terpineol derivatives.

Camphene, derived from α-pinene, is chlorinated to produce toxaphene, an insecticide.

Terpene resins include a variety of low-molecular-weight polymers produced from α-pinene or mixtures of α- and β-pinene. They are used in adhesives, (particularly in the compounding of pressure-sensitive adhesives), in hot-melt adhesives and coatings, and in general purpose solvent cements. Other uses include the formulation of chewing gum and dry-cleaning sizes. Recently, terpene resins have found application in paper size and as a modifier for polyolefin films.

TABLE III-B-6

ESTIMATED END USE OF U.S. TURPENTINE CONSUMPTION[a]

End-Use Category	Products	Percent
Synthetic pine oil	Pine oil (various grades); terpineols	40
Insecticides	Chlorinated camphene and mixtures of terpenes	15
Terpene resins	Polymerized α- and β-pinenes; mixtures of other terpenes	15
Flavors and perfumes	Isobornyl acetate, geraniol, linalool, citnal, etc.	13
Refined terpenes and derivatives	Camphene, -pinene, etc.	10
Paint, varnish and lacquer		Negligible
Other industrial uses		2
Retail turpentine, paint thinner, and solvent		6
		100%

(a) Includes gum, wood, and sulfate turpentine

Source: Arthur D. Little, Inc., estimates

An important and growing use of the alpha and beta pinenes is in the production of flavor and fragrance chemicals for use in perfumes, foods, and other consumer products. The major manufacturing route for these products begins with the conversion of β-pinene to myrcene, or α- and β-pinene to pinane; followed by the conversion of these derivatives to linalool, geraniol, and citral.

A mixture of monocyclic terpenes is released during several of the primary production processes discussed above, and is sold under the name "dipentene" for use primarily as a solvent. Dipentene may also be separated into its various constituents for processing into flavor and fragrance chemicals or used as a lubricant.

3. Substitute Products

The closest substitutes for sulfate turpentine are gum and wood turpentine. Although today these three products are considered essentially identical in quality, at one time sulfur odors present in sulfate turpentine gave gum and wood products a distinct advantage in the retail paint thinner and solvent markets. Improvements in the crude sulfate refining process now allow the removal of essentially all impurities, including any lingering sulfur odors, from the refined sulfate product.

Because of this one-time advantage, gum turpentine and, to a lesser extent, wood turpentine, may still be perceived by consumers as superior products. However, the rising prices and supply shortages of gum and wood turpentine are rapidly eroding any advantage that they may have derived from their superior image. As a consequence, sulfate turpentine is able to compete effectively with gum and wood turpentine in all markets, including the retail paint thinner market. Sulfate turpentine has always been of adequate quality for use in manufacture of turpentine-derived chemicals, and its lower price and greater availability have allowed it to dominate that market.

Other products that compete with sulfate turpentine include mineral spirits in the retail paint thinner market, and petroleum-based chemicals in various specialty chemical manufacturing processes. Flavors and fragrances that are now produced synthetically from turpentine are also obtained by extraction from the natural products.

4. Foreign Competition

World production statistics for crude sulfate turpentine are not readily available, although they can be estimated from a country's production of crude tall oil since both are by-products of the same kraft pulping process. The United States is probably the world's major producer of sulfate turpentine with roughly 45% of the total, followed by the Scandinavian countries (Sweden, Finland, and Norway) with an estimated combined total of 40%. The U.S.S.R., France, and Mexico are also known to produce sulfate turpentine.

The United States is a net exporter of turpentine. In 1977, the United States exported 685 thousand gallons of sulfate turpentine. Fifty percent of that total was sold to Japan, and another 45% went to France. Imports of turpentine (type unspecified) during that same period were valued at $342 thousand or an estimated 400 thousand gallons. They came almost exclusively from Mexico and probably consist mostly of gum products.

Since turpentine shortages are being experienced in all parts of the world, it is not likely that foreign imports will seriously threaten the U.S. industry over the next 10 years. Moreover, foreign demand for U.S. exports is expected to remain strong. There is, however, some indication that Japan may purchase an increased portion of the country's turpentine requirements from China, a large producer of gum turpentine.

5. Prices

Crude sulfate turpentine prices currently range from 55 to 60 cents per gallon. The general price trend over the past 10 years has been upward, from 30 cents per gallon in 1969 to 60 cents per gallon in 1978 as shown in Table III-B-7. This trend is expected to continue in the foreseeable future. Accompanying this upward price trend has been a decline in production volume.

During the 1973 and 1974 petroleum shortage, the steady upward price trend was temporarily interrupted. Prices had dipped slightly during late 1972, possibly in response to increased production during that year. They then shot up dramatically during late 1973 and early 1974 as the petroleum shortage increased in severity, and the demand for substitute turpentine-derived chemicals increased. Between December, 1973 and December, 1974 the price of crude sulfate turpentine rose 175% from 40 cents to 70 cents per gallon. These abnormally high prices declined during 1975.

Sulfate turpentine is priced below both gum and wood turpentine, and this differential is increasing. In 1969, the price of gum turpentine was 47 cents higher than the price of crude sulfate; by early 1978 gum's price was 87 cents above that of sulfate.

TABLE III-B-7

CRUDE SULFATE TURPENTINE PRICE HISTORY

Year	Quarter	Price (¢/gal)
1969	1	30
	2	32
	3	35
	4	35
1970	1	38
	2	42
	3	45
	4	50
1971	1	50
	2	50
	3	50
	4	50
1972	1	50
	2	48
	3	48
	4	43
1973	1	40
	2	37
	3	37
	4	37
1974	1	40
	2	50
	3	60
	4	70
1975	1	75
	2	75
	3	75
	4	75
1976	1	65
	2	45
	3	45
	4	45

TABLE III-B-7 (Continued)

CRUDE SULFATE TURPENTINE PRICE HISTORY

Year	Quarter	Price (¢/gal)
1977	1	45
	2	45
	3	50
	4	50
1978	1	50
	2[(a)]	55
	3	60

(a) Expected Price

Source: Arthur D. Little, Inc.

6. Growth Forecasts

This segment of the industry is expected to grow no faster than 2% to 3% per year in volume of production output over the next 10 years. Growth is slowed by the shortage of raw materials which will probably continue over the near future. However, there is reason to believe that opportunities exist for the segment to increase its dollar sales at a faster rate by continuing to slowly raise prices and by upgrading the product lines to include higher value-added materials.

C. Wood Rosin, Turpentine and Pine Oil (Subcategory B)

The wood chemicals industry uses pine stumps as its basic raw material. As the pine tree grows and matures, oleoresin is deposited in the heartwood, where it helps to protect this important structural part of the tree from insect attack and decay. When the tree is cut for timber, the stump deteriorates and its bark and sapwood slough off. After ten years or more, the residual stump is mostly heartwood, rich in oleoresin, containing up to 25% in the case of virgin longleaf stumps. At one time, large acreages of cutover pine lands in the Southeastern United States contained a rich supply of longleaf stumps for the wood chemicals industry.

Methods for removing the stump vary with terrain and soil. The earlier method of using dynamite has been replaced by a variety of modified forms of tractors and stump pullers. After extraction, the stumps are transported by rail or truck to plants where they are water-washed and reduced to chips.

Depending on the product desired and the operator, the chips are extracted under pressure with hot solvents such as gasoline, benzene, or a ketone. The extraction solvent is recovered by distillation and reused. The oleoresin is then subjected to further distillation to separate it into volatile oils and residual crude rosin.

Turpentine and pine oil, along with a mixture of monocyclic monoterpene hydrocarbons, are recovered by rectification of the volatile oils. The crude rosin is treated to remove undesirable color components by passing it through an adsorbent such as Fuller's earth or using a solvent such as furfural. After treatment, wood rosin is considered generally equivalent to the corresponding color grades of gum rosin.

1. Supply Characteristics

1.1 Producers

Only three U.S. companies are currently producing wood chemicals. These companies combined operate five plants, all located in the Southeastern United States, as shown in Table III-C-1.

Although capacity figures are not available, production has been decreasing and it is likely that all plants are now operating significantly below capacity.

1.2 Integration and Capital Requirements

Wood chemical producers are integrated backward into the procurement of stumps. As the readily available supplies of stumps have diminished, procurement operations have played an increasingly critical role in a company's ability to compete successfully.

The three producing companies are also integrated forward into rosin derivatives. Continental and Hercules both produce rosin derivatives at the same plants where wood stump distillation occurs. Reichhold manufactures rosin derivatives at plants located in Pensacola, FL and Telogia, FL.

Production of wood chemicals is not a highly capital-intensive operation. The ratio of investment to sales is estimated at 0.7 to 1.0. Equipment used by this industry segment is estimated to be over 20 years old.

1.3 Estimated Profitability

Profitability for the wood chemicals segment is probably in the low end of the 2% to 9% range estimated for this industry as a whole. Rising costs of both stump transportation and labor are expected to further erode this slim margin.

TABLE III-C-1

U.S. PRODUCERS OF WOOD ROSIN, TURPENTINE, AND PINE OIL

Company	Plant Location
Continental Turpentine & Rosin Company	Cross City, Florida
Hercules, Inc.	Brunswick, Georgia
Hercules, Inc.	Hattiesburg, Mississippi
Reichhold Chemical Co.	Pensacola, Florida
Reichhold Chemical Co.	Telogia, Florida

Source: Arthur D. Little, Inc.

1.4 Other Supply Characteristics

The regional location of this industry segment was originally influenced by the relatively high cost of transporting pine stumps from the cut over forest to the plant. As a result, plants were located as close as possible to stump sources. However, the supply of suitable pine stumps is rapidly declining even in these once-prime areas. This shortage both decreases the amount of raw material available for production and increases the cost of transporting the remaining limited supply because wider areas must be exploited.

This segment employs roughly two field workers to extract and transport stumps for every one plant worker. The majority of the positions are nonskilled or semi-skilled.

2. Demand Characteristics

2.1 Market Size and Share

Wood rosin and wood turpentine's market shares are shown in Tables III C-2, III-C-3 respectively. Both products have experienced a steady decline in market share over the past 20 years. Primarily because of a shortage of kraft pulping by-products, wood rosin and turpentine's market shares strengthened somewhat during the past two years.

The total U.S. production levels for pine oil are provided in Table III C-4. These figures include both "natural" or wood pine oil, produced during the stump distillation process, and "synthetic" pine oil produced from α-pinene. Wood pine oil represented an estimated 25% of the total pine oil production during the 1978 crop year.

TABLE III-C-2

WOOD ROSIN'S SHARE OF THE TOTAL U.S. ROSIN MARKET
(million pounds)

Year Ending March 31	Wood Rosin Production	Total U.S. Rosin Production	Wood Rosin's Market Share
1953	563	911	62
1954	631	926	68
1955	698	999	70
1956	712	1,013	70
1957	688	1,036	66
1958	622	970	64
1959	615	966	64
1960	623	996	63
1961	634	1,044	61
1962	575	1,067	54
1963	569	1,073	53
1964	571	1,083	53
1965	539	1,047	51
1966	562	1,075	52
1967	513	1,017	50
1968	502	971	52
1969	499	958	52
1970	432	906	48
1971	399	860	46
1972	382	849	45
1973	365	848	43
1974	342	823	42
1975	283	679	42
1976	186	565	33
1977	265	707	37
1978 (preliminary)	246	676	36

Source: Arthur D. Little, Inc., based on U.S. Department of Agriculture reports.

TABLE III-C-3

WOOD TURPENTINE'S SHARE OF THE TOTAL U.S. TURPENTINE MARKET

Year Ending March 31	Wood Turpentine Production (000 gals)	Total U.S. Turpentine Production (000 gals)	Wood Turpentine's Market Share (%)
1954	9,650	26,900	36
1955	10,400	30,900	34
1956	10,050	32,750	31
1957	9,750	32,250	30
1958	9,300	31,350	30
1959	8,650	30,400	28
1960	8,800	31,840	28
1961	8,150	30,270	27
1962	7,574	31,856	24
1963	7,631	32,653	23
1964	7,874	33,677	23
1965	7,873	33,955	23
1966	8,432	35,033	24
1967	7,727	33,275	23
1968	7,024	31,397	22
1969	6,430	32,609	20
1970	5,144	30,869	17
1971	4,731	28,790	16
1972	4,270	28,433	15
1973	3,769	28,303	13
1974	3,443	26,532	13
1975	3,113	24,352	13
1976	2,071	22,380	9
1977	2,986	24,112	12
1978 (preliminary)	2,544	23,878	11

Source: Arthur D. Little, Inc., based on U.S. Department of Agriculture reports.

TABLE C-III-4

PINE OIL PRODUCTION AND EXPORTS

Year Ending March 31	Production (000 gal)	Exports (000 gal)	Exports as a Percent of Production (%)	Percent Change in Production from Previous Year (%)
1956	9,351	1,991	21	-
1957	9,469	2,020	21	1.3
1958	9,271	2,188	24	-2.1
1959	9,713	2,154	24	4.8
1960	9,857	2,318	24	1.5
1961	8,348	2,556	31	-15.3
1962	9,082	2,952	33	8.8
1963	11,581	2,417	21	27.5
1964	10,912	2,790	26	-5.8
1965	11,687	3,262	28	7.1
1966	13,331	4,161	31	14.1
1967	13,675	4,075	30	2.6
1968	14,256	3,696	26	4.2
1969	14,460	3,876	27	1.4
1970	13,887	3,690	27	-4.0
1971	13,847	4,022	29	-0.3
1972	14,521	3,726	26	4.9
1873	13,013	3,805	29	-10.4
1974	12,473	4,529	36	-4.1
1975	10,663	4,719	44	-14.5
1976	8,561	3,604	42	-19.7
1977	9,503	3,466	36	11.0
1978	9,489	3,563	38	-0.1

Source: Arthur D. Little, Inc., based on U.S. Department of Agriculture reports

2.2 Major End Uses

The major end uses for wood turpentine, rosin, and pine oil are the same as those discussed for sulfate turpentine, gum rosin, and synthetic pine oil in Sections 1.2 and 1.3.

2.3 Substitute Products

Gum and sulfate/tall oil products are close substitutes for wood chemicals. Improvements in wood production processes have brought the quality of wood products on par with most gum chemicals. However, the rising price of wood chemicals caused largely by raw material shortages has not allowed wood products to compete effectively in many of the chemical manufacturing markets now dominated by sulfate/tall oil products.

Other substitute products for wood rosin, turpentine and pine oil include petrochemical derivatives and other hydrocarbons as discussed in Sections 1.2 and 1.3.

2.4 Foreign Competition

The United States and the U.S.S.R. are the only major world producers of wood, steam-distilled chemicals, although small amounts are also produced in Poland, Yugoslavia, and Honduras. U.S. production is estimated to be four times greater than the Soviet Union's, as shown in Table III-C-5.

U.S. import data provides no indication that any wood chemicals were imported into the United States during 1977. However, during that same period, the United States exported 48 million pounds of wood rosin and 468 thousand gallons of wood turpentine. Table III-C-6 shows that the Netherlands and Brazil are major markets for wood rosin, while

TABLE III-C-5

ESTIMATED WORLD PRODUCTION OF WOOD ROSIN
(tons)

	1972-73 Crop Year	1977-78 Crop Year
United States	181,906	123,000
Europe	(a)	-
U.S.S.R.	44,000	NA

(a) A small amount of wood rosin is produced in Poland, Yugoslavia, and Honduras

Source: "Pulp and Paper," January, 1975; "Chemical Week," October, 1976; and U.S. Department of Agriculture Reports

TABLE III-C-6

U.S. EXPORTS OF WOOD PRODUCTS BY COUNTRY

Product	Country	Amount Exported in 1977	
Wood Rosin	Netherlands	12,531	(000 lb)
	Brazil	9,128	"
	United Kingdom	5,779	"
	Canada	5,372	"
	Japan	3,040	"
	Germany	2,915	"
	Australia	1,494	"
	Venezuela	1,298	"
	Italy	1,038	"
	Republic of So. Africa	852	"
	Sweden	449	"
	China (Taiwan)	413	"
	Denmark	386	"
	Jamaica	316	"
	Argentina	306	"
	Spain	241	"
	Nicaragua	219	"
	New Zealand	173	"
	France	124	"
	Other countries	1,688	"
Wood Turpentine	Nicaragua	251,403	(gals)
	Other countries	216,988	"

Source: U.S. Export Data

Nicaragua is the U.S.'s major market for wood turpentine.

2.5 Prices

Historical price data for wood products are not readily available. In general, wood turpentine prices fall within a range bracketed by the price of gum turpentine on the high end, and sulfate turpentine on the lower end. The same relationship is found among the prices of gum, wood, and tall oil rosin, although the variety of grades available in each of these products makes the relationships less straightforward.

2.6 Growth Forecasts

The wood chemicals industry segment has been declining at approximately 6% per year over the past decade. This downward trend is expected to continue, perhaps at an even faster rate. Growing raw material shortages, the increased cost of transporting stumps to the plant site, and the impact of higher labor costs on this fairly labor-intensive operation all contribute to the segment's decline. Estimates of the length of time over which this industry segment can continue operating before all suitable stumps are exhausted vary widely within a range from 5 to 20 years.

D. Tall Oil Fractionation Products (Subcategory C)

Tall oil is a major by-product of the kraft pulping of pine trees. Recovered from the black liquor residue produced in the pulping operations, crude tall oil contains 55% resin and fatty acids, 35% water and 10% black liquor solids. In this form, it finds few direct applications and those which do exist value it primarily because it is a low cost material. Tall oil's real value is realized only after it is separated into its two major components: resin acids (rosin) and fatty acids. While many processes for carrying out this separation have been reported, the most effective and universally practiced method is fractional distillation. High quality fatty acid mixtures and relatively pure rosin is produced in this manner which have significantly higher sales value than the crude tall oil itself. Commercial grades of tall oil rosin do contain a small amount of sulfur, incorporated during the kraft pulping process, however, they are generally competitive with gum and wood rosins at equal or slightly lower prices.

In a typical fractional distillation process, the crude oil is first dehydrated to remove water completely and flash distilled through a stripping tower to separate the volatile rosin and fatty acids from the black liquor solids and non-volatile rosin residues referred to as tall oil pitch. The vaporized materials are passed through a continuous fractionating tower where odoriferous sulfur containing light ends are removed at the top, fatty acid fractions are removed at intermediate locations, and high quality tall oil rosin is removed at the bottom of the tower. The fatty acid fractions are further fractionated to yield high quality fatty acid mixtures and additional tall oil rosin.

The amount of fatty acid, rosin and pitch obtained in this manner is largely dependent on the composition of the crude tall oil itself, which is in turn dependent primarily on the geographic location where the pine trees are grown. Average percentage of recovered fractions for U.S. producers are: fatty acids, 25%; rosin, 40%; pitch and other secondary, neutral products, 35%.

The fatty acid fraction of tall oil is composed principally of oleic and linoleic acids which are linear hydrocarbon acids containing 18 carbon units. Neither of these acids are unique to tall oil as oleic acid is a major component of animal tallow and linoleic/oleic acid mixtures are obtained from vegetable oils: linseed oil, safflower oil and soybean oils. The rosin fraction of tall oil is composed primarily of terpene based monocarboxylic acids. The number of acids and the percent of composition varies with the geographical source of the pine trees pulped, however, the rosin fraction from tall oil is essentially identical to gum and wood rosin with the exception of trace color material. With modern purification schemes even this distinction is no longer significant.

1. Supply Characteristics

The supply of tall oil fractionation products is closely tied not only to the demand for both fatty acids and rosin but also to the production of wood pulp. Since crude tall oil is a by-product of the pulping of pine trees (softwood), its supply is limited by the quantity of softwood pulped in any given year. Since the kraft pulping process can accept both hardwood chips and recycled paper, the supply of crude tall oil can vary year to year depending on the quantity of softwood consumed in the kraft pulping process. As a rule of thumb, approximately 100 pounds of crude tall oil is produced for each ton (air dried) of softwood pulp produced. As the proportion of hardwood chips or recycled paper material is increased, the quantity of crude tall oil available is decreased. In recent years, declining use of softwoods has tightened the supply of crude tall oil considerably and at the present time the demand for crude tall oil exceeds the supplies even though the capacity utilization reported by the fractionators is a very low 65-70%.

A second factor complicating the supply of tall oil fractionation products is the interdependent relationship between tall oil rosin and fatty acids. About 1.1-1.5 pounds of rosin is produced for each pound of fatty acid. Since this ratio cannot be varied significantly, the ability to supply either fatty acids or rosin can be limited by the demand for the other co-product. Therefore, if the demand for rosin and fatty acid gets significantly out of line with the 1.1-1.5 to 1 production ratio, suppliers are typically unwilling to increase supplies. This typically has not been a limiting factor since the demand for both co-products contained in tall oil have exceeded the supply of crude.

1.1 Producers

The producers of tall oil fractionation products, along with plant location and 1977 capacity, are shown in Table III-D-1. Capacity is based on the volume of crude oil input and in most cases represents the optimum capacity depending on product mix and/or crude oil availability. Total industry capacity ranges between 891,000 and 998,000 tons of crude oil, depending on whether Crosby's Mississippi plant, currently on standby, and Hercules' Canadian plant are considered.

TABLE III-D-1

U.S. PRODUCERS OF TALL OIL FRACTIONATION PRODUCTS

Company	Plant Location	1977 Capacity[a] (000 tons)	1972 Capacity (000 tons)
Arizona Chemical	Panama City, Florida	100	105
Arizona Chemical	Spring Hill, Louisiana	50	45
Crosby Chemical[b]	Picayune, Mississippi	90	90
Hercules, Inc.	Franklin, Virginia	65	65
Hercules, Inc.	Hattiesburg, Mississippi	60	90
Hercules, Inc.	Portland, Oregon	30	25
Hercules, Inc.	Savannah, Georgia	65	65
Monsanto-Emery	Nitro, West Virginia	65	45
Reichhold	Bay Minnette, Alabama	36	36[e]
Reichhold	Oakdale, Louisiana	60	59[e]
Silvachem	Port St. Joe, Florida	100	55
Union Camp	Savannah, Georgia	105	110
Westvaco	Charleston, South Carolina	85	70
Westvaco	DeRidder, Louisiana	70	65
	Total U.S. Capacity	981	940
	Total U.S. Capacity in Currently Operating Plants[c]	891	
	Capacity Available to U.S. Market[d]	998	

[a] Capacity in terms of tons of crude oil input

[b] Plant currently on standby

[c] Excludes Crosby's Picayune, Mississippi, plant, currently on standby

[d] Includes Hercules' plant in Burlington, Ontario, Canada (capacity of 17,000 tons)

[e] Owned and operated by Tenneco in 1972.

Source: "Chemical Profiles," Schnell Publishing Co., Inc., January 1, 1978.

Capacity has increased only slightly since 1972 as seen in Table III-D-1. Silvachem was the only plant to increase capacity significantly over this period and the Hercules plant in Hattiesburg, Mississippi and the Crosby Chemical plant in Picayune, Mississippi are currently on partial or total standby cperation.

Capacity utilization within the industry is approximately 65-70% based on an estimated 1977 production of 405 million pounds of tall oil rosin. Total demand for tall oil in 1977 was about 755,000 tons of which about 80,000 tons was the U.S. net exports of tall oil, and 45,000 tons were used in the crude form. The remaining 630,000 tons were probably fractionated by the producers of fractionated tall oil products.

1.2 Integration and Capital Requirements

The producers of fractionated tall oil have historically located near and often adjacent to pulp mills in order to have a nearby source of raw material. Transporting the relatively high value tall oil fractions or even subsequent derivative products is far more economical than transporting the crude tall oil which contains about 45% of water and low value pitch material. As the tall oil fractionating industry grew and pulp mills began pulping more hardwood and recycled material, the capacity of the tall oil fractionating plants exceeded the supply of crude tall oil available from the pulp mill. Fractionators therefore, had to look to more and more distant locations to secure sufficient supplies of crude. Today, most of the large fractionators must purchase at least some of its crude requirements from pulp mills located as much as 300-400 miles away. Transporting crude much beyond that distance is economically impractical.

Of the 13 plants currently operating in the United States, 3 are totally owned and operated by paper companies, and 3 more are joint ventures between paper and chemical companies. These plants are located close to or contiguous with the paper companies pulp mill. At least 3 other plants, operated by chemical companies, are located in the same town location with a major pulp mill, and it is believed that there exists priviledged purchasing priority for these fractionators.

There is considerable downstream integration in the industry as well as primarily producing rosin derivatives rather than fatty acid products. The basic trend in this industry has been to up-grade tall oil rosin to produce higher value-added rosin derivatives. Seven of the 13 operating plants (Arizona Chemical - 2, Hercules - 2, Reichhold - 2, Union Corporation - 1), in this industry also produces a variety of rosin derivatives.

The capital investment requirements for tall oil fractionation is only moderate. The fixed investment to sales ratio is about 0.8 - 1.0 to 1.0. The capital equipment is neither extremely complex nor entirely specific to fractionating crude tall oil.

1.3 Estimated Profitability

Since many of these companies are either part of large paper or chemical companies or are engaged in several activities other than tall oil fractionation, little public data specific to this process is available on which to base an estimate of the profitability. However, the non-integrated fractionator is in the weakest supply position in the processing chain from crude to final products and in a period of overcapacity cannot expect to have above average profitability. These producers in turn condition the average profitability for the rest of the crude fractionators. We estimate that, at the present time, the profitability in this segment is no more than 4-5% of sales and conceivably could be less.

1.4 Other Supply Characteristics

The tall oil fractionating business is highly regional with only one plant located outside the "pine belt" region which includes the South Atlantic and South Central States.

This segment of the gum and wood chemicals industry is not exceptionally labor-intensive and requires only average skills to operate and maintain the plant and equipment.

While capacity has increased only marginally since 1972, three plants have changed hands and two companies have left the industry. Two plants operated by Tenneco at Bay Minette and Oakvale, La. were acquired by Reichhold in 1975 and one plant operated by Crosby in DeRidder, La. was acquired by Westvaco in 1977. Both Tenneco and Crosby have apparently left the Gum and Wood Chemicals industry although Crosby may still have a small position in sulfate turpentine.

2. Demand Characteristics

As indicated in Section 1.5.1 the supply of crude tall oil is at present limited, therefore, it is difficult to estimate the actual demand for tall oil fractionation products at current prices. It is assumed however, that demand is not significantly higher than supply since prices for tall oil fractionation products have not increased excessively over the past year and are substantially lower now than in 1973-74, especially for rosin.

2.1 Market Size and Share

Tall oil fatty acid competes principally with those materials produced from animal fats and vegetable oils. Because it is readily available and low in cost, tall oil fatty acid has successfully competed with these substitute materials and accounts for about 30% of the total fatty acid production and for nearly 50% of the unsaturated fatty acid production in the United States as shown in Table III-D-2. The share of the unsaturated fatty acid market and total fatty acid market attributable to tall oil fatty acid has declined significantly from that share held during most of the last decade. Production has remained relatively constant since 1969 with the exception of 1975, consistent with the constrained supply of crude tall oil.

Tall oil rosin represents a growing portion of a declining market for all rosins in the United States. As shown in Table III-D-3, tall oil rosin has increased market share from 2% in 1953-54 to about 60% in 1976-78. As with tall oil fatty acids, production of tall oil rosin has remained relatively constant over the period 1968-1977. However, the total United States production of rosin has declined about 25% over that same period.

2.2 Major End Uses

The principal uses for tall oil fatty acids are derived from the carboxylic group and the degree of unsaturation present in the molecule. The carboxylic group reacts with metallic ions to form soaps and ortho

TABLE III-D-2

TALL OIL FATTY ACID'S SHARE OF THE TOTAL U.S. FATTY ACID MARKET

Year	Tall Oil Fatty Acid Production (MM lb)	Total U.S. Production of Unsaturated Fatty Acids (MM lb)	Tall Oil's Share of Unsaturated Market (%)	Total U.S. Production of All Fatty Acids (MM lb)	Tall Oil's Share of Total Market (%)
1960	172.5	322.1	54	567.9	30
1961	195.6	336.0	58	572.2	34
1962	228.0	382.1	60	641.9	36
1963	238.8	408.6	58	679.8	35
1964	266.1	457.4	58	755.3	35
1965	298.2	490.3	61	791.8	38
1966	337.2	533.3	63	865.2	39
1967	333.1	519.9	64	864.0	39
1968	338.8	535.1	63	915.5	37
1969	370.8	570.2	65	974.1	38
1970	400.4	605.9	66	1005.5	40
1971	407.1	602.5	68	1002.1	41
1972	428.9	680.0	63	1106.9	39
1973	412.4	673.6	61	1189.8	35
1974	363.2	643.1	56	1171.7	31
1975	293.2	556.6	53	965.6	30
1976	373.3	712.2	52	1215.8	31
1977(e)	375	770	49	1310	29

Source: Arthur D. Little, Inc., based on data from Chemical Economics Handbook, Stanford Research Institute, 1976.

TABLE III-D-3

TALL OIL ROSIN'S SHARE OF THE TOTAL U.S. ROSIN MARKET

Year Ending March 31	Tall Oil Rosin Production (MM lbs.)	Total U.S. Rosin Production (MM lbs.)	Tall Oil Rosin's Market Share
1953	16	911	2
1954	18	926	2
1955	26	999	3
1956	65	1,013	6
1957	117	1,036	11
1958	140	970	14
1959	159	966	16
1960	199	996	20
1961	218	1,044	21
1962	245	1,067	23
1963	249	1,073	23
1964	275	1,083	25
1965	305	1,047	29
1966	326	1,075	30
1967	363	1,017	36
1968	354	971	36
1969	371	958	39
1970	412	906	45
1971	416	860	48
1972	419	849	49
1973	437	848	52
1974	443	823	54
1975	367	679	54
1976	342	565	61
1977	410	707	58
1978 (preliminary)	404	676	60

Source: Arthur D. Little, Inc., based on U.S. Department of Agriculture reports.

amines to form amides, which are converted to fatty acid amines, or esterfied with alcohols, glycols, and polyols for plasticizers, surfactants, and flotation agents. The double bond can be epoxidized to epoxy products useful as plasticizers. With phthalic and polyols, the fatty acids give alkyds for paints and coatings. Dimerized fatty acids find use as resins and epoxy curing agents. The estimated pattern of tall oil fatty acid end uses is shown in Table III-D-4.

Tall oil rosins are used in rubber and emulsion polymerization as emulsifiers. Paper sizing, once the principal market for tall oil rosin, is declining in importance but still represents a major end use. Table III-D-5 lists the estimated pattern of tall oil rosin end uses.

Producers also sell the tall oil pitches and heads obtained during the distillation process, but these end use markets are low value added applications and are not important to tall oil fractionators except as a vehicle to get rid of undesirable waste materials.

2.3 Substitute Products

Substitute products for tall oil fractionation products are different for each end use application. In general, tall oil fatty acids compete directly with animal fat and vegetable oil derived fatty acids. In some end use areas, these can be readily substituted for tall oil fatty acids and the decision as to which to purchase is made solely on price and availability. In most end use areas, the lead time for switching types of fatty acids is somewhat longer, however, the number of end use markets for which tall oil fatty acids are uniquely suited to are insignificant.

TABLE III-D-4

ESTIMATED END USES OF TALL OIL FATTY ACIDS

Product	Percent
Intermediate chemicals	40
Protective coatings	20
Soaps and detergents	10
Flotation Agents	2
Miscellaneous	14
Exports	14

Source: Chemical Products Synopsis; Mannsville Chemical Products, 1977.

TABLE III-D-5

ESTIMATED END USES OF TALL OIL ROSINS

Product	Percent
Chemicals and Rubber	30
Paper and Paper Sizing	25
Ester Gum and Resins	20
Miscellaneous	7
Exports	19

Source: Chemical Products Synopsis, Mannsville Chemical Products, 1977.

Substitute products for tall oil rosins are both gum/wood rosins and synthetic resins. In the case of gum/wood rosins the substitution is readily accomplished but over the past several years, the trend has been in favor of tall oil rosins. Synthetic resins, however, have penetrated many of the markets for rosin/rosin derivatives especially in paper sizing applications. The performance edge usually belongs to the synthetic resin but prices are usually higher, therefore a complex price/performance trade-off must be made before switching. Once the switch has been made, it rarely is reversed.

2.4 Foreign Trade

The United States was a net exporter of both crude tall oil and tall oil fatty acids and rosins. Most of the tall oil exports have been to Japan and other Southeast Asian countries. Canada has been an important trading partner but is a net exporter of products used by or produced in this industry segment. Therefore, foreign trade appears to contribute to the firm supply/demand picture in the United States.

2.5 Prices

Tall oil fatty acid and tall oil rosin prices were relatively stable until 1973. At that time, high domestic and export demand for crude tall oil and the lifting of price controls combined to push up tall oil fatty acid prices to 35 cents per pound, more than double their previous high. Rosin prices were up over 80% to 29 cents per pound and crude tall oil nearly tripled in price to 15 cents per pound in early 1975. With the onset of the recession in 1975, prices plummeted and remained low through most of 1976 until demand picked up for tall oil fatty acids.

Tall oil rosin prices still have not recovered to any measurable degree due to poor demand and competition from substitute products. The average price range for tall oil fatty acid and tall oil rosin is shown in Table III-D-6.

2.6 Growth Forecasts

Future growth for this industry segment will largely depend on whether the pulp and paper industry increases the quantity of softwood pulped thereby increasing the availability of crude tall oil. Most industry observers and industry participants in the Gum and Wood Chemical industry feel that crude tall oil supplies will increase by about 2% per year through the early 1980's. If the quantity exported does not increase over this period (it is not likely to decrease and conceivably could increase), the domestic availability of crude tall oil should allow a real growth of about 2.0-2.5% per year for both acids and rosins.

TABLE III-D-6

AVERAGE PRICES OF TALL OIL FRACTIONATION PRODUCTS

Year	Average Price Range[a] (¢/lb)		
	Tall Oil Fatty Acid[b]	Tall Oil Rosin	Crude Tall Oil
1960	8	NA	NA
1965	9-12	10	NA
1970	10	13-14	4
1973	13-16	15-16	5
1974	26-35	16-29	5-12
1975	35-24	29-18	15-7
1976	24-25	18	7
1977	25-25-1/2	18	7-8

(a) Trade List Price

(b) Containing less than 2% rosin

Source: Chemical Products Synopsis, Mannsville Chemical Products, 1977, Industry Data.

E. Rosin Derivatives (Subcategory D)

1. Supply Characteristics

The term "rosin derivative" is used to describe rosin after it has undergone a chemical reaction at the acid site or unsaturated site in the original molecule. Since most rosins are modified prior to use the distinction between modified rosins and rosin derivatives is not altogether clear. In general, it appears that modified rosins are those produced by a simple chemical transformation of the unsaturated site such as hydrogeneration, reaction with maleic anhydride, or polymerization. Rosin derivatives require a more complex chemical transformation or are modified at the acid rather than the unsaturated site.

The rosin derivatives of greatest commercial importance are salts and esters but others include the alcohol and amine derivatives as well as dicarboxylic acids produced from modified rosins. There has been a trend since the early 1960's for producers to manufacture higher performance rosin derivatives to preserve existing markets versus higher performance synthetic materials to develop new markets for rosin, and to increase revenue from rosin production since rosin derivatives frequently sell for substantially higher unit values vs. modified rosins.

1.1 Producers

Rosin derivatives are produced by many companies in a variety of United States industries, but, for the purposes of this report we have focused on companies directly involved in other gum and wood chemical processes. Table III-E-1, lists those companies which produce gum, wood or tall oil products in addition to rosin derivatives. Other producers exist which primarily convert modified or unmodified rosin into various types of rosin derivatives, however, these producers are classified

TABLE III-E-1

PRODUCERS OF BOTH "NAVAL STORES" AND ROSIN DERIVATIVES

		Estimated Annual Production Rosin Derivatives (MM lbs.)
Arizona Chemical Company	Panama City, FL	24
Arizona Chemical Company	Spring Hill, LA	10
Continental Turpentine Rosin Corp.	Cross City, FL	12
Crosby Chemicals, Inc.*	Picayune, MS	25
Hercules, Inc.	Brunswick, GA	58
Hercules, Inc.	Hattiesburg, MS	43
Monsanto: FRP	Baxley, GA	23
Reichhold Chemicals, Inc.	Bay Minette, AL	12
Reichhold Chemicals, Inc.	Oakdale, LA	16
Union Camp Corporation	Savannah, GA	32
Total		255

*Believed no longer operating its rosin derivatives facility.

Source: Arthur D. Little estimates

under SIC2821 - Plastic Materials, Synthetic Resins, and Nonvulcanizable Elastomers.

The estimated 1977 production of all types of rosin derivatives by the 7 producers included in this segment is 255 million pounds. The actual capacity is not known, however, it is believed to be somewhat in excess of production. Although rosin supplies are currently tight most producers prefer to devote existing rosin supplies to this activity since these products often realize the highest prices and margins.

1.2 Integration and Capital Requirements

All the major producers of rosin derivatives are integrated back to production of either tall oil or wood rosin. It appears that all but two producers manufacture sufficient rosin to supply its own annual raw material requirements although not necessarily at the plant producing rosin derivatives. Continental Turpentine & Rosin Corporation produces only wood rosin and its annual production is sufficient to supply only about half of its raw material needs. Crosby Chemical no longer produces rosin and it is believed to be phasing out its rosin derivative business

The capital intensity for rosin derivative production is highly dependent on the type of derivative produced. In general the investment to sales ratio ranges from 1.0 to 1.5 to 1.0. Many specialized rosin derivatives are recent innovations and to the extent that new production facilities were required for these products, the investment requirements are higher than average for these types of gum and wood chemicals. This has not apparently been a deterrent to product development since prices realized for the higher performance specialty products have been sufficient to justify investment.

1.3 Estimated Profitability

The profitability of rosin derivative production is believed to be well above average for this industry. Based on limited data, the pretax profitability ranges from about 10% to more than 20% of sales. The trend in this industry has been to produce higher performance products which offer the consumer exceptional value-in-use, providing both the opportunity to improve product performance and production costs (such as for pressure sensitive adhesives) and the option of using less expensive raw material (such as for paint & varnish production).

2. Demand Characteristics

Because the number of applications for rosin derivatives are numerous the demand for these products is not well characterized. However, many of the larger end use applications (e.g., paint/varnish, paper size) are established, mature markets and the demand for rosin derivatives is level or even declining. Many newer end use applications (e.g., adhesives, resin modifiers) are fast growth products and the demand is probably close to production capacity.

2.1 Market Size and Share

As shown in Table III-E-2 most of the rosin derivatives produced are consumed as rosin salts or specialized formulations specified in the other category. Of these major products for which we have some data, ester gum (principally the glycerol ester) is the most important product type. Plastic, phenolic, and fumaric resins in each accounted for about 5% of the 1977 production of rosin derivatives by those companies included in this report.

TABLE III-E-2

PRODUCTION OF ROSIN DERIVATIVES BY TYPE

Rosin Derivative	% of 1977 Production
Ester Gum	15%
Maleic	6%
Pehnolic Resins	5%
Fumaric Resins	4%
Other (includes Rosin Salts)	70%
Total	100%

Source: Arthur D. Little, Inc., estimates

The major end use areas for rosin consumption in 1970 and 1977 are shown in Table III-E-3. Ester gum and synthetic resins and the other applications have increased in market share relative to 1970, while the remaining end use areas have declined. Total consumption of rosin has declined from 760 million pounds in 1970 to 555 million pounds in 1977.

2.2 Major End Uses

The salt derivatives of rosin, called "salts of resin acids," find end uses in a variety of industries. Sodium resinate is used in soaps, where it improves sudsing action, and in paper size. Rosin salts of polyvalent metals (calcium, zinc, lead, and manganese), are used as driers for paints and varnishes and as constituents of printing inks, adhesives, and protective coatings.

The most important commercial rosin ester is made with glycerol, and usually called "ester gum." Rosin esters can also be formed with various alcohols. Esters are commonly used in lacquers and varnishes and in many adhesive compounds as tackifiers. A hydrogerated form of ester gum is used in chewing gum.

The properties of the rosin ester can be altered according to the type of modified rosin used in the manufacturing process. For example, ester gum produced from maleic-modified rosin is advantageous where light-colored, fast-drying, hard finishes are desired, while the phenolic-modified product is particularly outstanding for durability and chemical resistance.

The alcohol form of rosin derivatives (hydroabietyl alcohol), has found application as a plasticizing resin in lacquers and hot-melt coatings. It is also used in oil additives and wetting agents.

TABLE III-E-3

ROSIN CONSUMPTION BY MAJOR END USE MARKETS

End Use Market	% Consumption	
	1970	1977
Chemicals and Elastomers	42	35
Ester Gum and Synthetic Resins	15	23
Paint, Varnish, Lacquer	4	2
Paper and Paper Size	36	34
Other	3	6
Total	100%	100%

Source: Arthur D. Little, Inc., based upon U.S. Department of Agriculture publications.

Amines derived from rosin have been used effectively as cationic flotation reagents in ore operations. Rosin oil has been used in paper-wrapped cables, greases for skidways, rubber reclaiming, linoleum, and shoe polishes.

2.3 Substitute Products

Rosin derivatives compete to a large extent with synthetic petrochemical products. In most end use applications a synthetic material is available with equal or better performance properties. The principal advantage of rosin derivatives is price which in many end use applications gives them a superior cost/performance position. The shift from rosin derivatives to substitute materials would require substantial formulation and production changes. Therefore in most applications substitution is not a significant short term threat although it is possible.

2.4 Foreign Competition

Foreign trade in rosin derivatives does not appear to be significant at the present time. However, we do not have any statistics yet on the import-export balance.

2.5 Prices

No data on actual prices for rosin derivatives have been made available.

2.6 Growth Forecasts

While there is continuing interest in developing new derivatives for existing and new end use markets, these would only serve to offset a general decline in demand for rosin products. Future demand growth for rosin derivatives is expected to be modest at best and is likely to be in the 0-2% per year range. Most of the growth is likely to be for adhesive end use applications especially for hot melt and pressure sensitive types of adhesives.

F. Gum Rosin and Turpentine (Subcategory E)

The oleoresin of the living pine tree was once the only known source of rosin and turpentine, and the gum forms of these products represent their oldest commercial types.

Harvesting oleoresin is mechanically simple, involving only periodic wounding or scarification of the tree and collection of the exudate. The crude oleoresin is transported to central processing plants where it is steam-distilled to separate the turpentine from the rosin.

Work is continually under way to improve the gum industry processes. For example, trees are now sprayed with sulfuric acid to stimulate and prolong the flow of exudate. A process developed by the U.S. Department of Agriculture, (the Olustee process), allows 80% of all gum rosin currently produced to be placed in the top three or four color grades. Prior to this development, over 60% had been of the lower seven grades.

Only the actual distillation of gum oleoresin into turpentine and rosin is included in the scope of this report. The process of collecting oleoresin from the pine trees is included under SIC 0843, Extraction of Pine Gum.

1. Supply Characteristics

1.1 Producers

There are currently five major U.S. producers of gum rosin and turpentine, as shown in Table III-F-1. These five companies operate at seven plant sites, all located in Georgia.

The capacity of each of these plants is unknown; however, the U.S. production of gum products has declined an average of 13% per year

TABLE III-F-1

U. S. PRODUCERS OF GUM ROSIN AND TURPENTINE

Company	Plant Location
Monsanto: FRP	Baxley, Georgia
Monsanto: FRP	Douglas, Georgia
Monsanto: FRP	Helena, Georgia
Shelton Naval Stores Processing Co.	Valdosta, Georgia
Union Camp Paper Co., Nelio Div.	Valdosta, Georgia
K.S. Varn & Company	Hoboken, Georgia
Vidalia Gum Turpentine Co.	Vidalia, Georgia

Source: Arthur D. Little, Inc.

over the past decade. It is, therefore, reasonable to assume that these plants may now be operating significantly below capacity (i.e., at levels which represent 20% to 30% of full capacity).

1.2 Integration and Capital Requirements

There is little forward or backward integration at the plant level in this segment of the industry. All but two of the currently operating plants produce only gum rosin and turpentine. (The exceptions are Monsanto's FRP plant in Baxley, GA and Union Camp at Valdosta, GA which also produces some rosin derivatives.) Moreover, it is unlikely that any of these plants employ workers to collect the oleoresin from pine trees. Harvesting is probably carried out by Georgia farmers on privately owned timber lots during slow periods in their planting season.

Three of the five companies currently have no downstream operations, and sell their output as turpentine and rosin. Two do produce some rosin derivatives: FRP in the Baxley plant and Union Camp at a plant in Savannah, GA. There is no indication that producers are considering either backward integration (i.e., owning wood lots and employing harvesters), or increased forward integration into the production of derivatives.

This segment of the industry requires very little capital investment; the investment-to-sales ratio may be as low as 0.2 - 0.4 to 1.0. The age of the equipment used by the gum industry segment is estimated to be more than 30 years.

1.3 Estimated Profitability

Profitability within this segment of the industry varies widely, not only from company to company, but also from year to year. Since this segment comprises a relatively small percent of the total U.S. production of rosin and turpentine, the segment's pricing structure--and thus profits--depend on the performance of wood and sulfate/tall oil segments. In any given year, the operating results of an individual small producer of gum products could range from a profit of 20% of sales to a loss of the same magnitude. Over a longer period of time, the fluctuations probably average out to provide profit levels in the low end of the 2% to 9% range estimated for this industry as a whole.

1.4 Other Supply Characteristics

This segment of the gum and wood chemicals industry is highly regionalized. All seven plants are located within the state of Georgia, near the few remaining pine forests from which oleoresin is harvested.

In addition to raw oleoresin, a low cost labor pool is vital to the production of gum chemicals. The harvesting operation is both labor-intensive and highly seasonal. Oleoresin is typically harvested by nonskilled workers from mid-March through November. Traditionally, the employment has offered only minimum wages. Increases in the government's unemployment compensation program have decreased the number of willing workers available to harvest oleoresin.

The distillation plants, although less labor-intensive, also employ largely a nonskilled, low paid work force.

Historically, this segment of the industry has been declining since the early 1900's when production peaked at levels exceeding 2 million drums per year. By 1940, production had dropped by more than 50%. Today's production volume represents only 2% of that peak level.

The structure of the industry has also changed. In the early 1930's, the gum chemicals industry was comprised of 1300 backwoods stills. In 1934, the Olustee Naval Stores Laboratory began consolidating the industry to improve product quality and sales distribution, and to enable farmers owning pine forests to earn revenues without having to purchase distillation equipment. By 1948, this organization had succeeded in replacing all but 100 of the 1300 backwoods stills with 30 strategically located, large stills.

This decline in the number of separate producers has continued into the 1970's. In 1975 there were 10 gum processing plants in operation. Three years later, only seven plants remain in operation.

The major reason for the decline of this industry segment is the diminishing supply of both raw materials and labor. Over the years, there has been massive harvesting of pine trees in the Southeast by the pulp and paper industry, combined with little reforestation of trees suitable for the gum chemicals industry. The shortage of labor is intensified by the seasonal nature of the work and the low wages prevalent in the industry.

2. Demand Characteristics

2.1 Market Size and Share

Gum rosin's share of the total rosin market has decreased from 36% in 1953 to 4% in 1978, as shown in Table III-F-2. Over the same period, total U.S. rosin production remained relatively steady, declining somewhat in the 1970's. Production levels for all three types of rosin, along with apparent U.S. consumption, are listed in Table III-F-3.

TABLE III-F-2

GUM ROSIN'S SHARE OF THE TOTAL U.S. ROSIN MARKET

Year Ending March 31	Gum Rosin Production (MM lb)	Total U.S. Rosin Production (MM lb)	Gum Rosin Market Share (%)
1953	332	911	36
1954	277	926	30
1955	275	999	28
1956	236	1,013	23
1957	231	1,036	22
1958	208	970	21
1959	192	966	20
1960	174	996	17
1961	192	1,044	18
1962	247	1,067	23
1963	255	1,073	24
1964	237	1,083	22
1965	203	1,047	19
1966	187	1,075	17
1967	141	1,017	14
1968	115	971	12
1969	88	958	9
1970	62	906	7
1971	45	860	5
1972	48	849	6
1973	46	848	5
1974	38	823	5
1975	28	679	4
1976	37	565	7
1977	32	707	5
1978 (preliminary)	26	676	4

Source: Arthur D. Little, Inc., based on U.S. Department of Agriculture reports

TABLE III-F-3
U. S. ROSIN PRODUCTION AND APPARENT CONSUMPTION
(million pounds)

Year Ending March 31	Production: Gum	Wood	Tall Oil	Total	Exports	Imports	Apparent U.S. Consumption	Percent Change in Apparent Consumption From Previous Year
1953	332	563	16	911	186	-	656	-
1954	277	631	18	926	268	-	675	2.9
1955	275	698	26	999	347	-	667	- 1.2
1956	236	712	65	1,013	287	-	763	14.4
1957	231	688	117	1,036	314	-	745	- 2.4
1958	208	622	140	970	283	-	698	- 6.3
1959	192	615	159	966	265	-	716	2.6
1960	174	623	199	996	407	-	797	11.3
1961	192	634	218	1,044	327	-	684	-14.2
1962	247	575	245	1,067	282	2	709	3.7
1963	255	569	249	1,073	270	5	689	- 2.8
1964	237	571	275	1,083	252	NA	700	1.6
1965	203	539	305	1,047	252	2	725	3.6
1966	187	562	326	1,075	281	1	716	- 1.2
1967	141	513	363	1,017	343	1	723	1.0
1968	115	502	354	971	367	1	700	- 3.2
1969	88	499	371	958	335	1	744	6.3
1970	62	432	412	906	336	1	716	- 3.8
1971	45	399	416	860	296	-	664	- 7.3
1972	48	382	419	849	237	3	654	- 1.5
1973	46	365	437	848	248[a]	12	629[a]	- 3.8
1974	38	342	443	823	220	55	668	6.2
1975	28	284	367	679	139	84	534	-20.1
1976	37	186	342	565	90	11	512	- 4.1
1977	32	265	410	707	108	13	600	17.2
1978 (preliminary)	26	246	404	676	106	16	561	- 6.5

[a]Unrevised

Source: Naval Stores Annual Summary, U.S. Department of Agriculture, Crop Reporting Board

The gum turpentine industry has also declined over the past 20 years. Production levels for all types of turpentine were discussed in Section 1.2.2; gum turpentine's market share is provided in Table III-F-4. During the 1970's, the market share for gum turpentine has remained relatively constant at roughly 4%.

2.2 Major End Uses

Rosin, as it is obtained from the exudate of living pine trees (and from aged pine stumps and tall oil, discussed in earlier sections), is called unmodified rosin. In this form, rosin has three properties which make it unsuitable for many applications: it crystallizes in the presence of some solvents, it is oxidized by atmospheric oxygen, and it reacts with heavy metal salts. Chemical treatment increases the stability and improves the physical properties of rosin through modification of the phenanthrene-derived moiety. The products are known as modified resins.

Today, more rosin is used in modified than in unmodified forms. Current uses for unmodified rosin as such are few and include the manufacture of paste solder flux, soldering compounds, and cable oils for high-tension electrical lines. These markets for unmodified rosin consume an insignificant volume of the U.S. production.

Modified rosin products are used in the manufacture of paper size, synthetic resins, and rubber chemicals. Table III-F-5 demonstrates that currently over 60% of the rosin consumed in the United States is purchased by intermediate industries for incorporation into chemicals and synthetic resins. An estimated breakdown of the use of rosin within various end product categories is included in Table III-F-6.

TABLE III-F-4

GUM TURPENTINE'S SHARE OF THE TOTAL U.S. TURPENTINE MARKET

Year Ending March 31	Gum Turpentine Production (000 gals)	Total U.S. Turpentine Production (000 gals)	Gum Turpentine's Market Share (%)
1954	8,900	26,900	33
1955	8,800	30,900	28
1956	7,450	32,750	23
1957	7,200	32,250	22
1958	6,450	31,350	21
1959	6,000	30,400	20
1960	5,370	31,840	17
1961	5,970	30,270	20
1962	7,641	31,856	24
1963	7,605	32,653	23
1964	7,026	33,677	21
1965	5,979	33,955	18
1966	5,569	35,033	16
1967	4,211	33,275	13
1968	3,387	31,397	11
1969	2,521	32,609	8
1970	1,750	30,869	6
1971	1,292	28.790	4
1972	1,418	28,433	5
1973	1,328	28,303	5
1974	1,071	26,532	4
1975	781	24,352	3
1976	1,035	22,380	5
1977	871	24,112	4
1978 (preliminary)	727	23,878	3

Source: Arthur D. Little, Inc., based on U.S. Department of Agriculture reports

TABLE III-F-5

ROSIN CONSUMPTION
(millions of pounds)

Crop Year Beginning April 1	Reported Industrial Consumption							Apparent[(a)] Consumption
	Chemicals	Elastomers	Ester Gum and Synthetic Resins	Paint, Varnish, and Lacquer	Paper and Paper Size	Other	Total	
1940	48	3	53	66	136	143	449	547
1941	104	3	112	91	185	186	682	772
1942	108	3	77	68	153	179	587	620
1943	95	6	76	66	199	241	683	781
1944	138	12	130	69	197	256	802	794
1945	142	11	130	53	142	156	634	659
1946	179	14	140	59	178	136	706	713
1947	182	9	134	59	180	128	693	699
1948	180	8	111	58	185	105	646	642
1949	172	5	104	48	190	88	607	619
1950	209	8	166	53	238	107	782	798
1951	193	13	127	42	230	83	687	684
1952	165	18	136	41	207	72	639	640
1953	188	21	136	39	208	59	651	656
1954	190	19	129	35	228	52	653	641
1955	232	22	124	34	250	55	718	703
1956	237	29	117	28	218	39	669	636
1957	230	32	113	31	264	34	703	682
1958	240	35	114	29	282	30	729	716
1959	293	39	125	30	295	36	818	793

TABLE III-F-5 (Continued)

ROSIN CONSUMPTION
(millions of pounds)

Crop Year Beginning April 1	Chemicals	Elastomers	Ester Gum and Synthetic Resins	Paint, Varnish and Lacquer	Paper and Paper Size	Other	Total	Apparent Consumption[a]
1960	284	40	106	24	250	29	733	687
1961	270	46	115	22	264	33	750	708
1962	277	49	112	21	256	27	741	689
1963	284	50	120	20	270	27	771	699
1964	272	48	121	17	287	29	775	725
1965	346		126	25	268	34	798	715
1966	369		134	22	275	29	830	723
1967	338		123	22	268	26	776	700
1968	374		127	30	269	32	832	743
1969	365		120	28	260	28	801	715
1970	324		114	30	270	22	760	663
1971	300		112	37	268	26	743	654
1972	294		127	27	244	26	718	646
1973	290		138	26	180	27	661	668
1974	251		108	15	160	41	574	533
1975	197		110	9	161	26	503	512
1976	231		147	12	193	42	625	600
1977	196		126	12	186	36	555	561

(a) Discrepancies between apparent consumption and reported industrial consumption are due primarily to industrial consumption that was either not reported or reported incorrectly.

Source: U.S. Department of Agriculture publications.

TABLE III-F-6

U.S. ROSIN CONSUMPTION BY END PRODUCT

End Product	Percent of Total Rosin Consumption
Paper and Paper Size	35
Synthetic Rubber	15
Adhesives	14
Coatings	12
Inks	9
Others, including chewing gum and rosin oils	15
	100%

Source: Arthur D. Little, Inc., estimates

Gum rosin is usually consumed only in the higher quality, relatively price-insensitive segments of these rosin markets. However, gum rosin's higher quality is not derived from superior product performance within one color grade, but comes instead from a larger percentage of the total production output qualifying for top color grades (and therefore for quality-sensitive applications). Gum rosin does have one performance advantage over tall oil rosin: it has been approved by the Food and Drug Administration for use in chewing gum and other food-related applications, and tall oil rosin, which may contain trace amounts of sulfur, has not.

Major turpentine end markets and uses were discussed in Section 1.2. Gum turpentine has no real performance advantage over wood and sulfate products, but does comprise a slightly larger relative share of the retail turpentine market.

2.3 Substitute Products

The closest substitutes for gum rosin and turpentine are wood and sulfate/tall oil products. Although gum chemicals may now have a slight advantage because they don't contain any sulfur, this edge is being eroded by improved sulfate/tall oil processes. In the future, gum chemicals will probably face increased competition from other naval store products.

Other substitutes for turpentine were discussed in Section 1.2.2 Petrochemical products compete heavily with rosin, and in fact, now dominate many markets once supplied by resins based on rosin. Two areas are notable exceptions--paper sizing, and emulsion aids and tackifiers for rubber. The paper sizing market continues to be supplied by rosin derivatives that offer desired product characteristics at acceptable costs. Presumably this market is relatively price-insensitive, offering no immediate advantage to petrochemical products.

The other market--emulsion aids and tackifiers--is currently highly competitive. Producers of petrochemical resins made significant inroads into the market in recent years when they were able to offer prices nearly half those of the rosin-based resins. However, over the past several years, rosin prices have been dropping while petrochemical prices have increased. As a result, the so-called "natural resins" are regaining market shares in applications such as pressure-sensitive and hot melt adhesives. Producers of rosin tackifiers are also fighting for market share by upgrading their materials into specialty additives.

2.4 Foreign Competition

Foreign competitors play a dominant role in the markets for gum chemicals. Gum products represent an estimated 75% of all rosin and turpentine produced outside of the United States. In the case of rosin, foreign production of gum rosin comprises over 45% of the total world production of all three types of rosin combined.

Mainland China is the world's major producer of gum chemicals, although exact production figures are unknown. The U.S.S.R., Europe, and Mexico are also important producers, as shown in Table III-F-7. Production by European country is broken out in Table III-F-8, which reveals Portugal as the major European source of gum chemicals.

Specific data is not available on the size of gum chemical imports into the United States. However, in 1977 U.S. Import Data lists imports of miscellaneous wood products valued at $2.4 million, most of which

TABLE III-F-7

ESTIMATED WORLD PRODUCTION OF GUM ROSIN
(tons)

	1972-73 Crop Year	1977-78 Crop Year
United States	23,012	13,000
Mainland China	198-220,000	200,000
Europe	161,538	N.A.
Mexico	55,125	57,000
U.S.S.R.	105,000	N.A.

Source: Arthur D. Little, Inc.; "Pulp & Paper," January 1975; and "Chemical Week," October, 1976.

TABLE III-F-8

PRODUCTION OF GUM CHEMICALS
IN EUROPEAN COUNTRIES

Gum Rosin Production (in tons of 2000 lb)

Crop Year	France	Greece	Portugal	Spain
1972-73	12,870	14,300	103,568	30,800
1973-74	12,100	13,200	120,018	32,340
1974-75	9,900	14,300	115,500	33,000
1975-76	9,900	11,000-13,200	121,000	33,000
1977-78	NA	NA	92,000	NA
1978-79 (forecast)	NA	NA	56,000	NA

Gum Turpentine Production (in gallons)

Crop Year	France	Greece	Portugal	Spain
1972-73	3,300	3,520	25,000	8,800
1973-74	3,080	3,300	28,625	9,240
1974-75	2,530	3,520	26,400	9,460
1975-76	2,530	2,750-3,300	28,600	9,460
1977-78	NA	NA	22,000	NA
1978-79 (forecast)	NA	NA	12,000	NA

Source: Arthur D. Little, Inc., and "Pulp and Paper," January, 1975.

was probably gum rosin. Almost 60% of this total figure was imported from Mainland China, as shown in Table III-F-9. The United States also imported $0.3 million worth of turpentine, largely from Mexico. Gum turpentine imports probably comprised over half of this total.

The United States exported 6,715 thousand pounds of gum rosin and 56 thousand gallons of gum turpentine in 1977, as shown in Table III-F-10. Japan, the major market for U.S. exports of gum rosin, has recently begun importing increased amounts of these products from Mainland China. Over 80% of Japan's total rosin imports in 1976 were Chinese gum rosin, and this percent is expected to rise as China becomes increasingly competitive in world markets.

2.5 Prices

Current prices for gum rosin and gum turpentine are provided in Table III-F-11. The prices for both products are typically higher than those of the comparable wood or sulfate/tall oil products. For example, gum turpentine was priced 87 cents higher, or over one and one half times more than crude sulfate turpentine in early 1978. During the same period, a top grade of gum rosin was priced 17 cents higher, or over two and one-half times above a good tall oil rosin.

2.6 Growth Forecasts

The shortage of pine forests, and thus of raw materials in the gum chemical industry, is expected to grow more severe in the future. Production has been declining at an average rate of 13% per year over the past decade, and this downward trend will probably continue.

Rising labor costs, a general shortage of willing workers, and increased competition from foreign gum producers, are expected to contribute to the segment's decline.

TABLE III-F-9

U. S. IMPORTS OF WOOD PRODUCTS BY COUNTRY

Product	Country	Value of Imports in 1977 ($000)
Turpentine	Mexico	322
	Other countries	20
Wood Products, NEC*	China (People's Republic)	1,358
	Portugal	382
	Mexico	344
	Nicaragua	270
	Other countries	71

* Not Elsewhere Classified

Source: U.S. General Import Data

TABLE III-F-10

U.S. EXPORTS OF GUM PRODUCTS BY COUNTRY

Product	Country	Amount Exported in 1977
Gum Rosin	Japan	1,609 (000 lb)
	Canada	1,008 "
	Germany	871 "
	Netherlands	715 "
	France	520 "
	United Kingdom	463 "
	Australia	354 "
	Italy	315 "
	Other countries	860 "
Gum Turpentine	Other countries	55,820 (gals)

Source: U.S. export data

TABLE III-F-11

GUM ROSIN AND GUM TURPENTINE PRICES

Year Ending March 31	Gum Rosin Prices ($/100 lb)	Gum Turpentine Prices ($/gal)
1954	7.72	.516
1955	7.91	.519
1956	8.45	.556
1957	8.37	.555
1958	7.90	.543
1959	8.33	.513
1960	9.59	.534
1961	14.52	.479
1962	11.95	.247
1963	11.05	.201
1964	11.00	.339
1965	11.02	.450
1966	10.36	.555
1967	10.30	.562
1968	10.36	.574
1969	10.45	.770
1970	11.80	1.138
1971	15.03	1.200
1972	16.93	1.200
1973	18.89	1.046
1974	22.72	.806
1975	35.92	1.389
1976	25.15	1.585
1977	24.46	1.427
1978 (preliminary)	25.35	1.425

Source: U.S. Department of Agriculture

IV. Wastewater Effluent Control Costs

A. Discharge and Wastewater Treatment Status

Current treatment practices in the Gum and Wood Chemicals Industry include oil/water separation by all plants. Biological treatment facilities are in place for 7 of the 8 direct dischargers. Activated carbon columns as a secondary treatment system in place of biological treatment exist in one of these plants. The 12 indirect discharges have only oil/water separation and equalization in place. One indirect discharger currently utilizes extensive pretreatment facilities.

B. Alternative Treatment Technologies Considered

The control and treatment technologies used in arriving at the previously promulgated BPT effluent limitations for tall oil rosin, fatty acids, and pitch, wood rosin, turpentine, and pine oil; and rosin-based derivatives were: (1) in-plant control--reduction of wastewater generated by process water reduction and recycle, waste stream segregation, and oil/water separation; (2) equalization; (3) dissolved air flotation for wood rosin and tall oil subcategories only; (4) biological treatment by activated sludge; and (5) flocculation and clarification. This same treatment system, deleting dissolved air flotation, was used in arriving at BPT treatment levels for the sulfate turpentine subcategory in the current proposal. Additional control and treatment technologies available for this industry include: (6) Advanced Treatment I-metals precipitation (in plant removal and end-of-pipe removal), and (7) Advanced Treatment II--greater activated carbon columns.

In-plant control, preliminary treatment, and primary treatment technologies have been demonstrated within the Gum and Wood Chemicals Industry. Activated sludge biological treatment also has been demonstrated in the industry. Metals precipitation is currently in use at our sulfate turpentine facilities. One plant has isolated a wastewater source and is treating only that stream. Granular activated carbon columns are in use at one plant in lieu of biological treatment. Performance factors for use of activated carbon columns as a tertiary polishing treatment for organic toxic pollutants remaining after biological treatment of gum and wood chemicals wastewater are not available.

C. Wastewater Treatment Costs

The control cost data was developed by EPA's Technical Contractor and forwarded to us for use in this analysis. A plant by plant waste effluent control cost estimate was prepared in place of the model plant approach. For each control technology option a list of processing steps and equipment was developed which would be particularly suited to the specific flow volume and waste characteristics at each plant in the industry which cannot already discharge water of suitable quality specified under each option. The capital investment costs and operating costs were estimated based on the 1977 equipment costs and 1977 labor, power, fuel and other rates.

TABLE IV-1

EFFLUENT CONTROL COSTS ESTIMATES
Best Available Technology
(Direct Dischargers)

Plant No.	Option 2 In-Plant Metals Removal		Option 3 End-of-Pipe Metals Removal		Option 4 Tech. 2 + Activated Carbon	
	Capital ($000)	Operating ($000)	Capital ($000)	Operating ($000)	Capital ($000)	Operating ($000)
948	55.1	81.7	51.8	152.2	1,949.8	479.8
693	----	----	----	----	1,651.5	918.9
800	----	----	----	----	1,990.4	398.0
606	----	----	----	----	1,924.2	371.1
416	----	----	----	----	1,263.0	271.3
121	84.8	158.3	223.0	618.8	3,974.1	1,329.1
698	85.7	219.5	286.3	1,035.9	-------	-------
333	----	-----	-----	-------	2,916.1	809.5
Total-Direct Discharges	225.6	459.5	561.1	1,806.9	15,669.1	4,523.7

for the 8 direct discharge plants in this industry. Only 3 plants would be required to make investments under Options 2 and 3. The remaining 5 plants either do not have metals in their waste streams or have treatment technologies in place to reduce the metals concentration. All plants will have to make investments under Option 4 which for all but one plant are in excess of $1.0 million.

Table IV-2 summarizes the capital and operating cost estimates for the 12 indirect discharge plants in this industry. Only 4 plants would be required to make investments under Option 2 and 5 would be affected under Option 3. The remaining plants either have metals removal facilities in place or do not have metals in the plant wastewater stream to be removed.

Table IV-3 summarizes the capital and operating costs for four types of new source direct discharge plants. These plants are chosen as the types most likely to be constructed in the future considering 1) the growth potential of each category; 2) the raw material upgrading which does and will continue to take place; and 3) the present structure of the industry. Table IV-4 summarizes the capital and operating costs for three new source indirect discharge plants. These plants are the same type as for direct discharges except for a plant in Subcategory C which will not require any technologies considered. The technology in Option 1 is provided by the municipal treatment facilities or off-site biological treatment facilities into which it discharges, there

TABLE IV-2

EFFLUENT CONTROL COST ESTIMATES
PRE-TREATMENT STANDARDS EXISTING SOURCES
(Indirect Dischargers)

	Option 2 In-Plant Metals Removal		Option 3 End-of-Pipe Metals Removal	
Plant No.	Capital ($000)	Operating ($000)	Capital ($000)	Operating ($000)
111	---	---	---	---
168	---	---	---	---
532	---	---	---	---
355	---	---	---	---
346	---	---	---	---
641	---	---	---	---
607	---	---	---	---
151	103.1	143.2	145.7	366.1
686	37.7	32.6	58.2	125.2
087	98.3	246.8	98.3	246.8
266	---	---	46.7	99.1
090	19.3	34.3	19.3	34.3
Total Indirect Dischargers	258.4	456.9	368.2	871.5

TABLE IV-3

ESTIMATED CONTROL COSTS
New Sources - Direct Dischargers

Subcategories	Option 1		Option 2		Option 3		Option 4	
	Capital ($000)	Operating ($000)	Capital ($000)	Operating ($000)	Capital ($000)	Operating ($000)	Capital ($000)	Operating ($000)
C	1,712.0	388.0	Not Applicable		Not Applicable		2,921.0	495.9
C,D	1,486.0	296.8	84.9	115.0	141.1	343.3	2,749.1	410.4
A	1,945.0	400.0	86.2	115.0	125.2	288.0	2,590.4	335.2
A,C,D	1,630.4	410.0	135.3	171.5	104.7	233.9	2,884.0	416.7

TABLE IV-4

ESTIMATED CONTROL COSTS
New Sources - Indirect Dischargers

Subcategories	Option 1		Option 2	
	Capital ($000)	Operating ($000)	Capital ($000)	Operating ($000)
C,D	86.2	115.0	145.6	346.0
A	86.2	115.0	146.9	301.7
A,C,D	135.3	171.6	104.7	233.9

are no metals to treat in a tall oil fractionation plant, and activated-carbon treatment facilities are not considered for indirect dischargers. Therefore, there are no additional wastewater treatment costs for a new indirect discharge plant in ubcategory C.

V. Economic Impacts of Proposed Regulations

A. BPT Effluent Regulations

All but one subcategory-sulfate turpentine-in this industry has existing proposed limitations on effluent discharge promulgated Interim Final in 1976. The options considered for current BPT regulations were:

Option 1: Not to Regulate

Option 2: Remain with existing BPT Regulations

Option 3: Regulate based on performance of the treatment systems in the previously regulated subcategories

It is clear that Options 1 and 2 would require no additional capital investment and no increased operating costs and therefore would have no economic impacts associated with them. Option 3 implies that previously unregulated sulfate turpentine producers would have to install the appropriate BPT treatment facilities or hook into a municipal treatment system. Of the 7 plants in this subcategory, only two plants are currently direct dischargers and one of these plants already has access to a BPT treatment facility. The capital investment required for the remaining plant to install appropriate facilities has been estimated to be approximately $100,000 and annual operating costs have been estimated to be approximately $160,000.

Based on these estimates and an estimate of the plant profitability before taxes in 1978, we estimate a low economic impact since the annualized costs are less than 20% of pre-tax profitability and less than 5% of sales. It is likely that this one producer is neither able to significantly raise prices for its products relative to other suppliers nor develop and sell high value-in-use (upgraded) products over the short term to reinstate its present profitability. The capital investment required is relatively small and should present no severe problems other than limiting the financial resources for product upgrading. Therefore, we expect this producer to continue in business at a somewhat lower level of profitability than experienced historically. Since the growth and profit potential for the sulfate turpentine and derivatives subcategory has been well above average for the industry, we do not expect plant closure, community effects, or balance-of-trade impacts to result from this regulation.

B. Best Available Technology Effluent Regulations

Four technological options were considered for BAT effluent limitations:

- Option 1: Not to Regulate
- Option 2: Require at-the-source metals removal
- Option 3: Require end-of-pipe metals removal
- Option 4: Require at-the-source metals removal and activated carbon absorption

1. Economic Impact - Option 1

The costs and economic impacts for Option 1 are obviously zero for the producers in this industry.

2. Economic Impact - Option 2

Of the 8 plants which are currently direct dischargers in this industry, only 3 would be affected by the proposed limitations under Option 2. The estimated total industry capital investment required under this option is approximately $225,600 and total annual operating costs are approximately $459,500. There is a relatively narrow range in capital investment required for the three producers ($55,100 to $85,700) and a slightly wider range in annual operating costs ($81,700 to $219,500).

Table V-1 summarizes our expected economic impacts for the 8 direct dischargers in this industry. All producers will have either a low or no economic impact under this option, and no single producer will be significantly hampered by a high differential impact versus its competitors.

3. Economic Impact - Option 3

Of the 8 plants which are currently direct dischargers in this industry, only 3 would be affected by the proposed limitations under Option 3. These plants are the same plants affected by Option 2 limitations and as a general rule would experience costs roughly three times that estimated for Option 2. The estimated total industry capital investment required under this option is approximately $561,100 and the total annual operating costs are approximately $1,806,900. In contrast to Option 2, the range in capital investment required ($51,800 to $286,300) and annual operating costs ($152,200 to $1,035,900) is considerable.

Table V-1 summarizes our expected economic impacts for the 8 direct dischargers in this industry. One producer will likely experience a high economic impact as the result of Option 3.

TABLE V-1

ECONOMIC IMPACT SUMMARY
GUM AND WOOD CHEMICALS

PLANT	TYPE OF DISCHARGE	BUSINESS SUBCATEGORIES	OPTION 2	OPTION 3	OPTION 4
121	Direct	A, D	Low	High	High
333	Direct	C	None	None	High
606	Direct	B	None	None	High
800	Direct	A, C, D	None	None	Moderate/Low
948	Direct	C, D	Low	Low	Moderate/High
698	Direct	B, D	Low	Low	Low
416	Direct	C	None	None	Moderate
693	Direct	C	None	None	High

Key:
None = No cost to meet effluent limitations
Low = Cost <20% of before-tax profits and <5% of sales
Moderate = Cost >20% but <50% of before-tax profits and <5% of sales
High = Cost >50% of before-tax profits and >5% of sales

Note: Option 1 results in no impact for any direct discharger.

It would probably close down or sell out to another established producer in the industry. Since this plant is small, it is probable that few industry participants would be interested in purchasing it but rather would obtain its customer relationships and supply products from another location. The net result of either course of action would be a net loss of up to 150 jobs and a significant community impact. There are few other similar employment opportunities in or near this plant and absorption of the employees at this plant by the industrial community at large is expected to be a lengthy process. We do not expect plant closure for the plant experiencing a moderate economic impact. We also do not anticipate any balance-of-trade effects caused by Option 3 limitations.

4. Economic Impact - Option 4

All 8 plants which are currently direct dischargers in this industry would be affected by the proposed limitations under Option 4. The estimated total industry capital investment required is approximately \$15,699,100 and the total annual operating costs are approximately \$4,523,700. There is a broad range of both capital investments (\$1,263,000 to \$3,974,100) and operating costs (\$217,300 to \$1,329,100).

Table V-1 summarizes our expected economic impacts for the 8 direct dischargers. We expect that 4 of the direct dischargers will experience a high economic impact; in 2 cases the impact would be extremely high (more than 100% of estimated pre-tax profits and more than 15% of sales). Three of the 8 plants will experience a moderate impact and one will experience a low impact. We estimate that the economic impact for two of the 8 plants would lead to plant closure since the annualized operating costs are more than 145% of estimated before-tax operating costs. At one of these two plants, production might be shifted to an alternate location also operated by the owning corporation if adequate raw material feedstocks are available. The two remaining plants might also be closed but production would likely be shifted to a nearby plant if space and/or production capacity permitted, resulting in little, if any, impact on employment for the two plants most likely to close. We estimate a loss of between 350 to 400 jobs. A significant community impact would be experienced in both locations since there is little additional employment of this type in either area.

C. New Source Performance Standards

Four technological options were considered for new source performance standards:

Option 1: Require BPT Control Technology

Option 2: Require BPT plus at-the-source metals removal

Option 3: Require BPT plus end-of-pipe metals removal

Option 4: Require BPT plus at-the-source metals removal and activated carbon absorption

In assessing the economic impacts resulting from each of these technologies we have resorted to general approximations since: 1) it is not clear what size new source plant is considered the minimum economic size plant, 2) new plants will likely contain production facilities relating to more than one industry subcategory (except for tall oil or sulfate turpentine fractionation) and 3) a precise estimate of the capital investment required for a new plant is not available. It is noteworthy that only one new plant project has been announced for the forseeable future and that plant is a modest size tall oil fractionation unit.

In our analysis of the economic impact for new source performance standards, we have considered four types of plants: 1) tall oil fractionation only, 2) tall oil fractionation plus rosin derivative production, 3) sulfate turpentine fractionation and 4) tall oil fractionation, rosin derivative production, and sulfate turpentine fractionation. The model plants on which the control costs were based were chosen to be somewhat larger than the average size existing plant of each type. For each of the options 1-3, the capital costs were estimated to be less than 10% of the plant investment and the annualized operating costs were judged to be less than 20% of the new plant projected pre-tax margin. Neither of these conditions are sufficient to preclude future investment in production capacity for these industries as needed, but would likely result in delayed expansions until the prices for products were pushed up sufficiently high due to supply shortages. For Option 4, the capital costs were estimated to be nearly 20% of the plant investment and the annualized operating costs nearly 50% of the new plant projected pre-tax margin. Either of these conditions are likely to significantly retard investment in this industry, and it is likely that both together would all but prevent future capital investment in this industry.

D. Pretreatment Standards for Existing Sources

Three technological options were considered for PSES effluent limitations:

Option 1: Not to Regulate

Option 2: Require at-the-source metals removal

Option 3: Require end-of-pipe metals removal

1. Economic Impact - Option 1

The costs and economic impacts for Option 1 are obviously zero for the producers in this industry.

2. Economic Impact - Option 2

Of the 12 plants which are currently indirect dischargers in this industry, only four producers would be affected by the proposed limitations under Option 2. The estimated total industry capital investment required under this option is approximately $258,400 and the total annual operating costs are approximately $456,900. There is a moderate range in capital investment required by each of the four producers ($19,300 to $103,100) and in the annual operating costs ($34,300 to $246,800).

Table V -2 summarizes our expected economic impacts for the 12 indirect dischargers in this industry. There are no disproportionately high impacts for a producer in this subcategory and each of the four producers which will be affected by Option 2 effluent limitations will experience only a low economic impact. The range of estimated impacts is quite narrow (1.5% - 6.6% of profits) and no community or international trade effects are expected to result from Option 2 regulations.

3. Economic Impact - Option 3

Of the 12 plants which are currently indirect dischargers in this industry, 5 would be affected by Option 3. These plants are the same plants affected by Option 3 plus one plant which cannot meet the end-of-pipe standards but adequately controls the in-plant emission of certain heavy metals included in the control standards. For three of

TABLE V-2

ECONOMIC IMPACT SUMMARY
GUM AND WOOD CHEMICALS

PLANT	TYPE OF DISCHARGE	BUSINESS SUBCATEGORIES	OPTION 2	OPTION 3	OPTION 4
686	Indirect	C, D	Low	Moderate	--
168	Indirect	A, C, D	None	None	--
087	Indirect	A	Low	Low	--
532	Indirect	C	None	None	--
266	Indirect	A	None	Low	--
090	Indirect	E	Low	Low	--
151	Indirect	A, B, D	Low	Low	--
607	Indirect	A, B, D	None	None	--
641	Indirect	C	None	None	--
111	Indirect	C, D	None	None	--
355	Indirect	C	None	None	--
346	Indirect	C	None	None	--

Key: None = No cost to meet effluent limitations
Low = Cost <20% of before-tax profits and <5% of sales
Moderate = Cost >20% but <50% of before-tax profits and <5% of sales
High = Cost >50% of before-tax profits and >5% of sales

Note: Option 1 results in no impact for any indirect discharger.

of the four plants also affected by Option 2, the costs for Option 2 are roughly the same as for Option 3. For the fourth plant the costs are roughly three times that of Option 2.

The estimated total industry capital investment required under this option is approximately $368,200 and the total operating costs are approximately $871,600. As under Option 2, the range is capital investment required by each producer ($19,300 to $145,700 and annual operating costs ($34,300 to $366,100) is moderate.

Table V-2 summarizes our expected economic impacts for the 12 indirect dischargers in this industry. All producers affected will experience a low economic impact as annualized costs are estimated to be less than 20% of profits and 5% of sales for each plant. The range of economic impacts expected is quite low (2.7% to 10.7%) and no community or balance of trade impacts are expected.

E. Pretreatment Standards for New Sources

Two technological options were considered for new source pretreatment standards:

Option 1: Do not regulate

Option 2: Metals removal at-the-source

In assessing the economic impacts resulting from each of these technologies, we have resorted to general approximations since: 1) it is not clear what size new indirect discharge plant is considered the minimum economic size plant, 2) new plants will likely contain production facilities relating to more than one industry subcategory and 3) a precise estimate of the capital investment required for a new plant is not available.

In our analysis of the economic impact of pretreatment standards for new sources, we have considered three types of plants: 1) tall oil fractionation plus rosin derivative production, 2) sulfate turpentine fractionation and 3) tall oil fractionation, rosin derivative production, and sulfate turpentine fractionation. The model plants, on which the control costs are based, are somewhat larger than the average existing plant of each type. For each of the two options, the capital costs were estimated to be less than 1% of the plant investment and the annualized operating costs were estimated to be substantially less than 20% of the new plant projected pre-tax margin. Neither of these impacts are sufficient to preclude future investment in production capacity for these industries as needed, but would likely result in delayed expansions until the prices for products were pushed sufficiently high by supply shortages.

F. Summary by Industry Subcategory

A secondary assessment of the economic impact on this industry is based on a segment analysis. Competition occurs within a business segment and is independent of type of discharge. A complete analysis therefore has to consider the possibility of a plant producing a particular gum and wood chemical being impacted in a disproportionately high manner because the effluent from its product mix is more costly to treat than that of its competitors.

1. Sulfate Turpentine and Fractionation Products

Table V-3 shows the expected economic impacts resulting from each of the technological options applicable to the 7 plants active in this segment. Option 2 will impact all plants affected to about the same

TABLE V-3

SUBCATEGORY A:

SULFATE TURPENTINE & FRACTIONATION PRODUCTS

Plant	Economic Impact on Profitability: Option 2	Option 3	Option 4
Direct Dischargers			
121	Low	High	High
800	None	None	Low
Indirect Dischargers			
168	None	None	--
087	Low	Low	--
266	None	Low	--
151	Low	Low	--
607	Low	Low	--

Key: None = No cost to meet effluent limitations
Low = Cost <20% of before-tax profits and <5% of sales
Moderate = Cost >20% but <50% of before-tax profits and <5% of sales
High = Cost >50% of before-tax profits and >5% of sales

Note: Option 1 results in no impact for any producer.

degree and no large differential impacts are expected. Options 3 and 4 will clearly impact plant A much more dramatically than any of the other participants suggesting it as a plant closure candidate under these options. That plant A alone will experience a high impact and all others a low or no impact suggests that price relief from this impact will be very unlikely.

2. Wood Rosin and Turpentine

Table V-4 shows the expected economic impact resulting from each of the technological options applicable to the four plants active in this segment. Options 2 and 3 will impact all plants affected to the same degree and no significant defferential impacts are expected. Option 4 will impact plant A much more than plant B and also much more than Options 2 and 3 for plants C and D. Therefore, Option 4 might result in plant closure and transferral of production to another location if possible.

3. Tall Oil Fractionation

Table V-5 shows the expected economic impact resulting from each of the technological options applicable to the 12 plants active in this segment. Option 2 will impact all plants affected to about the same degree and no significant differential impacts are expected. Option 3 will impact one plant somewhat more harshly than others and may cause some product withdrawal or even withdrawal from the market altogether. Option 4 will cause severe differential impacts and would likely alter the competitive positioning of the large participants already well established in this segment. In addition to giving

TABLE V-4

SUBCATEGORY B.

WOOD ROSIN & TURPENTINE

Plant	Economic Impact on Profitability Option 2	Option 3	Option 4
Direct Dischargers			
606	None	None	High
698	Low	Low	Low
Indirect Dischargers			
151	Low	Low	--
607	None	None	--

Key: None = No cost to meet effluent limitations
Low = Cost <20% of before-tax profits and <5% of sales
Moderate = Cost >20% but <50% of before-tax profits and <5% of sales
High = Cost >50% of before-tax profits and >5% of sales

Note: Option 1 results in no impact for any producer.

TABLE V-5

SUBCATEGORY C.

TALL OIL FRACTIONATION PRODUCTS

PLANT	Economic Impact on Profitability		
	Option 2	Option 3	Option 4
Direct Dischargers			
333	None	None	High
800	None	None	Moderate
693	None	None	High
416	None	None	Low
948	Low	Low	Moderate
Indirect Dischargers			
168	None	None	---
111	None	None	---
532	None	None	---
355	None	None	---
686	Low	Moderate/Low	---
346	None	None	
641	None	None	

Key: None = No cost to meet effluent limitations
Low = Cost <20% of before-tax profits and <5% of sales
Moderate = Cost >20% but <50% of before-tax profits and <5% of sales
High = Cost >50% of before-tax profits and >5% of sales

Note: Option 1 results is no impact for any producer.

a strong cost advantage to indirect dischargers, it would likely cancel any expected cash flow for at least two of the plants. Under those circumstances we project plant closure as discussed under Option 4 technology for direct dischargers (p. 113).

4. Rosin Derivatives

Table V-6 shows the expected economic impact resulting from each of the technological options applicable to the 13 plants active in this segment. Option 2 will impact all plants affected to about the same extent and no significant differential impacts are expected. Option 3 will impact two plants much more than the other 7 and will likely reduce the profitability of these plants as they continue in operation. These two plants likely account for only 15-18% of industry capacity, and therefore, even acting together, cannot be expected to influence industry segment prices enough to get much price relief. Option 4 will result in significant differential impacts and will likely drive one producer out of the segment. The remaining producers have more than sufficient capacity to compensate for this loss of productive capacity.

5. Overall Summary

Option 2 appears to offer the best prospects of controlling the industry's dischargers but avoiding potentially damaging economic consequences in this industry. Option 3 appears to also offer relatively little possibility of adverse economic impacts (only two plants impacted) but the incremental improvement in effluent control is not demonstrated. Option 4 would severely impact certain segments of this industry-particularly tall oil fractionation products-and substantial differential impacts within each segment would be felt.

TABLE V-6

SUBCATEGORY D.

ROSIN DERIVATIVES

PLANT	Compliance Costs as % of Pretax Profitability		
	Option 2	Option 3	Option 4
Direct Dischargers			
121	Low	High	High
800	None	None	Low
948	Low	Low	Moderate
698	Low	Low	Low
Indirect Dischargers			
168	None	None	---
151	Low	Low	---
686	Low	Moderate/Low	---
111	None	None	---
607	None	None	---

Key: None =No cost to meet effluent limitations.
Low = Cost <20% of before-tax profits and <5% of sales
Moderate = Cost >20% but <50% of before-tax profits and <5% of sales
High = Cost >50% of before-tax profits and >5% of sales

VI. Major Assumptions and Limits of the Analysis

The basic assumption which underlies the quantitative assessment of the economic impact of proposed effluent control technologies in existing plants in the Gum and Wood Chemicals industry is that no cost pass through to mitigate the financial consequences of these control costs is considered. This assumption is valid for many types of gum and wood chemicals, although not necessarily valid for all types. Without a detailed study of the sensitivity of demand to higher prices and the intercompetitive relationship of these products with those not considered part of this industry, this assumption serves to define the worst case economic impact for this industry.

A second set of critical assumptions relates to the estimate of plant profitability. Three key assumptions were made which influence the accuracy of the estimated profitability:

1) Plant Sales Estimates: 1978 sales estimates were obtained from public sources for 13 of the 20 discharging plants in this industry. The The sales estimates for the remaining 7 were estimated based on production volume in each industry subcategory, average industry selling price, and employment. In most cases the average production volume times the average selling price gave an estimated sales volume significantly in excess of what we would expect compared to an existing plant of similar production volume size in the industry. To adjust these sales volumes downward, the plants were compared to existing plants with a similar product mix. Two factors were considered in adjusting the sales volume: 1) the ratio of reported sales volume to estimated production

value in the example plant, and 2) the ratio of reported sales to employment. It was assumed that the merchant sales and percentage of product upgrading in these two plants was roughly comparable even if different products were produced. To the extent this is not true the sales value is in error.

2) Sales By Industry Subcategory For Each Plant

The total sales for each plant was next apportioned to each industry subcategory known to exist in that plant on the ratio of production volume in each subcategory to total por luction volume adjusting for the selling price differences betwee subcategories. We have recognized that some double counting of production volume exists, and the validity of this step is contingent on a basic assumption that double counting is roughly the same in each subcategory. Since the double counting is likely related to product upgrading, this assumption is a fairly safe one except for Subcategory D - Rosin Derivatives, which draws raw materials from Subcategories B, C and E. To the extent that a plant is heavily engaged in both Subcategory D and one or more of B, C or E, our estimates would understate the plant profitability and overstate the impact. However, we do not believe that this assumption materially distorts this impact analysis.

The ratio of subcategory production volume to total production volume is insufficient to apportion total sales to each subcategory represented within each plant. The unit sales value for products in different subcategories is substantially different; therefore, we weighted the production volume more heavily for those subcategories which typically produce higher value products. The weighting factors used are estimated average selling prices for products in each subcategory. In specific cases where it is known that plants emphasize the higher unit value products within a subcategory, a higher average selling price was used.

The production volume for each subcategory was multiplied by the estimated average selling price. This product is expressed as a percentage of the sum of all such products for each plant. This percentage is also assumed to be the percentage of subcategory sales volume to total plant sales volume.

3) Plant Profitability

Current manufacturing cost estimates are based on data developed in an earlier study of the industry and are representative costs for specific manufacturing processes found in plants producing products in each subcategory. It was assumed that the processes costed in the earlier study are still representative of those used in the plants active now, and that the conversion cost variations between different products within a given subcategory are small. To the extent this is not true and differences between the product mix in a given subcategory in two separate plants are significant, the plant profitability estimate are in error. We do not believe the error to be significant.

This analysis does not represent a detailed study of the competitive economics of this industry. It is an analysis based on publically available information, a limited amount of economic data obtained from the industry, and considerable reasoned judgment concerning the basis of competition within segments and with products produced in other industries. We do believe that sufficient data has been developed or made available to allow a first order approximation of the economic impact of proposed regulations on the industry in total. However, the economic impacts for each plant are subject to considerable uncertainty. In spite of this uncertainty, the accuracy of each estimated impact is sufficient to justify the impact ranges chosen and it is not expected that refined data would result in more than a few changes in plant impact classifications. Therefore, the evaluation of the impact on the industry in total or on a subcategory within the industry is a fair use of the data contained in this report. The evaluation of the impact on a specific plant within a subcategory is not fair use of this data and is presented only to support, along with the data for other plants in the industry, our overall conclusions as to the economic impact on the industry.

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