4C PETROLEUM AND COAL PRODUCTS (SIC 29)

EPA's *Detailed Industry Questionnaire: Phase II Cooling Water Intake Structures* identified one 4-digit SIC code in the Petroleum and Coal Products Industry (SIC 29) with at least one existing facility that operates a CWIS, holds a NPDES permit, withdraws equal to or greater than two million gallons per day (MGD) from a water of the United States, and uses at least 25 percent of its intake flow for cooling purposes. (Facilities with these characteristics are hereafter referred to as "section 316(b) facilities"). Table 4C-1 below provides a description of the industry sector, a list of primary products manufactured, the total number of detailed questionnaire respondents (weighted to represent national results), and the number and percent of section 316(b) facilities.

Table 4C-1: Section 316(b) Facilities in the Petroleum and Coal Products Industry (SIC 29)

SIC	SIC Description	Important Products Manufactured	Number of Weighted Detailed Questionnaire Survey Respondents		
			Total	Section 316(b) Facilities	
				No.	%
2911	Petroleum Refining	Gasoline, kerosene, distillate fuel oils, residual fuel oils, and lubricants, through fractionation or straight distillation of crude oil, redistillation of unfinished petroleum derivatives, cracking, or other processes; aliphatic and aromatic chemicals as byproducts	163	31	19.2%

Source: U.S. EPA, 2000; Executive Office of the President, 1987.

4C.1 Domestic Production

The petroleum refining industry accounts for about 4 percent of the value of shipments of the U.S. entire manufacturing sector and for 0.4 percent of the manufacturing sector's employment (U.S. DOE, 1999a). According to the Economic Census, petroleum refineries had a real value of shipments of approximately $212 billion dollars ($2000) and employed 64,789 people in 1997. Petroleum products contribute approximately 40 percent of the total energy used in the United States, including virtually all of the energy consumed in transportation (U.S. DOE, 1999a).

U.S. DOE Energy Information Administration (EIA) data report that there were 155 operable petroleum refineries in the U.S. as of January 2001, of which 150 were operating and five were idle (U.S. DOE, 2000a).[1] Some data reported in this profile are taken from EIA publications. Readers should note that the Census data reported for SIC 2911 cover a somewhat broader range of facilities than do the U.S. DOE/EIA data, and the two data sources are therefore not entirely comparable.[2]

The petroleum industry includes exploration and production of crude oil, refining, transportation, and marketing. Petroleum refining is a capital-intensive production process that converts crude oil into a variety of refined products. Refineries range in complexity, depending on the types of products produced. Nearly half of all U.S. refinery output is motor gasoline.

The number of U.S. refineries has declined by almost half since the early 1980s. The remaining refineries have improved

[1] In addition, there are three idle refineries in Puerto Rico and one operating refinery in the Virgin Islands.

[2] For comparison, preliminary 1997 Census data included 244 establishments for NAICS 3241/SIC 2911, whereas U.S. DOE/EIA reported 164 operable refineries as of January 1997.

their efficiency and flexibility to process heavier crude oils by adding "downstream" capacity.[3] While the number of refineries has declined, the average refinery capacity and utilization has increased, resulting in an increase in domestic refinery production overall.

a. Output

Table 4C-2 shows trends in production of petroleum refinery products from 1990 through 2000. In general, production of refined products has grown over this period, reflecting growth in transportation demand and other end-uses. There was a reduction in output due to the domestic economic recession in 1991.

Table 4C-2: Petroleum Refinery Product Production (million barrels per day)

Year	Motor Gasoline	Distillate Fuel Oil	Jet Fuel	Residual Fuel Oil	Other Products[a]	Total Output	Percent change
1990	6.96	2.92	1.49	0.95	2.95	15.27	n/a
1991	6.98	2.96	1.44	0.93	2.95	15.26	-0.1%
1992	7.06	2.97	1.40	0.89	3.08	15.40	0.9%
1993	7.30	3.13	1.42	0.84	3.10	15.79	2.5%
1994	7.18	3.20	1.45	0.83	3.13	15.79	0.0%
1995	7.48	3.16	1.42	0.79	3.14	15.99	1.3%
1996	7.56	3.32	1.52	0.73	3.19	16.32	2.1%
1997	7.74	3.39	1.55	0.71	3.37	16.76	2.7%
1998	7.89	3.42	1.53	0.76	3.43	17.03	1.6%
1999	7.93	3.40	1.57	0.70	3.39	16.99	-0.2%
2000	7.95	3.58	1.61	0.71	3.40	17.25	1.5%
Total Percent Change 1990-2000	*14.2%*	*22.6%*	*8.1%*	*-25.3%*	*15.3%*	*13.0%*	
Average Annual Growth Rate	*1.3%*	*2.1%*	*0.8%*	*-2.9%*	*1.4%*	*1.2%*	
Jan-July 2000[b]	8.17	3.50	1.59	0.67			
Jan-July 2001[b]	8.27	3.65	1.56	0.73			
Percent change	*1.2%*	*4.3%*	*-1.9%*	*9.0%*			

[a] Includes asphalt and road oil, liquified petroleum gases, petroleum coke, still gas, kerosene, petrochemical feedstocks, lubricants, wax, aviation gasoline, special napthas, and miscellaneous products.

[b] Monthly data for motor gasoline production include blending of fuel ethanol and an adjustment to correct for the imbalance of motor gasoline blending components.

Source: U.S. DOE, 2000b; U.S. DOE, 2001.

[3] The first step in refining is atmospheric distillation, which uses heat to separate various hydrocarbon components in crude oil. Beyond this basic step are more complex operations (generally referred to as "downstream" from the initial distillation) that increase the refinery's capacity to process a wide range of crude oils and increase the yield of lighter (low-boiling point) products such as gasoline. These downstream operations include vacuum distillation, cracking units, reforming units, and other processes (U.S. DOE, 1999a).

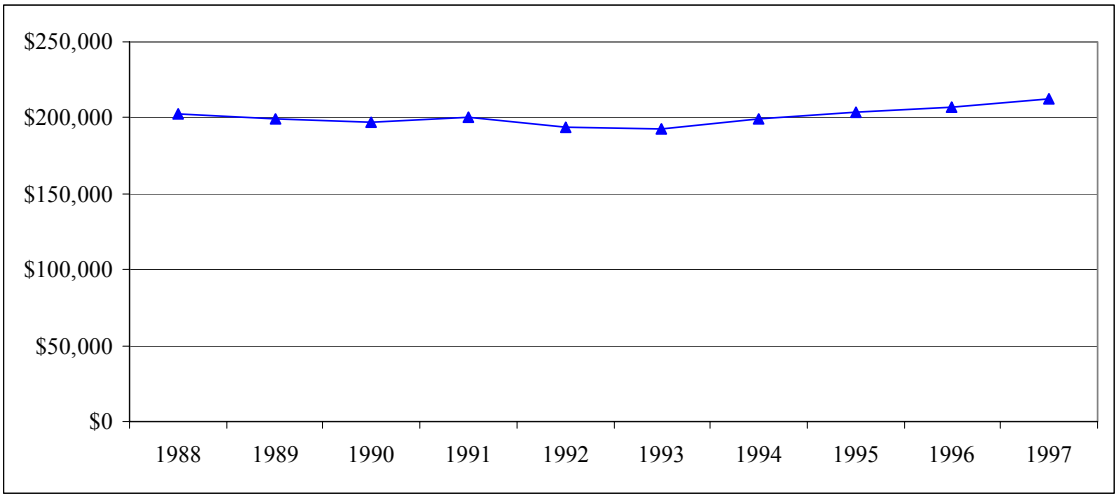
Value of shipments and ***value added*** are the two most common measures of manufacturing output.[4] These historical trends provide insight into the overall economic health and outlook for an industry. Value of shipments is the sum of the receipts a manufacturer earns from the sale of its outputs. It is an indicator of the overall size of a market or the size of a firm in relation to its market or competitors. Value added is used to measure the value of production activity in a particular industry. It is the difference between the value of shipments and the value of inputs used to make the products sold.

Nominal value of shipments and value added for petroleum refineries increased by 4 and 13 percent, respectively, from 1988 to 1997. Adjusted for changes in petroleum product prices (by the producer price index for SIC 2911), real value of shipments was fairly constant over this period, despite a decline in the number of operating refineries (see Figure 4C-1). Real value added for SIC 2911 declined from 1988 until 1990 and remained relatively stable through 1993. Between 1993 and 1997, there were significant gains with a decline in 1996.

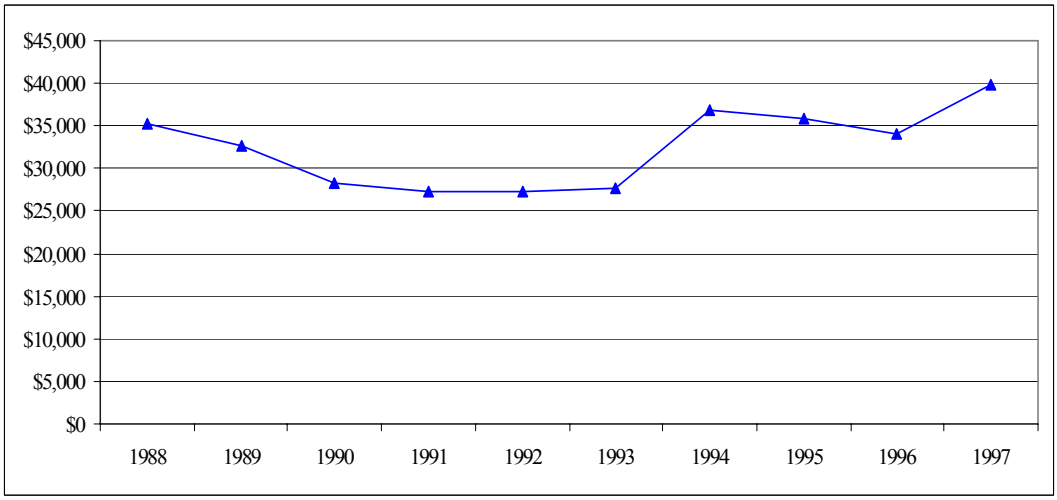
[4] Terms highlighted in bold and italic font are further explained in the glossary.

Figure 4C-1: Value of Shipments and Value Added for Petroleum Refineries (in millions, constant $2000)

Value of Shipments



Value Added



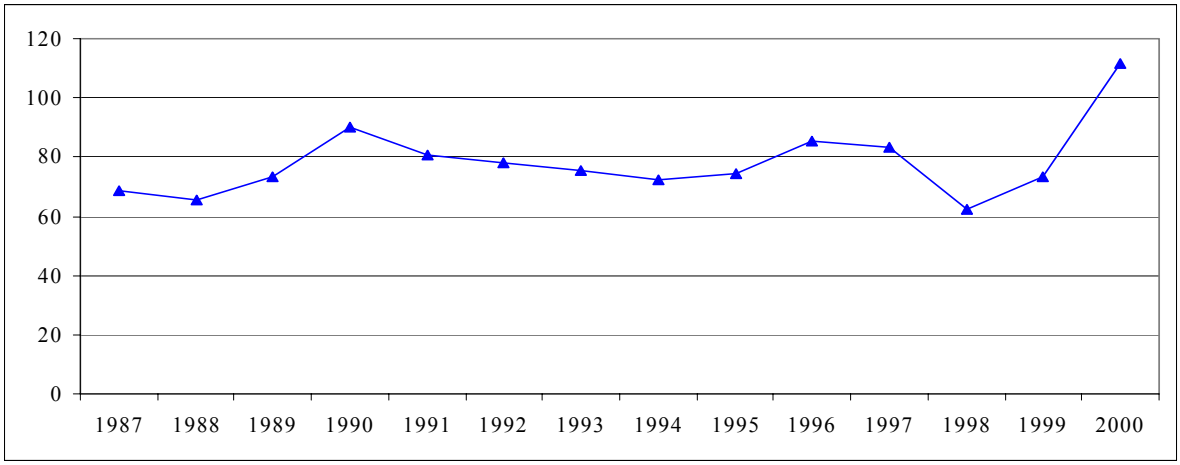
Source: U.S. DOC, 1988-1991 and 1993-1996; U.S. DOC, 1987, 1992, and 1997.

b. Prices

Figure 4C-2 shows the ***producer price index*** (PPI) for the Petroleum Refinery sector. The PPI is a family of indexes that measure price changes from the perspective of the seller. This profile uses the PPI to inflate nominal monetary values to constant dollars.

The PPI for refined petroleum products showed substantial fluctuations in petroleum product prices between 1987 and 1998, with a strong upward trend between 1998 and 2000, as shown in Figure 4C-2. Higher prices through 2000 reflect low refinery product inventories and higher crude oil input prices (Value Line, 2001). Subsequent reductions in crude oil prices and slackening demand due to a slowing economy are likely to result in some reduction in prices, however.

Figure 4C-2: Producer Price Index for Petroleum Refineries

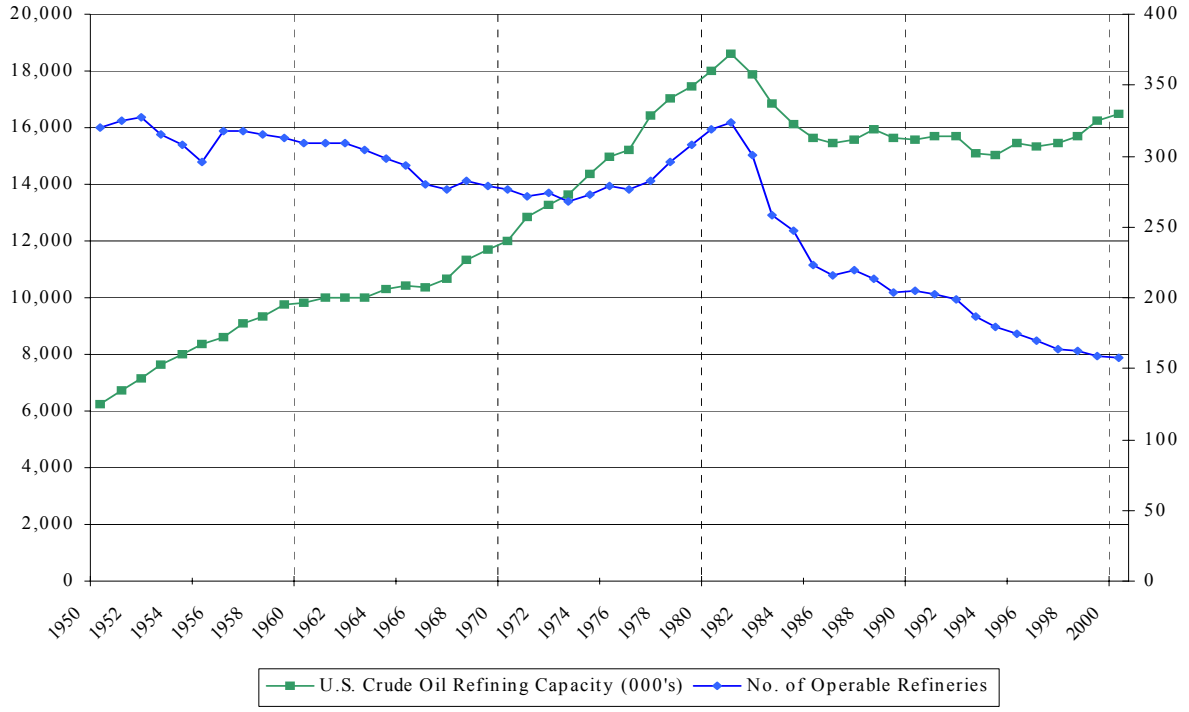


Source: BLS, 2000.

c. Number of facilities and firms

Figure 4C-3 shows historical trends in the numbers of refineries and refinery capacity. This figure shows that the number of operable refineries fell substantially between 1980 and 1999. This decrease resulted in part from the elimination of the Crude Oil Entitlements Program in the early 1980s. The Entitlements Program encouraged smaller refineries to add capacity throughout the 1970s. After the program was eliminated, surplus capacity and falling profit margins led to the closure of the least efficient capacity (U.S. DOE, 1999a). The decrease in the number of refineries has continued, as the industry has consolidated to improve margins. After peaking in the early 1980's, refining capacity decreased throughout the rest of the decade. Refining capacity has remained relatively stable since the decrease in the 1980's, with a slight upward trend in the past five years. This trend is expected to continue, with no new "greenfield" refineries likely to be built in the U.S., but continuing capacity expansion at existing facilities (S&P 2001).

Figure 4C-3: Trends in Numbers of Refineries and Refining Capacity 1949-2000



Source: U.S. DOE, 2000a.

Data from the Statistics of U.S. Businesses for SIC 2911 (Table 4C-3) shows that the number of firms reporting petroleum refining as their primary business has also declined since 1990.

Table 4C-3: Number of Firms and Facilities for Petroleum Refineries (SIC 2911)

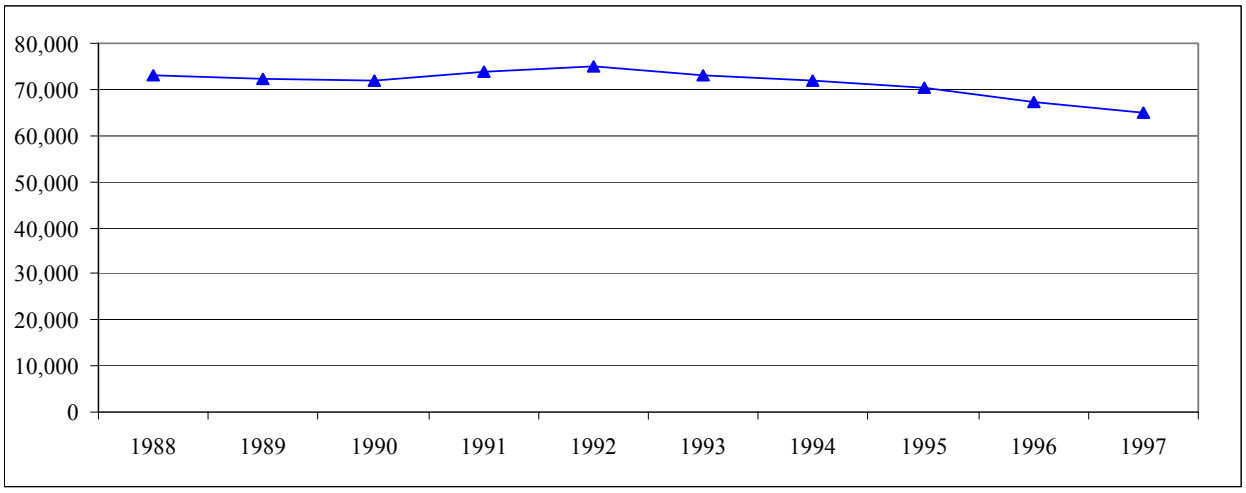
Year	Firms		Facilities	
	Number	Percent Change	Number	Percent Change
1990	215	n/a	340	n/a
1991	215	0%	346	2%
1992	185	-14%	303	-12%
1993	148	-20%	251	-17%
1994	161	9%	265	6%
1995	150	-7%	251	-5%
1996	173	15%	275	10%
1997	128	-26%	248	-10%
Total Percent Change 1990 - 1997	-40.5%		-27.1%	
Average Annual Growth Rate	-7.1%		-4.4%	

Source: U.S. SBA, 2000.

d. Employment and productivity

Employment levels in the petroleum refining industry declined by 13 percent between 1988 and 1997, from 73,200 to 64,789 employees, as shown in Figure 4C-4. After increasing in the early 1990s, employment at petroleum refineries has declined since 1992, reflecting overall industry consolidation.

Figure 4C-4: Employment for Petroleum Refineries (SIC 2911)



Source: U.S. DOC, 1988-1991 and 1993-1996; U.S. DOC, 1987, 1992, and 1997.

Table 4C-4 shows substantial year-to-year changes in productivity, measured by real value added per production hour. These fluctuations reflect volatility in real value added, which in turn reflect variations in the relationship between input prices (primarily crude oil) and refinery product prices. Changes in production hours from year to year have been less volatile, but how a net reduction over the period 1988 to 1997, resulting in a small growth in real value added per production hour over that period.

Table 4C-4: Productivity Trends for Petroleum Refineries (SIC 2911)

Year	Production Hours (millions)	Value Added (in millions, constant $2000)	Real Value Added/Hour (in millions, constant $2000)	Growth Rates		
				Production Hours	Value Added	Real Value Added/Hour
1988	103	$35,302	343	n/a	n/a	n/a
1989	105	$32,722	313	1.6%	-7.3%	-8.7%
1990	106	$28,268	267	1.1%	-13.6%	-14.7%
1991	107	$27,308	256	0.7%	-3.4%	-4.1%
1992	109	$27,224	249	2.6%	-0.3%	-2.7%
1993	107	$27,767	261	-2.6%	2.0%	4.8%
1994	110	$36,796	335	3.3%	32.5%	28.4%
1995	107	$39,320	337	-2.4%	6.9%	0.6%
1996	103	$34,024	332	-4.5%	-13.5%	-1.5%
1997	100	$39,869	398	-2.3%	17.2%	19.9%
Total Percent Change 1988-1997	*-2.7%*	*12.9%*	*16.0%*			
Annual Average Growth Rate	*-0.3%*	*1.4%*	*1.7%*			

Source: U.S. DOC, 1988-1991 and 1993-1996; U.S. DOC, 1987, 1992, 1997.

e. Capital expenditures

Petroleum industry capital expenditures increased substantially between 1988 and 1993, and decreased between 1993 and 1997, as shown in Table 4C-5. In 1997 the industry spent $5.7 billion in constant 2000 dollars, as compared with $3.9 billion ($2000) in 1988. In the early 1990's, capital expenditures peaked at over $8 billion per year in real terms. Much recent investment in petroleum refineries has been to expand and de-bottleneck units downstream from distillation, partially in response to environmental requirements. Changes in refinery configurations have included adding catalytic cracking units, installing additional sulfur removal hydrotreaters, and using manufacturing additives such as oxygenates. These process changes have resulted from two factors:

- processing of heavier crudes with higher levels of sulfur and metals; and
- regulations requiring gasoline reformulation to reduce volatiles in gasoline and production of diesel fuels with reduced sulfur content (U.S. EPA, 1996b).

Environmentally-related investments have also accounted for a substantial portion of capital expenditures. Substantial capital investments by refineries will be required in the future, to comply with product quality regulations, including EPA's Tier 2 Gasoline Sulfur Rule requiring reductions in the sulfur content of gasoline; reductions or elimination of the use of MTBE in gasoline; and proposed sulfur reductions in highway diesel fuel (NPC, 2000).

Table 4C-5: Capital Expenditures for Petroleum Refineries (SIC 2911)

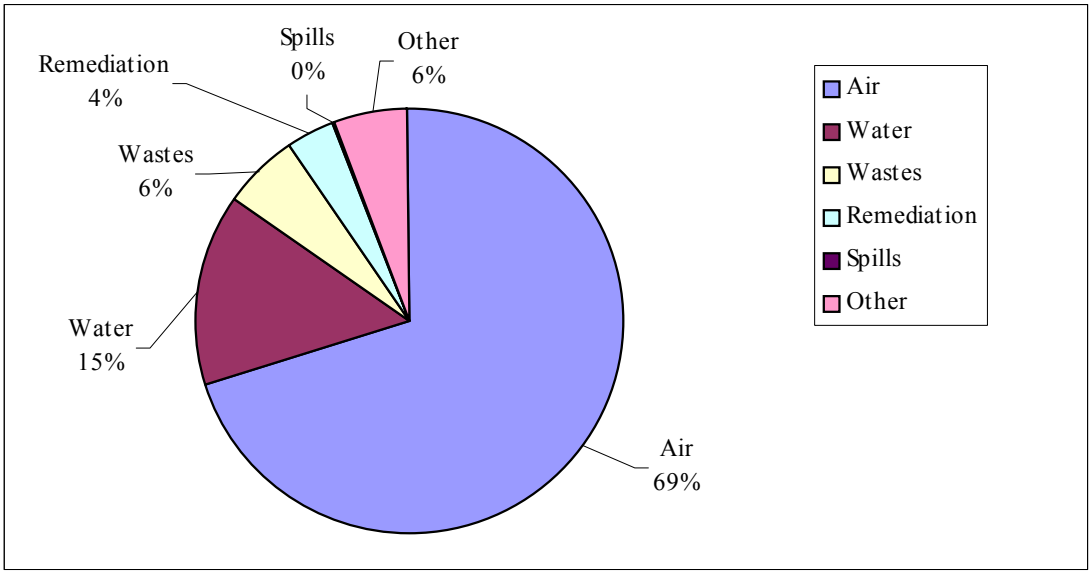
Year	Capital Expenditures (in millions, constant $2000)
1988	3,970
1989	4,529
1990	4,730
1991	7,726
1992	8,751
1993	8,883
1994	8,539
1995	8,788
1996	6,799
1997	5,704

Source: U.S. DOC, 1988-1991 and 1993-1996; U.S. DOC, 1987, 1992, and 1997.

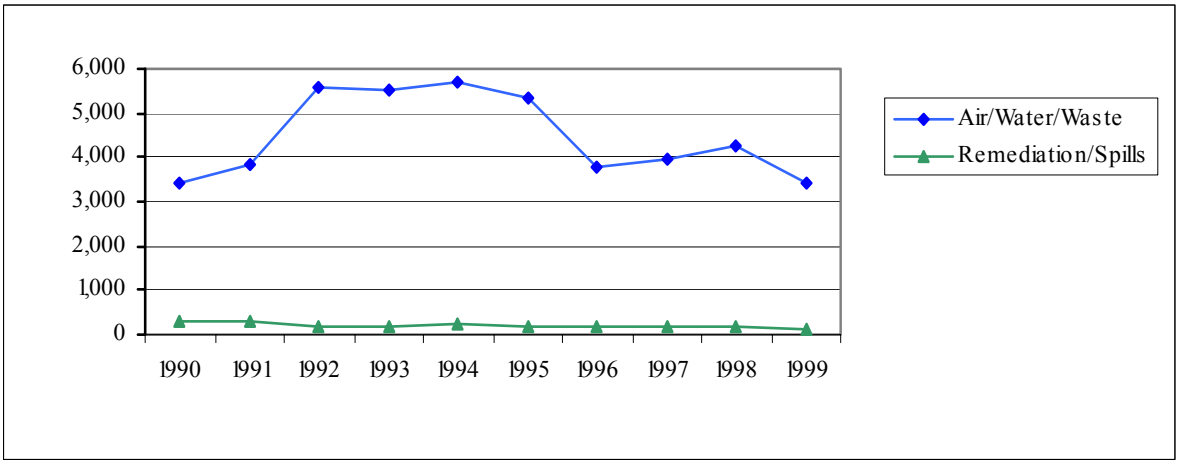
Figure 4C-5 shows pollution control expenditures (capital plus operating costs) reported by American Petroleum Institute (API) members. Expenditures to control current environmental releases (air, water and waste) account for the largest portion of total pollution control expenditures. Of the total 1999 environmental expenditures to address air, water, and waste pollution from on-going operations, 31 percent (1.8 million) was capital expenditures and 68 percent (4 million) was operating maintenance.

Figure 4C-5: Environmental Expenditures by Type and Medium for Petroleum Refineries (SIC 2911)

Environmental Expenditures by Individual Type, 1999



Refining Expenditures by Aggregated Types (in millions)



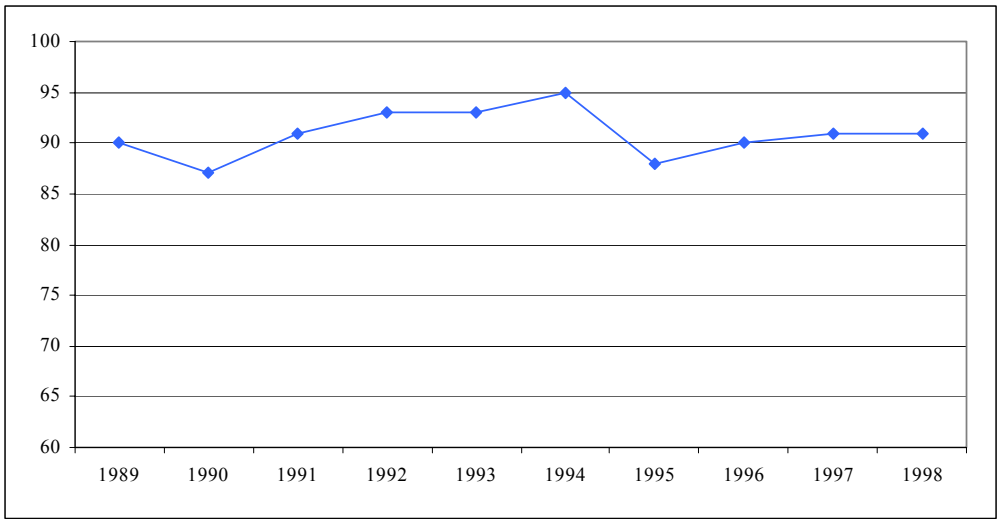
Source: American Petroleum Institute, 2001.

f. Capacity utilization

The most commonly-used measure of refinery capacity is expressed in terms of crude oil distillation capacity. EIA defines refinery capacity utilization as input divided by calendar day capacity. Calendar day capacity is the maximum amount of crude oil input that can be processed during a 24-hour period with certain limitations. Some downstream refinery capacities are measured in terms of "stream days," which is the amount a unit can process running full capacity under optimal crude and product mix conditions for 24 hours (U.S. DOE, 1999a). Downstream capacities are reported only for specific units or products, and are not summed across products, since not all products could be produced at the reported levels simultaneously.

As reported by the Census Bureau, Figure 4C-6 below shows the increase in overall capacity utilization in the petroleum industry from 1990 to 1994. After declining between 1994 and 1995, the capacity utilization gradually increased until 1998. Overall refinery utilization has remained high over this entire time period. Utilization of specific portions of refinery capacities may vary, however, as the industry adjusts to changes in the desired product mix and characteristics.

Figure 4C-6: Capacity Utilization Rates (Fourth Quarter) for Petroleum Refineries (SIC 2911)



Source: U.S. DOC, 1989-1998.

Standard & Poor's reports that utilization rates remained over 90 percent in 2000, as refineries appeared to operate on a "just-in-time" system to reduce costs, resulting in low refinery product inventories. High demand combined with low inventories has kept operating rates high (S&P 2001).

4C.2 Structure and Competitiveness

The petroleum refining industry in the United States is made up of integrated international oil companies, integrated domestic oil companies, and independent domestic refining/marketing companies. In general, the petroleum industry is highly integrated, with many firms involved in more than one sector. Large companies, referred to as the "majors," are fully integrated across crude oil exploration and production, refining, and marketing. Smaller, nonintegrated companies, referred to as the "independents," generally specialize in one sector of the industry.

Like the oil business in general, refining has been dominated in the 1990s by integrated internationals, specifically a few large companies such as Exxon Corporation, Mobil Corporation,[5] and Chevron Corporation. These three ranked in the top ten of Fortune's 500 sales ranking during this time period. Substantial diversification by major petroleum companies into other energy and non-energy sectors was financed by high oil prices in the 1970s and 1980s. With lower profitability in the 1990s, the major producers began to exit nonconventional energy operations (e.g., oil shale) as well as coal and non-energy operations in the 1990s. Some have recently ceased chemical production.

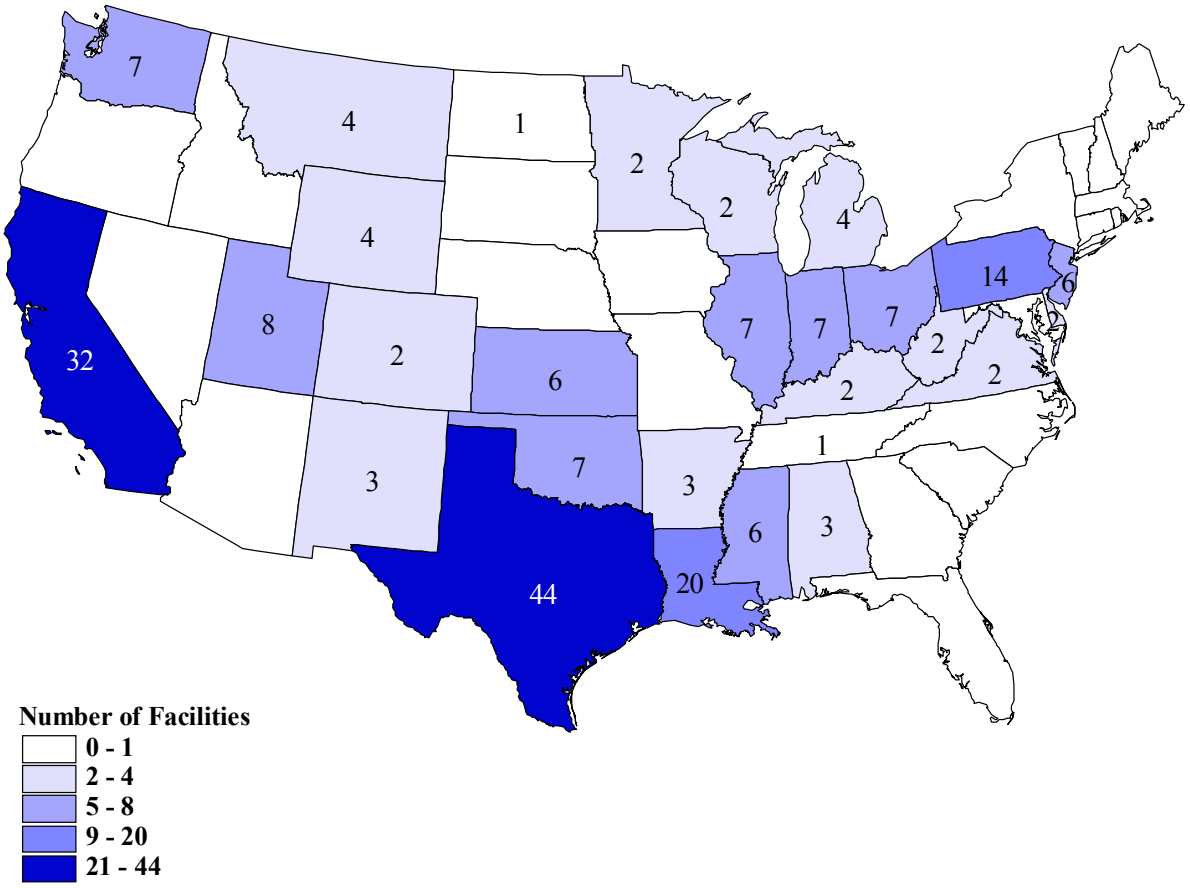
During the 1990s, several mergers, acquisitions, and joint ventures occurred in the petroleum refining industry in an effort to cut cost and increase profitability. This consolidation has taken place among the largest firms (as illustrated by the acquisition of Amoco Corporation by the British Petroleum and the 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) (U.S. DOE, 1999b). BP Amoco recently announced a deal to sell its 250,000 barrel per day Alliance refinery in Louisiana to the leading U.S. independent refining and marketing company Tosco Corp.

[5] Exxon and Mobil Corporations have recently merged into one company.

a. Geographic distribution

Petroleum refining facilities are concentrated in areas near crude oil sources and near consumers. The cost of transporting crude oil feed stocks and finished products is an important influence on the location of refineries. Most petroleum refineries are located along the Gulf Coast and near the heavily industrialized areas of both the east and west coasts (U.S. DOE, 1997). Figure 4C-7 below shows the distribution of U.S. petroleum refineries. In 1992, there were 44 refineries in Texas, 32 in California, and 20 in Louisiana, accounting for 43 percent of all facilities in SIC 2911 in the United States.

Figure 4C-7: Geographic Distribution of Petroleum Refineries (SIC 2911)

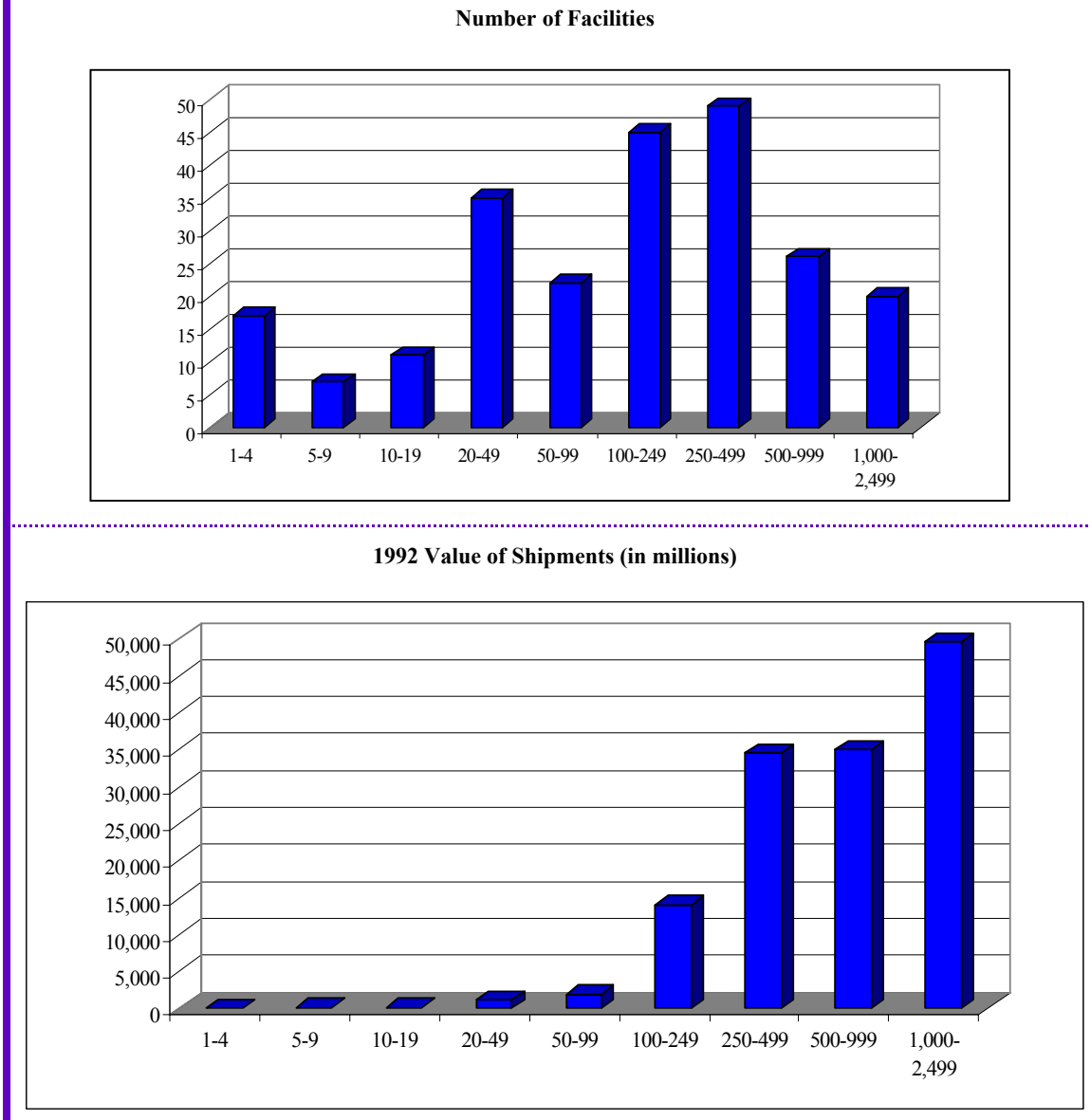


Source: U.S. DOC, 1987, 1992, and 1997.

b. Establishment size

A substantial portion of the facilities in SIC 2911 are large facilities, with 41 percent having 250 or more employees. Figure 4C-8 shows that approximately 87 percent of the value of shipments for the industry is produced by the 41 percent of establishments with more than 250 employees. Establishments with more than 1,000 employees are responsible for approximately 36 percent of all industry shipments.

Figure 4C-8: Value of Shipments and Number of Facilities for Petroleum Refineries by Employment Size Category (SIC 2911)



Source: U.S. DOC, 1987, 1992, and 1997.

c. Firm size

The Small Business Administration defines a small firm for SIC 2911 as a firm with 1,500 or fewer employees. The size categories reported in the Statistics of U.S. Businesses (SUSB) do not correspond with the SBA size classifications. It is therefore not possible to apply the SBA size threshold precisely. Table 4C-6 below shows the distribution of firms, establishments, and receipts in SIC 2911 by the employment size of the parent firm. The SUSB data show that 165 of the 248 SIC 2911 establishments reported for 1997 (67 percent) are owned by larger firms (those with 500 employees or more), some of which may be defined as small under the SBA definition, and 83 (33 percent) are owned by small firms (those with fewer than 500 employees).

Table 4C-6: Number of Firms, Establishments, and Estimated Receipts for Petroleum Refineries (SIC 2911) by Firm Employment Size Category (1997)

Employment Size Category	Number of Firms	Number of Establishments	Estimated Receipts (in millions, constant $2000)
0-19	27	27	451
20-99	22	23	1,432
100-499	25	33	6,508
500+	54	165	207,078
Total	*128*	*248*	*215,469*

Source: U.S. SBA, 2000.

d. Concentration and specialization ratios

Concentration is the degree to which industry output is concentrated in a few large firms. Concentration is closely related to entry barriers, with more concentrated industries generally having higher barriers.

The four-firm ***concentration ratio*** (CR4) and the ***Herfindahl-Hirschman Index*** (HHI) are common measures of industry concentration. The CR4 indicates the market share of the four largest firms. For example, a CR4 of 72 percent means that the four largest firms in the industry account for 72 percent of the industry's total value of shipments. The higher the concentration ratio, the less competition there is in the industry, other things being equal.[6] An industry with a CR4 of more than 50 percent is generally considered concentrated. The HHI indicates concentration based on the largest 50 firms in the industry. It is equal to the sum of the squares of the market shares for the largest 50 firms in the industry. For example, if an industry consists of only three firms with market shares of 60, 30, and 10 percent, respectively, the HHI of this industry would be equal to 4,600 ($60^2 + 30^2 + 10^2$). The higher the index, the fewer the number of firms supplying the industry and the more concentrated the industry. An industry is considered concentrated if the HHI exceeds 1,000.

The petroleum industry is considered competitive, based on CR4 and the HHI. As shown in Table 4C-6, the CR4 and the HHI for SIC 2911 are both below the benchmarks of 50 percent and 1,000, respectively.

The ***specialization ratio*** is the percentage of the industry's production accounted for by primary product shipments. The ***coverage ratio*** is the percentage of the industry's product shipments coming from facilities from the same primary industry. The coverage ratio provides an indication of how much of the production/product of interest is captured by the facilities classified in an SIC code. The specialization and coverage ratios presented in Table 4C-7 show a very high degree of specialization by petroleum refineries: In 1997, 97 percent of the value of shipments from SIC 2911 establishments were classified as SIC 2911 petroleum products. In addition, SIC 2911 establishments accounted for 99 percent of the value of all petroleum products shipped domestically.

Table 4C-7: Selected Ratios for Petroleum Refineries (SIC 2911/NAICS 324110)

SIC	Year	Total Number of Firms	Concentration Ratios					Specialization Ratio	Coverage Ratio
			4 Firm (CR4)	8 Firm (CR8)	20 Firm (CR20)	50 Firm (CR50)	Herfindahl-Hirschman Index		
2911	1987	200	32%	52%	78%	95%	435	99%	99%
	1992	132	30%	49%	78%	97%	414	99%	99%
	1997	122	28%	49%	83%	98%	422	97%	99%

Source: U.S. DOE, 1987, 1992, and 1997.

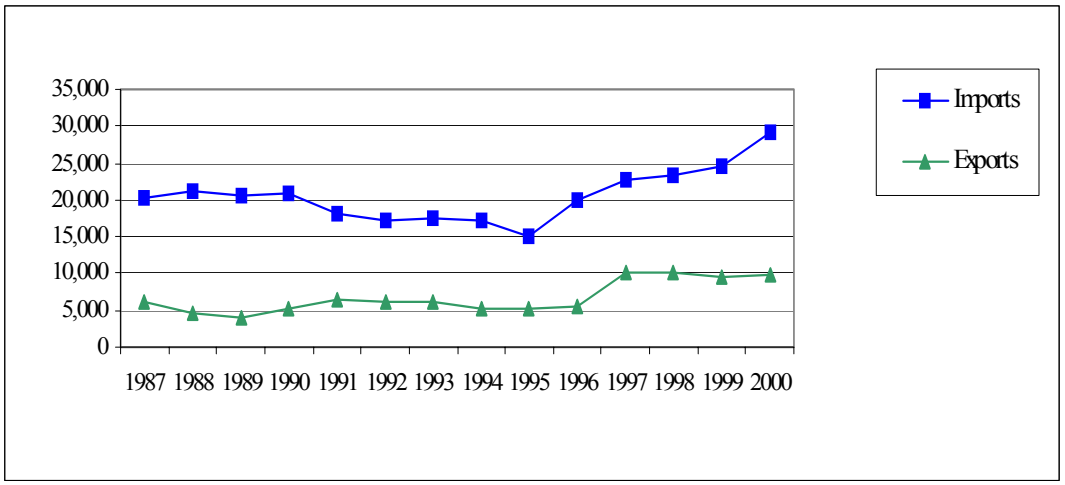
[6] Note that the measured concentration ratio and the HHF are very sensitive to how the industry is defined. An industry with a high concentration in domestic production may nonetheless be subject to significant competitive pressures if it competes with foreign producers or if it competes with products produced by other industries (e.g., plastics vs. aluminum in beverage containers). Concentration ratios are therefore only one indicator of the extent of competition in an industry.

e. Foreign trade

The United States consumes more petroleum than it produces, requiring net imports of both crude oil and products to meet domestic demand. In 1997, the U.S. imported 8.23 million barrels per day (MBD) of crude oil, or 56 percent of the total crude oil supply of 14.77 MBD, and imported 1.94 MBD of refined products. These refined product imports represented ten percent of the 18.62 MBD of refined products supplied to U.S. consumers. The U.S. exported 0.9 MBD of refined products in 1997.

Imports of refined petroleum products have fluctuated since 1985. Imports rose to 2.3 MB in the early 1980s, due to rapid growth in oil consumption, especially consumption of light products, which exceeded the growth in U.S. refining capacity. Imports then declined as a result of the 1990/91 recession and a surge in upgrading of refinery capacity resulting primarily from the Clean Air Act Amendments and other environmental requirements (U.S. DOE, 1997). Since the lowest point in 1995, imports have been steadily increasing through 2000 (see Figure 4C-9).

Figure 4C-9: Value of Imports and Exports for Petroleum Refining (in millions, constant $2000)



Source: U.S. DOE, 2000b.

Until the early 1980s, petroleum product exports consisted primarily of petroleum coke, because trade in most other products was restricted by allowances. Export license requirements for various petroleum products imposed in 1973 were eliminated in late 1981, however, and exports of other products began to grow. Petroleum exports continue to include heavy products such as residual fuel oil and petroleum coke, which are produced as co-products with motor gasoline and other light products. Production of these heavier products often exceeds U.S. demand, and foreign demand absorbs the excess. Petroleum coke is the leading petroleum export product, accounting for 30 percent of petroleum exports in 1997, followed by distillate fuel oil (15 percent of exports) and motor gasoline (almost 14 percent) (U.S. DOE, 1997). Exports generally reflect foreign demand, but other factors influence exports as well. For example, exports of motor gasoline increased due to high prices in Europe at the time of the 1990 Persian Gulf crisis. U.S. refiners and marketers have gained experience in marketing to diverse world markets, and U.S. products are now sold widely abroad (U.S. DOE, 1997). As reported by the International Trade Administration and shown in Figure 4C-9, the real value of petroleum exports fluctuated during the years 1989 to 1996, and have been steady for the four year period of 1997 through 2000.

Export dependence and ***import penetration*** are the two measures of foreign competition that are used in this profile. Export dependence is the share of value of shipments that is exported. Import penetration is the share of domestic consumption met by imports. Trade statistics for petroleum refineries from 1989 to 1997 are presented in Table 4C-8. This table shows the stability of both import penetration and export dependence for the petroleum refining industry.

Table 4C-8: Foreign Trade Statistics for Petroleum Refining

Year	Value of imports (in millions, constant $2000)	Value of exports (in millions, constant $2000)	Value of Shipments (in millions, constant $2000)	Implied Domestic Consumption[a]	Import Penetration[b]	Export Dependence[c]
1989	20,470	6,547	198,927	212,850	10%	3%
1990	20,933	5,239	197,450	213,144	10%	3%
1991	18,168	6,415	200,565	212,318	9%	3%
1992	17,075	6,086	194,180	205,169	8%	3%
1993	17,423	6,159	192,868	204,132	9%	3%
1994	17,219	5,194	198,911	210,936	8%	3%
1995	14,905	5,333	203,761	213,333	7%	3%
1996	19,978	5,560	206,804	221,222	9%	3%
1997	22,736	10,139	212,100	224,697	10%	5%
Total Percent Change 1989-1997	11%	55%	7%	6%		
Average Annual Growth Rate	1.3%	6%	0.8%	0.7%		

[a] Calculated by EPA as shipments + imports - exports.
[b] Calculated by EPA as imports divided by implied domestic consumption.
[c] Calculated by EPA as exports divided by shipments.

Source: U.S. DOC, 2001; U.S. DOE, 2000b.

4C.3 Financial Condition and Performance

Refiners' profitability depends on the spread between product prices on the one hand, and the price of crude oil and other inputs (the gross refining margin), investment costs, and operating costs on the other hand. Operating costs in turn reflect facility configurations (complexity), scale and efficiency, the mix of high-end versus low-end products produced, and location. Refinery yields vary with refinery configuration, operating practices, and crude oil characteristics. Revenues earned from a barrel of crude depend on the prices of different products, the mix of products produced, and the refinery yield for each product. Relatively small swings in the price of gasoline (which represents the largest product output) and the price of crude oil can cause large changes in cash margins and refinery profits.

Returns on investments to produce higher quality products from a given mix of crude oil (or to produce a given product mix from heavier crude oil) depend on the differentials between high and low quality crude. Price discounts for low quality crude have not always been enough to earn competitive returns on investments in extra coking and sulfur removal capacity.

Through the first half of the 1990s, the U.S. refining and marketing industry was characterized by unusually low product margins, low profitability, and substantial restructuring. These low profit margins were the result of three different factors: (1) increases in operating costs as a result of governmental regulations; (2) expensive upgrading of processing units to accommodate lower-quality crude oils;[7] and (3) upgrading of operations to adapt to changes in demand for refinery products.[8] A combination of higher cost as a result of these three trends and lower product prices as a result of competitive pressures led to pressure on profits (American Petroleum Institute, 1999).

In the late 1990s, the U.S. majors aggressively pursued cost-cutting throughout their operations (Rodekohr, 1999). There were improvements in both gross and net margins.[9] Reductions in costs resulted from:

- divesting marginal refineries and gasoline outlets;
- divesting less profitable activities (e.g., gasoline credit cards);
- reducing corporate overhead costs, including eliminating redundancies through restructuring;
- outsourcing some administrative activities; and
- use of new technologies requiring less labor.

These cost-cutting measures, along with increases in the prices of petroleum refining products, have resulted in significantly improved margins in the petroleum refining sector. Refinery profits remained high in 2000 and the first half of 2001, due to low product inventories and high operating rates.

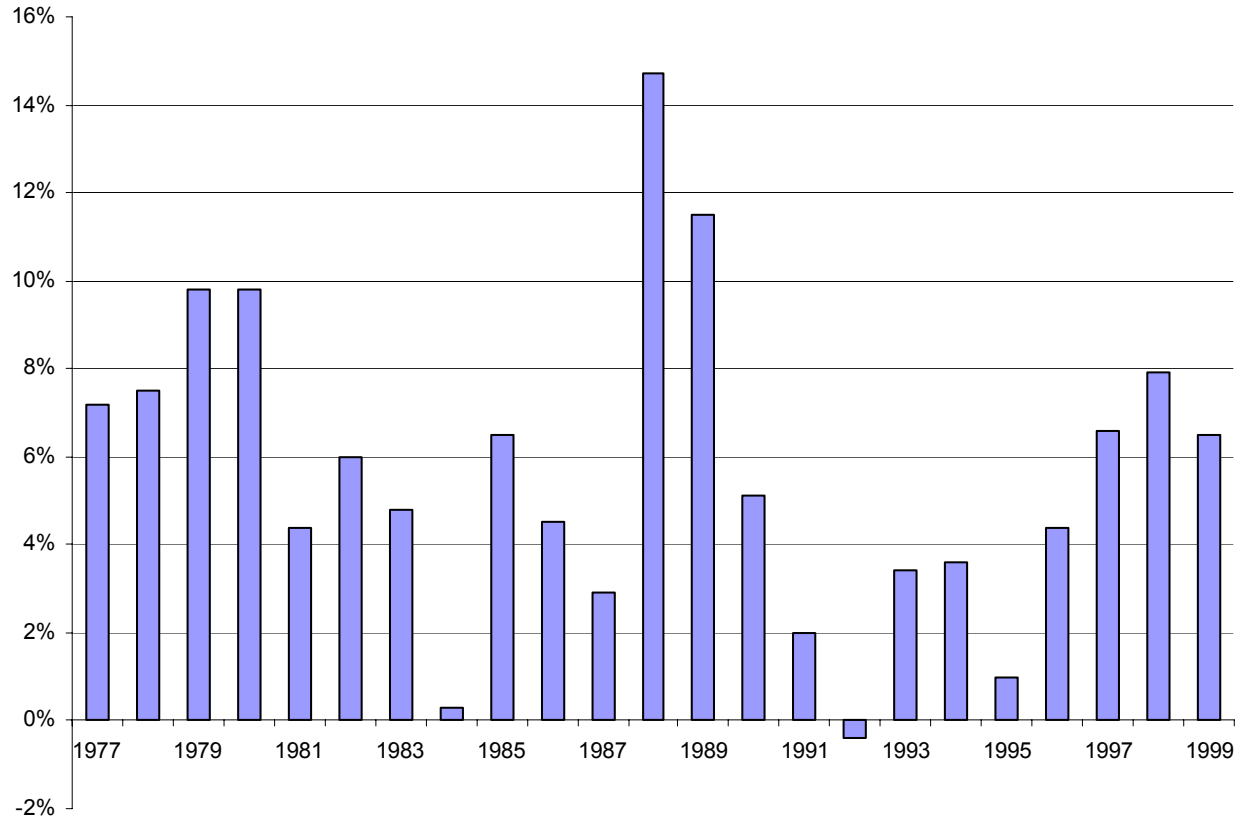
[7] Crude oils processed by U.S. refineries have become heavier and more contaminated with materials such as sulfur. This trend reflects reduced U.S. dependence on the more expensive high gravity ("light") and low sulfur ("sweet") crude oils produced in the Middle East, and greater reliance on crude oil from Latin America (especially Mexico and Venezuela), which is relatively heavy and contains higher sulfur ("sour") (U.S. DOE, 1999a).

[8] Demand for lighter products such as gasoline and diesel fuel has increased, and demand for heavier products has decreased.

[9] Gross margin is revenues per refined product barrel less raw materials cost (i.e., average product price minus average crude oil cost). Net margin is gross margin minus operating costs (all out-of-pocket refining and retailing expenses such as energy costs and marketing costs.)

The substantial fluctuation in return on investment from 1977 through 1999, including the relatively low returns in the early 1990s and improvements in the late 1990s, are shown in Figure 4C-10.[10]

Figure 4C-10: U.S. Petroleum and Natural Gas Refining and Marketing, Return on Investment 1977 - 1999



Source: U.S. DOE, Financial Reporting System.

[10] The Financial Reporting System (FRS) is described in U.S. DOE, 1997. Quarterly financial results are collected for a group of specialized refiner/marketers and major integrated petroleum companies. Data are reported separately for their U.S. refining/marketing lines of business. Companies drop in and out of the survey as a result of acquisitions and mergers. Data include only the U.S. operations for foreign affiliates (BP American, Fina, Shell Oil) but worldwide operations for U.S.-based companies. The surveyed companies account for approximately 80 percent of total U.S. companies' worldwide investment in petroleum and natural gas, and approximately 25 percent of worldwide refining capacity (excluding State Energy Companies) (Rodekohr, 1999).

Table 4C-9 below shows trends in estimated operating margins for the petroleum refining industry, based on Census data for SIC 2911. Margins increased over one percent overall between 1988 and 1997, from 15.6 percent to 16.5 percent, after declining in the early 1990s.

Table 4C-9: Operating Margins for Petroleum Refineries (SIC 2911)

Year	Value of Shipments (in millions, constant $2000)	Cost of Materials (in millions, constant $2000)	Payroll (all employees) (in millions, constant $2000)	Operating Margin
1988	$202,773	$166,070	$4,998	15.6%
1989	$198,927	$167,584	$4,525	13.5%
1990	$197,450	$171,595	$3,958	11.1%
1991	$200,565	$170,941	$4,757	12.4%
1992	$194,180	$166,627	$5,183	11.5%
1993	$192,868	$163,659	$5,543	12.3%
1994	$198,911	$163,074	$5,890	15.1%
1995	$203,986	$168,572	$5,678	14.6%
1996	$206,804	$173,851	$4,890	13.6%
1997	$212,100	$171,916	$5,161	16.5%

Source: U.S. DOC, 1988-1991 and 1993-1996; U.S. DOC, 1987, 1992, 1997.

4C.4 Facilities Operating Cooling Water Intake Structures

In 1982, the Petroleum and Coal Products industry (SIC 29) withdrew 590 billion gallons of cooling water, accounting for approximately 0.8 percent of total industrial cooling water intake in the United States. The industry ranked 4th in industrial cooling water use, behind the electric power generation industry and the chemical and primary metals industries (1982 Census of Manufactures).

This section presents information from EPA's *Detailed Industry Questionnaire: Phase II Cooling Water Intake Structures* on existing facilities with the following characteristics:

- they withdraw from the waters of the United States;
- they hold an NPDES permit;
- they have a design intake flow of equal to or greater than two MGD;
- they use at least 25 percent of that flow for cooling purposes.

These facilities are not "new facilities" as defined by the section 316(b) New Facility Rule and are therefore not subject to this regulation. However, they meet the criteria of the rule except that they are already in operation. These existing facilities therefore provide a good indication of what new facilities in these sectors may look like. The remainder of this section refers to existing facilities with the above characteristics as "section 316(b) facilities."

a. Cooling water uses and systems

Information collected in the Detailed Questionnaire found that an estimated 31 of 163 petroleum refining facilities, or 19 percent, meet the characteristics of a section 316(b) facility. Eighty-seven percent of these facilities use cooling water for production line (or process) contact or noncontact cooling. Approximately 35 and 16 percent of the section 316(b) facilities also reported use of cooling water in electricity generation and air conditioning, respectively.

Table 4C-10 shows the distribution of existing section 316(b) petroleum refineries by type of water body and cooling system. Twenty-two facilities, or 71 percent, obtain their cooling water from either a freshwater stream or a river. Four facilities (13 percent) of refineries obtain their cooling water from either an estuary or a tidal river. Two facilities, or 6.5 percent, obtain their cooling water from a Great Lake. The other two sources of cooling water reported for petroleum refineries were oceans and a joint withdrawal from lakes/reservoirs and estuaries/tidal rivers, accounting for three percent each.

The most common cooling water system used by petroleum refineries is a recirculating cooling system, representing approximately 48 percent of all systems used by refineries. Thirty-two percent of all refineries use a combination cooling system. The remaining 20 percent use a once-through cooling system or another type of cooling system.

Table 4C-10: Number of Section 316(b) Petroleum Refining Facilities by Water Body Type and Cooling System Type

Water Body Type	Cooling System								Total
	Recirculating		Once-Through		Combination		Other		
	Number	% of Total	Number	% of Total	Number	% of Total	Number	% of Total	
Estuary or Tidal River	0	0%	1	25%	3	75%	0	0%	4
Freshwater Stream or River	14	64%	2	9%	5	23%	1	5%	22
Great Lake	0	0%	0	0%	2	100%	0	0%	2
Lake or Reservoir	1	100%	0	0%	0	0%	0	0%	1
Lake or Reservoir & Estuary or Tidal River	0	0%	1	100%	0	0%	0	0%	1
Ocean	0	0%	1	100%	0	0%	0	0%	1
Total[a]	***15***	***48%***	***5***	***16%***	***10***	***32%***	***1***	***3%***	***31***

[a] Individual numbers may not add up to total due to independent rounding.

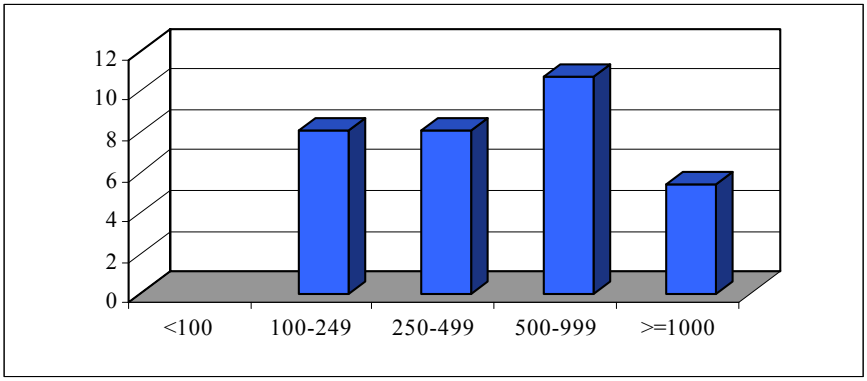
Source: U.S. EPA, 2000.

According to the American Petroleum Institute and EPA, water use in the petroleum refining industry has been declining because facilities are increasing their reuse of water. These restrictions are likely to reduce section 316(b)-related costs, and a complete phase out of once-through cooling water in refineries is expected (U.S. EPA, 1996a).

b. Facility size

Section 316(b) facilities in SIC 2911 are somewhat larger on average than the average employment size distribution of the industry as a whole, as reported in the Census. Figure 4C-11 shows the number of section 316(b) facilities by employment size category. Fifty-two percent of section 316(b) refineries employ over 500 people and all employ over 100 employees.

Figure 4C-11: Number of Section 316(b) Petroleum Refineries by Employment Size Category (SIC 2911)



Source: U.S. EPA, 2000.

c. Firm size

EPA used the Small Business Administration (SBA) small entity thresholds to determine the number of existing section 316(b) petroleum refineries owned by small firms. Firms in this industry are considered small if they employ fewer than 1,500 people. Table 4C-11 shows that 94 percent of all section 316(b) petroleum refineries are owned by large firms. Only two section 316(b) petroleum refining facilities are owned by small firms.

Table 4C-11: Number of Section 316(b) Petroleum Refineries by Firm Size

SIC	Large		Small		Total
	No.	% of SIC	No.	% of SIC	
2911	29	94%	2	6%	31

Source: U.S. EPA, 2000; D&B, 2001.

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