Organic Liquid Distribution NESHAP: Industry Profile

Draft Report

Prepared for

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EPA Contract Number 68-D-99-024
RTI Project Number 7647-001-008

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CONTENTS

LIST OF FIGURES

LIST OF TABLES

SECTION 1

INTRODUCTION TO THE ORGANIC LIQUIDS DISTRIBUTION (OLD) SOURCE CATEGORY

Under Title III of the Clean Air Act Amendments of 1990, the U.S. Environmental Protection Agency's (EPA's) Office of Air Quality Planning and Standards (OAQPS) is developing a national emission standard for hazardous air pollutants (NESHAP) to limit air emissions from source categories covered under the proposed organic liquids distribution (OLD) NESHAP. The NESHAP, which is also a maximum achievable control technology (MACT) standard, is scheduled to be proposed in August 2000. The Innovative Strategies and Economics Group is responsible for developing an economic impact analysis (EIA) in support of evaluating impacts associated with the regulatory options considered for this NESHAP. Industries that will be affected by this NESHAP include chemical manufacturers, petroleum refiners, and pipeline owners and operators (organic liquids other than gasoline).

1.1 Brief Description of Source Category

The organic liquids distribution (OLD) source category consists of all of the source category operations that receive, store, and distribute organic liquids throughout the economy. For the purposes of this MACT standard, only those organic liquids with appreciable hazardous air pollutant (HAP) content (beyond trace quantities) are considered to be "organic liquids." These liquids may consist of pure HAP chemicals (single HAP) or chemical blends, refined petroleum products, natural gas liquids, or crude oil. They also may consist of "appreciable" organic HAPs blended with inorganic, non-HAP liquids (such as water).

OLD operations are carried out by a large number of industries. "Plant sites performing OLD activities include those that produce, consume, or merely store and distribute organic liquids. The four principal industries with the greatest volumes of OLD operations are chemical manufacturing, petroleum refining, crude oil and natural gas liquids pipeline transportation, and liquid terminalling and warehousing" (Abt, 1998).

Distributed organic liquids of concern in this profile fall under two broad categories:

- chemicals, including synthetic chemicals and petrochemicals (i.e., chemicals manufactured from crude petroleum); and
- petroleum liquids, including crude oil, natural gas liquids, and nongasoline refined products.

Gasoline, which is subject to the gasoline distribution NESHAP, is not covered by the OLD source category. Section 2 provides a more detailed description of the liquids covered by this regulation.

For the purposes of this regulation, *distribution* includes the bulk transfer of an organic liquid across a plant site boundary, either into or out of the plant site (Abt, 1998). Also covered under this definition are the storage of OLD liquids after receipt and before distribution, and waste and wastewater treatment and disposal practices associated with distribution and storage activities. Not included in the OLD source category are the following activities: the movement of packaged liquids (e.g., drummed or canned liquids); any production, compounding, blending, or packaging activities at OLD facilities; and the transportation of OLD liquids for activities other than loading and unloading.

The OLD activities described above take place at sites that serve as distribution points from which organic liquids can be obtained for further use and processing. Distribution activities are either collocated with liquid production operations, or they are carried out at stand-alone storage and distribution terminals. Although the MACT standards developed under this regulation will apply to any facility that receives, stores, and/or distributes nongasoline liquids with HAP content, this profile focuses on five categories of OLD facilities for which model plants were developed:

- chemical production,
- petroleum refineries,
- liquid terminals
- crude oil pipeline pumping/breakout stations, and
- petroleum terminals.

These categories were identified from EPA's April 1998 source category survey as accounting for the majority of OLD HAP emissions (Gale Business Resources, 1999).

1.2 Current Economic Conditions and Trends

OLD distribution points will incur the costs of this regulation; therefore, this profile examines the current condition of the OLD source category as it relates to distribution activities. This section briefly describes recent trends in each of the five principal, OLD facility categories.[1]

1.2.1 Chemical Production

Recent trends in the chemical manufacturing industry include increased capital spending and declining employment. In an effort to save money and increase efficiency, many of the activities associated with repackaging, blending, reformulating, bar-coding, testing, and quality assurance have been contracted out to third-party operators. This trend has been growing in the chemical manufacturing business. With more of this work being outsourced, manufacturers' costs are decreasing (*Distribution*, 1996).

1.2.2 Petroleum Refineries

Over the past two decades, oil companies have been closing refineries that are no longer profitable. To avoid expensive environmental cleanup costs, companies have started to convert the refineries' storage tanks and to operate them as storage and distribution centers. However, in recent years, a stable supply market for crude oil has led to a reduction in oil inventories, creating excess storage space at refineries. Refineries have responded to this situation by leasing out this excess space to third parties. With continued merger and cost-cutting activities in the source category, it is conceivable that more excess space will be created in the future and more refineries will continue to lease increasing amounts of storage space at their installations.

1.2.3 Liquid and Petroleum Terminals

The bulk liquid terminalling industry is undergoing changes as the major manufacturers of organic liquids and chemicals are restructuring their industries to meet present and future demands. Terminals face a dual challenge in the future. One challenge is increasing regulatory demands that are raising the cost of operation for refineries, chemical plants, and terminals. In addition, excess storage capacity at petroleum refineries and newly

[1]This discussion is largely based on the July 24, 1998, EPA memorandum entitled "Production Projections for the OLD Source Category."

created storage capacity at smaller chemical distributors have started to directly compete with the larger bulk terminals. Major consolidations within the chemical industry have also affected the bulk terminalling industry. Major chemical companies have begun outsourcing and consolidating their storage requirements at single-party terminals, rather than spreading their operations across many terminals.

1.2.4 Crude Oil Pipeline Pumping and Breakout Stations

The Federal Energy Regulatory Commission (FERC) regulates interstate pipeline companies. Similar to some of the other categories, these pipeline companies are experiencing difficult times as well. In 1997 earnings from operations were down, following a 2-year trend. The effects of warmer-than-normal weather during 1997 in North America also caused oil deliveries to decrease. This decrease affected both operating revenues and net income for pipeline companies (*Oil & Gas Journal*, 1998).

1.3 Environmental Concerns

EPA has identified four emission sources that account for the majority of HAP emissions from OLD activities:[2]

- storage tanks,
- liquid transfer activities involving tank trucks and railcars (loading racks),
- container filling operations, and
- leaks from equipment components (e.g., pumps, valves).

Table 1-1 shows the nationwide HAP totals for each industry resulting from the different emission sources. Storage tanks emit 63,315 tons/yr of HAPs, accounting for approximately 70 percent of the total OLD source category. Equipment leaks are the next greatest source of HAP emissions, representing almost 19 percent of the source category total.

[2]Originally, wastewater and semi-aqueous waste were also believed to be sources of HAP emissions for the OLD source category. However, responses to the OLD survey indicated that insufficient information is available to determine nonzero MACT floors for wastewater. In addition, the survey indicated that semi-aqueous waste generated from OLD operations is generally kept in closed containers once it is collected. The handling of these wastes, at both chemical facilities and refineries, is already covered under the Resource Conservation and Recovery Act (RCRA) ("MACT Floor Development for the OLD Source Category," Memo, May 5, 1999). Consequently, emission sources associated with wastewater and semi-aqueous waste are excluded from this analysis.

Table 1-1. Nationwide HAP Totals (tons/yr)[a]

Industry Segment	No. of Major Source Facilities Nationwide[b]	Storage Tanks	Loading Racks	Container Filling	Equipment Leaks	Totals
Chemical production	370	38,785	4,660	48	10,030	53,520
Petroleum refinery	111	4,365	2,100	1	1,460	7,930
Liquid terminals	94	17,990	2,890	1	5,015	25,900
Crude oil pipelines	35	440	__[a]	__[a]	45	490
Petroleum terminals	41	1,735	260	1	965	2,960
Total	**651**	**63,315**	**9,910**	**51**	**17,515**	90,800

[a] There are no transfer rack or container filling emissions at facilities with SIC code 46.
[b] Estimated number of facilities based on industry data and previous NESHAP reports, as described in the source document. Only 239 facilities returned surveys on their OLD activities. Emissions data for the nonresponding facilities were estimated to develop the estimate of nationwide impacts.

Source: U.S. Environmental Protection Agency. 2000. *Technical Support Document for the Organic Liquids Distribution (Non-gasoline) Industry*. Washington, DC: U.S. Environmental Protection Agency, Office of Air Quality Planning and Standards.

Table 1-2 lists all of the facility categories as well as the modes of transportation employed and the emission sources covered by the OLD source category.

1.4 Organization of Report

Although numerous SIC codes and facility categories are covered by the regulation, this report will focus on only the two primary facility categories—chemical liquids and petroleum liquids. As shown in Table 1-1, 57 percent of the facilities affected by the OLD NESHAP belong to the chemical industry. The remaining 43 percent of facilities are involved in the distribution of petroleum liquids. Because the two types of facilities will face different demand structures, the industry profile is broken into two virtually independent profiles, one for each of the categories. Sections 2 and 3 are both organized as follows: background, production overview, source category organization, characterization of uses and consumers, and market information.

Table 1-2. Summary of Facility Categories, Liquids, Modes of Transportation, and Emissions Sources Covered by the OLD Source Category

Facility Category	Liquids Handled	Mode of Liquid Transportation	Emission Sources
Chemical production	Synthetic chemicals Petrochemicals	Tank truck Tank car (railroad) Sometimes pipelines	Storage tanks Liquid transfer Container filling Equipment leaks
Petroleum refineries	Crude oil Natural Gas Liquids, (NGLs) Nongasoline refined Products	Pipeline Tanker ships Barges Tank car Tank truck	Storage tanks Liquid transfer Container filling Equipment leaks
Liquid terminals	Synthetic chemicals Petrochemicals Crude oil Nongasoline refined Products	Tank car Tank trucks	Storage tanks Liquid transfer Container filling Equipment leaks
Crude oil pipelines	Crude oil	Pipeline Tanker ships Barges Tank car Tank truck	Storage tanks Equipment leaks
Petroleum terminals	Crude oil NGLs Nongasoline refined Products	Tanker ship Barge Pipeline Tank car Tank truck	Storage tanks Liquid transfer Container filling Equipment leaks

Sources: Various background documents.
Gale Business Resources. Pipelines, Crude Petroleum. 1999.
American Petroleum Institute. August 1998. *Heating Oil in the United States.*

SECTION 2

DISTRIBUTION OF ORGANIC CHEMICAL LIQUIDS

Organic chemical liquids include synthetic chemicals and petrochemicals (chemicals manufactured from crude petroleum). Synthetic organic chemicals cover a wide range of intermediate products, including inputs to the manufacture of synthetic resins, plastics materials, and nonvulcanized elastomers, as well as cyclic organic intermediates and dyes/pigments, and aliphatic and acrylic chemicals and solvents.

Petrochemicals are intermediate products resulting from the refinery process. Petrochemical feedstocks include naphtha, a liquid obtained from refining crude oil, as well as products recovered from natural gas and refinery gases (ethane, propane, and butane). Other feedstocks include ethylene; propylene; normal- and iso-butylenes; butadiene; and aromatics such as benzene, toluene, and xylene. The volume of petroleum liquids available to the petrochemical industry depends primarily on the following three factors: crude petroleum input to refineries, refinery process configuration and operating conditions, and the demands and prices for naptha and gas oil in their primary fuel markets (DOE, EIA, 1999).

2.1 Chemical OLD Background

Synthetic organic chemical manufacturing industry (SOCMI) facilities manufacture a variety of liquid chemicals that are pure HAPs or contain HAPs. A SOCMI facility typically contains storage tanks, transfer racks, liquid piping and components, and a wastewater handling and treatment system or systems, each a potential source of HAP emissions. The Hazardous Organic NESHAP (HON) regulates these emission sources if they are assigned to a chemical manufacturing process unit. Since many such activities are also involved in distribution, many OLD activities at SOCMI facilities are already being regulated under the HON. However, instances exist (especially certain storage tanks and transfer racks) where such OLD activities are not currently covered by a MACT (Abt, 1998).

2.1.1 SIC and NAICS Codes and Description of Service Providers

Synthetic chemicals are associated with the OLD source category when they are distributed from SOCMI facilities to liquid terminals. These chemicals are typically transported by means of tank truck or tank car.

Petrochemical feedstocks travel by various modes throughout their product life. The distribution components associated with the OLD source category are the shipments of feedstocks from refineries to liquid terminals and SOCMI facilities. Most often, petrochemicals travel by means of tank truck or tank car; however, some SOCMI facilities have pipelines by which their products are distributed.

Synthetic organic chemical and petrochemical distribution facilities are most likely to be classified under the three Standard Industrial Classification (SIC) codes listed in Table 2-1. The table includes the North American Industry Classification System (NAICS) codes that correspond to the affected SIC-coded industries.

2.1.2 Affected Markets

The chemical markets potentially affected by regulating the OLD source category include the markets for both petrochemicals and their end products, including synthetic organic chemicals. As with petroleum liquids, the demand for these chemicals depends primarily on their end use. Organic chemicals, particularly petrochemicals, play an important role in society. Petrochemicals are usually an intermediate product that is converted into a variety of consumer and industrial products. Some of the end products include plastics, antifreeze, synthetic fibers, rubber, solvents, and detergents. Higher demand for these products translates into higher demand for their inputs (EPA, 1995).

2.2 Production/Service Overview

OLD distribution is a service that is part of the production process for organic liquids.

2.2.1 Service Overview

After a refining process, petrochemicals might be distributed to chemical production plants for processing into synthetic chemicals, or they might be transported to an independent liquid terminal for storage before further processing. In addition, independent liquid terminals may also receive processed synthetic chemicals for storage. Liquids stored

Table 2-1. Principal OLD Facility Categories

SIC Code	SIC Description	NAICS Codes	NAICS Description
Chemical Production (118 survey responses)			
2821	Plastics Materials, Synthetic and Resins, and Nonvulcanizable Elastomers	325211	Plastics Material and Resin Manufacturing
2865	Cyclic Organic Crudes and Intermediates, and Organic Dyes and Pigments	325192	Cyclic Crude and Pigment Manufacturing
		32511	Petrochemical Manufacturing[a]
		325132	Synthetic Organic Dye and Pigment Manufacturing
2869	Industrial Organic Chemicals, NEC	325188	All Other Basic Inorganic Chemical Manufacturing[a]
		32511	Petrochemical Manufacturing[a]
		325193	Ethyl Alcohol Manufacturing
		32512	Industrial Gas Manufacturing
		325199	All Other Basic Organic Chemical Manufacturing[a]

[a] Only part of the NAICS industry is made up of facilities from the corresponding SIC-coded industry.

Source: U.S. Census Bureau. March 2000. "1987 SIC Matched to 1997 NAICS." http://www.census.gov/epcd/naics/NSIC3B.HTML. As obtained on March 13, 2000.

at independent liquid terminals might be transported to chemical production plants or refineries for further processing, they might be sent to a blending/packaging/distribution facility, or they might be distributed to end users (Abt, 1998).

2.2.2 Major By-Products and Co-Products, if Applicable

By-products and co-products are unregulated commodities that result from the production process in question. Knowledge of such products is important because they may have economic value that should be considered when determining a regulation's impacts on a facility.

The Census assigns a “primary” SIC code to each establishment that corresponds to the SIC code for the largest (by value) single type of product shipped by the establishment. Thus, products shipped by an establishment that are classified in the same industry as the establishment are considered “primary,” and all other products shipped by the establishment are considered “secondary.” The Census then calculates two ratios to illustrate the product mix between primary and secondary products in each industry.

The *specialization ratio* represents the ratio of primary product shipments to total product shipments for all establishments classified in the industry. It answers the question: “What percentage of the output of industry’s facilities is associated with the industry’s primary SIC code?” By definition, if an industry does not have output other than its primary product, by-products and co-products cannot contribute significantly to the industry’s revenues. While a high specialization ratio precludes the existence of marketable by- or co-products, a low specialization ratio does not necessarily prove the existence of these products. A large percentage of a facility’s output not associated with its primary SIC code may indicate the presence of by-products; however, it may also be the result of a separate production line that would be neither directly nor indirectly affected by regulation.

The *coverage ratio* represents the ratio of primary products shipped by the establishments classified in the industry to the total shipments of such products that are shipped by all establishments classified in all industries. It answers the question: “What percentage of the industry’s output is supplied by firms with the industry’s primary SIC code?”

Analysts often use the specialization ratio and the coverage ratio as proxies when determining the likely importance of by-products and co-products in an industry. Table 2-2 presents the specialization and coverage ratios for the industries covered under the OLD source category. The numbers in Table 2-2 show that chemical manufacturers are characterized by a high degree of specialization—between 75 and 86 percent.

The specialization ratio is a useful tool for assessing the likelihood of *marketable* co- and by-products in an industry. However, by-products with economic value may exist even if they are not sold in the market. Such by-products would not be reflected by the specialization ratio because they do not represent “shipments.” Even if a facility does not derive revenues from nonmarketable by-products, it may still benefit from them through cost savings. One by-product that is not always sold in the market is electricity. Some facilities

Table 2-2. Specialization and Coverage Ratios for OLD Industries, 1982, 1987, and 1992

SIC Code	SIC Description	1987[a]	1992[a]	1997[b]
Chemical Production				
2821	Plastics Materials, Synthetic Resins, and Nonvulcanizable Elastomers			
	Primary Products Specialization Ratio	88	86	86
	Coverage Ratio	81	80	83
2865	Cyclic Organic Crudes and Intermediates, Organic Dyes and Pigments			
	Primary Products Specialization Ratio	80	86	85[c]
	Coverage Ratio	61	61	75[c]
2869	Industrial Organic Chemicals, NEC			
	Primary Products Specialization Ratio	75	76	78[c]
	Coverage Ratio	84	85	81[c]

[a] Abt Associates. October 15, 1998. *Characterization of the Organic Liquid Distribution (Nongasoline) Industry*. Prepared for the U.S. Environmental Protection Agency.
[b] U.S. Census Bureau. 2000. "Survey of Plant Capacity: 1998." Current Industrial Reports. MQ-C1(98). Washington, DC: Government Printing Office.
[c] Weighted average of ratios of the corresponding NAICS-coded industries. Weight = (number of facilities in NAICS-coded industry that are in a given SIC-coded industry)/(total number of facilities in the SIC-coded industry).

in both the petroleum and the chemical industries use excess heat from their production processes to generate electricity through a mechanism commonly referred to as "cogeneration." For those facilities, electricity is a by-product because it is inextricably linked to the production of organic liquids and has economic value to the facility (DOE, EIA, 1999).[1]

2.2.3 Costs of Production

Knowledge about the cost of production in an industry is important when estimating likely shifts in the supply curve as a result of regulation. However, distribution costs are not readily available. As indicated earlier, the demand and supply of OLD distribution activities

[1]This information is presented for information purposes only and will not be used as an input into the EIA.

are driven by the market for the end product. Therefore, Table 2-3 presents overall production costs for potentially affected OLD industries by SIC code. The Census Department publishes production costs for manufacturing industries.

Table 2-3. Annual Production Costs ($1997 10^3)[a]

Cost of Production	2821[b] (percent of total)	2865[b] (percent of total)	2869[b] (percent of total)
Capital expenditures	$2,863,610 (9.08%)	$1,005,883 (10.86%)	$5,218,629 (10.29%)
Raw material costs	$25,542,668 (81.02%)	$7,173,464 (77.46%)	$39,258,273 (77.44%)
Labor costs	$1,699,895 (5.39%)	$541,138 (5.84%)	$2,865,312 (5.65%)
Electricity costs	$747,999 (2.37%)	$194,272 (2.10%)	$910,493 (1.80%)
Fuel costs	$671,049 (2.13%)	$345,990 (3.74%)	$2,443,975 (4.82%)
Total	$31,525,221	$9,260,747	$50,696,682
Number of establishments[c]	449	206	705
Production cost per establishment	$70,212	$44,955	$71,910

[a] Dollar values adjusted using the producer price index for four-digit SIC codes from the Bureau of Labor Statistics.
[b] 1996 Annual Survey of Manufactures
[c] 1992, Census of Manufactures

In terms of the percentage of total costs composed of capital, raw materials, labor, or fuel and electricity, the three chemical manufacturing industry groups (SICs 2821, 2865, 2869) are very similar. In terms of production costs per facility, SIC 2865 (Cyclic Organic Chemicals) is the smallest of these groups, and SICs 2821 and 2869 (Plastic Materials and Synthetic Resins, Industrial Organic Chemicals NEC) are approximately the same size (Abt, 1998).

2.2.4 Supply Elasticities

The supply elasticity for synthetic organic chemicals and petrochemicals depends on the ability and willingness of firms to scale up production in the face of higher demand. Supply elasticity refers to the ratio of a given percentage change in price to a resulting percentage change in quantity supplied. At a given point in time, firms can be expected to supply an approximately profit-maximizing quantity, given their available technology. For a given increase in the price of chemicals, the increase in quantity supplied will be greater when the producers of that chemical have excess capacity and when new production lines for the chemical are easy and inexpensive to establish.

2.2.5 Emissions

As shown in Table 1-1, facilities involved in the distribution of synthetic organic chemicals and petrochemicals are estimated to account for 59 percent of all emissions. As described in Section 1, four emission sources have been identified as accounting for the majority of HAP emissions during the distribution of synthetic organic chemicals and petrochemicals:

- storage vessels;
- liquid transfer activities involving tank trucks and railcars (loading racks);
- container filling operations; and
- leaks from equipment components (e.g., pumps, valves).

2.3 Industry Organization

This section describes the organization of the segments of the chemical industry most likely to be affected by the NESHAP regulation and provides specific information on affected OLD facilities and firms when such information is available. The section begins with a discussion of market structure, followed by information on facilities that distribute organic chemicals and the firms that own them.

2.3.1 Market Structure

The structure of the affected market(s) is an important factor in estimating the potential impacts from a regulation. For example, in a competitive market where each producer has little market power, it would be difficult for an affected firm to pass on compliance costs to its consumers. On the other hand, in an industry with very few producers or where the products are highly differentiated, it may be possible for affected firms to recover part or all of the compliance costs through price increases. The most important factors determining the competitive structure of an industry are the number of producers, the degree of product differentiation, and the presence of barriers to entry. The remainder of this subsection will provide a brief explanation of these factors and discuss the competitive structure of the OLD markets in terms of each factor (CMA, 1995).

2.3.1.1 Producers

Table 2-4 lists the top five companies for each of the three chemical SIC groups within this source category, ranked by sales. In addition to providing the name of the five largest companies, the table also indicates whether the company is publicly or privately held, and whether it is the parent or a subsidiary with a parent in a different SIC group.

2.3.1.2 Product Differentiation

Product differentiation is a form of nonprice competition used by firms to establish market power in a specific product market. Product differentiation may result from unique product characteristics or from brand recognition. In general, a company that sells a product with valued characteristics that no or few other products possess will have more market power than a company that sells a product that has no distinguishable characteristics from other products in the same market. Similarly, market power is created if customers place a higher value on a product produced by a specific company, or brand, even though the product characteristics are identical to the products produced by other companies.

The products of concern to the OLD source category are characterized by a high degree of homogeneity. Thus, brand loyalty is not expected to be an important factor in the organic chemicals market (CMA, 1995; Arnold, 1989; Gale, 1999; DOE, EIA, 1999).

Table 2-4. Top Five OLD Companies Ranked by Sales within Four-Digit SIC

2821	2865	2869
1. Monsanto Co. (Public)	1. Huntsman Corp. (Private)	1. Bayer Corp. (Private Subsidiary)
2. Ashland Chemical Co. (Private Subsidiary)	2. Crompton and Knowles Corp. (Public)	2. Union Carbide Corp. (Public)
3. Rohm and Haas Co. (Public)	3. Clariant Corp. (Private Subsidiary)	3. ARCO Chemical Co. (Public)
4. MA Hanna Co. (Public)	4. ChemFirst Inc. (Public)	4. Dow Corning Corp. (Joint Venture)
5. Hercules Inc. (Public)	5. System Bio-Industries Inc. (Private Subsidiary)	5. Witco Corp. (Public)

Sources: Gale Research. 1998. *Ward's Business Directory of U.S. Private and Public Companies, 1999.* Detroit, MI. Gale Research.
American Petroleum Institute. 1998. *Heating Oil in the United States*.
U.S. Environmental Protection Agency. 1995. Economic Impact Analysis for the Petroleum Refining NESHAP.

2.3.1.3 Market Share

The number of producers and the market shares of the largest firms are important determinants of the degree of market power individual firms may have. The term "concentration" refers to the combined percentage of total output accounted for by the largest producers in the industry. For example, the four-firm concentration ratio (CR4) refers to the market share of the four largest firms. The higher the concentration ratio, the more concentrated the industry. A market is generally considered highly concentrated if the CR4 is greater than 50 percent. The Herfindahl-Hirschman index (HHI) is an alternative measure of concentration. It is equal to the sum of the squares of the market shares for the largest 50 firms in the industry. The higher the index, the fewer the number of firms supplying the industry and the more concentrated the industry is at the top. The Justice Department uses the HHI for antitrust enforcement purposes. The benchmark used by the Justice Department is 1,000, where any industry with an HHI less than 1,000 is considered to be unconcentrated. The advantage of the HHI over the concentration ratio is that the former gives information about the dispersion of market share among all the firms in the industry, not just the largest firms (Arnold, 1989).

In general, an industry with a large number of firms and a small concentration will be relatively more competitive than an industry with few firms and a high concentration. Firms that operate in a more competitive market will be relatively more affected by new regulations because they are less likely to be able to pass on compliance costs.

Table 2-5 shows concentration ratios by SIC code for the affected OLD industries. Ratios are included for the census years 1987 and 1992 (where possible). For some SIC codes, data are available for only 1992. The numbers in Table 2-5 show that, by and large, the OLD industries are characterized by a large number of firms and generally unconcentrated markets, indicating a high degree of competitiveness in their respective product markets. When interpreting the data presented in Table 2-5, it is important to note that firms reporting SIC codes classified under the chemical production industry may produce a variety of products that should not be regarded as belonging to one single market. Therefore, although the numbers presented in Table 2-5 indicate the presence of many firms and a low degree of market concentration, producers of certain specialty chemicals are likely to have a higher degree of market power in "niche markets" than the data suggest. However, it is expected that the majority of chemical production does not belong to such niche markets, and that the chemical production industry can generally be classified as competitive with respect to total number of producers and market concentration.

The chemical industry is undergoing a trend of mergers, acquisitions, and general industry consolidation. According to an analysis by Speed (1999), "the market will [comprise] fewer but larger companies, global in scope, and more focused in their business pursuits."

2.3.1.4 Market Structure

Barriers to entry are the mechanisms through which the total number of firms in an industry can be kept small and a high degree of market concentration can exist. Where barriers to entry are present, new firms find it impossible or unprofitable to enter the market. Barriers to entry therefore create market power for the firms that already operate in the market. Typically, barriers to entry exist when industries are capital intensive, are

Table 2-5. Concentration Ratios by SIC Code

SIC Code	Year	Total Number of Firms	Concentration Ratio				Herfindahl-Hirschman Index
			4 Firm	8 Firm	20 Firm	50 Firm	
Chemical Production							
2821: Plastics Materials, Synthetic Resins, and Nonvulcanizable Elastomers							
	1987	288	20%	33%	61%	89%	248
	1992	240	24%	39%	63%	90%	284
2865: Cyclic Organic Crudes and Intermediates, Organic Dyes and Pigments							
	1987	131	34%	50%	77%	96%	542
	1992	150	31%	45%	72%	94%	428
2869: Industrial Organic Chemicals, NEC							
	1987	491	31%	48%	68%	86%	376
	1992	489	29%	43%	67%	86%	336

Source: U.S. Department of Commerce, Bureau of the Census. Economic Census, 1992.

characterized by significant economies of scale, require specialized knowledge (e.g., patents), or are subject to government regulation (Speed, 1999).

2.3.2 Facilities

Table 2-6 presents an overview of the total number of facilities for each OLD SIC code, the total number of firms potentially affected by the OLD source category, and the percentage of the source category potentially affected.

Although EPA received surveys from only about 32 percent (117 out of 370)[2] of the universe of organic liquids distributors in the chemical industry, an examination of the data provided in the surveys does illustrate general characteristics of those facilities. The figures and tables in this section include four facilities classified in SIC codes 30, 38, and 39 in addition to the 117 facilities classified as part of the chemical industry. Facilities in SIC

[2] Some portions of the Technical Support Document (TSD) report that 118 facilities in SIC code 28 returned surveys. However, the report shows assigned model plant numbers for only 117 facilities in this SIC code. (One facility, numbered 30-Q, was listed in the TSD but is nonexistent in the database compiled from ICR survey responses. The TSD failed to report a model number for plant 32-E, which was in the database. Facility 30-Q was excluded from analysis and 32-E was included.

Table 2-6. Number of Total OLD Facilities and Affected Facilities, 1997

SIC Code	SIC Description	Total Number of Facilities[a]	Total Number of Affected Facilities[b]	% of Source Category that is Affected
Chemical Production				
2821	Plastics Materials, Synthetic and Resins, and Nonvulcanizable Elastomers	532		
2865	Cyclic Organic Crudes and Intermediates, and Organic Dyes and Pigments	184	370	25.4%
2869	Industrial Organic Chemicals, NEC	738		

[a] U.S. Census Bureau. August 1999. "Cyclic Crude and Intermediate Manufacturing." *1997 Economic Census, Manufacturing—Industry Series*, E97M-3251I, Washington, DC: Government Printing Office.
[b] U.S. Environmental Protection Agency. 2000. *Technical Support Document for the Organic Liquids Distribution (nongasoline) Industry*. Washington, DC: U.S. Environmental Protection Agency, Office of Air Quality Planning and Standards.

Sources: U.S. Census Bureau. August 1999. "Plastics Material and Resin Manufacturing." *1997 Economic Census, Manufacturing—Industry Series*, E97M-3251I, Washington, DC: Government Printing Office.
U.S. Census Bureau. August 1999. "All Other Basic Organic Chemical Manufacturing." *1997 Economic Census, Manufacturing—Industry Series*, E97M-3251I, Washington, DC: Government Printing Office.
U.S. Census Bureau. August 1999. "Synthetic Organic Dye and Pigment Manufacturing." *1997 Economic Census, Manufacturing—Industry Series*, E97M-3251I, Washington, DC: Government Printing Office.
U.S. Census Bureau. August 1999. "All Other Basic Inorganic Chemical Manufacturing." *1997 Economic Census, Manufacturing—Industry Series*, E97M-3251I, Washington, DC: Government Printing Office.
U.S. Census Bureau. August 1999. "Ethyl Alcohol Manufacturing." *1997 Economic Census, Manufacturing—Industry Series*, E97M-3251I, Washington, DC: Government Printing Office.
U.S. Census Bureau. August 1999. "Industrial Gas Manufacturing." *1997 Economic Census, Manufacturing—Industry Series*, E97M-3251I, Washington, DC: Government Printing Office.
U.S. Census Bureau. August 1999. "Petrochemical Manufacturing." *1997 Economic Census, Manufacturing—Industry Series*, E97M-3251I, Washington, DC: Government Printing Office.

codes 30, 38, and 39 use synthetic organic chemicals and petrochemicals as an input into their production of various plastic parts and products. The data presented here are for the 105 facilities (out of 121) who did not request that their surveys be considered classified information.

2.3.2.1 Location

Figure 2-1 shows the distribution of 105 organic chemical liquids distribution facilities across 26 states. Twenty-nine percent of organic chemical liquids distribution facilities are located in Texas, 9 percent are located in Louisiana, and 8 percent are located in Ohio.

2.3.2.2 Production Capacity and Utilization

Table 2-7 shows that, in 1998, facilities classified under SIC codes 2821, 2865, and 2869 were using a fairly high percentage of their plant capacity, with some potential for increasing their production. The OLD NESHAP is specifically concerned with the distribution of chemicals, rather than their production. However, a facility's ability to store and transfer chemicals is considered in the calculation of plant capacity, so the data below provide some indication of storage and transfer capacity.

2.3.2.3 Employment

Figure 2-2 shows almost all organic chemical liquids distribution facilities employ more than 50 people and that more than 35 percent of those facilities employ at least 500 hundred employees each.

2.3.3 Firm Characteristics

Although facilities are the physical unit regulated by the OLD source category, this regulation may also affect the firms that own the facilities. Firms are legal business entities that have the capacity to conduct business transactions and make business decisions that affect the facility. In this analysis, the terms firm and company are used synonymously.

2.3.3.1 Ownership

The legal form of ownership may affect the cost of capital, the availability of capital, and the effective tax rate faced by the firm. Firms are generally organized as corporations,

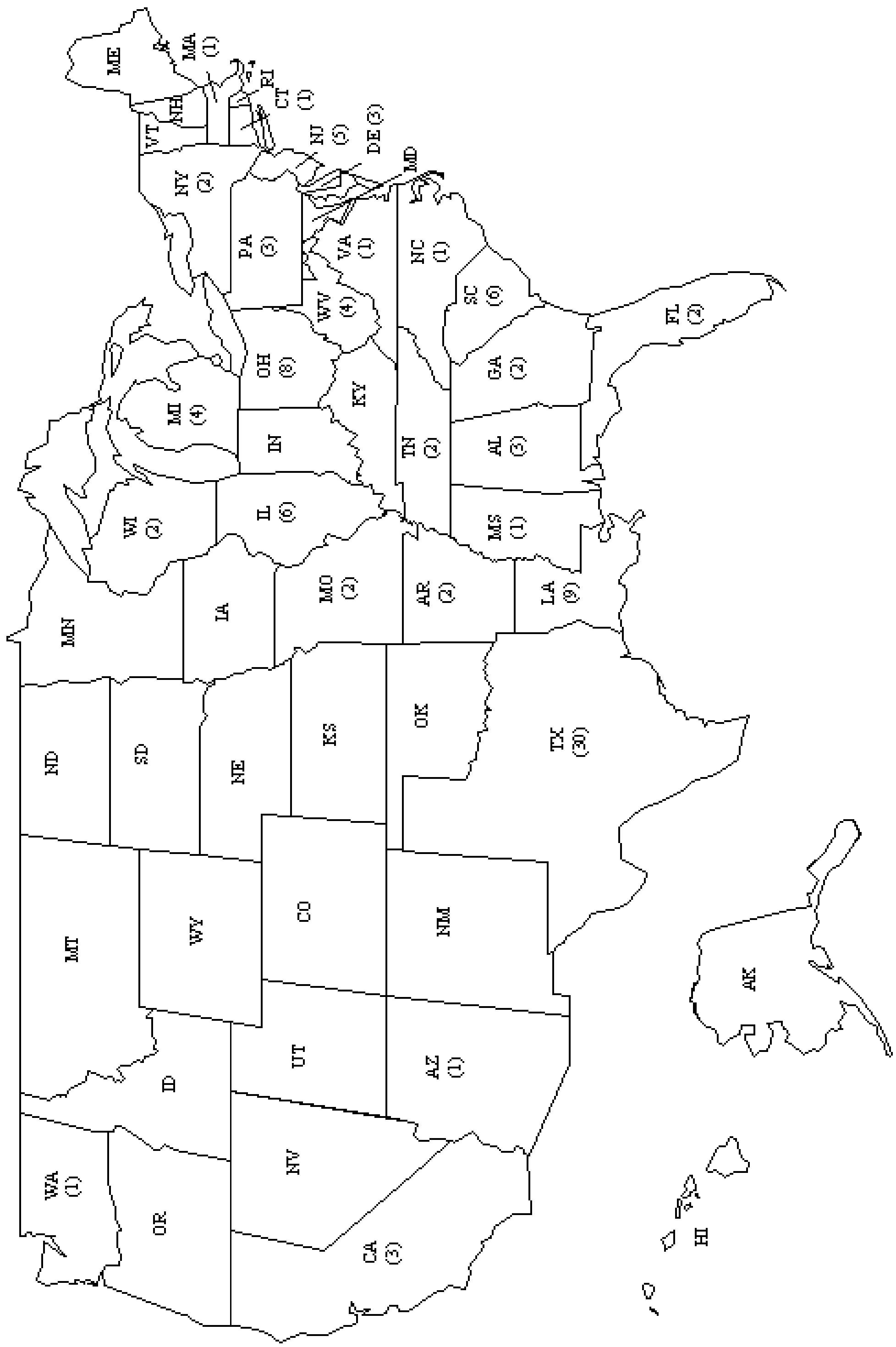

Figure 2-1. Distribution of Organic Chemical Liquids Facilities

Table 2-7. Capacity Utilization Rates by Industry

SIC Code	SIC Description	Capacity Utilization Rate in 1998
2821	Plastics Materials and Resins	81%
2865	Cyclic Crudes and Intermediates	80%
2869	Industrial Organic Chemicals, Not Elsewhere Classified	80%

Source: U.S. Census Bureau. 2000. "Survey of Plant Capacity: 1998." Current Industrial Reports. MQ-C1(98). Washington, DC: Government Printing Office.

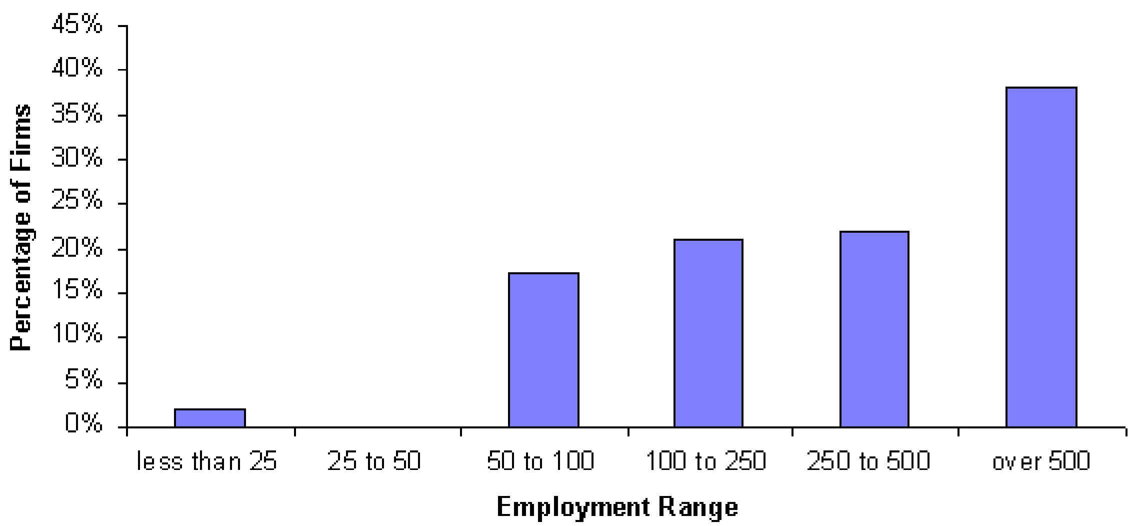

Figure 2-2. The Distribution of Organic Chemical Liquids Facilities by Employment

Source: Nonclassified responses to the 1998 Industry Specific Information Collection Request for the Development of an Organic Liquids Distribution Maximum Achievable Control Technology.

sole proprietorships, or partnerships. Each type has its own legal and financial characteristics that may influence how firms are affected by regulating the OLD source category.

Table 2-8 presents the legal form of ownership for the SIC codes associated with the OLD source category. The OLD source category is heavily dominated by firms organized as corporations. For example, 449 of 491 SIC 2869, Industrial Inorganic Chemicals, NEC, (or 91.4 percent) were classified as corporations in 1987. (DOE, EIA, 1999; Speed, 1999).

Table 2-8. Firms' Legal Form of Organization for OLD Industries, 1987

SIC Code	Corporations	Sole Proprietorship	Partnerships	Other and Unknown	Total
Chemical Production					
2821	259	9	9	11	288
2865	125	2	1	3	131
2869	449	4	19	19	491

Sources: U.S. Department of Commerce. Year?. 1987 Census of Manufacturers, Subject Series.

2.3.3.2 Size Distribution

Firm size is important when analyzing the distribution of the regulation's financial impacts. Analysis of likely impacts on small entities is required under the Small Business Regulatory Flexibility Enforcement Act (SBREFA) and requires the categorization of firms as either small or large. The Small Business Administration (SBA) publishes general size standard definitions for small entities by SIC code. The size standards are defined either by employment or by annual firm revenue, depending on the SIC code.

Table 2-9 presents the SBA small business standards for the chemical industries most likely to be affected by the OLD NESHAP and also shows the number of small firms in the source category. The SBA size definitions for all chemical industries is defined in terms of number of employees. The size standard for these SIC categories ranges from 750 to 1,000 employees. Based on the SBA's *Statistics of U.S. Businesses*, the number of small firms can only be estimated. For most of the SIC groups of interest, the size categories provided do not correspond to the SBA definition. Data are available for firms with fewer than 100 employees, between 0 and 499 employees, more than 500 employees, and more than 2,500

Table 2-9. Small Business Size Standards for OLD Industries

SIC Code	SIC Description	SBA Small Business Standard	Total Firms[a]	Number of Definitely Small Firms (percent of total)[a,b]	Number of Potentially Small Firms (percent of total)[a,c]
Chemical Production					
2821	Plastics Materials, Synthetic and Resins, and Nonvulcanizable Elastomers	750 employees	403	309 76.67%	344 85.36%
2865	Cyclic Organic Crudes and Intermediates, and Organic Dyes and Pigments	750 employees	152	107 70.39%	128 84.21%
2869	Industrial Organic Chemicals, NEC	1,000 employees	444	316 71.17%	356 80.18%

[a] Source: Statistics of U.S. Businesses, 1996
[b] Includes firms with fewer than 500 employees, except for SICs 5169 and 5171, where entry includes firms with fewer than 100 employees.
[c] Includes firms with fewer than 2,500 employees.

employees.[3]

Thus, Table 2-9 presents two estimates—the number of definitely small firms and the number of potentially small firms. For all SIC groups with SBA definitions of 750 or more, the definitely small estimate is of firms with fewer than 500 employees. The potentially small firm estimate includes the difference between those firms with 2,500+ employees and 500+ employees. Thus, the two estimates bracket the actual number of small firms. Note that between 70 and 85 percent of chemical production firms are shown to be small according to these statistics.

Although the above paragraphs present a general impression of the relative number of small firms involved in the distribution of organic liquids, only a percentage of firms in each of the three industries listed in Table 2-9 are actually going to be affected by the OLD NESHAP. An examination of the data from the EPA survey of facilities in OLD source categories shows that facilities affected by the NESHAP rule are much less likely to be

[3]The SBA data do not rank firms by revenue.

owned by small firms than is suggested by data from the *Statistics of U.S. Businesses.* Less than 4 percent of surveyed firms are small businesses, compared to a 70 to 85 percent of all firms in the affected source categories.

As previously stated, only 121 facilities out of an estimated 370 that handle organic chemical liquids responded to the ICR survey. Those facilities are owned by 31 different firms. Only one of those 31 firms is small according to the SBA small business standards. That one small firm owns two facilities that distribute organic liquids. If the 121 facilities are an accurate sample of the actual facilities, we can conclude that only about 1.7 percent of all affected facilities are owned by small businesses. However, this could be an inaccurate conclusion if a large percentage of nonresponding affected facilities are owned by small firms.

Figures 2-3 and 2-4 show the distribution of surveyed firms by firm size as measured by revenue and employment; respectively. The majority of affected firms took in more than $1 billion in revenues in 1998 and employed more than 10,000 people.

2.3.3.3 Vertical and Horizontal Integration

Vertical and horizontal integration are important determinants in analyzing a firm's potential for impacts. Both measures are concerned with the types of industries in which a firm operates. Vertical integration refers to the degree to which a firm operates facilities that are part of the same supply chain. For example, if the same firm owns facilities in the petroleum production, refining, and transportation industries, it would be considered vertically integrated. Vertical integration is potentially important in analyzing firm-level impacts because a regulation could affect a vertically integrated firm at more than one level. Horizontal integration refers to the scale of production in a single-product firm or its scope in a multiproduct one. A single-product firm is considered horizontally integrated if it owns more than one facility producing the same product, which may be an advantage to the firm's ability to absorb costs if not all of the facilities are subject to the regulation and if the firm can shift parts of the production to the unregulated facilities. A multiproduct firm is considered horizontally integrated if it owns facilities in several unrelated industries. Here, horizontal integration may improve a firm's ability to absorb compliance costs if only one or a few of the industries in which the firm operates are directly affected by the regulation.

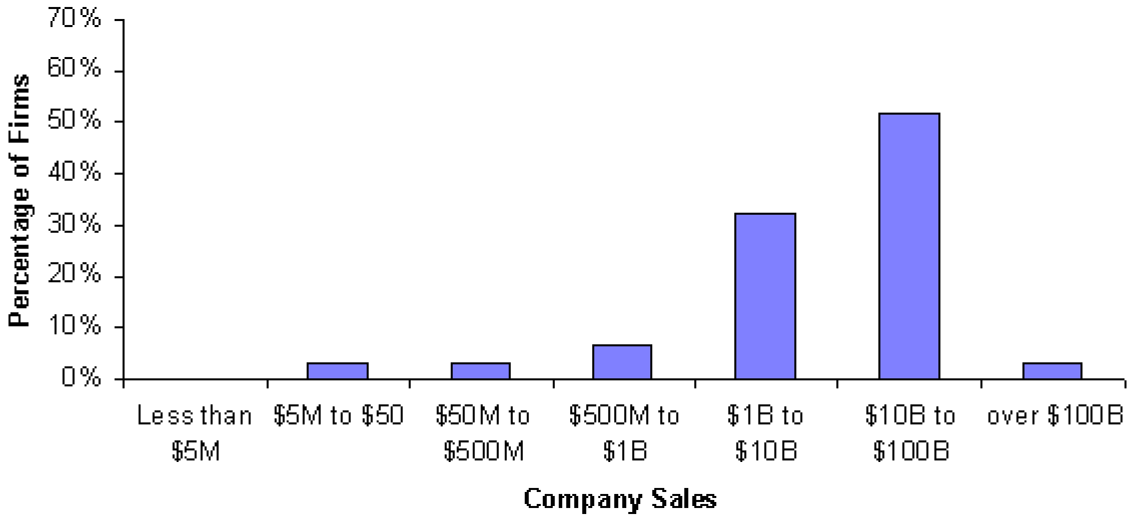

Figure 2-3. The Size Distribution of Companies that own OLD Facilities involved in Chemical Distribution, by 1998 Sales (in $1997)

Sources: Dun & Bradstreet. 1999. Company Capsules. As available on EBSCO.
General Business File International (formerly Business ASAP). 1999. Gale Group Collections. As obtained from InfoTrac Web.
Hoover's Incorporated. 1999. Hoover's Company Profiles. Austin, TX: Hoover's Incorporated. <http://www.hoovers.com/>.
Company Websites.
Company 10k Reports.
U.S. Environmental Protection Agency. 2000. "Technical Support Document for the Organic Liquids Distribution (non-gasoline) Industry." Washington, DC: USEPA, Office of Air Quality Planning and Standards.

According to industry sources, the degree of horizontal integration in the chemical industry varies among different companies—while some companies (including Exxon, BP, and Shell) have chosen to focus solely on basic chemicals, others (including ICI, Clariant, and Ciba) are focusing on chemical specialties. A third group (including Dow) have sought to balance their portfolios between cyclical commodities and less cyclical differentiated and specialty businesses (Speed, 1999; Gale Business Resources, 1999).

2.3.3.4 Financial Condition

The 31 firms that are known to own chemical facilities that will be affected by the OLD NESHAP have an average (median) profit margin of 5.4 (5.3) percent. Table 2-10

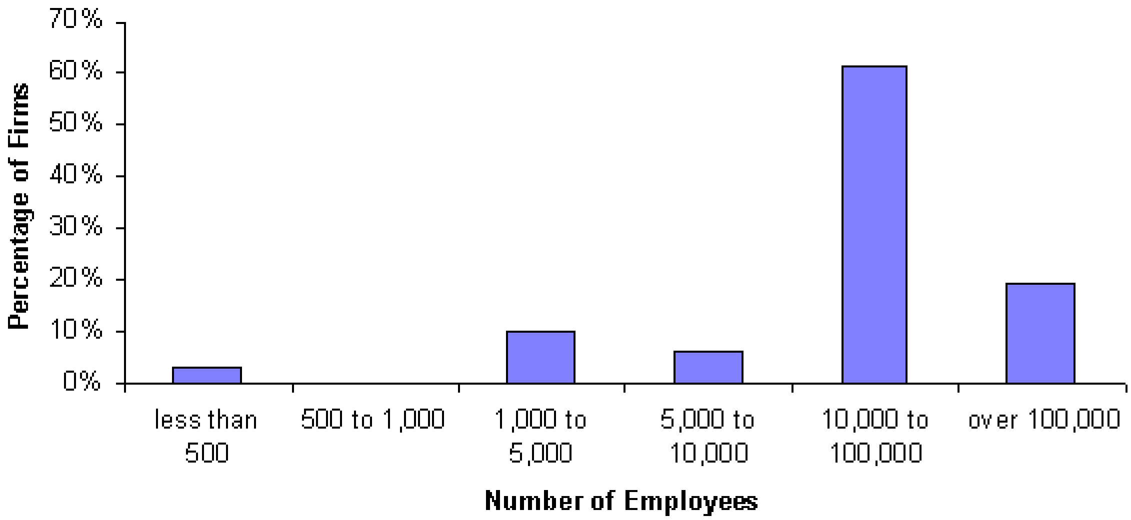

Figure 2-4. Size Distribution of Companies that own OLD Facilities involved in Chemical Distribution

Sources: Dun & Bradstreet. 1999. Company Capsules. As available on EBSCO.
General Business File International (formerly Business ASAP). 1999. Gale Group Collections. As obtained from InfoTrac Web.
Hoover's Incorporated. 1999. Hoover's Company Profiles. Austin, TX: Hoover's Incorporated. <http://www.hoovers.com/>.
Company Websites.
Company 10k Reports.
U.S. Environmental Protection Agency. 2000. "Technical Support Document for the Organic Liquids Distribution (non-gasoline) Industry." Washington, DC: USEPA, Office of Air Quality Planning and Standards.

shows the average, median, minimum, and maximum profit margins of these 31 firms.

Table 2-10. Profit Margins of Firms that own Organic Chemical Liquids Distribution Facilities

Median	0.054088
Average	0.052776
Maximum	–0.04093
Minimum	0.11828

Source: Nonclassified responses to the 1998 Industry Specific Information Collection Request for the Development of an Organic Liquids Distribution Maximum Achievable Control Technology.

Figure 2-5 shows the distribution of profit margins among the firms.

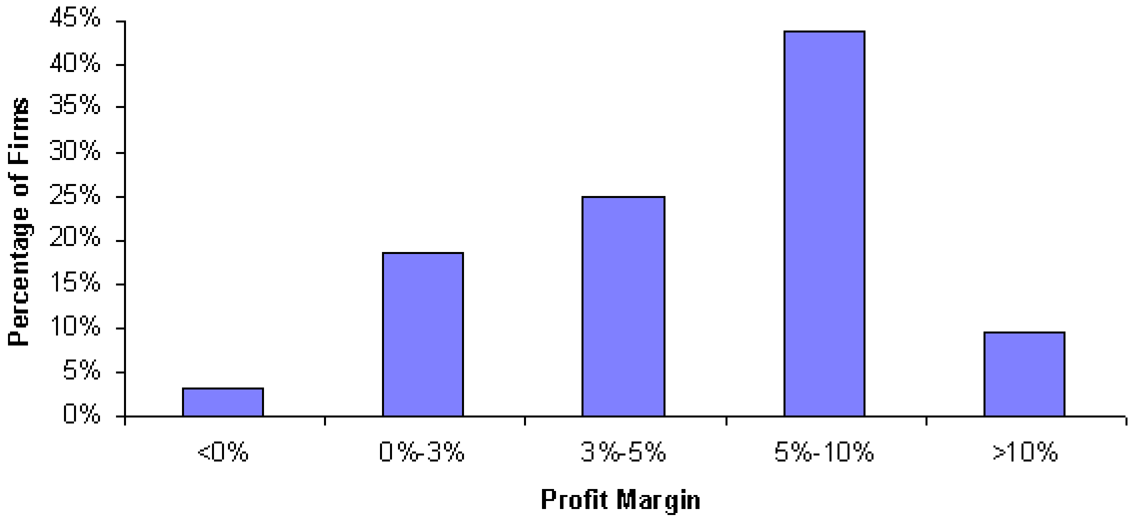

Figure 2-5. Distribution of Firms by Profit Margin

Sources: Dun & Bradstreet. 1999. Company Capsules. As available on EBSCO.
General Business File International (formerly Business ASAP). 1999. Gale Group Collections. As obtained from InfoTrac Web.
Hoover's Incorporated. 1999. Hoover's Company Profiles. Austin, TX: Hoover's Incorporated. <http://www.hoovers.com/>.
Company Websites.
Company 10k Reports.
U.S. Environmental Protection Agency. 2000. *Technical Support Document for the Organic Liquids Distribution (Non-gasoline) Industry*. Washington, DC: USEPA, Office of Air Quality Planning and Standards.
Dun & Bradstreet. 1997. *Industry Norms & Key Business Ratios*. Desk-Top Edition 1996–1997.

Table 2-11 provides a more general view of the financial condition of firms in the chemical industry. The table shows various measures of the financial condition of the organic liquid distribution source category between 1996 and 1998. Each indicator is discussed briefly below.

- **Return on sales** is an indicator of a firm's ability to withstand adverse conditions such as falling prices, rising costs, and declining sales. It is calculated by dividing net profit after taxes by annual net sales.
- **Return on assets** is a key indicator of profitability that compares operating profits with the assets available to earn a return. It is calculated by dividing a

Table 2-11. Financial Condition of Firms in the Chemical Industry

	SIC 28	SIC 2821			SIC 2865			SIC 2869		
	1998	1998	1997	1996	1998	1997	1996	1998	1997	1996
Indicator	Value	Value			Value			Value		
Return on sales	4.4	4.1	4.8	4.9	3.7	2.7	4.6	4.6	7.2	6.4
Return on assets	6.7	7.7	7.9	9.1	4.8	8.5	8.4	8.4	8.1	9.1
Return on equity	14.3	16.4	15.5	21.2	21.4	26.1	16.7	16.7	19.4	18.0
Current ratio	2.2	2.0	2.0	1.8	1.9	2.4	2.1	2.1	1.7	1.7
Quick ratio	1.2	1.1	1.2	1.0	0.9	1.3	1.2	1.2	0.9	0.9
Number of establishments in sample	1,381	97	130	144	23	27	29	29	79	93

Source: U.S. Environmental Protection Agency. July 1995. *Economic Impact Analysis for the Petroleum Refinery NESHAP*, Revised Draft for Promulgation.

firm's net profit after taxes by its total assets. According to Dun & Bradstreet, companies that use their assets efficiently will have a relatively higher return on assets than firms that do not use their assets efficiently.

- **Return on equity** is used to analyze the firm's ability to realize an adequate return on the capital invested by the firm's owners. It is calculated by dividing net profit after taxes by net worth. According to Dun & Bradstreet, this ratio is used increasingly as a "final criterion" of profitability, and a relationship of at least 10 percent is regarded as desirable for providing dividends plus funds for future growth.

- The **current ratio** is a measure of liquidity that gauges a company's ability to cover its short-term liabilities. It is calculated by dividing a firm's current assets by its current liabilities. The standard guideline for financial health is a ratio of two or higher.

- The **quick ratio** also indicates a company's ability to cover short-term liabilities. It is a variant of the current ratio, which does not include inventories, advances on inventories, marketable securities, or notes receivables. The quick ratio measures the protection afforded creditors in cash or near-cash assets. Any time this ratio is one or greater, the firm is said to be in a liquid condition.

2.4 Uses and Consumers

As with petroleum liquids, the demand for organic chemicals depends primarily on their end use. Organic chemicals, particularly petrochemicals, play an important role in society. Petrochemicals are usually an intermediate product that is converted into a variety of consumer and industrial products. Some of the end products include plastics, antifreeze, synthetic fibers, rubber, solvents, and detergents. Higher demand for these products translates into higher demand for their inputs (EPA, 1995). This section lists the major consumers of organic chemicals, the purposes of chemical consumption, and the factors affecting the elasticity of demand for chemicals.

2.4.1 Major Consumers

Nearly everyone is a consumer of chemicals in some way. Chemicals are used as inputs into the majority of manufacturing industries both domestically and internationally. As with petroleum products, the markets for end-use products drive the demand for individual chemicals. The major industrial consumers of chemicals in the United States are

- housing,
- motor vehicles,
- crops,
- tires,
- paper products,
- plastic products,
- textile mill products,
- apparel,
- furniture and fixtures,
- aluminum,
- basic steel and mill products, and
- household appliances (*Oil & Gas Journal*, 1999).

2.4.2 Purpose of Consumption

Two of the larger markets that drive demand for both petrochemicals and synthetic chemicals are the housing and automotive industries. The housing industry consumes chemicals as inputs to virtually all housing materials, including plastics used to make pipe, siding, window sills and frames, roofing, carpeting, insulation, and sealants. The average house completed in the United States contains chemical building products valued at $12,925, approximately 7 percent of the cost of building a house (U.S. Department of Commerce, 1996). In addition to the house itself, the purchase of a home leads to purchases of appliances, furniture, wallcoverings, and many other items that also have a heavy chemical content. With 1.48 million houses started in 1997, the housing market generated $19.1 billion in chemical sales (CMA, Nov. 1995).

The automotive industry is an another important customer for the chemical industry. This is especially true for the industrial chemicals segment, because every light vehicle produced in the United States contains approximately $2,160 of chemical products and chemical processing. Included, for example, are antifreeze and other fluids, plastic dashboards, rubber tires and hoses, paint, and adhesives. With 15.0 million light vehicles sold in 1997, this important market represents $32 billion in chemical sales (CMA, Sept. 1995).

2.4.3 Characterization of Demand—Derived Demand Elasticity

As with petroleum products, the price elasticity of demand for chemicals depends on the availability of substitutes, either substitute products for the same use or alternative production processes that do not need this chemical. There are 65 HAPs covered; since the availability of substitutes varies among these chemicals, so will their demand elasticities.

2.5 Markets

Many business analysts view the chemical manufacturing industry as a mature, slow-growth, and conservative industry. In 1998, the chemical industry continued its current pattern of restructuring. Mergers of big chemical producers were announced or completed, new joint ventures were created, companies continued to trim or expand their portfolios, and traditional chemical companies strived to redirect their operations in new directions. These signs all point to a chemical industry that is experiencing a slump worldwide. The spreading financial crisis in Asia only worsened the condition for the chemical industry. Production of chemicals throughout the world generally fell from their 1997 levels. Foreign markets tightened, leading to diminished chemical trade surpluses in many countries, including the United States growth of domestic demand for chemicals also slowed in many countries. As a consequence, sales, profits, and profitability declined for many chemical producers (*Chemical & Engineering News*, 1999).

A recent study conducted by the Chemical Manufacturers Association (CMA) showed that U.S. shipments of chemicals and allied products for 1998 had increased by only 0.6 percent compared to the previous year. Domestic demand was the main driver of this increase as exports declined 2.0 percent, the result of the Asia crisis and the high U.S. dollar. Shipments of industrial chemicals, however, fell by 6.9 percent. Imports rose 8.5 percent, which led to a reduction in the trade surplus from $19.1 billion (1997) to $13.4 billion (1998). Deficits occurred in organic chemicals, pharmaceuticals, and inorganic chemicals.

The CMA expects the overall condition of the U.S. economy to remained favorable through the first half of 2000. The financial crisis in Asia has come to an end, and exports rebounded through June 2000. With continued expansion of the U.S. economy, overall growth in chemical and allied products production volume is expected to be 1.3 percent during 1999 (CMA, 1999; CMA, 2000).

2.5.1 Market Volumes

2.5.1.1 Domestic Production

The *Annual Survey of Manufactures* provides production information for the chemical industry, expressed in terms of value of shipments. Table 2-12 shows the constant dollar value of shipments for 1989 through 1996 and a per-establishment value of shipments estimate. As shown, the value of shipments for all three SIC codes associated with OLD chemical manufacturers has declined for this period, with SIC 2865 showing the greatest decline. SIC 2869 has both the highest value of shipments and the greatest number of establishments. It also, for the most part, generates the highest value of shipments per establishment.

Table 2-12. Value of Shipments, 1989–1996 ($1997 10^3)

Year	2821 (Average per Establishment)	2865 (Average per Establishment)	2869 (Average per Establishment)
Establishments	**449**	**206**	**705**
1989	$41,663,543	$13,545,127	$68,292,396
	$92,792	*$65,753*	*$96,869*
1990	$37,617,734	$13,080,430	$65,038,291
	$83,781	*$63,497*	*$92,253*
1991	$34,147,102	$12,302,326	$61,292,533
	$76,051	*$59,720*	*$86,940*
1992	$35,185,584	$10,759,827	$60,981,721
	$78,364	*$52,232*	*$86,499*
1993	$34,545,260	$11,144,727	$58,438,582
	$76,938	*$54,101*	*$82,892*
1994	$39,899,914	$11,927,513	$62,091,775
	$88,864	*$57,901*	*$88,073*
1995	$45,402,987	$12,953,745	$66,028,846
	$101,120	*$62,882*	*$93,658*
1996	$40,893,978	$12,364,816	$63,986,002
	$91,077	*$60,023*	*$90,760*
Percentage Change 1989–1996	–1.85%	–8.71%	–6.31%

Source: U.S. Department of Commerce, Bureau of the Census. *Annual Survey of Manufactures*. Washington, DC: Government Printing Office.

According to trade journals, however, production in the overall chemical industry has increased in the past few years. Production in the overall chemical industry rose 4 percent in 1997, and 3 percent in 1996, according to the Federal Reserve Board's index of production for chemicals and allied products. Eleven of 13 chemical categories posted production gains, according Federal Reserve figures. Production levels for the industrial organic chemicals group increased 6 percent in 1997 (CMA, 1998). During 1998, however, the chemical industry posted only a modest gain of 1 percent. In 1998, only seven of the 13 chemical groups posted production gains, and five groups showed a decline in production. A 1 percent decline in production occurred in the industrial organic chemical group (DOE, EIA, 1999; *Chemical & Engineering News*, 1998).

2.5.1.2 Domestic Consumption

Domestic consumption of chemicals appears to have fluctuated greatly from 1990–1996. Table 2-13 shows the variations in consumption.

Table 2-13. Apparent Domestic Consumption, 1990–1996 ($1997 10^3)

Year	2821 (Average per Establishment)	2865 (Average per Establishment)	2869 (Average per Establishment)
1990	$4,969,288	$463,508	$4,128,328
1991	$6,325,065	$438,219	$4,344,540
1992	na	na	na
1993	na	na	na
1994	$5,838,556	$2,986,261	$716,683
1995	$657,905	$3,864,625	$1,168,075
1996	$6,773,578	$2,736,519	$160,646
Percentage Change 1990–1996	36.00%	490.00%	–96.00%

na = not available at this time

Note: Apparent Domestic Consumption = U.S. Value of Shipments – Value of Domestic Exports + Value of U.S. Imports for Consumption. Trade values adjusted using the PPI for the respective industry.

Sources: U.S. Department of Commerce, Bureau of the Census. *Annual Survey of Manufactures*. Washington, DC: Government Printing Office.
U.S. International Trade Commission, Dataweb database. www.dataweb.usitc.gov
U.S. Bureau of Labor Statistics, Producer Price Index – Current Series, Series Ids: PCU2869#, PCU2869#, PCU2821#. Data downloaded from www.bls.gov

2.5.1.3 International Trade

The chemical industry was the third largest export sector in the United States in 1998. Only the machinery and transport equipment and miscellaneous manufacturers sectors accounted for larger exports. Chemical exports fell for the first time in years in 1998, dropping 2 percent from $70.8 billion in 1997 to $69.3 billion in 1998. At the same time, chemical imports increased by 9 percent between 1997 and 1998, rising from $50.3 billion to $54.6 billion. The increase in imports and decrease in exports has lowered the chemical industry's trade surplus by 28 percent from 1997. The surplus decreased from $20.5 billion in 1997 to $14.7 billion in 1998 (*Chemical & Engineering News*, 1999). Table 2-14 presents the value of imports and exports between 1989 and 1996 for the specific segments of the chemical industry most affected by the OLD NESHAP.

Table 2-14. Value of Imports and Exports, 1989–1996 ($1997 10^6)

	2821		2865, 2869[a]	
Year	Imports	Exports	Imports	Exports
1989	$1,623	$5,767	$7,750	$13,198
1990	$1,998	$6,910	$8,565	$13,369
1991	$1,981	$8,240	$8,748	$13,453
1992	$2,408	$8,182	$9,720	$13,528
1993	$2,929	$8,353	$10,157	$14,479
1994	$3,666	$9,418	$11,763	$16,833
1995	$3,953	$10,005	$11,118	$16,433
1996	$4,296	$10,891	$11,555	$14,220

[a] Dollar values normalized using the producer price index (PPI) from the BLS for associated SIC codes. The PPI for SIC 2869 was used to normalize the trade category combining 2865 and 2869.

Source: U.S. Department of Commerce: International Trade Administration, Trends Tables.

2.5.2 Market Prices

Market prices for the chemical and allied products category were up only 0.3 percent in 1998. However, prices for the important industrial chemicals category, which accounts for more than 45 percent of chemicals and allied products shipments, declined by almost 4 percent from 1997 (*Chemical & Engineering News*, 1999). Table 2-15 presents the producer price index (PPI) for the three SIC codes comprising the OLD chemical manufacturing industry. The table shows that producer price levels have fluctuated over the 10-year period but have increased compared to their 1988 levels.

Table 2-15. Producer Price Index (PPI), 1988–1997

Year	2821 Plastic Resins and Materials	2865 Industrial Organic Materials: Intermediates	2869 Basic Organic Chemicals
1988	132.4	114.5	108.2
1989	133.4	123.9	116.2
1990	124.1	122.8	112.9
1991	120.0	120.5	110.6
1992	116.4	111.0	108.1
1993	117.1	107.5	110.0
1994	122.4	121.2	114.5
1995	143.5	155.9	130.9
1996	133.1	132.2	127.9
1997	137.3	123.2	128.4
Percentage Change 1988–1997	3.70%	7.60%	18.67%

Source: Bureau of Labor Statistics

As noted in previously in this section, organic liquids distributors handle a large number of chemicals. Table 2-16 lists the prices of 59 of the chemicals handled by facilities that responded to the 1998 EPA survey.

2.5.3 Future Projections

Constant-dollar shipments of organic chemicals are forecasted to increase at about 1.4 percent annually through 2002. This low growth rate is expected to result from slowing U.S. domestic markets and competition from foreign producers. Competition in the chemical industry is not only increasing in foreign markets, but in domestic markets as well. While imports have grown consistently since 1989 (and now account for 17 percent of demand),

Table 2-16. Current Market Prices of Common Organic Chemicals

Organic Chemical Liquid	Price per Pound ($)	Price per Gallon ($)
1,1,1 Trichloroethane	1.015	
1,2 Ethylene Dichloride	0.17	
Acetaldehyde	0.455	
Acetone	0.165	
Acetonitrile	0.65	
Acrylic Acid	0.87	
Acrylonitrile	0.53	
Aniline	0.495	
Carbon Tetrachloride	0.3825	
Chlorine	0.1275	
Creosote		0.925
Cresylic Acid		0.575
Cumene	0.2025	
Diethanolamine	0.7225	
Dispersions-Dibutyl Phthalate	0.78	
Epoxy/Ester Blend	1.58	
Ethanol	1.225	
Ethyl acrylate	0.8	
Ethylbenzene	0.2545	
Ethyl chloride	0.3375	
Ethylene Dibromide	0.76	
Ethylene Dichloride	0.17	
Ethylene Glycol	0.29	
Ethylene Oxide	0.49	
Formaldehyde Solution	0.125	
Gama-Butyrolactone	1.925	
Heptane	0.815	
Hexane	1.04	
Hydrazine	1.57	
Hydrochloric Acid	0.036	
Hydrogen Fluoride	1.83	
Isophorone	0.85	

(continued)

Table 2-16. Current Market Prices of Common Organic Chemicals (continued)

Organic Chemical Liquid	Price per Pound ($)	Price per Gallon ($)
Methyl Alcohol		0.47
Methyl Ethyl Ketone	0.46	
Methyl Formate	0.4117	
Methyl isobutyl ketone	0.65	
Methyl methacrylate	0.65	
Methyl tert butyl ether		0.975
Methylcyclohexane		1.1
Methylene Chloride	0.425	
Monochlorobenzene	0.55	
Naphtha		0.835
n-Hexane		1.04
Normal Heptane	0.815	
o-Cresol	0.735	
m-Cresol	0.125	
Perchloroethylene/Tetrachloroethylene	0.335	
Phenol	0.38	
Polyester	0.7425	

Source: *Chemical Market Reporter.* May 22, 2000. Chemical Prices. Pages 34–43. Schnell Publishing.

export prospects have been less positive. The United States is expected to remain a net exporter but the country's trade surplus is expected to continue to decline. Nevertheless, U.S. producers of petrochemicals and other organics should continue to benefit from low raw material and utility costs and productivity advantages (U.S. Industry and Trade Outlook, 1998).

SECTION 3

PETROLEUM LIQUIDS

Petroleum liquids are made up of a number of different liquids:

- **Crude Oil**. Crude oil is a mixture of hydrocarbons that exists in liquid phase in underground reservoirs and remains liquid at atmospheric pressure after passing through surface-separating facilities. Refineries turn crude oil into a myriad of refined petroleum products.
- **Natural Gas Liquids (NGLs)**. Natural gas is a mixture of hydrocarbon compounds existing in the gaseous state or in solution with oil in natural underground reservoirs. Through a process of condensation, NGL are separated from the "wet" natural gas, producing "dry" natural gas which is ready for consumption.
- **Nongasoline Refined Products**. Refinery products fall into three major categories—motor gasoline (about 46 percent of production); fuels and liquefied petroleum gases (about 45 percent of production); and other products, such as asphalt, lubricants, and petrochemical feedstocks (about 9 percent of production) (DOE, EIA, 1999). Table 3-1 shows the distribution of petroleum products produced at U.S. refineries in 1997.

3.1 Petroleum OLD Background

Since gasoline is already covered by the gasoline distribution NESHAP, this profile discusses the two major categories of nongasoline refined products—fuels and liquified petroleum gases (LPGs). The main fuel products included in the OLD source category are distillate fuel oil, kerosene-type jet fuel, and residual fuel oil. Distillate fuel oil includes diesel oil, heating oils, and industrial oils. It is used to power diesel engines in buses, trucks, trains, automobiles, and other machinery. In addition, it is used to heat residential and commercial buildings and to fire industrial and electric utility boilers. Kerosene-type jet fuel is primarily used in commercial airlines. Sometimes it is blended into heating oil and diesel fuel during periods of extreme cold weather. Residual fuel is used by electric utilities to

Table 3-1. Petroleum Products Produced at U.S. Refineries, 1997

Petroleum Product	Percent Produced
Motor gasoline	45.7%
Distillate fuel oil	22.5%
Jet fuel	10.3%
Residual fuel oil	4.7%
Still gas	4.4%
Petroleum coke	4.6%
Liquefied petroleum gases	4.6%
Asphalt and road oil	3.2%
Petrochemical feedstocks	2.9%
Lubricants	1.2%
Other	1.4%

Source: EIA, *Petroleum: An Energy Profile, 1999*, Figure 5-2.

generate electricity. It is also used as fuel for ships, industrial boiler fuel, and heating fuel in some commercial buildings (DOE, EIA, 1999).

While most LPGs are used as feedstocks for petrochemical production processes, individual LPG products also have distinct uses. Ethane is used primarily as a petrochemical feedstock. Butane is used as a gasoline blending component and for many domestic and industrial uses (DOE, EIA, 1999).

3.1.1 SIC and NAICS Codes and Description of Service Providers

- **Crude Oil**. The parts of the crude oil distribution channels that are relevant for the OLD source category are storage in crude oil pipeline stations, distribution to independent liquid terminals (including liquid terminals and petroleum terminals), and distribution of crude oil into the refineries. As shown in Table 3-2, pipelines are the most heavily used mode of transportation to deliver crude oil to refineries from domestic sources. Occasionally, trucks are used to transport crude oil from remote field storage sites. Railroads carry only a small amount of petroleum, generally products rather than crude. The most common mode of transporting imported crude oil into refineries is by tanker. Because the unloading of tankers at domestic refineries is already covered under the marine vessels MACT, it is not

Table 3-2. U.S. Refinery Receipts of Crude Oil by Method of Transportation and Source, 1998

Transport Method/Source	Receipts (10^3 Barrels) Domestic	Foreign
Pipeline	1,788,758	941,907
Tanker	424,939	2,121,744
Barge	66,995	64,458
Tank Car	13,019	0
Trucks	67,192	0
Total	2,360,903	3,128,109

Source: EIA, *Petroleum Supply Annual, 1988,* Vol. 1, Table 46.

subject to the OLD regulation.

- **NGLs**. Refineries can receive NGLs directly from the production field. or from gas processing plants. NGLs obtained from the production field are transported directly with the crude oil in the same pipelines. NGLs received from gas processing plants are transported by several different modes.

- **Nongasoline Refined Products**. Nongasoline refined products can be transported in several ways. Petroleum product pipelines are often used to transport refined products from refineries to storage facilities. Trucks are mainly used to deliver products from bulk storage to retail outlets or final consumers. Railroads carry only a small amount of petroleum, generally products.

Table 3-3 lists the SIC codes that fall under this description as well as corresponding NAICS codes.

3.1.2 Affected Markets

Three types of petroleum liquids are covered by the OLD source category—crude oil, NGLs, and refined petroleum products. Since crude oil and NGLs are the primary inputs into the production of refined petroleum products, the discussion in this section focuses on the consumers of, demand for, and price elasticities of the refined petroleum products (DOE,

Table 3-3. Principal OLD Facility Categories

SIC Code	SIC Description	NAICS Code	NAICS Description
Petroleum Refinery (56 survey responses)			
2911	Petroleum Refining	32411	Petroleum Refineries
Liquid Terminal (32 survey responses)			
4226	Special Warehousing and Storage, NEC	49311 49319	General Warehousing and Storage Other Warehousing and Storage
Crude Oil Pipeline Pumping/Breakout Station (24 survey responses)			
4612	Crude Petroleum Pipelines	48611	Pipeline Transportation of Crude Oil
Petroleum Terminal (10 survey responses)			
5169	Chemicals and Allied Products, NEC	42269	Other Chemical and Allied Products Wholesalers
5171	Petroleum Bulk Stations and Terminals	42271 454311 454312	Petroleum Bulk Stations and Terminals Heating Oil Dealers[a] LP Gas Sold Via Retail Method[a]

[a] Only part of this NAICS-coded industry consists of facilities that would also be classified in the corresponding SIC code.

Source: U.S. Census Bureau, March 2000, “1987 SIC Matched to 1997 NAICS” http://www.census.gov/epcd/naics/NSIC3B.HTML. As obtained on March 13, 2000.

EIA, 1999).

Petroleum liquids are inputs to virtually every industry in the United States. Crude oil becomes gasoline, diesel fuel, and jet fuel, which affects the transportation industry and facilitates the distribution of manufactured goods and the transportation industry. Refineries separate crude oil into petrochemical feedstocks that are used as inputs in the chemical industry and eventually become plastic or synthetic rubber products, automobile lubricants or antifreeze, cleaning compounds, or cosmetics. LPGs also become inputs into chemical compounds or fuel for household or farm use.

3.2 Production/Service Overview

OLD distribution is a service that is part of the production process for petroleum liquids.

3.2.1 Service Overview

Organic liquids first enter the path of the OLD source category at the point of custody transfer, shortly before the refinery stage. Pipelines carry crude oil and/or NGLs from production fields into the refineries. Along the way, the liquids are channeled through crude oil pipeline stations, which are used for surge capacity, sorting, measuring, rerouting, and temporary storage of the transported liquid. Crude oil pipeline stations are the first point of OLD regulation for petroleum liquids.

From the crude oil pipeline station, crude oil and NGLs are transported to a petroleum refinery; crude oil can also be transported to an independent liquid terminal (either a liquid terminal or a petroleum terminal). Petroleum refineries process crude oil and/or NGLs into refined petroleum products (including gasoline, distillate fuel oil, residual fuel oil, liquified petroleum gases, and petrochemicals).

After the refining process, the refined petroleum products might be distributed to one of three destinations—refined petroleum products might be distributed to end users belonging to different industries or they might be transported to an independent liquid terminal for storage before further processing. Liquids stored at independent liquid terminals might be transported to chemical production plants or refineries for further processing, they might be sent to a blending/packaging/distribution facility, or they might be distributed to end users.

3.2.2 Major By-Products and Co-Products, if Applicable

As discussed in Section 2, the U.S. Census Bureau calculates the specialization and coverage ratios only for industries that are classified as manufacturers (establishments with primary SIC codes between 20 and 40). Therefore, no specialization and coverage ratios are readily available for Liquid Terminal Facilities (SIC codes 4226—Special Warehousing and Storage, NEC); Crude Oil Pipeline Stations (SIC code 4612—Crude Petroleum Pipelines); or Petroleum Terminals (SIC codes 5169—Chemicals and Allied Products, NEC and 5171—Petroleum Bulk Stations and Terminals) (DOE, EIA, 1999).

Table 3-4 provides these ratios for petroleum refineries. The table shows a high degree of specialization by petroleum refineries. From 1987 to 1997, 99 percent of shipments from firms owning refineries were petroleum products. In 1997, 97 percent of all petroleum products supplied domestically originated from firms classified as petroleum refineries (DOE, EIA, 1999).

Table 3-4. Specialization and Coverage Ratios for OLD Industries, 1982, 1987, and 1992

SIC Code	SIC Description	1987	1992	1997
Petroleum Refinery				
2911	Petroleum refining			
	Primary products specialization ratio	99	99	99
	Coverage ratio	100	99	97

Sources: U.S. Department of Commerce, Bureau of the Census. 1992. Economic Census.
U.S. Department of Commerce, Bureau of the Census. 1999. *1997 Economic Census*, Manufacturing—Industry Series, "Petroleum Refining." Report E97M-3241A. Washington, DC.

3.2.3 Costs of Production

Table 3-5 presents overall production costs for potentially affected OLD industries by SIC code. The Census Bureau publishes production costs for manufacturing industries. No data are available for the transportation industries (4226 and 4612). Only operating costs are available for the wholesale industries (5169 and 5171). In contrast to the chemical sectors, SIC 2911 (Petroleum Refinery) spends relatively less on capital, labor, electricity and fuel, and relatively more on raw materials. In terms of production costs per facility, SIC 2911 (Petroleum Refinery) is approximately the same size as SICs 2821 and 2869.

3.2.4 Supply Elasticities

The price elasticity of supply, or own-price elasticity of supply, is a measure of the responsiveness of producers to changes in the price of a product. The price elasticity of supply indicates the percentage change in the quantity supplied of a product resulting from each 1 percent change in the price of the product.

The EIA for the petroleum refinery NESHAP (1995) econometrically estimated the price elasticity of supply for five petroleum products (motor gasoline, jet fuel, residual fuel oil, distillate fuel oil, and LPGs). The price elasticity of supply for the five petroleum products was estimated to be 1.24. Foreign supply is assumed to have the same price elasticity of supply as domestic supply. A supply elasticity of 1.24 is considered elastic. The

Table 3-5. Annual Production Costs ($1997 10^3)[a]

Cost of Production	2911 (Percentage of Total)[b]
Capital expenditures	$5,062,962 (3.60%)
Raw material costs	$129,453,238 (92.16%)
Labor costs	$2,240,193 (1.60%)
Electricity costs	$1,290,729 (0.92%)
Fuel costs	$2,418,863 (1.72%)
Total	$140,465,985
Number of establishments[c]	232
Production cost per establishment	$605,457

[a] Dollar values adjusted using the PPI for four-digit SIC codes from the Bureau of Labor Statistics.
[b] Source: U.S. Department of Commerce. 1996 Annual Survey of Manufactures. Washington, DC.
[c] Source: U.S. Department of Commerce. 1992 Census of Manufactures. Washington, DC.

percentage change in quantity exceeds the percentage change in price. In other words, quantity supplied is relatively responsive to a change in price in percentage terms.

3.2.5 Emissions

As shown in Section 1, EPA estimates that 281 petroleum liquids distributors perform activities that will be affected by the OLD NESHAP. Four emission sources have been identified that account for the majority of HAPs emissions from OLD activities:[1]

- storage tanks;

[1]Originally, wastewater and semi-aqueous waste were also believed to be sources of HAP emissions for the OLD source category. However, responses to the OLD survey indicated that insufficient information is available to determine nonzero MACT floors for wastewater. In addition, the survey indicated that semi-aqueous waste generated from OLD operations is generally kept in closed containers once it is collected. The handling of these wastes, at both chemical facilities and refineries, is already covered under the Resource Conservation and Recovery Act (RCRA) ("MACT Floor Development for the OLD Source Category," Memo, May 5, 1999). Consequently, emission sources associated with wastewater and semi-aqueous waste are excluded from this analysis.

- liquid transfer activities involving tank trucks and railcars (loading racks);
- container filling operations; and
- leaks from equipment components (e.g., pumps, valves).

3.3 Industry Organization

This section describes the organization of industries that distribute petroleum liquids, including market structure, the characteristics of distribution facilities, and the firms that own them.

3.3.1 Market Structure

Overall, the petroleum liquids distributors face a large degree of competition from fellow distributors. This section describes the producers, product differentiation, market concentration, and barriers to entry.

3.3.1.1 Producers

Suppliers in the petroleum industry can be divided into two principal types of firms:

- "Majors" are large companies that are typically fully integrated and operate facilities in all of the different petroleum sectors (i.e., exploration, production, transportation, refining, and marketing);
- "Independents" are smaller, nonintegrated companies that generally specialize in one aspect, such as crude oil exploration and production or product marketing (DOE, EIA, 1999).

Historically, majors have dominated the petroleum industry. However, the majors recently began a trend of selective refining/marketing divestiture that reduced their share of U.S. refining capacity from 72 percent in 1990 to 54 percent in 1998. Over the same period, the share of the independents rose from 8 percent to 23 percent.

Table 3-6 lists the top five companies for each of the petroleum SIC groups within this industry, ranked by sales. In addition to providing the name of the five largest companies, the table also indicates whether the company is publicly or privately held, and whether it is the parent or a subsidiary with a parent in a different SIC group. Although many of the most widely known companies in the U.S. economy are on the list, certain SIC groups (e.g., 4226, 5171) are dominated by companies that are not widely known outside their industry.

Table 3-6. Top Five OLD Companies Ranked by Sales within Four-Digit SIC

2911	4226	4612
1. Exxon Corp. (Public)	1. GATX Terminals Corp. (Private Subsidiary)	1. TransMontaigne Oil Co. (Public)
2. Mobil Corp. (Public)	2. DSC Logistics Inc. (Private)	2. Exxon Pipeline Co. (Private Subsidiary)
3. Texaco Inc. (Public)	3. Pierce Leahy Corp. (Public)	3. Lakehead Pipe Line Partners LP (Public)
4. Chevron Corp. (Public)	4. Support Terminal Services Inc. (Private Subsidiary)	4. Golden West Refining Co. (Private Subsidiary)
5. Shell Oil Co. (Private Subsidiary)	5. Continental Terminals Inc. (Private)	5. Williams Pipe Line Co. (Private Subsidiary)

5169	5171
1. Degussa Corp. (Private Subsidiary)	1. EOTT Energy Partners LP (Public)
2. Harris Chemical Group Inc. (Private)	2. Coastal Oil New England Inc. (Private Subsidiary)
3. Airgas Inc. (Public)	3. AmeriGas Propane (Private Subsidiary)
4. CHEMCENTRAL Corp. (Private)	4. Truman Arnold Co. (Private)
5. SOCO Chemical Inc. (Private Subsidiary)	5. Carlos R Leffler Inc. (Private)

Sources: Gale Research. 1999. *Ward's Business Directory of U.S. Private and Public Companies: 1999*. Detroit, MI: Gale Research, Incorporated.
American Petroleum Institute. August 1998. *Heating Oil in the United States.*
U.S. Environmental Protection Agency. July 1995. *Economic Impact Analysis for the Petroleum Refinery NESHAP*, Revised Draft for Promulgation.

3.3.1.2 Product Differentiation

Petroleum products are produced according to quality grade specifications and therefore do not vary much from one another. Brand loyalty is not expected to be an important factor in the petroleum products market (DOE, EIA, 1999).

3.3.1.3 Market Share

Table 3-7 shows concentration ratios by SIC code for the affected OLD industries involved in petroleum product distribution. Ratios are included for the census years 1987 and 1992 (where possible), although only 1992 data are available for some SIC codes.

Table 3-7. Concentration Ratios by SIC Code

SIC Code	Year	Total Number of Firms	Concentration Ratio				Herfindahl-Hirschman Index
			4 Firm	8 Firm	20 Firm	50 Firm	
Petroleum Refinery							
2911: Petroleum Refining							
	1987	200	32%	52%	78%	95%	435
	1992	132	30%	49%	78%	97%	414
Liquid Terminal							
4226: Special Warehousing and Storage, NEC							
	1992	1,212	27%	36%	50%	64%	NA
Crude Oil Pipeline Station							
4612: Crude Petroleum Pipelines							
	1992	52	60%	80%	97%	10%	NA
Petroleum Terminal							
5169: Chemicals and Allied Products, NEC							
	1992	7,446	27%	35%	50%	65%	NA
5171: Petroleum Bulk Stations and Terminals							
	1992	8,266	21%	34%	53%	64%	NA

Source: U.S. Department of Commerce, Bureau of the Census, Economic Census, 1992.

The numbers in Table 3-7 show that, by and large, the petroleum liquids distribution industries are characterized by a large number of firms and generally unconcentrated markets, indicating a high degree of competitiveness in their respective product markets. The exception is crude oil pipeline stations, which has relatively few firms (52) and high concentration ratios (a CR4 of 60.3 percent and a CR8 of 79.7 percent), indicating a high degree of concentration. These numbers are not surprising given that the pipeline industry is highly capital intensive (see discussion on barriers to entry in Section 3.3.1.3). In addition, FERC legislates and monitors the liquids pipeline industries. FERC ensures fair access to pipeline transportation at reasonable rates. Interestingly, the vast majority of crude oil pipeline companies with corporate offices in the United States are operated as subsidiaries of other corporate entities, mostly major oil companies. Only a few of the pipeline companies are independently listed on any stock exchange (Gale Business Resources, 1999).

An interesting fact can also be observed in the data for petroleum refineries—between 1987 and 1992, the total number of firms operating refineries decreased from 200 to 132 (a reduction of 34 percent). At the same time, neither the concentration ratios nor the HHI showed a trend to increased industry concentration. All indicators except the CR50 remained at their 1987 levels (or even declined).

More recently, two other trends in the petroleum market have affected the number and market shares of firms—mergers/joint ventures and divestitures. Over the past few years, a number of mergers and joint ventures have been undertaken in an effort to cut costs and increase profitability. This merger activity has occurred among the largest firms (as best illustrated by the recently approved acquisition of U.S.-based Amoco Corporation by the UK-based British Petroleum and the announced mega-merger of Exxon and Mobil Corporation) as well as among independent refiners and marketers (e.g., the independent refiner/marketer Ultramar Diamond Shamrock [UDS] acquired Total Petroleum North America in 1997 and announced a joint venture with Phillips Petroleum in October 1998, which was later abandoned) (DOE, EIA, 1999).

During the 1990s, the U.S. majors also began a process of selective refining/marketing divestiture to counter the long period of low profitability in the refining/marketing line of business. This divestiture of downstream assets by the majors created opportunities for smaller, independent U.S. refiners/marketers to acquire domestic refineries and petroleum marketing outlets and to move into market areas formerly dominated by the U.S. majors. In 1990, the U.S. majors (including their joint ventures) held 72 percent of U.S. refining capacity. The independent refiners/marketers who pursued acquisition growth strategies in the 1990s (the "fast-growing independent refiners") then held only 8 percent of domestic capacity, while all other refiners held 20 percent. By October 1998, the U.S. majors' share of domestic crude distillation capacity had fallen to 54 percent (60 percent including their joint ventures), and the fast-growing independent refiners had increased their share to 23 percent, an almost threefold increase. The remaining capacity (18 percent) is still held by all other refiners (DOE, EIA, 1999).

3.3.1.4 Barriers to Entry

As explained in Section 2, barriers to entry are an important component of the market structure. As indicated above, common carrier pipelines in the United States are government regulated due to the industry's structure, which can be characterized as a natural monopoly. The crude oil pipeline industry is capital intensive. Start-up costs are high, and entry into the industry is restricted, as is indicated by the small number of firms operating with headquarters in the United States. However, since the day-to-day maintenance of capital-intensive industries tends to be relatively moderate, successful companies within the pipeline industries have been able to take advantage of economies of scale.

3.3.2 Facilities

Although EPA has received surveys from only about 45 percent (126 out of 281) of the universe of OLD in the chemical industry, an examination of the data provided in the surveys does have the capacity to illustrate general characteristics of those facilities. The data presented here are for the 118 facilities (out of 126) who did not request that their surveys be considered classified information.

3.3.2.1 Location

Figure 3-1 shows that 31 percent of petroleum liquids distributors are located in Texas, 12 percent are in Louisiana, and 10 percent are located in Alaska.

3.3.2.2 Production Capacity and Utilization

Facilities in SIC code 2911 were operating at 91 percent capacity in 1998 and 1997 according to the U.S. Census Bureau (U.S. Department of Commerce).

3.3.2.3 Employment

Figure 3-2 shows that almost 40 percent of facilities involved in the distribution of petroleum liquids employ fewer than 25 people on-site, while another 40 percent of facilities employ more than 250 employees each.

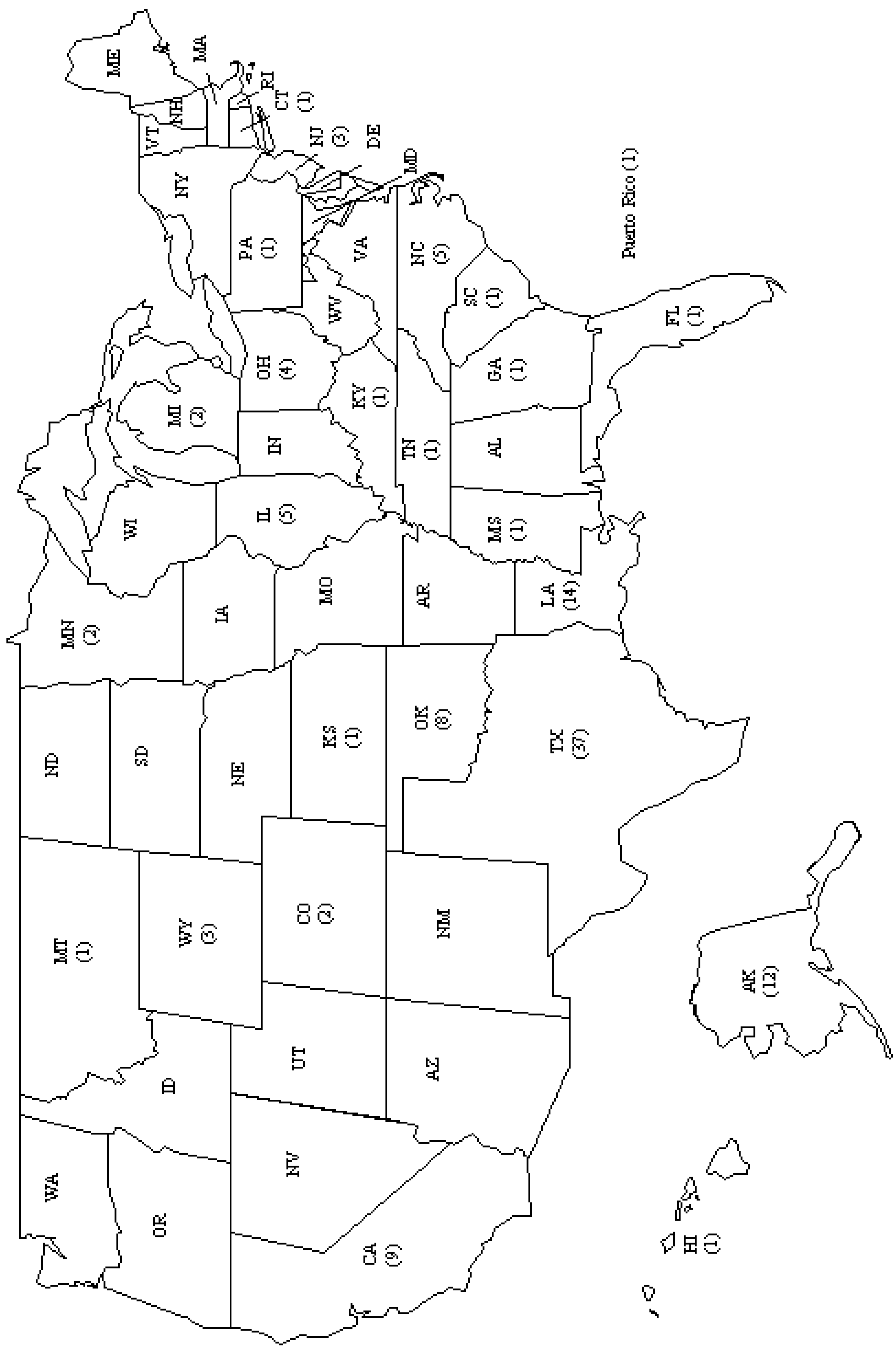

Figure 3-1. Location of Petroleum Liquids Distributors

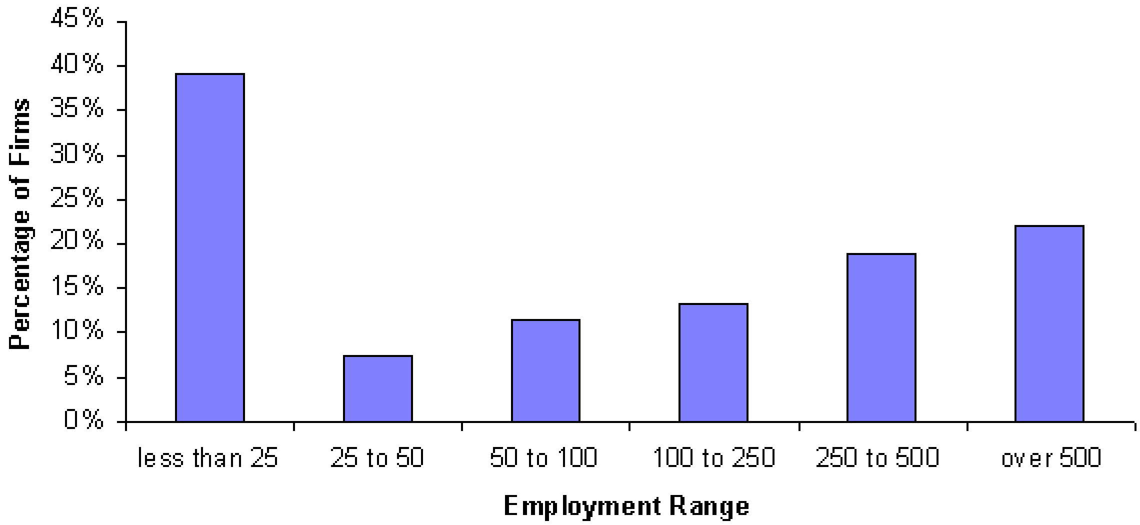

Figure 3-2. The Distribution of Organic Chemical Liquids Facilities by Employment

Source: Nonclassified responses to the 1998 Industry Specific Information Collection Request for the Development of an Organic Liquids Distribution Maximum Achievable Control Technology.

3.3.3 Firm Characteristics

Table 3-8 presents an overview of the total number of firms for each petroleum OLD SIC code, the total number of firms potentially affected by the OLD source category, and the percentage of the source category potentially affected.

3.3.3.1 Ownership

Table 3-9 presents the legal form of ownership for the SIC codes associated with the OLD source category. The OLD source category is heavily dominated by firms organized as corporations. For example, in 1987, 177 of 200 petroleum refineries (or 88.5 percent) were classified as corporations. In 1992, 914 of 1,212 liquid terminals (or 75.4 percent), and 49 of 52 crude oil pipeline stations (or 94.2 percent) were classified as corporations (DOE, EIA, 1999; Speed, 1999).

3.3.3.2 Size Distribution

Table 3-10 presents the SBA small business standards for the OLD source category and also shows the number of small firms in the industry. The SBA size definitions for all

Table 3-8. Number of Total OLD Firms and Affected Firms, 1996

SIC Code	SIC Description	Total Number of Establishments[a]	Total Number of Affected Facilities	% of Source Category that is Affected
Petroleum Refinery				
2911	Petroleum Refining	244	111	45.5%
Liquid Terminal				
4226	Special Warehousing and Storage, NEC	1,218 - 2,576[b]	94	3.6% to 7.7%
Crude Oil Pipeline Station				
4612	Crude Petroleum Pipelines	482	35	7.3%
Petroleum Terminal				
5169	Chemicals and Allied Products, NEC	8,892	41[d]	0.2%
5171	Petroleum Bulk Stations and Terminals	6,729[c]		

[a] U.S. Census Bureau. September 1999. "Petroelum Refinery." *1997 Economic Census, Manufacturing—Industry Series*, E97M-3251I, Washington, DC: Government Printing Office.
U.S. Census Bureau. January 2000. "Transportation and Warehousing." *1997 Economic Census, Manufacturing—Industry Series*, E97M-3251I, Washington, DC: Government Printing Office.
U.S. Census Bureau. January 2000. "Wholesale Trade." *1997 Economic Census, Manufacturing—Industry Series*, E97M-3251I, Washington, DC: Government Printing Office.
U.S. Census Bureau. March 2000. "Retail Trade." *1997 Economic Census, Manufacturing—Industry Series*, E97M-3251I, Washington, DC: Government Printing Office.
U.S. Census Bureau. February 1998. "Statistics for Industry Groups and Industries." *1997 Economic Census, Manufacturing—Industry Series*, E97M-3251I, Washington, DC: Government Printing Office.

[b] The smallest number is the minimum number of facilities in this category. The larger number is the maximum number of facilities in this category, calculated by including all 877 facilities in NAICS industry 49311 (General Warehousing and Storage) and all 486 facilities in NAICS industry 49312 (Refrigerated Warehousing and Storage) in the source category, although only part of the facilities in those industries would actually fit into the SIC code 4226.

[c] This is an underestimate. Facilities now classified in NAICS codes 454311 (Heating Oil Dealers) and 454312 (Liquified Petroleum Dealers) are not included.

[d] This is the combined estimated number of affected facilities in this industry.

OLD industries, except for liquid terminals, is defined in terms of employees. The size standard for these SIC categories ranges from 100 employees in the petroleum terminal industry to 1,500 employees for petroleum refineries and crude oil pipeline stations. Based on currently available data (i.e., SBA's Statistics of U.S. Businesses), the number of small firms can only be estimated. For most of the SIC groups of interest, the size categories provided do not correspond to the SBA definition. Data are available for firms with fewer than 100 employees, with between 0 and 499 employees, with more than 500 employees, and with more than 2,500 employees.[2]

Thus, Table 3-10 presents two estimates—the number of definitely small firms and the number of potentially small firms. For all SIC groups with SBA definitions of 750 or more, the definitely small estimate is of firms with fewer than 500 employees. The potentially small firm estimate includes the difference between firms with 2,500+ employees and those with 500+ employees. Thus, the two estimates bracket the actual number of small

[2]The SBA data do not rank firms by revenue.

Table 3-9. Firms' Legal Form of Organization for OLD Industries, 1987 and 1992

SIC Code	Corporations	Sole Proprietorship	Partnerships	Other and Unknown	Total
Petroleum Refinery[a]					
2911	177	3	7	13	200
Liquid Terminal[b]					
4226	914	168	126	4	1,212
Crude Oil Pipeline Station[b]					
4612	49	—	1	2	52
Petroleum Terminal[c]					
5169	6,857	490	88	11	7,446
5171	7,040	985	173	68	8,266

Sources: [a]1987 Census of Manufactures, Subject Series, Table 2.
[b]1992 Census of Transportation, Subject Series, Table 7.
[c]1992 Census of Wholesale Trade, Subject Series, Table 9.

Table 3-10. Small Business Size Standards for OLD Industries

SIC Code	SIC Description	SBA Small Business Standard	Total Firms[a]	Number of Definitely Small Firms (Percentage of Total)[a,b]	Number of Potentially Small Firms (Percentage of Total)[a, c]
Petroleum Refinery					
2911	Petroleum Refining	1,500 employees	173	118 68.21%	133 76.88%
Liquid Terminal					
4226	Special Warehousing and Storage, NEC	$18.5 million[d]	1,299		
Crude Oil Pipeline Station					
4612	Crude Petroleum Pipelines	1,500 employees	52	19 36.54%	26 50.00%
Petroleum Terminal					
5169	Chemicals and Allied Products, NEC	100 employees	8,040	7,634 94.95%	N/A
5171	Petroleum Bulk Stations and Terminals	100 employees	5,854	5,362 91.60%	N/A

[a] Source: Statistics of U.S. Businesses, 1996
[b] Includes firms with fewer than 500 employees, except for SICs 5169 and 5171, where entry includes firms with fewer than 100 employees.
[c] Includes firms with fewer than 2,500 employees.
[d] The SBA small business standard for SIC Code 4226 represents annual firm revenue. Firm size by revenue is not available in Statistics of U.S. Businesses 1996.

Sources: Small Business Association. Small Business Size Standards Matched to SIC codes as of June 14, 1999.
Speed, Phillip J. "The Changing Competitive Landscape of the Chemical Industry." *Chemicalbond*. <http://www.socma.org/bond/feature1.html>. As obtained on September 2, 1999.
U.S. Department of Energy, Energy Information Administration. July 1999. *Petroleum: An Energy Profile 1999*. DOE/EIA-0545(99).

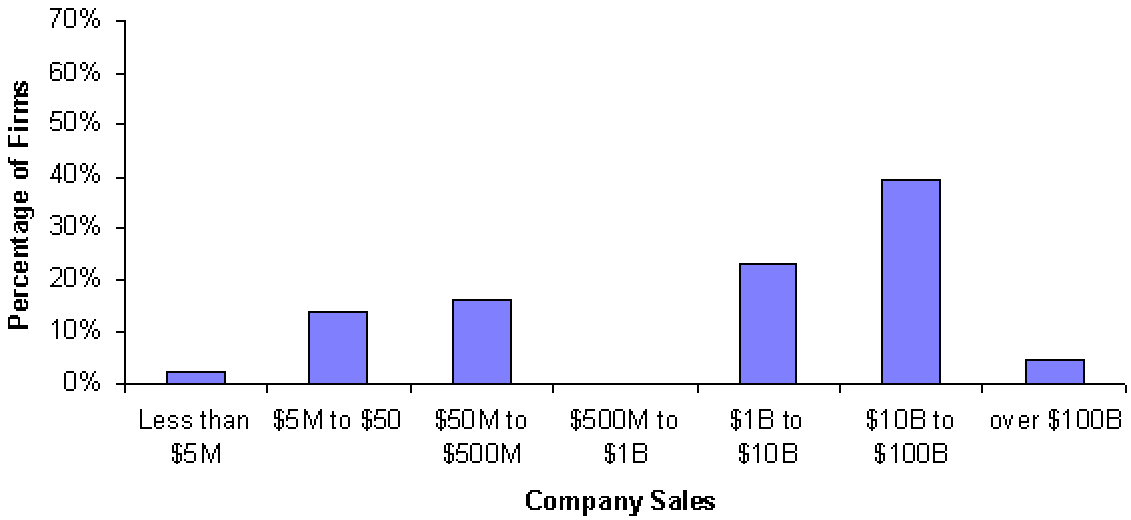

Figure 3-3. The Size Distribution of Companies that own OLD Facilities involved in the Distribution of Nongasoline Petroleum Liquids, by 1998 Sales (in $1997)

Note: Sales data are from 1998 but were converted into 1997 dollars to: (1) facilitate comparison with other figures reported in this profile and (2) allow easy comparison with estimated compliance costs, which are calculated in 1997 dollars.

Sources: Dun & Bradstreet. 1999. Company Capsules. As available on EBSCO.
General Business File International (formerly Business ASAP). 1999. Gale Group Collections. As obtained from InfoTrac Web.
Hoover's Incorporated. 1999. Hoover's Company Profiles. Austin, TX: Hoover's Incorporated. <http://www.hoovers.com/>.
Company Websites.
Company 10k Reports.
U.S. Environmental Protection Agency. 2000. *Technical Support Document for the Organic Liquids Distribution (Non-gasoline) Industry*. Washington, DC: USEPA, Office of Air Quality Planning and Standards..

firms. Note that nearly all petroleum terminals are small and between 70 and 78 percent of petroleum refineries are small. In contrast, only between 36 and 50 percent of crude oil pipeline firms are small.

Although Table 3-10 provides a general impression of the size of firms owning petroleum liquid distribution facilities, EPA's survey of OLD facilities provides a more accurate representation of firms owning facilities affected by the OLD NESHAP. The 126 surveyed facilities are owned by 45 companies. According to SBA standards, 9 percent (4

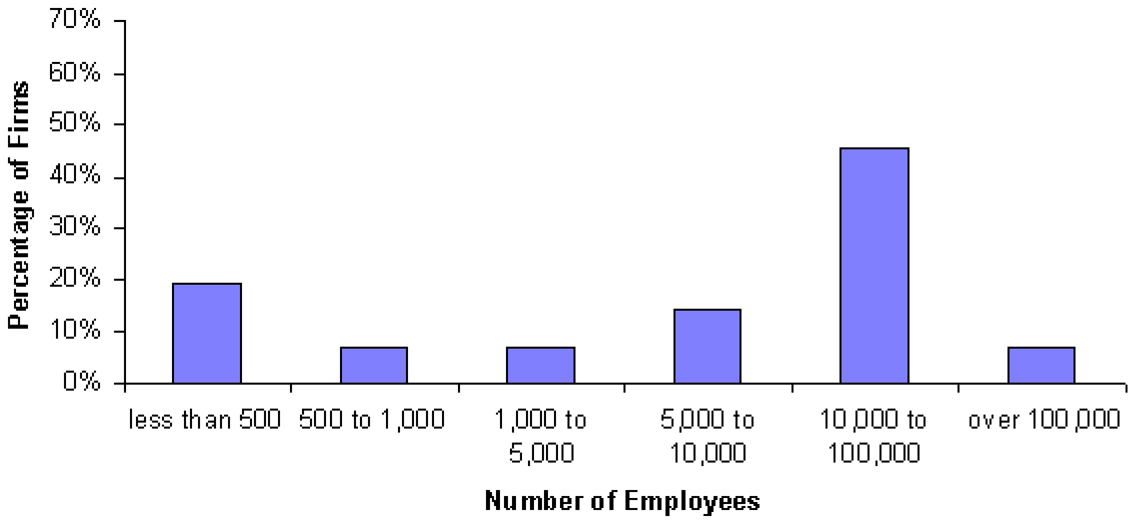

Figure 3-4. Size Distribution of Companies that own OLD Facilities involved in the distribution of non-gasoline petroleum liquids

Sources: Dun & Bradstreet. 1999. Company Capsules. As available on EBSCO.
General Business File International (formerly Business ASAP). 1999. Gale Group Collections. As obtained from InfoTrac Web.
Hoover's Incorporated. 1999. Hoover's Company Profiles. Austin, TX: Hoover's Incorporated. <http://www.hoovers.com/>.
Company Websites.
Company 10k Reports.
U.S. Environmental Protection Agency. 2000. *Technical Support Document for the Organic Liquids Distribution (Non-gasoline) Industry*. Washington, DC: USEPA, Office of Air Quality Planning and Standards.

out of 45) of those companies are small businesses. A larger percentage of unsurveyed petroleum liquid distribution facilities may be owned by small businesses, but even if all of those facilities are owned by small businesses, the percentage of firms affected by the OLD NESHAP that are small would at most be 57 percent.

Figures 3-3 and 3-4 show the distribution of surveyed firms by firm size as measured by revenue and employment. The majority of affected firms took in more than $1 billion in revenues in 1998 and employ more than 5,000 people.

3.3.3.3 Vertical and Horizontal Integration

- **Vertical Integration**. The petroleum industry consists of two main functional sectors—the upstream sector (including exploration and production) and the downstream sector (including refining, transportation, and marketing). The industry exhibits a high degree of vertical integration with many firms operating in more than one sector (DOE, EIA, 1999). For example, the crude petroleum pipeline industry is dominated by giant oil companies with assets in many of the downstream sectors of the industry (Gale Business Resources, 1999). Of the two types of petroleum firms, majors are generally fully integrated and operate facilities in all the different sectors. Independents, on the other hand, are nonintegrated and generally specialize in one aspect, such as crude oil exploration and production or product marketing (DOE, EIA, 1999).

- **Horizontal Integration**. Major petroleum companies are horizontally integrated because they operate several refineries that are often distributed around the nation. On the other hand, the smaller independent firms typically operate only one refinery each and are therefore not horizontally integrated (EPA, 1995). Fifty-six of the facilities that responded to EPA's survey for the OLD NESHAP are petroleum refineries. Those refineries are owned by 21 firms. Three (14 percent) of those firms own six refineries each. Nine (43 percent) of those firms own two to four refineries each. The remaining nine firms own only one refinery each and so are totally nonintegrated horizontally.

3.3.3.4 Financial Condition

Throughout the 1990s, the U.S. refining and marketing industry was characterized by unusually low product margins, low profitability, selective retrenchment, and substantial restructuring. Profitability (measured as return on investment) from refining operations of domestic petroleum companies has varied widely throughout the decade (and even before 1990). During 1997, the profitability of U.S. refining and marketing was the highest since 1989, which was in part achieved by low energy costs as well as cost-cutting measures, including a number of mergers and joint ventures in the downstream sector (DOE, EIA, 1999).

The crude petroleum pipeline industry has experienced modest but steady growth since 1993. As a result, company profits have also increased. This trend has been a result of lower operating costs and moderate expanses in deliveries (Gale Business Resources, 1999; DOE, EIA, 1999).

Table 3-11 shows that, for the firms that own the 126 facilities that responded to the EPA survey,[3] the average (median) profit margin was 4.3 (4.7) percent. Figure 3-5 shows the distribution of profit margins among firms that own petroleum liquids distributors.

Table 3-11. Profit Margins of Firms that own Organic Chemical Liquids Distribution Facilities

Median	0.043364
Average	0.04732
Maximum	0.347377
Minimum	–0.06935

Source: Nonclassified responses to the 1998 Industry Specific Information Collection Request for the Development of an Organic Liquids Distribution Maximum Achievable Control Technology.

3.4 Uses and Consumers

This section describes the uses and consumers of petroleum liquids, as well as the demand elasticities and possible substitutes for the product.

3.4.1 Major Consumers

Five major economic sectors consume petroleum products (DOE, EIA, 1999):

- Residential Sector: This sector includes private households that consume energy primarily for space heating, water heating, air conditioning, refrigeration, cooking, and clothes drying.
- Commercial Sector: This sector includes nonmanufacturing or nontransportation business establishments, including numerous service enterprises; health, social, and educational institutions; religious and nonprofit organizations; and government institutions. Street lights, pumps, bridges, and public services are also included.

[3]Forty-five firms own surveyed facilities. Profit, employment, and sales data were identified for only 43 of those facilities.

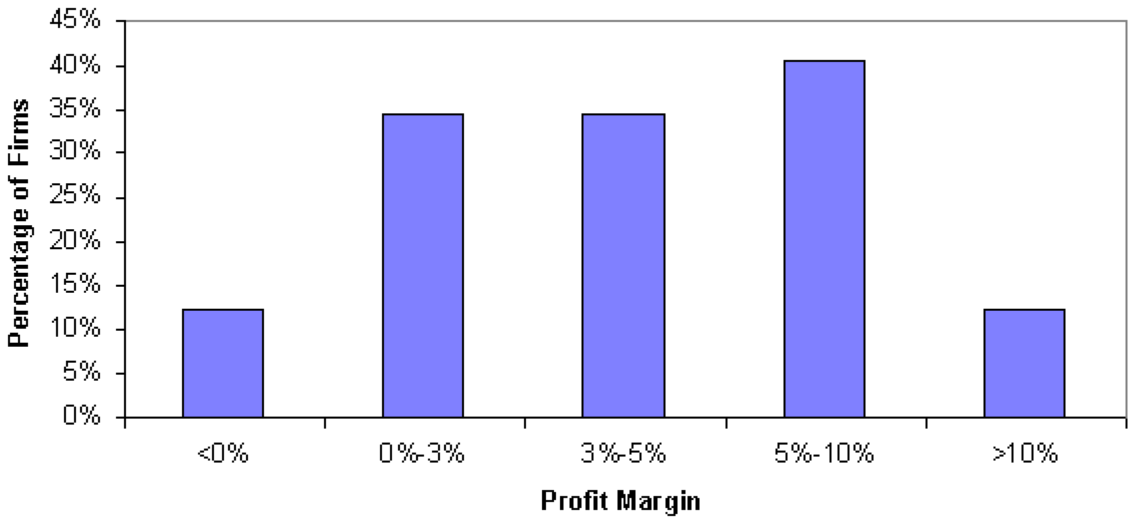

Figure 3-5. Distribution of Firms by Profit Margin

Sources: Dun & Bradstreet. 1999. Company Capsules. As available on EBSCO.
General Business File International (formerly Business ASAP). 1999. Gale Group Collections. As obtained from InfoTrac Web.
Hoover's Incorporated. 1999. Hoover's Company Profiles. Austin, TX: Hoover's Incorporated. <http://www.hoovers.com/>.
Company Websites.
Company 10k Reports.
U.S. Environmental Protection Agency. 2000. *Technical Support Document for the Organic Liquids Distribution (Non-gasoline) Industry*. Washington, DC: USEPA, Office of Air Quality Planning and Standards.
Dun & Bradstreet. 1997. Industry Norms & Key Business Ratios: Desk-Top Edition 1996–1997.

- Industrial Sector: This sector includes manufacturing, construction, mining, agriculture, fishing, and forestry establishments.
- Transportation Sector: This sector includes private and public vehicles (e.g., automobiles, trucks, buses, motorcycles, railroads and railways, aircraft, ships, barges, and natural gas pipelines).
- Electric Utility Sector: This sector includes privately and publicly owned establishments that generate, transmit, distribute, or sell electricity primarily for use by the public. Nonutility power producers are not included in the electric utility sector

3.4.2 Purpose of Consumption

The demand for petroleum products is influenced by several factors, including crude oil prices, economic growth trends, and weather conditions. Low oil prices tend to stimulate demand. Demand also increases during periods of economic expansion, particularly in the industrial and transportation sectors. Economic expansions lead to an increase in the production of goods, which contributes in turn to an increase in the demand for transportation of raw materials and the deliveries of finished products. Petroleum demand is also influenced by weather conditions. Extreme weather tends to either increase or decrease the use of heating oil and electricity, which contributes to the demand for petroleum products. Weather can also contribute to the seasonal variations in demand for transportation fuels (such as gasoline).

As discussed in Section 3.1, the main refinery products are motor gasoline, distillate fuel oil, jet fuel, residual fuel oil, and LPGs. The demand for each of these products is briefly discussed below. The demand for petrochemicals, an output from the refinery process but an input into chemical manufacturing, is discussed in Section 2.

- Motor Gasoline: Although motor gasoline is not included in the OLD source category, the discussion of its demand is relevant to this source category because it accounts for the largest share of crude oil use. Demand for motor gasoline alone accounts for more than 40 percent of the total demand for petroleum products. A number of factors influence the demand for motor gasoline. For example, rising gasoline prices encourage consumers to reduce discretionary driving and stimulate consumer demand for smaller, more fuel efficient automobiles (DOE, EIA, 1999).

- Distillate Fuel Oil: Distillate fuel oil markets include transportation (diesel-powered trucks), household (space-heating), industrial (fuel for commercial burners), and electric utilities (electricity generation). Most diesel fuel is used for transportation purposes; highway diesel fuel represents more than half of distillate fuel sales. Residential heating, the next largest end-use category, represents about 12 percent of annual distillate use but is concentrated in the winter months (DOE, EIA, 1999). In addition, trucking use has been the fastest growing segment of distillate demand, accounting for only 40 percent of distillate oil sold in 1986, but more than 52 percent in 1996 (API, 1998).

- Distillate fuel oil is the primary source of space heating for millions of businesses and residences. This demand is concentrated in the Northeast. Between 1990 and 1996, the annual demand for heating oil for commercial and residential use ranged between 9 and 11 billion gallons a year (API, 1998). As a country, the United States now uses less heating oil than it did in the 1970s, when demand was at its peak. The decline in heating oil use reflects the increased availability of natural gas in the Northeast, the development of more efficient electric heating systems, and the investment in energy conservation by homes and businesses, all of which coincided with high oil prices.

- Jet Fuel Oil: Jet fuel is primarily used in commercial airlines. Its demand is therefore driven by a combination of price concerns and the overall health of the airline industry (EPA, 1995). Sometimes, jet fuel is also blended into heating oil and diesel fuel during periods of extreme cold weather (DOE, EIA, 1999).

- Residual Fuel Oil: The main uses of residual fuel oil include the commercial and industrial sectors (heating), utilities (electricity generation), and the transportation sector (fuel for ships). Nonutility use of residual fuel has been decreasing due to interfuel substitution in the commercial and industrial sectors. Although electric utilities use relatively little petroleum compared with the transportation and industrial sectors, this sector depends on petroleum for about 5 percent of its total energy requirements. Much of the surplus capacity for electricity generation is oil-fired, so petroleum use by utilities is expected to increase along with electricity demand (DOE, EIA, 1999). Annual demand for residual fuel oil has fallen for 9 consecutive years and has been on a downward trend since peaking at approximately 3 million barrels per day in 1977 (*Oil & Gas Journal*, 1999).

- LPGs: LPGs such as propene, ethane, propane, isobutane, and n-butane rank fifth in usage among petroleum products. Their major nonfuel use is as feedstocks for petrochemicals. They are also used as fuel for domestic heating and cooking, and farming operations and as an alternative to gasoline for use in internal combustion engines. Demand levels for LPGs can be attributed to their various end uses (DOE, EIA, 1999).

3.4.3 Characterization of Demand—Derived Demand Elasticity

The demand for petroleum is also influenced by the price of petroleum itself and the price of available substitutes. The degree to which the price of petroleum influences the quantity of petroleum products demanded is called the *price elasticity of demand*. Generally speaking, the price elasticity of demand represents the percentage change in the quantity demanded resulting from a 1 percent change in the price of the product. Table 3-12 lists the price elasticities of demand for several of the major petroleum products.

The elasticity estimates indicate that each of these products has inelastic demand. Regulatory control costs are more likely to be paid by consumers of products with inelastic

Table 3-12. Estimates of Price Elasticity of Demand for Petroleum Products

Motor gasoline	–0.55 to –0.82
Jet fuel	–0.15
Residual fuel oil	–0.61 to –0.74
Distillate fuel oil	–0.50 to –0.99
Liquified petroleum gases	–0.60 to –1.0

Source: EPA, *Economic Impact Analysis for the Petroleum Refining NESHAP*, July 1995, p. 78.

demand as compared to products with elastic demand, all other factors held constant. Price increases for products with inelastic demand lead to revenue increases for the producers. Thus, one can predict that price increases resulting from implementation of regulatory control costs will lead to higher gross revenues for the producers (EPA, 1995).

Demand becomes more elastic with the availability of substitutes and the passage of time. In the short run, there may not be substitutes readily available for consumption. However, over time, consumers have the opportunity to adjust to the price increase and will seek alternatives. In the case of the petroleum industry, as the prices of crude oil and petroleum products increase, consumers may not be able to respond immediately. The short-run demand elasticity is inelastic because petroleum plays a critical role in today's lifestyles (*Oil & Gas Journal*, 1999).

3.4.4 Substitution Possibilities

As time passes, consumers can adjust to price changes, and consumer behavior may change. If the price of these products increases because of regulatory actions, consumers will switch fuels (especially at electric utilities) in industrial plants having dual-fuel boilers and in households that have wood-burning stoves and electric heaters. Sustained high prices may also encourage actions such as design changes that increase fuel efficiency in automobiles, improved insulation in newly constructed and existing buildings, and design changes in appliances to improve energy efficiency. Once in place, these long-term conservation measures continue to affect fuel use, regardless of subsequent price fluctuations.

The discussion of substitution in this section only addresses substitution among end products. However, conceptually, it may be possible for a facility to substitute one mode of liquid transportation for another. This substitution could make sense economically if the loading or unloading activities associated with one mode of transportation were found to account for significantly more HAP emissions, and therefore potential compliance requirements, than another. However, it is equally important that a switch from one mode of transportation to another must be technically feasible. Neither engineering analyses nor compliance cost estimates developed for this regulation have given any indication of potential substitutability between different modes of liquid transportation. Therefore, this analysis assumes that the only substitution possibilities exist between end products (*Oil & Gas Journal*, 1999; EPA, 1995).

3.5 Markets

The petroleum industry is a major sector in the U.S. economy. A significant portion of the petroleum consumed domestically is imported. The industry experienced relatively high prices in 1996 and 1997; however, petroleum prices declined substantially in 1998 (Gale Business Resources, 1999).

3.5.1 Market Volumes

Petroleum refining is one of the leading manufacturing industries in the United States. The value of shipments by the petroleum refining industry accounts for about 4 percent of the value of shipments by the entire manufacturing sector of the U.S. economy. In 1996, the value of shipments by the petroleum refining industry was an estimated $158 billion (DOE, EIA, 1999).

Figures 3-6 and 3-7 compare trends in the value of shipments by petroleum refineries (SIC code 2911) to gross domestic product (GDP) growth between 1989 and 1996. While GDP grew every year except 1992, value of shipments of petroleum refineries decreased between 1990 and 1994. This decrease is the result of sharp drops in the prices of petroleum products. The fact that value of shipments decreased despite increases in the production of petroleum products (see Table 3-13) reflects that the price elasticity of demand for petroleum products is relatively inelastic—for each 1 percent decrease in price, the quantity demanded increases by less than 1 percent, causing value of shipments to fall.

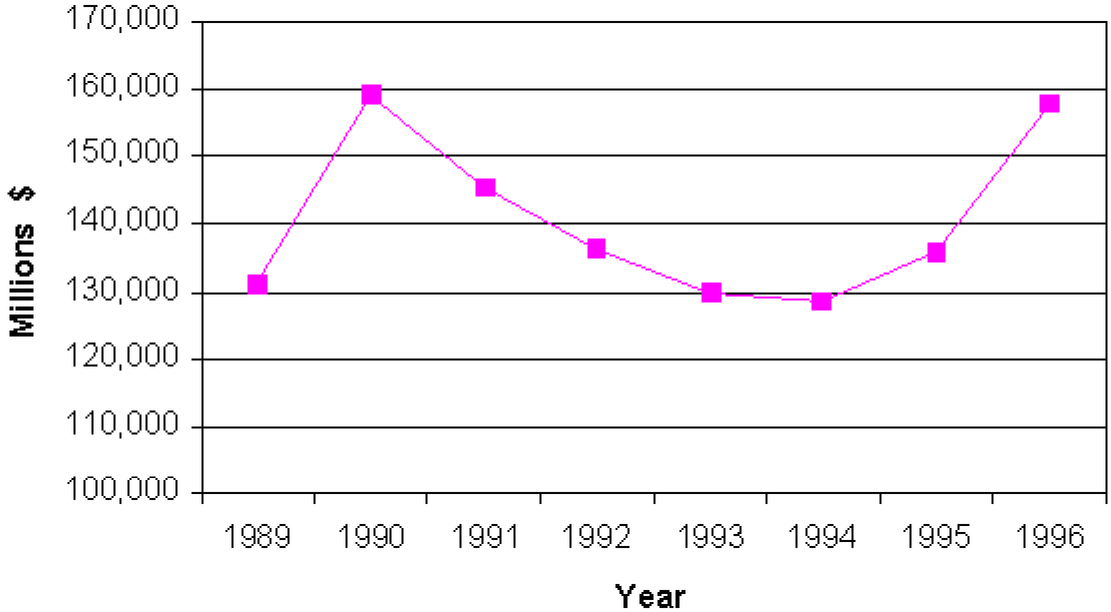

Figure 3-6. Value of Shipments, 1989–1996 (SIC 2911)

3.5.1.1 Domestic Production

Table 3-13 lists the domestic production trends for crude oil and petroleum products for the past decade. From its peak of 9.6 million barrels per day in 1970, domestic crude oil production has declined to 6.3 million barrels per day in 1998. In the past decade, the production of crude oil has declined by 18 percent from its 1989 production level. The decline in domestic production of crude oil has been attributed to a transfer of U.S. investment from domestic sources to foreign production. The transfer is a result of lower labor costs, less stringent regulatory environments, and the increased likelihood of discovering larger fields in overseas activity.

In contrast to crude oil, the domestic production of most petroleum products has increased in the past decade. Refinery production of motor gasoline has increased each year,

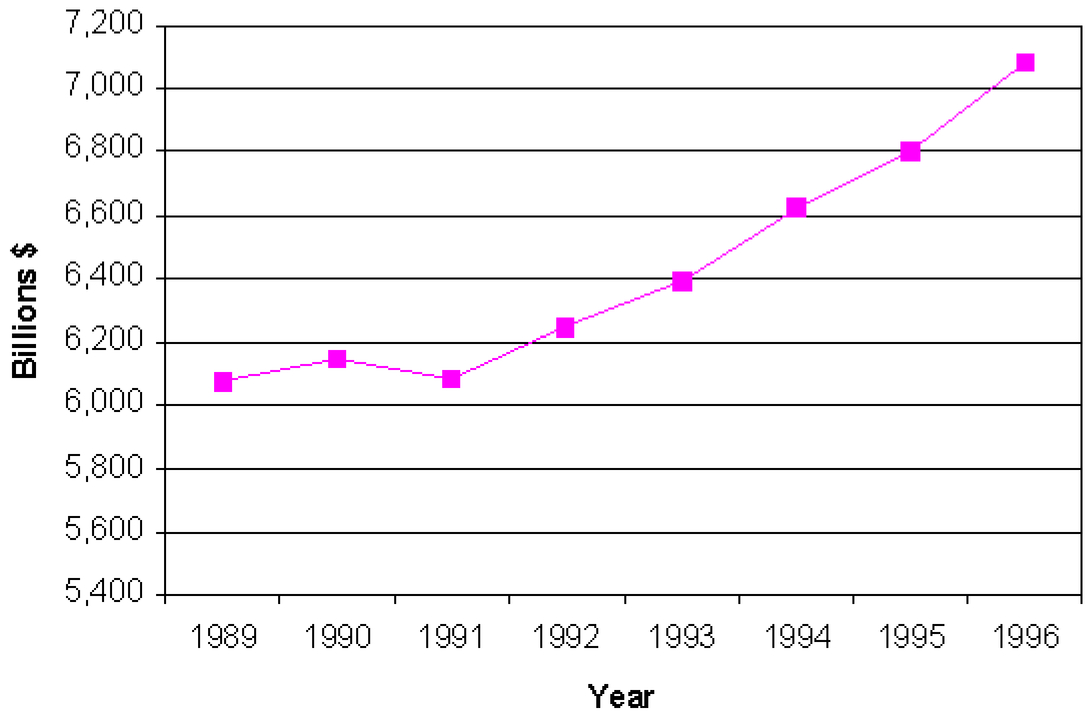

Figure 3-7. GDP, 1989–1996

with the exception of periods of economic recession. Distillate fuel oil production has also increased in the past decade, with a 1998 production level that is 16 percent higher than the 1989 level. Residual fuel oil is the only petroleum product that has not experienced an increase in production over the last 10 years. The current production rate is 20 percent lower than it was a decade ago. Domestic production of jet fuel, LPGs, and other petroleum products has also grown, with increases of 9 percent, 17 percent, and 17 percent, respectively.

3.5.1.2 Domestic Consumption

Table 3-14 presents domestic consumption of crude oil and petroleum products for the past decade. Crude oil is the primary input for the production of the various petroleum products. Therefore, as consumption of the various end products either increases or

Table 3-13. Total Production of Petroleum Products, 1989-1998 (10^3 barrels/day)

Year	Crude Oil	Finished Motor Gasoline	Distillate Fuel Oil	Residual Fuel Oil	Jet Fuel	LPG	Other Petroleum Products[a]
1989	7,613	6,963	2,899	954	1,403	1,668	2,771
1990	7,355	6,959	2,925	950	1,488	1,556	2,842
1991	7,417	6,975	2,962	934	1,438	1,689	2,826
1992	7,171	7,058	2,974	892	1,399	1,755	2,928
1993	6,847	7,360	3,132	835	1,422	1,734	3,035
1994	6,662	7,312	3,205	826	1,448	1,880	2,973
1995	6,560	7,588	3,155	788	1,416	1,899	3,031
1996	6,465	7,647	3,316	726	1,515	2,012	3,108
1997	6,452	7,870	3,392	708	1,554	2,038	3,204
1998	6,252	8,082	3,424	762	1,526	1,952	3,253
Percentage Change 1989-1998	–18%	16%	18%	–20%	9%	17%	17%

[a] Other petroleum products include pentanes plus other hydrocarbons and oxygenates, unfinished oils, gasoline blending components, and all finished petroleum products except for those listed in the table.

Source: EIA, *Petroleum Supply Annual,* 1998, Vol. I, Table S2, S4, S5, S6, S7, S9, S10

decreases, so does the consumption of crude oil. While there were slight declines in crude oil consumption in the early 1990s, the overall demand for crude oil has increased by 9 percent in the past decade.

Table 3-14 also shows that domestic consumption of petroleum products has fluctuated in the past decade. However, the overall trend has been an increase in consumption for most products. Level of consumption and increase in consumption have been greatest for LPGs, motor gasoline, and other petroleum products. The consumption of motor gasoline has increased by 13 percent in the past 10 years. The increase in motor gasoline in the late 1990s can be partly attributed to more vehicles with reduced fuel efficiency (i.e., light truck, vans, and sport utility vehicles) being purchased in response to low gasoline prices (DOE, EIA, 1999). Also responsible for the increase in motor gasoline consumption is the increase in vehicle miles driven per car from 8,813 in 1980 to 11,314 in

Table 3-14. Consumption of Petroleum Products, 1989–1998 (10^3 barrels/day)

Year	Crude Oil	Finished Motor Gasoline	Distillate Fuel Oil	Residual Fuel Oil	Jet Fuel	LPG	Other Petroleum Products[a]
1989	17,325	7,328	3,157	1,370	1,489	1,668	2,285
1990	16,988	7,235	3,021	1,229	1,522	1,556	2,402
1991	16,714	7,188	2,921	1,158	1,471	1,689	2,269
1992	17,033	7,268	2,979	1,094	1,454	1,755	2,470
1993	17,237	7,476	3,041	1,080	1,469	1,734	2,426
1994	17,718	7,601	3,162	1,021	1,527	1,880	2,518
1995	17,725	7,789	3,207	852	1,514	1,899	2,457
1996	18,309	7,891	3,365	848	1,578	2,012	2,608
1997	18,620	8,017	3,435	797	1,599	2,038	2,733
1998	18,917	8,253	3,461	887	1,622	1,952	2,741
Percentage Change 1989-1998	9%	13%	10%	-35%	9%	17%	20%

[a] Other petroleum products include pentanes plus other hydrocarbons and oxygenates, unfinished oils, gasoline blending components, and all finished petroleum products except for those listed in the table.

Source: EIA, *Petroleum Supply Annual,* 1998, Vol. I, Table S2, S4, S5, S6, S7, S9, S10

1996 (*Oil & Gas Journal*, 1998). Residual fuel oil consumption has experienced perhaps the most noticeable change in the past decade, declining 35 percent. This decline in demand can be attributed to a change from heavier fuels to lighter ones, as industry complies with environmental regulations (mainly air emission reductions). In addition, lower natural gas prices have contributed to displacing residual fuel use. An increasing number of air passengers and flights has led to a rise in the demand for jet fuel from 1989 to 1998.

3.5.1.3 International Trade

Imports. Foreign trade plays a critical role in the U.S. crude oil market, and imports of crude oil in the United States far outweigh exports of crude oil. With a decline in domestic production and an increase in consumption, crude oil imports provide the missing link as U.S. oil demand continues to increase. Table 3-15 shows imports of petroleum between 1989 and 1998.

Table 3-15. Imports of Petroleum Products, 1989-1998 (10^3 barrels/day)

Year	Crude Oil	Finished Motor Gasoline	Distillate Fuel Oil	Residual Fuel Oil	Jet Fuel	LPG	Other Petroleum Products[a]
1989	5,843	369	306	629	106	181	627
1990	5,894	342	278	504	108	188	705
1991	5,782	297	205	453	67	147	675
1992	6,083	294	216	375	82	131	707
1993	6,787	247	184	373	100	160	770
1994	7,063	356	203	314	117	183	761
1995	7,230	265	193	187	106	146	708
1996	7,508	336	230	248	111	166	879
1997	8,225	309	228	194	91	169	945
1998	8,706	311	210	275	124	194	888
Percentage Change 1989-1998	49%	–16%	-31%	–56%	17%	7%	42%

[a] Other petroleum products include pentanes plus other hydrocarbons and oxygenates, unfinished oils, gasoline blending components, and all finished petroleum products except for those listed in the table.

Source: EIA, *Petroleum Supply Annual,* 1998*,* Vol. I, Table S2, S4, S5, S6, S7, S9, S10

As shown in Table 3-15, U.S. imports of crude oil have increased 49 percent in the last decade alone. Imports of refined petroleum products, on the other hand, have declined since the mid-1980s, accounting for slightly more than one-third of total petroleum imports in 1985, but less than one-fifth by 1997 (DOE, EIA, 1999). In the past decade, the amount of motor gasoline, distillate fuel oil, and residual fuel oil imported have all declined, while imports of LPG and other petroleum products have increased.

Similarly, the import-to-consumption ratios presented in Table 3-16 show a pattern of increasing dependency on imports. The import-to-consumption ratio reveals the degree to which imports account for the amount of crude oil used domestically. It is quite substantial in the United States, accounting for 46 percent in 1998 and has been increasing over the period shown.

Table 3-16. Crude Oil Imports as a Percentage of Consumption, 1989-1998 (10^3 barrels/day)

Year	Imports	Consumption	Percent
1989	5,843	17,325	34%
1990	5,894	16,988	35%
1991	5,782	16,714	35%
1992	6,083	17,033	36%
1993	6,787	17,237	39%
1994	7,063	17,718	40%
1995	7,230	17,725	41%
1996	7,508	18,309	41%
1997	8,225	18,620	44%
1998	8,706	18,917	46%

Source: EIA, *Petroleum Supply Annual, 1998*, Vol. I, Table S2.

The Organization of Petroleum Exporting Countries (OPEC) leads the world oil market. OPEC accounted for approximately 46 percent of crude oil imports to the United States in 1997. Most petroleum imports enter the United States in the following three areas: the Gulf Coast, the East Coast, and the Midwest. The consumers of these imports are refiners, brokers, and bulk terminals. Companies that operate refineries are the leading importers of crude oil and petroleum products in the United States. Large integrated oil companies are also heavy importers of crude oil, but they also import petroleum products. Smaller refineries tend to import either refined products exclusively or a mix that is predominately crude oil. Bulk terminal operators, brokers, and consumers bring in nearly one-half of the major petroleum products imported. Despite unused domestic refining capacity, traders and consumers can sometimes obtain products more economically from foreign sources, if nearby refineries lack the facilities, location, or distribution system necessary to serve them at competitive prices (DOE, EIA, 1999).

Exports. Although the United States is a net importer of petroleum, some exports of crude oil and petroleum products do occur. The United States exported a combined 1 million barrels per day of crude oil and petroleum products in 1997, matching the record level set in

1993. The five leading countries that receive United States exports of petroleum are Mexico, Canada, Japan, Republic of Korea, and Spain. Crude oil exports averaged 110,000 barrels per day in 1998. This average is down from its peak in 1980 of 287,000 barrels per day. Product exports have averaged more than 600,000 barrels per day since 1986 and reached 896,000 barrels per day in 1997, when they accounted for more than 89 percent of petroleum exports. This number dropped in 1998 to 835,000 barrels per day, representing 88 percent of total petroleum exports. The three leading petroleum product exports, in order of volume exported, are petroleum coke, distillate fuel oil, and motor gasoline (DOE, EIA, 1999).

Table 3-17 shows that the exports of crude oil, residual fuel oil, and jet fuel have all declined in the past decade. The most noticeable export increase has been in motor gasoline, which has increased by 221 percent in the past 10 years. While foreign demand is the primary factor determining export levels for the heavier petroleum products, there are other economic incentives for exporting petroleum products. For example, shipping costs may be lower for exports than for domestic transfers because many international water shipments are shorter than domestic transfers. In addition, because many United States ports cannot accommodate large supertankers, domestic shipments are often unable to realize the same economies of scale as international shipments.

Table 3-18 shows the percentage of domestic production that is exported. This ratio is extremely small, showing that most crude oil produced in the United States is used for domestic consumption. The ratio has remained stable over the past 10 years, only varying between 1 and 2 percent.

3.5.2 Market Prices

Crude oil prices are set in international market and have been on a general decline since 1981. OPEC has the ability to influence oil prices worldwide because its members possess such a large portion of the world's oil supply. If OPEC restricts supply, prices increase. If OPEC floods the market with crude oil, prices decrease, which is what happened in 1986 when prices fell dramatically because OPEC increased supplies of crude oil. The sharp price decline in 1998 was attributable to plentiful crude oil supplies (partly due to Iraq's increased production). There has also been a general trend of price decline in petroleum products. Part of this decline is due to a reduction in demand from suffering

Table 3-17. Exports of Petroleum Products, 1989-1998 (10^3 barrels/day)

Year	Crude Oil	Finished Motor Gasoline	Distillate Fuel Oil	Residual Fuel Oil	Jet Fuel	LPG	Other Petroleum Products[a]
1989	142	39	97	215	27	35	305
1990	109	55	109	211	43	40	289
1991	116	82	215	226	43	41	277
1992	89	96	219	193	43	49	263
1993	98	105	274	123	59	43	300
1994	99	97	234	125	20	38	329
1995	95	104	183	136	26	58	348
1996	110	104	190	102	48	51	376
1997	108	137	152	120	35	50	402
1998	110	125	124	138	26	42	380
Percentage Change 1989-1998	–23%	221%	28%	–36%	–4%	20%	25%

[a] Other petroleum products include pentanes plus other hydrocarbons and oxygenates, unfinished oils, gasoline blending components and all finished petroleum products except for those listed in the table.

Source: EIA, *Petroleum Supply Annual,* 1998, Vol. I, Table S2, S4, S5, S6, S7, S9, S10.

Asian economies and a decrease in United States demand for heating oil because of unseasonably warm weather (API, 1999).

Table 3-19 shows that the price of crude oil and refined petroleum products have all substantially decreased from 1989 to 1998. The largest drop was in crude oil, closely followed by kerosene-type jet fuel, and residual fuel oil.

3.5.3 Future Projections

The current status of the potentially affected industries is important to establish a baseline for the economic impact analysis. However, since compliance costs will not be incurred until some time in the future, it is also important to consider projections of future economic trends when estimating likely impacts of a regulation.

Table 3-18. Crude Oil Exports as a Percentage of Production, 1989-1998 (10^3 barrels/day)

Year	Exports	Production	Percent
1989	142	7,613	2%
1990	109	7,355	1%
1991	116	7,417	2%
1992	89	7,171	1%
1993	98	6,847	1%
1994	99	6,662	1%
1995	95	6,560	1%
1996	110	6,465	2%
1997	108	6,452	2%
1998	110	6,252	2%

Source: EIA, *Petroleum Supply Annual, 1998*, Vol. I, Table S2.

The Energy Information Administration (EIA) publishes the *Annual Energy Outlook*, which presents midterm forecasts on energy supply, demand, and prices. The analysis performed focuses on a reference case and four other cases that assume higher and lower economic growth and higher and lower world oil prices than in the reference case. The projections are based on results from EIA's National Energy Modeling System (NEMS). Information on petroleum found in this section is based on the 1999 *Annual Energy Outlook*.

3.5.3.1 Domestic Production

Domestic crude oil production is expected to continue to decline throughout the next 20 years. It is expected to decrease by 1.1 percent a year, from 6.5 million barrels per day in 1997 to 5.0 million barrels per day in 2020. This decline in domestic production will lead to a decline in domestic petroleum supply. Domestic supply in 1997 was 9.4 million barrels per day. In NEMS's low price projection, supply drops to 7.6 million barrels per day in 2020; in its high price projection, supply drops to 9.3 million barrels.

Table 3-19. Table United States Crude Oil and Petroleum Products Prices ($/gal)

Year	Refiner Acquisition Cost of Crude Oil (Domestic)	Motor Gasoline	No. 2 Distillate Fuel Oil	Residual Fuel Oil	Kerosene-Type Jet Fuel
1989	$0.43	$0.76	$0.59	$0.39	$0.59
1990	$0.54	$0.88	$0.73	$0.44	$0.77
1991	$0.46	$0.80	$0.65	$0.34	$0.65
1992	$0.44	$0.79	$0.62	$0.34	$0.61
1993	$0.40	$0.76	$0.60	$0.34	$0.58
1994	$0.37	$0.74	$0.56	$0.35	$0.53
1995	$0.41	$0.77	$0.56	$0.39	$0.54
1996	$0.49	$0.85	$0.68	$0.46	$0.65
1997	$0.47	$0.84	$0.64	$0.42	$0.61
1998	$0.31	$0.67	$0.49	$0.30	$0.45
Percentage Change 1989-1998	–28%	–12%	–17%	–23%	–24%

Source: EIA, *Petroleum Marketing Monthly*, September 1999, Table 1&2.

3.5.3.2 Domestic Consumption

Domestic consumption of petroleum is expected to increase over the next 20 years. United States petroleum consumption is projected to increase by 6.0 million barrels per day between 1997 and 2020 in the reference case, 3.9 million barrels per day in the low growth case, and 8.2 million in the high growth case. The transportation sector is expected to account for most of the increase in petroleum consumption. However, a change in the consumption pattern of the transportation sector is expected to occur. Gasoline accounted for 65 percent of the petroleum consumed for transportation. However, this share is expected to decrease to 61 percent in 2020 as alternative fuels are introduced to the transportation market. The share of jet fuel is expected to increase from 13 percent to 17 percent as air travel continues to expand.

3.5.3.3 International Trade

As domestic production continues to decline and domestic consumption continues to grow, oil imports will continue to increase. The projections for net petroleum imports in 2020 range from a high of 18.3 million barrels per day in the low oil price case to a low of 14.3 million barrels per day in the low growth case. This is more than double the 1997 level of 9.2 million barrels per day. Table 3-20 shows consumption and net imports of crude oil and petroleum products for 1997 and projections for 2020.

Table 3-20. Petroleum Consumption and Net Imports in 1997 and 2020 (10^6 barrels/ day)

Year and Projection	Consumption	Net Imports	Net Crude Imports	Net Product Imports
1997	18.6	9.2	8.1	1.0
2020 Projections				
Reference	24.7	16.0	12.0	4.0
Low oil price	26.0	18.3	13.1	5.2
High oil price	24.0	14.6	11.5	3.1
Low growth	22.5	14.3	11.4	2.9
High growth	26.8	17.7	12.6	5.1

Source: EIA, *Annual Energy Outlook 1999*, Table 10.

As discussed earlier, crude oil imports currently account for the majority of foreign imports of petroleum. Crude oil is expected to continue as the major component of petroleum imports. However, the import share of refined products is expected to increase in the future. More imports of petroleum products will be needed as growth in demand for refined products exceeds the expansion of domestic refining capacity.

Future exports of petroleum from the United States will depend on economic conditions worldwide and the restrictions placed on trade both in the United States and abroad. The industrialized countries will continue to be the major oil consumers over the next 20 years. However, petroleum use will increase at the fastest rate in developing countries. The United States will continue to export petroleum products (especially the heavy products, which are in less demand in this country) (DOE, EIA, 1999).

3.5.3.4 Market Prices

Oil prices have fluctuated greatly in the past, which makes future price projections uncertain. However, future oil prices are expected to be higher than current prices. The latest year for which comprehensive data is available is 1998, a year which saw uncharacteristically low prices for petroleum-based products. The reference case for oil projects prices to rise by about 0.9 percent a year, reaching $22.73 in constant 1997 dollars in 2020. In nominal dollars, the reference case price exceeds $43 in 2020. The low price case projects prices rising to $14.57 by 2005 and remaining at about that level until 2020. The high price case has a price rise of about 2.5 percent per year until 2015 and then remains at $29.35 until 2020. The leveling off at about $29.35 in the high price case is due to the market penetration of alternative energy supplies that could become economically viable at that price (DOE, EIA, 1999).

REFERENCES

Abt Associates. October 15, 1998. *Characterization of the Organic Liquid Distribution (Nongasoline) Industry*. Prepared for the U.S. Environmental Protection Agency.

American Petroleum Institute. August 1998. *Heating Oil in the United States.*

American Petroleum Institute. February 26, 1999. *Economic State of the U.S. Petroleum Industry.*

Arnold, Roger A. 1989. *Microeconomics*. 2nd Ed. St. Paul: West Publishing Company.

Baseline Emissions for the Organic Liquids Distribution (Nongasoline) Source Category. Memo to Docket. June 7, 1999.

Chemical & Engineering News. 1999. "Facts and Figures for the Chemical Industry." 77(26).

Chemical & Engineering News. June 29, 1998.

Chemical Manufacturers Association. Mid-2000 Business of Chemistry Outlook, as obtained on June 22, 2000. <www.cmahq.com/cmahg.com/cmawebsite.nsf/s?readform&nnar-ljhw6>.

Chemical Manufacturers Association. March 1999*. The 1998 U.S. Chemical Industry Performance and Outlook*. Downloaded from website.

Chemical Manufacturers Association website (www.cmahq.com). Economic News and Information: *Houses and Chemicals*, based on an article in the November 1995 issue of CMA News.

Chemical Manufacturers Association website (www.cmahq.com). Economic News and Information: *Cars and Chemicals*, based on an article in the September 1995 issue of CMA News.

Chemical Market Reporter. May 27, 2000. Chemical Prices. Pages 34–43. Schnell Publishing.

Distribution. August 1996. "More Work for Chemical Distributor."

Dun & Bradstreet. 1999. Company Capsules. As available on EBSCO.

Dun & Bradstreet. 1997. *Industry Norms & Key Business Ratios.* Desk-Top Edition 1996–1997.

EIA, Petroleum: An Energy Profile, 1999, p. 30.

Encyclopedia Britannica. "Petrochemical." As obtained on June 19, 2000. <www.britannica.com.>

Gale Business Resources. 1999. "Chemicals and Allied Products, Not Elsewhere Classified."

Gale Business Resources. 1999. "Pipelines, Crude Petroleum."

Gale Business Resources. 1999. "Special Warehousing and Storage, Not Elsewhere Classified."

Gale Research. 1999. *Ward's Business Directory of U.S. Private and Public Companies: 1999*. Detroit, MI: Gale Research, Incorporated.

General Business File International (formerly Business ASAP). 1999. Gale Group Collections. As obtained from InfoTrac Web.

Hoover's Incorporated. 1999. Hoover's Company Profiles. Austin, TX: Hoover's Incorporated. <http://www.hoovers.com/>.

Oil & Gas Journal. 1999. "Supply Management By Major Exporters Key to Market In Year's Second Half." July 27:60-61.

Oil & Gas Journal. 1998. "Weather, Construction Inflation could Squeeze North American Pipelines." 96(35).

Small Business Administration. *Statistics of U.S. Businesses, 1996*. Washington, DC.

Speed, Phillip J. "The Changing Competitive Landscape of the Chemical Industry." *Chemicalbond*. <http://www.socma.org/bond/feature1.html>. As obtained on September 2, 1999.

U.S. Bureau of Labor Statistics, Producer Price Index – Current Series, Series Ids: PCU2869#, PCU2869#, PCU2821#. Data downloaded from www.bls.gov

U.S. Census Bureau. March 2000. "1987 SIC Matched to 1997 NAICS." http://www.census.gov/epcd /naics/NSIC3B.HTML. As obtained on March 13, 2000.

U.S. Census Bureau. August 1999. "Plastics Material and Resin Manufacturing." *1997 Economic Census, Manufacturing—Industry Series*, E97M-3251I, Washington, DC: Government Printing Office.

U.S. Census Bureau. August 1999. "All Other Basic Organic Chemical Manufacturing." *1997 Economic Census, Manufacturing—Industry Series*, E97M-3251I, Washington, DC: Government Printing Office.

U.S. Census Bureau. August 1999. "Synthetic Organic Dye and Pigment Manufacturing." *1997 Economic Census, Manufacturing—Industry Series*, E97M-3251I, Washington, DC: Government Printing Office.

U.S. Census Bureau. August 1999. "All Other Basic Inorganic Chemical Manufacturing." *1997 Economic Census, Manufacturing—Industry Series*, E97M-3251I, Washington, DC: Government Printing Office.

U.S. Census Bureau. August 1999. "Ethyl Alcohol Manufacturing." *1997 Economic Census, Manufacturing—Industry Series*, E97M-3251I, Washington, DC: Government Printing Office.

U.S. Census Bureau. August 1999. "Industrial Gas Manufacturing." *1997 Economic Census, Manufacturing—Industry Series*, E97M-3251I, Washington, DC: Government Printing Office.

U.S. Census Bureau. August 1999. "Petrochemical Manufacturing." *1997 Economic Census, Manufacturing—Industry Series*, E97M-3251I, Washington, DC: Government Printing Office.

U.S. Department of Commerce, Bureau of the Census. 1999. *1997 Economic Census*, Manufacturing—Industry Series, "Petroleum Refining." Report E97M-3241A. Washington, DC.

U.S. Department of Commerce, Bureau of the Census. *U.S. Industry and Trade Outlook 1998: Chemicals and Allied Products*. Washington, DC.

U.S. Department of Commerce, Bureau of the Census. January 1996. *Current Construction Reports: Value of New Construction Put in Place*. Washington, DC.

U.S. Department of Commerce, Bureau of the Census. December 1995/January 1996. *Housing Completions*. Washington, DC.

U.S. Department of Commerce. 1996 Annual Survey of Manufactures. Washington, DC.

U.S. Department of Commerce. 1992 Census of Manufactures. Washington, DC.

U.S. Department of Commerce, Bureau of the Census. 1992. Economic Census.

U.S. Department of Energy, Energy Information Administration. July 1999. *Petroleum: An Energy Profile 1999*. DOE/EIA-0545(99).

U.S. Department of Energy, Energy Information Administration. *Annual Energy Outlook, 1999*.

U.S. Department of Energy, Energy Information Administration. "The U.S. Petroleum Refining and Gasoline Marketing Industry." *Overview of Domestic Petroleum Refining and Marketing.* <http://www.eia.doe.gov/emeu/finance/usi&to/downstream/>. As obtained on July 9, 1999.

U.S. Department of Energy, Energy Information Administration. "The U.S. Petroleum Refining and Gasoline Marketing Industry." *Recent Structural Changes in U.S. Refining: Joint Ventures, Mergers, and Mega-Mergers.* <http://www.eia.doe.gov/emeu/finance/usi&to/downstream/>. As obtained on July 9, 1999.

U.S. Department of Energy, Energy Information Administration. July 1999. *Petroleum: An Energy Profile 1999.* DOE/EIA-0545(99).

U.S. Department of Energy, Energy Information Administration. June 1999. *Petroleum Supply Annual 1998*. Volume 1. DOE/EIA-0340(98)/1. Washington, DC.

U.S. Environmental Protection Agency. 2000. *Technical Support Document for the Organic Liquids Distribution (Non-gasoline) Industry*. Washington, DC: U.S. Environmental Protection Agency, Office of Air Quality Planning and Standards.

U.S. Environmental Protection Agency. May 5, 1999. Memorandum. "MACT Floor Development for the OLD Source Category."

U.S. Environmental Protection Agency. June 24, 1998. Memorandum. "Production Projections for the OLD Source Category."

U.S. Environmental Protection Agency. July 1995. *Economic Impact Analysis for the Petroleum Refinery NESHAP*, Revised Draft for Promulgation.

U.S. Environmental Protection Agency. *Crude Oil and Natural Gas Production and Natural Gas Distribution NESHAP*.

U.S. International Trade Commission, Dataweb database. www.dataweb.usitc.gov