The U.S. Petroleum Industry:

Past As Prologue

1970 - 1992

September 1993

Energy Information Administration
Office of Oil and Gas
U.S. Department of Energy
Washington, DC 20585

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1. Introduction

Present-day domestic petroleum operations and consumption patterns have been significantly influenced by the Nation's desire to improve air quality and reduce petroleum imports. The recurrent oil price and supply shocks of the past 2 decades at times disturbed the economic stability of the country. The shocks led to the enactment of U.S. laws designed to reduce petroleum imports through domestic price incentives, fuel efficiency improvements, or the use of alternative fuels.

The establishment of air quality standards under the Clean Air Act Amendments of 1970 set the stage for subsequent legislation enacted to curb emissions of toxic pollutants from petroleum and other fuels (Table 1). The 1970 Amendments affected the petroleum market throughout the 1970's, 1980's, and early 1990's. The enactment of the Clean Air Act Amendments of 1990 and the Energy Policy Act of 1992 demonstrates that the reduction of petroleum imports and environmental quality will continue to be primary concerns well into the 21st century.

The U.S. petroleum industry and its customers responded to changes in Federal laws and sudden oil price shocks by altering petroleum supply and consumption patterns. Price-related declines in domestic crude oil exploration and production, and petroleum's growth in the transportation sector were particularly significant. The march of events over the years forced changes in the petroleum industry, and it evolved into a sophisticated supply mechanism stretching from the wellhead to the local retail dealer. During this evolution, new markets were developed for the myriad products manufactured from a barrel of crude oil.

The globalization of petroleum markets accelerated during the 1980's and early 1990's. The principal factors in this were the common national interests of petroleum consuming countries in allaying supply problems in the face of future petroleum supply disruptions, and the growth in foreign economies. The more global petroleum markets helped to mitigate the effects of the 1990 disruption in world oil supplies.

Foreign economic growth increased the demand for light petroleum products, particularly transportation fuels, and created the need for greater refinery downstream conversion capacity. These factors expanded the market for U.S. petroleum products, and created additional sources of supply for oxygenates and other U.S. petroleum needs. The newly industrialized countries' expanded petroleum use increased air quality concerns. As in the United States, by 1992, many foreign countries were moving toward the production and use of oxygenated motor gasoline and working toward improving oil spill controls.

Investments made during the past 23 years to modernize the industry's operations now provide a base for decisions to be made as the 1990's progress. This report focuses on the developments that shaped the domestic petroleum industry and U.S. supply and demand patterns between 1970 and 1992. It also highlights foreign demand and refinery trends. These events are presented in statistical terms in Chapter 2, and are described in detail in Chapter 3. Some similarity in information noted in Chapters 2 and 3 allows each chapter to stand independently to facilitate the report's use. The report is intended to provide background information on the petroleum industry and its history, and to act as a reference for those more familiar with the industry.

- Chapter 2 describes the patterns of change for each component of supply and demand, and briefly touches on the events (fully described in Chapter 3) that induced significant change or fluctuation. Supplemental data are contained in the Appendix section.
- Chapter 3 presents a chronology of the major petroleum-related events and their consequences. The Chapter also describes the actions or reactions of the petroleum industry to the event, and the impact of the events and actions taken on domestic and/or foreign economies.

Notes: • Unless otherwise referenced, data in this report are from the EIA publications *Petroleum Supply Annual 1992*, Volumes 1 and 2 and predecessor reports, *Annual Energy Review 1992*, *Monthly Energy Review*, June 1993, and *Historical Monthly Energy Review 1973 - 1988*. All data through 1992 are considered final and are not subject to further revision. • In this report, terminology for petroleum consumption also includes demand and product supplied.

Table 1. Significant Events Affecting the U.S. Petroleum Industry, 1970 - 1992

	Laws and Regulations (As Amended), and Events	Date of Enactment or Occurrence	Primary Impact
	U.S. Crude Oil Production Peaks	October 1970	U.S. dependence on foreign sources of crude oil increased, primarily from the Organization of Petroleum Exporting Countries (OPEC).
PL 91-604	Clean Air Act of 1970 (CAA)	December 31, 1970	Fuel quality changes for air pollution reduction were mandated. Sophisticated downstream refinery processing techniques were developed to produce high-octane blending components. Leaded gasoline production and consumption were virtually phased out by 1992.
	1973 Arab Oil Embargo	October 17, 1973 - March 18, 1974	Petroleum supplies were disrupted and prices escalated. U.S. consumers made efforts to conserve energy and reduce petroleum consumption. Bulk petroleum heating fuels lost market share.
PL 93-159	Emergency Petroleum Allocation Act of 1973 (EPAA)	November 27, 1973	Government controls replaced market forces on domestic petroleum price and supply.
	Supplier-Purchaser Rule, Buy-Sell Program, and Crude Oil Entitlements Program	1974	Below-market petroleum prices and allocated supplies created the following situations: <ul style="list-style-type: none"> • Disincentives for crude oil exploration and production. • Proliferation of smaller, inefficient refineries. • Restrictions on exports. • Subsidies on petroleum imports made it more profitable to import petroleum. • The U.S. economy was shielded from price hikes, stimulating domestic demand.
	Introduction of Unleaded Motor Gasoline	1974	Pollution from lead emissions was greatly reduced. The transition to unleaded motor gasoline was aided by its compatibility with the catalytic converter that was developed in 1973 to eliminate vehicle tailpipe emissions.
PL 94-163	Energy Policy and Conservation Act of 1975 (EPCA)	December 22, 1975	Corporate Average Fuel Economy (CAFE) Standards were established to increase vehicle fuel efficiency. The Strategic Petroleum Reserve (SPR) was established. Modifications to EPAA's crude oil pricing regulations created incentives to import crude oil.
PL 95-91	Department of Energy Organization Act of 1977 (DOE)	August 4, 1977	Federal energy-related functions were consolidated under one Agency.
	U.S. Petroleum Demand Peaks	1978	Refinery utilization rates dropped. Subsequent decline in demand contributed to refinery shutdowns in the early 1980's. The ensuing decline contributed to lower crude oil imports.
PL 95-504	Airline Deregulation Act of 1978	October 24, 1978	Airline competition increased through removal of Federal restrictions on airline operations.
PL 95-620	Powerplant and Industrial Fuel Use Act (PIFUA)	November 9, 1978	Construction of electric powerplants with petroleum or natural gas as the primary fuel was restricted.
	1978 Iranian Revolution	November 1978- March 1979	Declines in Iran's crude oil production began a series of OPEC price escalations between 1979 and 1981. A worldwide recession and depressed oil consumption occurred after prices escalated.
Exec. Order 12287	Petroleum Price and Allocation Decontrol	January 28, 1981	Market forces on petroleum prices were reinstated. Refinery efficiency improved. Domestic crude oil production was revitalized. Higher-priced residual fuel oil lost its competitive position.

Table 1. Significant Events Affecting the U.S. Petroleum Industry, 1970 - 1992 (Continued)

Laws and Regulations (As Amended), and Events	Date of Enactment or Occurrence	Primary Impact
Net back Pricing	Fourth Quarter 1985- First Quarter 1986	Refiners were guaranteed specific margins. A crude oil glut on the world market was created.
1986 Crude Oil Price Collapse	First Quarter 1986	Domestic crude oil production declined. Dependence on OPEC crude oil increased. Lower petroleum prices stimulated economic growth.
Exxon Valdez Oil Spill	March 1989	Attention focused on oil spill prevention, tanker safety, and protection of U.S. coastal areas that culminated in the Oil Pollution Act of 1990.
CFR 40, App. E Reid Vapor Pressure Regulations of 1989 and 1992 (RVP)	June 1, 1989; June 1, 1990	Emissions of smog-producing compounds in motor gasoline were reduced.
PL 101-549 Clean Air Act Amendments of 1990 (CAA Amendments; CAAA)	November 15, 1990	Mandated programs to reduce emissions of harmful substances in fuels include: <ul style="list-style-type: none"> • Reduction of carbon monoxide levels in motor gasoline. • Elimination of lead in gasoline. • Reduction in sulfur content of highway diesel fuel. • Addition of oxygen to winter motor gasoline.
Persian Gulf Crisis of 1990 - 1991	August 1990 - March 1991	The impact from sudden price rises and supply cutoffs was reduced, compared with previous disruptions, through worldwide cooperation: <ul style="list-style-type: none"> • Strategic reserves built up by the International Energy Agency (IEA) since 1974 had a calming influence on oil markets. • OPEC, particularly Saudi Arabia, increased crude oil production to mitigate the loss of supplies. • Non-OPEC countries shifted supply patterns to offset lost supplies. • Efficiency improvements and fuel-switching capability improvements, made during the 1980's, reduced the impact of the supply cutoff.
PL 101-380 Oil Pollution Liability and Compensation Act of 1990	August 18, 1990	Some tanker owners stopped delivering oil to U.S. ports other than the Louisiana Offshore Oil Port (LOOP), but a very small portion of deliveries was affected. U.S. petroleum companies began increasing their foreign-flag double-hulled tanker fleets.
Dissolution of the Soviet Union in 1991	December 31, 1991	Exploration and production opportunities have required caution and patience in the new Russia. Declines in petroleum supplies from the former Soviet Union have been offset by exports from the United States and other countries.
PL 102-486 Energy Policy Act	October 8, 1992	Petroleum will provide a smaller share of energy consumption in the future because of : <ul style="list-style-type: none"> • Influx of alternative transportation fuels. • Effects of energy efficiency standards that are to be developed. • Research and development projects that will result in new production technologies and highly efficient equipment.
Oxygenated Fuels Program Implemented	November 1, 1992	Winter carbon monoxide (CO) emissions were reduced in specified U.S. nonattainment areas. Gasoline prices in nonattainment areas increased to offset higher production costs.

Source: Energy Information Administration, Office of Oil and Gas.

2. Patterns of Supply and Demand

Introduction

The United States derives more energy (measured in British thermal units) from petroleum than from any other energy source--nearly twice as much as either coal or natural gas and nearly four times as much as nuclear energy, hydroelectricity, and all other energy sources combined. It is also one of the largest petroleum producers in the world, but consumes far more than it produces.

A complex system has developed to accommodate the logistics of petroleum supply and demand (**Figure 1**). The 1992 volumes for each process in the supply and demand of petroleum illustrate the contribution each process makes. The flow of petroleum begins with the origins of the supply of crude oil, then proceeds through the refining process that transforms the crude oil into petroleum products. Some of these products are exported, and some are supplemented by imports for final disbursement to fill a variety of consumer needs.

The first part of this chapter, **Highs and Lows in Petroleum Data**, looks at the highest and lowest levels of petroleum consumed, produced, imported, exported and stored since 1970. These extremes demonstrate the ability of the petroleum supply and demand system to respond quickly to change.

The remainder of the chapter examines consumer demand for petroleum products, how the industry responds to that demand through refinery production and product imports, how these products are dispersed for consumption, and finally, the impact of the Nation's reliance on others for the crude oil supplies necessary to meet the country's needs:

- **Petroleum Demand** - Petroleum demand moved toward lighter fuels in the United States, as transportation use expanded during the past 2 decades. Cleaner-burning or less expensive fuels replaced petroleum as sources of heat and power in domestic and foreign markets.
- **Petroleum Refining** - Although the number of U.S. petroleum refineries declined after 1981, those remaining became more complex and efficient through technological advancements and additions to downstream units. At foreign refineries, downstream capacity increases served to offset declines in crude oil distillation capacity.
- **Petroleum Product Imports and Exports** - Imports of light petroleum products have surpassed those for heavier products in recent years, mainly in response to reduced demand for heavy products. Foreign markets for light U.S. products have expanded during the 1990's.
- **Petroleum Transportation and Storage** - Shifts in the transportation network and types of petroleum held in storage

during the past 2 decades were in direct response to changing world and U.S. economic and political situations. Crude oil stocks, excluding the Strategic Petroleum Reserve, have claimed an increased share of total stocks, and petroleum inter-regional deliveries have shifted more toward pipelines.

- **Crude Oil Supplies** - The need to supplement domestic supplies of crude oil after 1970 led to greater reliance on the Organization of Petroleum Exporting Countries (OPEC) for imports. This reliance increased the United States' vulnerability to petroleum supply disruptions.

Highs and Lows in U.S. Petroleum Data Since 1970

The domestic petroleum industry has responded to changes in U.S. laws and world political and economic events through expansions or contractions of its various operations through the years. The unfolding of events during the 1970's, 1980's, and early 1990's brought shifts in consumer needs and abrupt changes in petroleum supply patterns that challenged the industry's flexibility. The highest and lowest annual levels recorded for the various components of U.S. petroleum supply and demand signified these shifts.

Energy Production

Domestic crude oil production reached its peak in October 1970 at 10.0 million barrels per day (**Table 2**). Although still a significant source of energy production at the end of 1992, crude oil declined from its high in 1970 to its low point of 7.0 million barrels per day in November 1992. In 1985, crude oil production, in British thermal units (Btu's), was a close second to coal. Since 1988, diminishing production has resulted in crude oil's drop from second to third in importance, behind natural gas and coal (**Figure 2**). Petroleum's share of energy production has dropped from 33 to 23 percent.

Energy Consumption

Petroleum has been the most important U.S. source of energy since 1970. Petroleum's share of total domestic energy consumption, in Btu's, peaked in 1977 at 49 percent. Since then, heightened use of coal and the increased availability of nuclear power have cut into petroleum's share of total energy use. Petroleum's share of total energy consumption was lowest in 1991, when it comprised 41 percent of the Nation's energy.

Petroleum Demand

The variation in U.S. petroleum demand (measured as product supplied) has been linked to changes in the prices of petroleum products relative to one another, and relative to other energy sources. Dramatic petroleum price increases and eventual steep

Figure 1. U.S. Petroleum Flow, 1992
(Million Barrels per Day)

Sources: Energy Information Administration, *Petroleum Supply Annual*, Vol. 1, 1992, and *Petroleum: An Energy Profile*, 1991.

Table 2. Highest and Lowest Levels for Major U.S. Petroleum Supply and Demand Elements, 1970 - 1992
(Thousand Barrels per Day Unless Otherwise Noted)

Item	Production		Imports		Exports		Demand		Refinery Inputs		Stocks (Million Barrels)	
	Volume	Date	Volume	Date	Volume	Date	Volume	Date	Volume	Date	Volume	Date
Crude Oil, excluding SPR												
Lowest.....	7,024	Nov 1992	1,122	Jan 1971	0	1970-1976*	--	--	10,633	Feb 1983	233	Jan 1974
Highest.....	10,013	Oct 1970	7,068	Jul 1977	370	Mar 1979	--	--	15,421	Dec 1978	397	Apr 1981
Alaskan Crude Oil												
Lowest.....	188	Feb 1972	--	--	--	--	--	--	--	--	--	--
Highest.....	2,086	Mar 1988	--	--	--	--	--	--	--	--	--	--
Crude Oil Imports by Source:												
Arab OPEC												
Lowest.....	--	--	30	Jan 1974	--	--	--	--	--	--	--	--
Highest.....	--	--	3,377	Jan 1979	--	--	--	--	--	--	--	--
Other OPEC												
Lowest.....	--	--	246	Jan 1971	--	--	--	--	--	--	--	--
Highest.....	--	--	2,978	Jul 1977	--	--	--	--	--	--	--	--
Total OPEC												
Lowest.....	--	--	429	Aug 1970	--	--	--	--	--	--	--	--
Highest.....	--	--	6,184	Jul 1977	--	--	--	--	--	--	--	--
Non-OPEC												
Lowest.....	--	--	629	Feb 1976	--	--	--	--	--	--	--	--
Highest.....	--	--	3,024	Jul 1992	--	--	--	--	--	--	--	--
Motor Gasoline												
Lowest.....	5,561	Feb 1970	36	Oct 1971	(s)	1970-1981*	5,341	Feb 1970	--	--	190	Oct 1970
Highest.....	7,833	Dec 1978	585	May 1990	184	Dec 1992	7,913	Jun 1978	--	--	285	Mar 1981
Distillate Fuel Oil												
Lowest.....	1,993	Mar 1983	42	Mar 1983	(s)	1970-1981*	1,622	Jul 1970	--	--	90	Mar 1988
Highest.....	3,696	Feb 1977	731	Feb 1973	393	Feb 1991	5,103	Jan 1977	--	--	271	Nov 1977
Residual Fuel Oil												
Lowest.....	567	Jun 1970	280	Jul 1992	1	Jan 1971	887	Sep 1992	--	--	36	Apr 1987
Highest.....	1,955	Feb 1977	2,196	Mar 1973	330	Nov 1989	3,974	Feb 1978	--	--	97	Jan 1980
Jet Fuel												
Lowest.....	765	May 1970	3	Jun 1982	0	1979-1981*	905	Apr 1970	--	--	25	1972-1973
Highest.....	1,630	Oct 1990	286	Oct 1972	159	Feb 1991	1,745	Dec 1989	--	--	52	Dec 1990
Liquefied Petroleum Gases												
Lowest.....	1,466	Feb 1982	26	Jun 1970	9	Sep 1979	933	May 1970	162	May 1971	37	Feb 1970
Highest.....	2,106	May 1992	327	Feb 1981	149	Aug 1981	2,184	Dec 1992	461	Dec 1988	157	Sep 1978
All Products												
Lowest.....	--	--	1,330	Apr 1981	156	Jan 1976	13,175	May 1970	--	--	--	--
Highest.....	--	--	3,635	Feb 1973	1,288	Feb 1991	21,288	Feb 1979	--	--	--	--

-- = Not Applicable.

(s) = Less than 500 barrels per day.

*Indicates that the level occurred more than once during the period.

Sources: Energy Information Administration, *Petroleum Supply Annual*, Vol. 1, 1991-1992, Tables S1 - S8, and predecessor reports, and *Historical Monthly Energy Review 1973-1988*, Tables 3.1A-3.9.

Figure 2. U.S. Energy Production and Consumption by Source, 1970 - 1992

Note: Because vertical scales differ, graphs should not be compared.

Sources: Energy Information Administration, *Annual Energy Review 1992* and *Monthly Energy Review*, June 1993.

drops were in response to wars, political upheaval in producing areas, and supply disruptions during the past 2 decades. During this period, the more stable and lower prices of alternative fuels led consumers to switch from petroleum as their fuel of economic choice. Except during periods of economic recession, U.S. petroleum demand grew during the 1970's. From a low of 14.7 million barrels per day in 1970, demand reached its peak at 18.8 million barrels per day in 1978.

Motor gasoline demand increased from a 1970 low of 5.8 million barrels per day to a high of 7.4 million barrels per day in 1978. The increase reflected a 31-percent growth in the number of automobiles in use¹ and a 25-percent growth in miles traveled. From 1985 to 1992, motor gasoline accounted for about 42 percent of all petroleum products consumed and remained the most important fuel in the United States, averaging over 7 million barrels per day (Figure 3).

Changes in demand for distillate fuel oil were similar to motor gasoline in that consumption reached its lowest and highest levels in 1970 and 1978 respectively. Demand increased from 2.5 to 3.4 million barrels per day during the period. Between 1985 and 1992, consumption was relatively stable at about 3 million barrels per day and accounted for about 18 percent of total U.S. petroleum consumption.

Residual fuel oil demand, in response to lower-priced natural gas and other factors, fell 64 percent, from a high of 3.1 million barrels per day in 1977 to 1.1 million barrels per day in 1992.

In contrast, expanding air travel spurred a 57-percent growth in jet fuel demand between 1970 and 1990. Demand increased from a

Figure 3. U.S. Demand for Petroleum Products, 1970 - 1992

Sources: Energy Information Administration, *Annual Energy Review 1992* and *Petroleum Supply Annual*, Vol. 1, 1992.

¹U.S. Department of Energy, Office of Transportation Technologies, *Transportation Energy Data Book*: Edition 13, March 1993, Table 3.4.

1970 low of 1.0 million barrels per day to 1.5 million barrel per day in 1990.

Refinery Capacity and Utilization

With rising demand for petroleum products throughout the 1970's, the number of refineries and the capacity to distill crude oil rose rapidly. Between 1970 and the beginning of 1981, there was a 16-percent increase in the number of U.S. refineries; their number grew from 279 to 324. Crude oil refinery capacity also increased, from a low of 12.0 million barrels per day at the beginning of 1970 to its high of 18.6 million barrels per day at the beginning of 1981 (Figure 4).

In 1978, the Iranian Revolution and the subsequent disruption of crude oil supplies triggered a rush to conservation and efficiency improvements. The dramatic drop in U.S. petroleum consumption between 1978 and 1983 resulted in a large decline in refinery utilization rates. Between the beginning of 1978 and the beginning of 1983, utilization dropped from 87.4 to 71.7 percent, and the U.S. refining industry entered a period of significant rationalization. By the beginning of 1986, 108 refineries had closed, representing a loss of more than 3 million barrels per day of crude oil distillation capacity. This restructuring has continued, with the number of refineries falling to a low of 187 at the beginning of 1993.

Petroleum Imports and Exports

Total petroleum imports, including imports for the Strategic Petroleum Reserve (SPR), increased from a low of 3.4 million

barrels per day in 1970 to peak at 8.8 million barrels per day in 1977. The 158-percent increase was the result of declining domestic crude oil production and escalating demand prior to the Iranian Revolution. Crude oil imports peaked at 6.6 million barrels per day in 1977.

Product imports were highest at 3.0 million barrels per day in 1973. As refining capacity grew under U.S. price and allocation controls, product imports declined, reaching a low of 1.6 million barrels per day in 1981. Residual fuel oil imports had the greatest impact on the decline during that period (Figure 5).

Crude oil exports were very low until the phaseout of price controls began in 1976. Exports peaked in 1980, then declined through 1992. The decline was primarily in response to decreasing U.S. production (Figure 6).

Petroleum product exports also picked up after price controls on petroleum were lifted in 1981. Exports of most major petroleum products reached their highest levels in 1991 or 1992. During that period, U.S. demand was relatively stable, and world supply lines were realigned. These higher exports, particularly distillate fuel oil, served to offset shortages from Kuwait resulting from the Persian Gulf crisis and lower exports from the former Soviet Union after restructuring. The United States also provided petroleum products to newly industrialized countries in recent years. Notably, the United States was a net exporter of distillate fuel oil in both 1991 and 1992.

The net imports (gross imports minus exports) of crude oil rose quickly from the low of 1.3 million barrels per day in 1970 to 6.6

Figure 4. Number of Operable U.S. Refineries and Refinery Utilization, 1970 - 1992

Note: Because vertical scales differ, graphs should not be compared.

Sources: Energy Information Administration, *Annual Energy Review 1992* and *Petroleum Supply Annual*, Vol. 1, 1992.

Figure 5. U.S. Petroleum Imports, 1970 - 1992

Note: Because vertical scales differ, graphs should not be compared.
Sources: Energy Information Administration, *Annual Energy Review 1992* and *Petroleum Supply Annual*, Vol. 1, 1992.

Figure 6. U.S. Petroleum Exports, 1970 - 1992

Note: Because vertical scales differ, graphs should not be compared.
Source: Energy Information Administration, *Annual Energy Review 1992* and *Petroleum Supply Annual*, Vol. 1, 1992.

million barrels per day in 1977. Then, higher prices following the Iranian Revolution triggered a decline to 3.0 million barrels per day by 1985 (**Figure 7**). Petroleum product net imports, on the other hand, peaked at 2.8 million barrels per day in 1973, and have since witnessed a general decline, falling to a low of 944,000 barrels per day in 1992.

Domestic and Foreign Demand

Domestic Uses of Petroleum Products

Petroleum supplies energy in varying degrees to the four basic sectors of the economy. Each sector--Household and Commercial, Industrial, Transportation, and Electric utilities--uses different types of products in the respective energy mixes.

Nowhere is petroleum's use more widespread than in the transportation sector (**Table 3**). Light transportation fuels dominate this area. Together with heavy marine bunkering fuel, they power the millions of automobiles, trucks, airplanes, ships,

trains, barges, and military vehicles which provide goods and services to the Nation.

Use in the industrial sector includes a wide range of petroleum products. Bulk fuels such as residual and distillate heating oils are used for boiler and power fuel, and diesel fuel is used to operate construction and farm equipment. Non-fuel products are used for specialized operations, as petrochemical feedstocks and in manufacturing processes. Other non-fuels used in industrial operations are asphalt and road oil for highway and building construction, lubricants and greases, petroleum coke, and wax. Petroleum fuels in the industrial sector compete with natural gas, coal, and electricity.

Petroleum energy in the household and commercial sector is furnished primarily by the bulk light heating oils, distillate and propane. Its principal competitors in this sector are natural gas and electricity.

In the electric utility sector, petroleum supplies energy in the form of bulk heavy residual fuel oil and smaller amounts of bulk light distillate fuel oil. Some kerosene-type jet fuel is used for peak

Figure 7. Gross Petroleum Imports, Exports, and Net Imports, 1970 - 1992

Note: Because vertical scales differ, graphs should not be compared.

Source: Energy Information Administration, *Petroleum Supply Annual*, Vol. 1, 1992, and predecessor reports. See Table A4 for corresponding data.

Table 3. U.S. Transportation and Other Demand for Selected Petroleum Products, 1970 - 1992
(Thousand Barrels per Day)

Year	Motor Gasoline			Distillate Fuel Oil			Jet Fuel			Liquefied Petroleum Gases		
	Transportation	Other	Total	Transportation	Other	Total	Transportation	Other	Total	Transportation	Other	Total
1970	5,589	195	5,784	737	1,803	2,540	967	0	967	33	1,192	1,225
1971	5,827	187	6,014	800	1,861	2,661	1,010	0	1,010	36	1,216	1,252
1972	6,199	177	6,376	910	2,003	2,913	1,022	23	1,045	38	1,382	1,420
1973	6,496	178	6,674	1,044	2,048	3,092	1,041	18	1,059	36	1,413	1,449
1974	6,373	164	6,537	1,036	1,912	2,948	978	15	993	33	1,373	1,406
1975	6,512	163	6,675	997	1,854	2,851	992	9	1,001	30	1,303	1,333
1976	6,817	161	6,978	1,074	2,059	3,133	978	9	987	33	1,371	1,404
1977	7,021	156	7,177	1,170	2,182	3,352	1,022	17	1,039	36	1,386	1,422
1978	7,264	148	7,412	1,260	2,172	3,432	1,044	13	1,057	38	1,375	1,413
1979	6,894	140	7,034	1,367	1,944	3,311	1,068	8	1,076	16	1,576	1,592
1980	6,440	139	6,579	1,311	1,555	2,866	1,063	5	1,068	14	1,455	1,469
1981	6,460	128	6,588	1,364	1,465	2,829	1,003	4	1,007	25	1,441	1,466
1982	6,422	117	6,539	1,312	1,359	2,671	1,011	2	1,013	25	1,474	1,499
1983	6,510	112	6,622	1,367	1,323	2,690	1,044	2	1,046	30	1,479	1,509
1984	6,555	138	6,693	1,475	1,370	2,845	1,175	0	1,175	30	1,542	1,572
1985	6,668	163	6,831	1,507	1,361	2,868	1,218	0	1,218	22	1,577	1,599
1986	6,872	162	7,034	1,553	1,361	2,914	1,307	0	1,307	19	1,493	1,512
1987	7,042	164	7,206	1,594	1,382	2,976	1,385	0	1,385	16	1,596	1,612
1988	7,178	158	7,336	1,730	1,392	3,122	1,449	0	1,449	16	1,640	1,656
1989	7,170	158	7,328	1,806	1,351	3,157	1,489	0	1,489	16	1,652	1,668
1990	7,082	153	7,235	1,803	1,218	3,021	1,522	0	1,522	16	1,540	1,556
1991	7,031	157	7,188	1,730	1,191	2,921	1,471	0	1,471	16	1,673	1,689
1992 ¹	7,109	159	7,268	1,764	1,215	2,979	1,454	0	1,454	17	1,738	1,755

	Residual Fuel Oil			All Other			All Products		Total Demand
	Transportation	Other	Total	Transportation ²	Other	Total	Transportation	Other	
1970	332	1,870	2,202	121	1,858	1,979	7,779	6,918	14,697
1971	304	1,992	2,296	116	1,864	1,980	8,093	7,120	15,213
1972	281	2,248	2,529	117	1,967	2,084	8,567	7,800	16,367
1973	318	2,504	2,822	120	2,092	2,212	9,055	8,253	17,308
1974	304	2,335	2,639	114	2,016	2,130	8,838	7,815	16,653
1975	310	2,152	2,462	110	1,890	2,000	8,951	7,371	16,322
1976	358	2,443	2,801	112	2,046	2,158	9,372	8,089	17,461
1977	397	2,674	3,071	116	2,254	2,370	9,762	8,669	18,431
1978	430	2,593	3,023	120	2,390	2,510	10,156	8,691	18,847
1979	534	2,292	2,826	126	2,548	2,674	10,005	8,508	18,513
1980	607	1,901	2,508	111	2,455	2,566	9,546	7,510	17,056
1981	532	1,556	2,088	104	1,976	2,080	9,488	6,570	16,058
1982	444	1,272	1,716	93	1,765	1,858	9,307	5,989	15,296
1983	359	1,062	1,421	95	1,848	1,943	9,405	5,826	15,231
1984	350	1,019	1,369	100	1,972	2,072	9,685	6,041	15,726
1985	342	860	1,202	97	1,911	2,008	9,854	5,872	15,726
1986	376	1,040	1,418	101	1,995	2,096	10,230	6,051	16,281
1987	392	872	1,264	103	2,119	2,222	10,532	6,133	16,665
1988	397	981	1,378	102	2,240	2,342	10,872	6,411	17,283
1989	425	945	1,370	102	2,211	2,313	11,008	6,317	17,325
1990	446	783	1,229	101	2,324	2,425	10,970	6,018	16,988
1991	448	710	1,158	95	2,192	2,287	10,791	5,923	16,714
1992 ¹	423	671	1,094	103	2,380	2,483	10,870	6,163	17,033

¹ Transportation and other demand were calculated based on previous year's share of total demand for each product.

² Lubricants and aviation gasoline.

Sources: Energy Information Administration, *Petroleum Supply Annual*, Vol. 1, 1992, Tables S1 and S4-S8, and predecessor reports, and *State Energy Data Report 1960-1991*, Tables 12 and 16.

shaving purposes. Petroleum inputs at electric utilities were modest compared to coal throughout the past 23 years. After 1978, natural gas, nuclear power, and hydroelectricity inputs also overtook petroleum. Electricity generated by utilities becomes a secondary energy source which competes with petroleum in other sectors of the economy.

Impact of Events on Domestic Demand

The decade of the 1970's proved to be very different for the domestic petroleum industry and its customers than the 2 decades that preceded it. From the end of the Second World War, petroleum demand had risen steadily with supplies adequate to meet demand.

However, late in 1973, a combination of domestic and foreign circumstances crystallized into the first peacetime petroleum supply disruption in the history of the Nation. The disruption marked the end of the era of cheap, secure oil supplies. The economic recession that followed is widely considered to have been caused by the disruption (**Figure 8**), though some recent economic studies indicate that U.S. monetary policy may have contributed.² Crude oil prices worldwide tripled in one year, but price controls in effect in the United States partially shielded the economy from the full impact of the price hikes. Nevertheless, the retail prices of gasoline and home heating oil rose 35 and 58 percent, respectively--indicative of the additional cost increases to the U.S. economy.

Following several years of economic readjustment and stable oil markets, petroleum demand began a resurgence that lasted until 1978. Then, early in 1979, a revolution in the Middle East precipitated a second global peacetime petroleum supply disruption. Again, petroleum prices advanced rapidly and by 1981, U.S. refiners were paying 183 percent more for crude oil than in 1978, and 749 percent more than in 1973.

Since the energy market does not operate in a vacuum, the rapid rise in petroleum prices caused similar types of price increases for other energy sources.³ Faced with vastly higher energy costs, economic activity retreated. By 1983, U.S. demand had fallen to 15.2 million barrels per day, 19 percent below its 1978 peak and the lowest level since 1971.

Figure 8. U.S. Petroleum Demand, Gross Domestic Product, and Economic Recessions, 1970 - 1992

Note: Periods of economic recessions are shaded.

Sources: • Energy Information Administration, *Petroleum Supply Annual*, Vol. 1, 1992 and predecessor reports; • U.S. Department of Commerce, Bureau of Economic Analysis, *Survey of Current Business*, December 1992 and March 1993.

An additional constraint to demand growth was the 1978 implementation of the Corporate Average Fuel Economy (CAFE) legislation that mandated increased fuel efficiency in highway vehicles. In 1977, passenger cars averaged 13.8 miles per gallon. Yearly increases in gas mileage since the CAFE standards went into effect brought the average miles per gallon in 1991 to 21.7.

²Douglas R. Bohi, *Energy Price Shocks and Macroeconomic Performance*, Resources for the Future 1989, pp. 1, 3, and 83 - 87.

³Energy Information Administration, *State Energy Price and Expenditure Report 1970-1981*, p. 3.

Economic growth began to recover in 1983 and continued for almost eight years, until the Persian Gulf crisis of 1990. As crude oil prices gradually moderated and the availability of supplies increased, petroleum demand also began to revive.

In 1986, a third global oil price shock occurred. Unlike the previous two, this one was a sharp decline, as foreign producers, competing for market share, dumped their excess crude oil into the market. The world price of crude oil responded during the first quarter of 1986 by dropping more than 50 percent from the price at the end of 1985. Crude oil prices reverted to levels not seen since 1977 and 1978. Between 1985 and 1986, the retail price of regular motor gasoline declined 23 percent while the retail price of No. 2 home heating oil fell 24 percent. By 1989, demand had returned to the 1973 level.

The Changing Mix of Bulk, Transportation, and Nonfuels

In response to the first oil price shock of 1973, U.S. consumers and industry sought ways to reduce petroleum use or switch to alternative energy sources. Residential consumers moderated their heating and cooling temperatures, installed more insulation,⁴

⁴Energy Information Administration, *Energy Consumption Indicators, 1984 Annual Report*, Figures 14, 24, 40, and 43.

⁵U.S. Department of Transportation, Federal Highway Administration, *Traffic Volume Trends*, April 1993, Figure 1.

⁶Energy Information Administration, *Sales of Fuel Oil and Kerosene in 1977*, Figures 1 and 2.

⁷Energy Information Administration, *Availability of Heavy Fuel Oils by Sulfur Levels*, December 1977, and predecessor reports, 1975 and 1976, Tables 3 and 5.

and drove less.⁵ Industry increased use of alternative energy sources wherever possible and streamlined operations to reduce petroleum use and overall energy use, in general.

Initially, bulk heating oils (distillate and propane of the light oils and residual among heavy oils) lost energy market share in the economy. However, the reductions were somewhat offset by other factors at work.

Legislation enacted in the 1970's mandated crude oil price and allocation controls, froze buyer-seller relationships, and limited the fuel choices of electric utilities. Collectively, the legislation reduced the flexibility of the petroleum industry and the economy to fully respond to the impact of the supply disruption, and tended to subsidize demand.

As a result, after the economy began to recover in 1975, low-cost bulk heating oils recaptured much of the energy markets they had lost in the industrial and electric utility sectors.⁶ By switching to low-sulphur residual fuel oil from the high-sulphur product, electric utilities and industrial plants were able to economically satisfy both their energy needs and their environmental obligations.⁷

Petroleum Products, By Type

Bulk Fuels:

Bulk petroleum fuels are used in all sectors of the U.S. economy. They are used as industrial boiler and power fuel, household and commercial heating fuel, and specialty fuels. They are also used in electric power generation, construction and farm operations. These fuels compete with alternative energy sources, and lost market share after 1978.

Light Bulk Fuels:

- Kerosene
- Distillate fuel oil
- Liquefied petroleum gases
- Still gas
- Miscellaneous products

Heavy Bulk Fuels:

- Petroleum coke
- Residual fuel oil

Transportation Fuels

Transportation fuels are primarily engine fuels for vehicles used in highway, marine, and aviation modes. For the foreseeable future, petroleum will remain the principal engine fuel, as it is not yet largely replaceable by alternative fuels.

Light Transportation Fuels:

- Aviation gasoline
- Diesel fuel
- Jet fuel
- Liquefied petroleum gases
- Motor gasoline

Heavy Transportation Fuels:

- Lubricants
- Residual fuel oil

Nonfuels

Specialized industrial operations are the predominant uses for petroleum nonfuels. These operations include the production of petrochemicals, manufacturing processes, highway and building construction. Consumption of light nonfuels doubled between 1970 and 1992.

Light Nonfuels:

- Liquefied petroleum gases
- Petrochemical feedstocks
- Miscellaneous products
- Still gas
- Special naphthas

Heavy Nonfuels:

- Asphalt and road oil
- Lubricants
- Petroleum coke
- Waxes

Table 4. U.S. Demand for Light and Heavy Petroleum Products, 1970 - 1992
(Thousand Barrels per Day)

Year	Light				Heavy				Total			
	Transportation ¹	Bulk ²	Nonfuel ³	Total Light	Transportation ¹	Bulk ²	Nonfuel ³	Total Heavy	Transportation ¹	Bulk ²	Nonfuel ³	Total Demand
1970....	7,382	3,346	960	11,688	397	1,870	742	3,009	7,779	5,216	1,702	14,697
1971....	7,723	3,368	1,001	12,092	370	1,991	760	3,121	8,093	5,359	1,761	15,213
1972....	8,215	3,613	1,142	12,969	352	2,248	797	3,397	8,567	5,861	1,939	16,367
1973....	8,663	3,641	1,218	13,522	392	2,505	889	3,786	9,055	6,146	2,107	17,308
1974....	8,463	3,427	1,229	13,119	375	2,335	824	3,534	8,838	5,762	2,053	16,653
1975....	8,570	3,355	1,117	13,042	381	2,151	748	3,280	8,951	5,506	1,865	16,322
1976....	8,937	3,536	1,259	13,832	435	2,443	751	3,629	9,372	6,079	2,010	17,461
1977....	9,288	3,794	1,399	14,481	474	2,674	802	3,950	9,762	6,468	2,201	18,431
1978....	9,644	3,766	1,490	14,900	512	2,593	842	3,947	10,156	6,359	2,332	18,847
1979....	9,383	3,886	1,499	14,768	622	2,292	831	3,745	10,005	6,178	2,330	18,513
1980....	8,862	3,343	1,534	13,739	684	1,901	732	3,317	9,546	5,244	2,266	17,056
1981....	8,882	3,209	1,114	13,205	606	1,556	691	2,853	9,488	4,765	1,805	16,058
1982....	8,795	2,984	1,056	12,835	512	1,272	677	2,461	9,307	4,256	1,733	15,296
1983....	8,975	2,831	1,175	12,981	430	1,061	759	2,250	9,405	3,892	1,934	15,231
1984....	9,259	2,884	1,322	13,465	426	1,019	814	2,259	9,685	3,903	2,136	15,726
1985....	9,441	2,886	1,287	13,614	413	860	839	2,112	9,854	3,746	2,126	15,726
1986....	9,784	2,886	1,271	13,941	446	1,040	854	2,340	10,230	3,926	2,125	16,281
1987....	10,061	2,905	1,458	14,424	471	871	899	2,241	10,532	3,776	2,357	16,665
1988....	10,402	2,880	1,631	14,913	470	981	919	2,370	10,872	3,861	2,550	17,283
1989....	10,506	2,929	1,556	14,991	502	945	887	2,334	11,008	3,874	2,443	17,325
1990....	10,445	2,599	1,689	14,733	525	782	948	2,255	10,970	3,381	2,637	16,988
1991....	10,271	2,540	1,792	14,603	520	710	881	2,111	10,791	3,250	2,673	16,714
1992 ⁴ ...	10,366	2,587	1,970	14,923	504	716	890	2,110	10,870	3,303	2,860	17,033

¹ Light transportation fuels include motor gasoline, aviation gasoline, distillate(diesel fuel), jet fuel, and liquefied petroleum gases. Heavy transportation fuels include residual fuel oil and lubricants.

² Light bulk fuels include motor gasoline, distillate fuel oil, jet fuel, liquefied petroleum gases, kerosene, still gas, and miscellaneous products. Heavy bulk fuels include residual fuel oil.

³ Light nonfuels include liquefied petroleum gases, naphtha and other oils for petrochemical feedstock use, special naphthas, pentanes plus, still gas, miscellaneous products, and other liquids. Heavy nonfuels include crude oil, lubricants, wax, asphalt and road oil, and petroleum coke.

⁴ Transportation, Bulk, and Nonfuel data were calculated based on previous year's share of total for each type.

Sources: • Energy Information Administration, **Bulk and Nonfuel, except liquefied petroleum gases: Petroleum Supply Annual**, Vol. 1, 1981-1992, Table 2, and predecessor reports. **Transportation: State Energy Data Report 1960-1991**, Table 12. **Bulk and Nonfuel liquefied petroleum gases: Sales of Liquefied Petroleum Gases and Ethane, 1977-1982**, Table 1, and predecessor reports. • American Petroleum Institute, *Sales of Natural Gas Liquids and Liquefied Refinery Gases*, 1984-1991, Table 1.

Since technology to reduce pollutants from coal burning was in its developmental stages, competition from coal was minimal at that time. Natural gas use generally was restricted to the residential market, since it was in short supply. Consequently, demand for bulk oils grew, reaching a peak of 6.5 million barrels per day in 1977 (Table 4).

Price and allocation decontrol in 1981 followed on the heels of the 1979 petroleum supply shock. This time, the U.S. economy was fully exposed to the effects of the large increases in energy prices in general and petroleum prices in particular. In order to reduce their energy bills, consumers intensified their efforts to conserve energy. They further moderated heating and cooling habits, increased insulation,⁸ and traveled even less. Residential consumers switched to electricity and natural gas as alternatives

to petroleum.⁹ Many consumers bought smaller, more fuel efficient automobiles, or turned to mass transit to reduce transportation costs.¹⁰

Industry turned to electricity and natural gas as alternatives to petroleum. In addition, industry researched and developed new technologies to reduce overall energy use and installed fuel switching capabilities to minimize costs.

Electric utilities turned more to other energy sources, and away from petroleum after prices were decontrolled in 1981. Coal was plentiful and more economical. Hydroelectric and nuclear power were also competitive and more secure. Gradually, natural gas supplies became price competitive and also began to displace petroleum in the electric utility sector. Within a few years after

⁸Energy Information Administration, *Energy Consumption Indicators, 1984 Annual Report*, Figures 14, 19, 24, and 40.

⁹Energy Information Administration, *Residential Energy Consumption and Expenditures by End Use for 1978, 1980, and 1981*, Figure 1.

¹⁰U.S. Department of Energy, Office of Transportation Technologies, *Transportation Energy Data Book, Edition 13*, March 1993, Tables 3.18 and 3.30.

the repeal of the Powerplant and Industrial Fuel Use Act in 1987, electricity generation from natural gas was stable while generation from petroleum was declining substantially.

Although overall energy demand declined 10 percent from 1978 to 1983, petroleum demand decreased by 19 percent, losing 3.6 million barrels per day. Sixty-eight percent of the lost volume was made up of bulk oils, light and heavy. Collectively, their use was diminished by 2.5 million barrels per day. Residual fuel oil, the predominant heavy bulk oil, lost 1.5 million barrels per day, accounting for 42 percent of the total decline in demand. Demand for bulk oils after 1983 remained relatively stable until 1990, when they continued to lose market share. By 1992, demand of 3.3 million barrels per day was 15 percent below the 1983 volume and only about half of the volume consumed in 1978 (**Figure 9**).

In contrast to bulk fuels, nonfuel products maintained or increased their respective market positions. Nonfuel products made up approximately 13 percent of total demand in 1983. By 1992, they comprised almost 17 percent. Much of this growth is attributable to the increase in demand for plastics and other basic chemicals.

This growth is mainly reflected in the increase of light nonfuel products, which expanded 68 percent from 1983 to 1992.

The transportation sector, unlike other sectors, did not see a decrease in petroleum's influence. Over the entire 2-decade period, petroleum transportation fuels supplied more than 95 percent of the energy used in the transportation sector. In turn, light transportation fuels, mainly motor gasoline, jet fuel and diesel, dominated that petroleum market, providing 95 percent of the volume.

During the 1990's, the influx of alternative transportation fuels will continue, but petroleum will retain its dominance in the transportation market. The Energy Policy Act of 1992 mandates the phase-in of alternative fuels such as methanol, ethanol, natural gas, and electricity in automobile and truck fleets.

The greatest demand for light transportation fuels is for highway travel. Almost all motor gasoline is used for this purpose. Some 59 percent of total distillate oil demand also was dedicated to transportation in 1992, with on-highway use representing about

Figure 9. U.S. Demand for Light and Heavy Petroleum Products for Transportation, Bulk, and Nonfuel Uses, and Related Events, 1970-1992

Source: Energy Information Administration, *Petroleum Supply Annual*, Vol. 1, 1981-1992 and predecessor reports. See Table 4 for corresponding data and definitions.

46 percent. Diesel's contribution to the growth of light transportation fuels cannot be underestimated. While motor gasoline grew by 27 percent from 1970 to 1992, diesel fuel use more than doubled.

Excluding small amounts used for electric utility peak shaving, all jet fuel is consumed for transportation. Though some kerosene-type jet fuel is blended with diesel fuel for vehicle engine ignition in cold weather, the major portion goes to the commercial aviation market. Demand for jet fuel grew 150 percent from 1970 to 1992.

Heavy transportation fuels, principally marine bunkering fuel, grew in the United States throughout the 1970's. Sheltered by price controls, domestic bunker fuels were a bargain. After price decontrol in 1981, domestic bunkering prices escalated to world levels and demand receded. Since the mid-1980's, heavy transportation fuel use has remained fairly static.

Over the years, the growth in light transportation fuels altered the composition of total domestic petroleum demand. In 1970, light transportation fuels made up 50 percent of total demand. When petroleum demand peaked in 1978, their share was 51 percent. After price decontrol in 1981, they commanded an even larger share of the market. In 1992, they comprised 61 percent of all petroleum use.

Since the 1973 supply disruption, U.S. consumers have learned to use energy more efficiently. While the gross domestic product expanded 51 percent from 1973 to 1992, the amount of energy expended to produce each dollar declined 26 percent. As a result, the overall energy market grew only 11 percent.

While petroleum's share of the energy market declined from 49 percent in 1977, it still commanded 41 percent of the larger 1992 market. Petroleum continued to be the predominate energy source in the U.S. economy, though consumption of coal and nuclear power grew.

Foreign Demand

Foreign demand for petroleum grew from 32.1 to 49.8 million barrels per day between 1970 and 1991, an increase of 55 percent. Growth in demand for light products expanded during this period, while demand for heavy products was about the same in 1991 as in 1970.

Replacement of heavy bulk fuels in Western Europe and Far Eastern countries served to offset increases in developing areas. In Japan and France, for example, replacing residual fuel oil with nuclear power for electric generation has been a way to counter the lack of indigenous energy resources.¹¹ Japan is also

expanding its use of lower-priced natural gas as a way to diversify its energy sources.

As in the United States, light products (excluding LPG's for lack of data prior to 1986), increased and claimed a greater share of foreign petroleum demand after 1970. In the Far East and Oceania, total petroleum demand doubled between 1970 and 1990, and continued to rise in 1991 (**Table 5**). Demand for light products almost tripled to 7.1 million barrels per day by 1990, and its share of total demand grew from 40 to 52 percent (**Figure 10**).

Western Europe's total petroleum demand grew from 12.6 to 13.0 million barrels per day between 1970 and 1990. The share attributed to light products increased from 47 to 62 percent over the period. Among heavy products, residual fuel oil remains a primary fuel for power generation in Italy and other Western European countries, but is gradually being replaced by nuclear power in France and Scandinavia. Residual fuel oil's share of Western European petroleum demand fell from 36 percent in 1970 to 18 percent in 1990.

Among the other products, foreign demand for LPG's grew after the mid-1980's. In 1986, LPG's comprised 26 percent of the demand for other products. By 1990, foreign LPG demand of 3.7 million barrels per day represented 37 percent of foreign demand for other products.¹²

The switch from heavy products was less dramatic in some of the developing areas of the world. In North America, Mexico's recent booming economy continued to rely on residual fuel oil for power generation and industrial power.¹³ Among the other products, however, LPG demand in Mexico grew.¹⁴ LPG is the leading residential fuel, dominant petrochemical feedstock, and competes with motor gasoline as a transportation fuel.¹⁵ In Africa, where total petroleum demand almost tripled between 1970 and 1990, residual fuel oil use more than doubled, but its share declined from 32 to 25 percent. Demand for both light and heavy products increased in Eastern Europe and the Former Soviet Union, but the shares of each remained about the same through the years. Selected light fuels comprised about 50 percent of the total in Eastern Europe and the Former Soviet Union, and selected heavy fuels accounted for about 32 percent.

Light transportation fuels predominate in developed areas of the world, but the mix of fuels (excluding air travel) differs from that in the United States. Of the non-air light transportation fuel U.S. consumers used in 1990, 79 percent was motor gasoline and 20 percent diesel fuel. In contrast, Italy's diesel fuel share was 57 percent. The mix in Japan and France was 56 percent motor gasoline to 44 percent diesel fuel (**Figure 11**). The cost of diesel fuel to motorists is about one-half the cost of motor gasoline in many European and Far Eastern countries. In addition, diesel fuel is a primary fuel in foreign mass transit.

¹¹Energy Information Administration, *International Energy Outlook 1990*, p. 17.

¹²Energy Information Administration, *International Energy Annual*, 1987, Table 11, 1991, Table 18.

¹³"Mexican Energy Law Developments," *Petroleum Economist*, July 1992, Energy Law special supplement.

¹⁴Energy Information Administration, *International Energy Annual*, 1987, Table 11, and 1988 - 1991, Table 18.

¹⁵"High Mexican Prices Take Bite Out Of Local Demand," *Petroleum Intelligence Weekly*, December 7, 1992, p. 5.

Table 5. Primary Components of World Demand, Selected Years
(Thousand Barrels per Day)

Area	Year	Selected Light Products					Selected Heavy Products		All Other Products	Total Demand
		Motor Gasoline	Distillate Fuel Oil	Jet Fuel/Kerosene	Total	Percent of Demand	Residual Fuel Oil	Percent of Demand		
United States	1970	5,783	2,540	1,230	9,553	65.0	2,203	15.0	2,941	14,697
	1975	6,675	2,851	1,159	10,685	65.5	2,462	15.1	3,175	16,322
	1980	6,579	2,866	1,226	10,671	62.6	2,508	14.7	3,877	17,056
	1985	6,831	2,868	1,333	11,032	70.2	1,202	7.6	3,492	15,726
	1989	7,328	3,157	1,573	12,058	69.6	1,370	7.9	3,897	17,325
	1990	7,235	3,021	1,565	11,821	69.6	1,229	7.2	3,938	16,988
	1991	7,188	2,921	1,517	11,626	69.6	1,158	6.9	3,930	16,714
Other North America	1970	602	475	141	1,218	60.1	412	20.3	395	2,025
	1975	789	614	159	1,562	61.6	488	19.2	487	2,537
	1980	995	744	174	1,913	60.8	571	18.1	664	3,148
	1985	883	653	149	1,685	56.7	450	15.1	839	2,974
	1989	991	629	197	1,817	53.4	677	19.9	907	3,401
	1990	1,007	616	185	1,808	53.2	670	19.6	942	3,422
	1991	1,019	590	171	1,780	52.2	547	16.0	1,084	3,412
Central and S. America.....	1970	532	425	162	1,119	45.3	840	34.0	511	2,470
	1975	709	629	188	1,526	50.0	939	30.8	584	3,049
	1980	791	827	235	1,853	51.9	986	27.6	734	3,573
	1985	738	800	229	1,767	55.5	637	20.0	781	3,185
	1989	925	951	215	2,091	58.5	754	21.1	732	3,577
	1990	930	953	223	2,106	58.6	734	20.4	755	3,595
	1991	NA	NA	NA	NA	NA	NA	NA	NA	3,653
Western Europe.....	1970	1,714	3,761	473	5,948	47.4	4,518	36.0	2,093	12,559
	1975	2,128	4,136	545	6,809	50.6	4,483	33.3	2,173	13,465
	1980	2,475	4,351	555	7,381	52.9	3,728	26.7	2,838	13,947
	1985	2,487	4,172	527	7,186	59.8	2,467	20.5	2,370	12,023
	1989	2,851	4,306	686	7,843	61.0	2,357	18.3	2,659	12,859
	1990	2,962	4,393	714	8,069	62.2	2,344	18.1	2,551	12,964
	1991	NA	NA	NA	NA	NA	NA	NA	NA	13,568
E. Europe and Former USSR ...	1970	1,249	1,341	463	3,053	47.3	2,110	32.7	1,293	6,456
	1975	1,687	1,710	616	4,013	43.7	3,255	35.4	1,921	9,189
	1980	1,857	2,510	753	5,120	46.2	3,208	28.9	2,754	11,082
	1985	1,913	2,318	751	4,982	46.0	3,050	28.2	2,792	10,824
	1989	1,895	2,253	733	4,881	46.5	3,211	30.6	2,398	10,490
	1990	2,070	2,312	678	5,060	50.6	3,243	32.4	1,704	10,007
	1991	NA	NA	NA	NA	NA	NA	NA	NA	9,281
Middle East	1970	83	161	94	338	32.3	564	53.9	144	1,046
	1975	160	298	187	645	46.7	545	39.5	190	1,380
	1980	290	436	275	1,001	48.6	646	31.4	411	2,058
	1985	479	791	301	1,571	55.0	815	28.6	468	2,854
	1989	503	917	322	1,742	51.9	1,036	30.9	577	3,355
	1990	542	965	377	1,884	54.4	1,010	29.1	571	3,465
	1991	NA	NA	NA	NA	NA	NA	NA	NA	3,520
Africa.....	1970	159	208	88	455	59.1	243	31.6	72	770
	1975	237	314	127	678	61.7	268	24.4	152	1,098
	1980	314	406	179	899	61.0	332	22.5	243	1,474
	1985	402	496	214	1,112	60.9	424	23.2	290	1,826
	1989	439	559	232	1,230	61.8	468	23.5	293	1,991
	1990	460	574	239	1,273	60.6	516	24.6	311	2,100
	1991	NA	NA	NA	NA	NA	NA	NA	NA	2,169
Far East and Oceania.....	1970	961	1,030	693	2,684	39.6	2,691	39.7	1,411	6,786
	1975	1,220	1,635	1,096	3,951	43.1	3,176	34.7	2,031	9,158
	1980	1,432	2,210	1,109	4,751	44.3	3,749	34.9	2,229	10,729
	1985	1,617	2,445	1,119	5,181	48.5	2,493	23.3	3,012	10,686
	1989	2,055	3,273	1,346	6,674	51.2	2,972	22.8	3,386	13,032
	1990	2,184	3,497	1,428	7,109	52.2	3,124	22.9	3,381	13,614
	1991	NA	NA	NA	NA	NA	NA	NA	NA	14,244
Total Foreign.....	1970	5,300	7,400	2,114	14,814	46.1	11,378	35.4	5,919	32,111
	1975	6,928	9,335	2,916	19,179	48.1	13,155	33.0	7,542	39,876
	1980	8,154	11,484	3,279	22,917	49.8	13,219	28.7	9,875	46,011
	1985	8,519	11,675	3,286	23,480	52.9	10,335	23.3	10,557	44,372
	1989	9,659	12,888	3,732	26,279	54.0	11,475	23.6	10,951	48,705
	1990	10,155	13,311	3,843	27,309	55.5	11,642	23.7	10,216	49,167
	1991	NA	NA	NA	NA	NA	NA	NA	NA	49,847
Total World.....	1970	11,083	9,940	3,344	24,367	52.1	13,581	29.0	8,860	46,808
	1975	13,603	12,186	4,075	29,864	53.1	15,617	27.8	10,717	56,198
	1980	14,733	14,350	4,505	33,588	53.3	15,727	24.9	13,752	63,067
	1985	15,350	14,543	4,619	34,512	57.4	11,537	19.2	14,049	60,098
	1989	16,987	16,045	5,305	38,337	58.1	12,845	19.5	14,848	66,030
	1990	17,390	16,332	5,408	39,130	59.1	12,871	19.5	14,154	66,155
	1991	NA	NA	NA	NA	NA	NA	NA	NA	66,560

NA = Not Available.

Note: Totals may not equal sum of components due to independent rounding.

Sources: Energy Information Administration, Office of Energy Markets and End Use, *Annual Energy Review 1992*, Table 11.10, *International Energy Annual*, 1991, Table 18, and International Statistics Branch.

Figure 10. Distribution of Selected Light and Heavy Products In World Petroleum Demand by Area, 1970 and 1990

Note: The remainder above each bar represents all other products, both light and heavy, for which individual data are not available.

Source: Energy Information Administration, Office of Energy Markets and End Use, *Annual Energy Review 1992*. See Table 6 for corresponding data.

Petroleum's share of the total foreign energy market remained at about 39 percent since at least 1988. In areas where petroleum's share declined, generally the switch was to natural gas.¹⁶

Domestic and Foreign Petroleum Refining

Crude oil quality changes, shifting petroleum demand patterns, and evolving regulations (described in Chapter 3) during the past 23 years provoked changes that resulted in a more complex, more flexible domestic refining industry. Refining capacity and utilization, configuration and processing flexibility, slates and product yields were reshaped. Ownership of U.S. refineries changed through consolidation and foreign investments. As the U.S. industry evolved and became more sophisticated during the 1980's and early 1990's, the foreign refining industry was also modernizing to accommodate shifts in world product markets.

U.S. Refineries and Utilization Rates

A record number of U.S. refineries were operating at the beginning of 1981 when crude oil distillation capacity peaked at 18.6 million barrels per day. The number of refineries and refining capacity

had both grown steadily under the price and allocation programs set up in 1973 and 1974. These programs benefitted small refineries, with the result that the number of refineries proliferated before price controls and allocations were removed in early 1981.

At the beginning of 1973, 281 U.S. refineries, with an average crude oil distillation capacity of 49,000 barrels per day, were in operation. Between 1973 and the beginning of 1981, while 32 refineries shut down, 75 newly constructed refineries were activated, and only two of these had distillation capacities exceeding 50,000 barrels per day.¹⁷ The average capacity of the additional plants was 14,700 barrels per day. Crude oil distillation capacity continued to increase even after the 1978 Iranian Revolution caused demand to drop through 1981 (Table 6).

The operable refinery utilization rate¹⁸ began falling after the Iranian Revolution, and reached a low of 68.5 percent by January 1, 1982.¹⁹ The restoration of market forces in 1981 and the decline in petroleum demand in the early 1980's caused many small refineries and older, inefficient plants to shut down. From the beginning of 1981 to the beginning of 1983, refinery closings resulted in the net loss of 66 U.S. refineries, or 20 percent of those in operation at the beginning of 1981. The shutdowns accounted

¹⁶Energy Information Administration, *International Energy Annual*, 1988-1989, Table HL2, and 1990-1991, Table ES2.

¹⁷American Petroleum Institute, *Entry and Exit in U.S. Petroleum Refining, 1948-1992*, January 1993, Tables 7 and 8.

¹⁸The operable utilization rate represents the utilization of the atmospheric crude oil distillation units of refineries. The rate is calculated by dividing the gross refinery inputs (crude and other oils) by the operable refining capacity of the units.

¹⁹Energy Information Administration, *Petroleum Refining in the 1980's*, October 1990, Table C4.

Figure 11. Distribution of Motor Gasoline and Diesel Fuel for Non-Air Transportation Use, Selected Countries, 1990

Sources: • Energy Information Administration, *State Energy Data Report 1960-1991*, Table 16. • *Bloomberg Oil Buyers Guide*, February 17, 1992.

Table 6. Number and Operable Capacity of U.S. Petroleum Refineries as of January 1, 1971 - 1993
(Thousand Barrels per Stream Day, Except Where Noted)

Year	Number	Crude Oil Distillation (thousand barrels per calendar day)	Vacuum Distillation	Thermal Cracking	Catalytic Cracking (Fresh & Recycled)	Catalytic Reforming	Catalytic Hydrocracking	Catalytic Hydrotreating
1971	279	12,860	--	--	--	--	--	--
1972	282	13,292	--	--	--	--	--	--
1973	281	13,642	--	--	--	--	--	--
1974	284	14,362	--	--	--	--	--	--
1975	290	14,961	--	--	--	--	--	--
1976	287	15,237	--	--	--	--	--	--
1977	291	16,398	--	--	--	--	--	--
1978	302	17,048	--	--	--	--	--	--
1979	311	17,441	--	--	--	--	--	--
1980	319	17,988	6,381	1,564	5,773	3,970	864	4,616
1981	324	18,621	7,033	1,587	6,136	4,098	909	8,487
1982	301	17,890	7,197	1,782	6,036	3,966	892	8,539
1983	258	16,859	7,180	1,715	5,890	3,918	883	8,354
1984	247	16,137	7,165	1,852	5,802	3,907	952	9,009
1985	223	15,659	6,998	1,858	5,738	3,750	1,053	8,897
1986	216	15,459	6,892	1,880	5,677	3,744	1,125	8,791
1987	219	15,566	6,935	1,928	5,716	3,805	1,189	9,083
1988	213	15,915	7,198	2,080	5,806	3,891	1,202	9,170
1989	204	15,655	7,225	2,073	5,650	3,911	1,238	9,440
1990	205	15,572	7,245	2,108	5,755	3,896	1,282	9,537
1991	202	15,676	7,276	2,158	5,862	3,926	1,308	9,676
1992	199	15,696	7,172	2,100	5,888	3,907	1,363	9,644
1993	187	15,121	6,892	2,082	5,784	3,728	1,397	9,677

-- = Data not available 1971-1979.

Sources: Energy Information Administration, *Petroleum Supply Annual*, Vol.1, 1991 and 1992, Table 36, *The U.S. Petroleum Refining Industry in the 1980's*, October 1990, Table 1, and *Petroleum Refineries in the United States and U.S. Territories, 1977-1979*, Table 1, and predecessor reports.

for a 9-percent reduction in crude oil distillation capacity. The refinery shutdowns resulted in improved operating efficiency. This enabled the refinery utilization rate to increase, despite lower crude oil inputs than during the era of price controls in the 1970's (**Figure 12**). Refinery closings continued at a slower pace after 1983, reflecting changing economics and technological advancements.

Downstream Processing

Price and allocation decontrol in 1981 changed refining economics. It was no longer profitable or feasible to produce heavy bulk oils. Production of light fuels, principally transportation types, claimed more of the production from a barrel

of crude oil, and became essential to the economic viability of refiners.

Most of the 187 U.S. refineries in operation at the beginning of 1993 increased their flexibility and complexity through expansions in downstream processing capacities after 1981. A significant change was the addition of downstream capacity to desulfurize and process poorer quality crude oils into lighter products than could be obtained through distillation. These heavier, more sour crude oils have been used increasingly since the 1980's (**Table 7**).

Downstream processing units have also been essential as a means for U.S. refineries to conform to new and emerging environmental

Figure 12. U.S. Operable Refinery Capacity, Crude Oil Inputs, Petroleum Demand, and Related Events, 1970 - 1992

Note: Operable refining capacity data are per calendar day as of January 1 of the following year.

Sources: Energy Information Administration, *Petroleum Supply Annual*, Vol. 1, 1981-1992, and predecessor reports. See Table A1 for corresponding data.

Table 7. U.S. Utilization of Heavier, Higher Sulfur Crude Oil, 1981 - 1992

Year	Sulfur Percent by Weight	API Gravity (degrees)
1981	0.89	33.74
1982	0.91	33.11
1983	0.90	33.19
1984	0.94	32.96
1985	0.91	32.46
1986	0.96	32.33
1987	0.99	32.22
1988	1.04	31.93
1989	1.06	32.14
1990	1.10	31.86
1991	1.13	31.64
1992	1.16	31.32

Sources: Energy Information Administration, *Petroleum Supply Annual*, Vol. 1, 1991, Tables FE9 and 16, and 1992, Table 16.

regulations. For example, downstream units have been used in the production of unleaded gasoline since lead phaseout regulations took effect in the mid-1970's. Since 1989, when Reid Vapor Pressure regulations were first implemented, downstream units have been important for the production of gasoline blending components that are needed in the summer gasoline pool to replace butane. Additions to downstream processing will continue to be made, to produce low-sulfur highway diesel fuel and reformulated gasolines as required by the 1990 Clean Air Act (CAA) Amendments.

Refinery Yields

Downstream units also enabled refiners to increase or maintain yields of light products, despite the decline in crude oil distillation capacity. Yields of motor gasoline comprise the greatest portion of all refinery yields (about 45 percent). With the 1974 introduction of unleaded motor gasoline, as required by the Clean Air Act of 1970, unleaded gasoline yields began to grow steadily, and over the years, leaded gasoline was virtually phased out. Distillate fuel oil yields have been relatively stable (about 20 percent) through the years. Yields of kerosene-type jet fuel increased more than any other product since 1980. Yields of residual fuel oil increased during the period of price controls in the 1970's, when small, inefficient refineries were operating. Declines since then brought 1992 yields to the same rate as in 1970 (Figures 13 and 14).

Among the remaining product yields, those for still gas, liquefied refinery gases (LRG's), and petroleum coke showed the greatest changes between 1970 and 1992. The more severe processing of the growing downstream operations increased yields of LRG's and still gas by about 1 percent each. In 1992, the typical barrel of crude oil yielded 4.3 percent LRG's and

4.7 percent still gas. Yields of petroleum coke rose more dramatically because of the increased use of heavy crude oils requiring thermal cracking. Petroleum coke yields increased from 2.7 percent in 1970 to 4.2 percent in 1992.

Partially offsetting the increased yields of these products, yields of asphalt and road oil declined by about 1 percent, and comprised 3 percent of all refinery yields in 1992. The greater severity of refining operations as more downstream capacity came on stream also increased the volumes of refined products, resulting in greater processing gains since 1980. During the 1970's, the annual processing gain was between 3 and 4 percent. As downstream processing grew during the 1980's, processing gains were greater, and in 1992, the processing gain was almost 6 percent.

Refinery Production

Refinery production increased 32 percent between 1970 and 1978, when it peaked at 16.0 million barrels per day. After the Iranian Revolution in 1978, refinery production declined by 18 percent over the next 5 years to a low of 13.1 million barrels per day in 1983. A significant increase in domestic demand in 1984 served to stimulate domestic refinery production. Refiners have increased production almost every year since 1984. In 1992, 15.4 million barrels of petroleum products were produced at U.S. refineries (Table 8).

Except during periods of economic recession, refinery production of motor gasoline generally rose each year. In 1970, production was 5.7 million barrels per day, then increased generally through 1978, when production of 7.2 million barrels per day was 26 percent higher than in 1970. Output declined between 1979 and

Figure 13. Refinery Yields of Major Petroleum Products, 1970-1992

Source: Energy Information Administration, *Petroleum Supply Annual*, Vol. 1, 1981-1992 and predecessor reports. See Table A2 for corresponding data.

Figure 14. U.S. Refinery Yields and Petroleum Product Uses, 1992

Light Products

Source: Energy Information Administration, *The U.S. Petroleum Refining Industry in the 1980's*, October 1990, and *Petroleum Supply Annual*, Vol. 1, 1992.

Table 8. U.S. Refinery Production of Selected Products, 1970 - 1992
(Thousand Barrels per Day)

Year	Motor Gasoline	Distillate Fuel Oil	Kerosene-Type Jet Fuel	Residual Fuel Oil	Other Products	Total Products
1970.....	5,699	2,454	827	706	2,427	12,113
1971.....	5,970	2,495	835	753	2,445	12,498
1972.....	6,281	2,630	847	799	2,523	13,080
1973.....	6,527	2,820	859	971	2,677	13,854
1974.....	6,358	2,668	836	1,070	2,566	13,498
1975.....	6,518	2,653	871	1,235	2,408	13,685
1976.....	6,838	2,924	918	1,377	2,620	14,677
1977.....	7,031	3,277	973	1,754	2,839	15,874
1978.....	7,167	3,167	970	1,667	2,995	15,966
1979.....	6,837	3,152	1,012	1,687	3,075	15,763
1980.....	6,492	2,661	999	1,580	2,890	14,622
1981.....	6,400	2,613	968	1,321	2,688	13,990
1982.....	6,336	2,606	978	1,070	2,401	13,391
1983.....	6,338	2,456	1,022	852	2,470	13,138
1984.....	6,453	2,680	1,132	891	2,523	13,679
1985.....	6,419	2,686	1,189	882	2,574	13,750
1986.....	6,752	2,796	1,293	889	2,792	14,522
1987.....	6,841	2,729	1,343	885	2,828	14,626
1988.....	6,956	2,857	1,370	926	2,913	15,022
1989.....	6,963	2,899	1,403	954	2,956	15,175
1990.....	6,959	2,925	1,488	950	2,950	15,272
1991.....	6,975	2,962	1,438	934	2,947	15,256
1992.....	7,058	2,974	1,254	892	3,220	15,398

Source: Energy Information Administration, *Petroleum Supply Annual*, Vol. 1, 1981-1992, Table 3, and predecessor reports.

1982 to 6.3 million barrels per day, then slowly increased through 1988. Between 1988 and 1992, production was steady at about 7.0 million barrels per day.

From 2.5 million barrels per day in 1970, refinery output for distillates increased generally through 1977, when output peaked at 3.3 million barrels per day. Over the next 6 years, refinery production fell back to 2.5 million barrels per day, its 1970 level. Then, output increased slightly almost every year, reaching 3.0 million barrels per day in 1992.

Unlike motor gasoline and distillates, kerosene-type jet fuel refinery output grew throughout the 1970's and 1980's, with only a few dips interrupting growth. Output was 0.8 million barrels per day in 1970, and almost doubled by 1990 before declining to 1.3 million barrels per day in 1992.

Residual fuel oil refinery production grew rapidly, from 0.7 million barrels per day in 1970 to a peak of 1.8 million barrels per day in 1977. After 1977, output generally declined, and was 0.9 million barrels per day in 1992.

Refinery Ownership

Consolidation and foreign investments in U.S. refining expanded during the late 1980's. Foreign-affiliated companies have long been active in the U.S. refining and marketing sector and have played major roles in shaping the industry. At the beginning of 1983, foreign-affiliated companies owned interests in 14 percent

of total U.S. operating capacity. By the beginning of 1991, foreign affiliation had risen to 28 percent of the U.S. total.²⁰ Foreign affiliation declined slightly during 1991.

Venezuela and Saudi Arabia were major investors in U.S. refining operations in the late 1980's. At that time, producing countries wanted access to refineries near consuming regions, where stable product markets would assure outlets for their crude oil. At the same time, foreign acquisitions increased the financial stability of the U.S. refining industry.

Foreign Refining

As in the United States, the foreign refining industry has turned toward expansions in downstream capacity since 1981 (the earliest data available), while crude oil distillation capacity has declined. Total foreign expansions to reforming, catalytic, and thermal cracking capacity increased 43 percent to 14.7 million

barrels per day between the beginning of 1981 and the beginning of 1992 (**Table 9**). Downstream additions were greatest in Western Europe and the Far East and Oceania. These are areas where total demand for petroleum is almost as high as in the United States.

During the early 1970's, total foreign crude oil inputs exceeded foreign demand. At the time, U.S. operable refining capacity was not sufficient to meet growing U.S. petroleum demand, and excess refined products from foreign refineries were supplied to the United States. By 1980, however, U.S. crude oil distillation capacity was at its peak, and downstream operations were becoming an important means of producing domestic products. As a result, foreign crude oil inputs became about equal to foreign demand (**Figure 15**).

Increases to foreign operable refinery capacity (measured as crude oil distillation capacity) during the 1970's were primarily in Western Europe and the Far East and Oceania. Operable refinery capacity in Western Europe grew from 13.9 million barrels per day at the beginning of 1970 to 20.2 million barrels per day at the beginning of 1980. A slump in European and U.S. demand during the 1980's caused Western European operable refining capacity to recede. Capacity dropped to about the same level as in 1970 by the beginning of 1989.²¹

Operable refining capacity increased in the Far East and Oceania from 5.6 to 10.3 million barrels per day during the 1970's, then stabilized until the early 1990's, when capacity increased to 13.2 million barrels per day.

²⁰Energy Information Administration, *Profiles of Foreign Direct Investment in U.S. Energy, 1986*, Table 10, 1990, Table 9, and 1991, Table 10.

²¹American Petroleum Institute, *Basic Petroleum Data Book*, Vol. XII, Number 3, September 1992, Section VIII, Table 1.

Table 9. World Refinery Capacity and Number of Refineries, As of January 1, Selected Years
(Thousand Barrels per Calendar Day)

Area	Year	Number of Refineries	Crude Oil Distillation Capacity	Downstream Capacity			
				Catalytic Cracking	Thermal Cracking	Reforming	Total
United States	1981	324	18,620	4,775	338	3,690	8,803
	1986	216	15,459	5,393	1,786	3,557	10,736
	1989	204	15,655	5,368	1,969	3,715	11,052
	1990	205	15,572	5,467	2,003	3,701	11,171
	1991	202	15,676	5,569	2,050	3,730	11,349
	1992	199	15,696	5,594	1,995	3,712	11,301
Other North America	1981	42	3,560	755	109	469	1,333
	1986	37	3,125	674	156	517	1,347
	1989	36	3,210	655	170	528	1,353
	1990	37	3,366	654	170	530	1,354
	1991	37	3,561	655	171	525	1,351
	1992	36	3,479	646	151	559	1,356
Central and S. America.....	1981	74	7,157	654	501	334	1,489
	1986	68	5,491	851	474	309	1,634
	1989	68	5,629	922	574	327	1,823
	1990	70	5,641	906	574	340	1,820
	1991	74	5,875	880	604	321	1,805
	1992	76	5,981	966	691	341	1,998
Western Europe.....	1981	166	20,545	1,114	1,049	2,607	4,770
	1986	124	14,516	1,556	1,553	2,094	5,203
	1989	113	13,843	1,796	1,689	1,943	5,428
	1990	116	14,216	1,932	1,749	2,031	5,712
	1991	127	14,814	2,025	1,876	2,261	6,162
	1992	124	14,811	2,055	1,936	2,282	6,273
E. Europe and Former USSR	1981	70	14,227	NA	NA	NA	NA
	1986	83	15,350	NA	NA	NA	NA
	1989	84	15,598	NA	NA	NA	NA
	1990	99	15,598	157	90	171	418
	1991	77	14,317	69	13	95	177
	1992	74	14,305	173	127	189	489
Middle East.....	1981	33	3,390	97	184	250	531
	1986	36	3,831	68	233	384	685
	1989	38	4,353	188	293	477	958
	1990	38	4,465	198	292	472	962
	1991	40	5,039	202	336	531	1,069
	1992	40	5,011	204	349	532	1,085
Africa.....	1981	41	1,698	117	71	195	383
	1986	43	2,521	130	83	290	503
	1989	44	2,789	174	94	333	601
	1990	44	2,824	173	94	330	597
	1991	44	2,872	173	103	335	611
	1992	44	2,866	173	103	330	606
Far East and Oceania.....	1981	129	12,365	611	207	979	1,797
	1986	128	12,262	811	473	1,067	2,351
	1989	142	12,263	988	509	1,096	2,593
	1990	142	12,181	1,023	549	1,087	2,659
	1991	143	12,603	1,061	566	1,169	2,796
	1992	143	13,195	1,095	518	1,273	2,886
Total Foreign.....	1981	555	62,942	3,348	2,121	4,834	10,303
	1986	519	57,096	4,090	2,972	4,661	11,723
	1989	525	57,685	4,723	3,329	4,704	12,756
	1990	546	58,291	5,043	3,518	4,961	13,522
	1991	542	59,081	5,065	3,669	5,236	13,970
	1992	537	59,648	5,310	3,875	5,505	14,690
Total World	1981	879	81,562	8,123	2,459	8,524	19,106
	1986	735	72,555	9,483	4,758	8,218	22,459
	1989	729	73,340	10,091	5,298	8,419	23,808
	1990	751	73,863	10,510	5,521	8,662	24,693
	1991	744	74,757	10,634	5,719	8,966	25,319
	1992	736	75,344	10,904	5,870	9,217	25,991

NA = Not Available.

Note: Totals may not equal sum of components due to independent rounding.

Sources: Energy Information Administration, *International Energy Annual*, 1980, Table 21, 1985, Table 14, and 1991, Table 21.

Large export refineries were constructed to provide products to other markets. Oil-producing countries in the Middle East have the largest concentration of export refineries²² and provide refined products to the Far East and other areas.²³

As in the United States, countries in Western Europe and the Far East began moving toward oxygenated motor gasoline to combat pollution in recent years. Oxygenate facilities were added at refineries or built independently.²⁴ The European Fuel Oxygenate Association was formed in November 1984 to address issues concerning oxygenates in the European gasoline pool.²⁵ Finland began using oxygenated gasoline in June 1991, and by the end of 1992, this product accounted for approximately 70 percent of Finnish motor gasoline consumption. Norway has been planning for the future use of oxygenated fuels. Italy, with serious pollution problems and higher gasoline demand than Norway and Finland, replaced some of the lead in gasoline with aromatics,²⁶ as the United States had done in earlier years.²⁷ Aromatics increase tailpipe emissions of ozone precursors and toxic air pollutants such

as benzene. In the Far East, Korea has moved toward a mandatory program to begin in 1993, and some Japanese companies were producing oxygenated gasoline in 1992.

Product Imports and Exports

The market for crude oil and petroleum products has been an international one for over 75 years. The shared effects of oil supply disruptions and price changes since the 1970's have modified the patterns of U.S. petroleum imports and exports. In contrast to crude oil imports, which are a primary component of crude oil supplies, imports of petroleum products are used to augment refinery production.

Net Imports

U.S. total net imports of petroleum products increased 50 percent between 1970 and 1973, when they peaked (**Table 10**). At the time, residual fuel oil accounted for 66 percent of the 2.8 million

²²"Worldwide refining," *Oil and Gas Journal*, December 21, 1992, pp. 57-72.

²³BP Statistical Review of World Energy, June 1993, pp. 16 and 17.

²⁴"Worldwide refiners making big move into modernization," *Oil and Gas Journal*, December 21, 1992, p. 48.

²⁵MTBE/Oxygenates/New Fuels, October 22, 1992, p. 1.

²⁶MTBE/Oxygenates/New Fuels, November 5, 1992, p. 1.

²⁷Congressional Research Service, *Alternative Transportation Fuels: Are They Reducing Oil Imports?*, January 15, 1993, p. CRS-4.

Figure 15. Foreign Operable Refinery Capacity, Crude Oil Inputs, and Petroleum Demand, 1970 - 1991

Source: Energy Information Administration, *Annual Energy Review 1991 and 1992*, and *International Energy Annual*, 1991. See Table A1 for corresponding data.

Table 10. U.S. Imports, Exports, and Net Imports of Selected Petroleum Products, 1970 - 1992
(Thousand Barrels per Day)

Year	Motor Gasoline			Distillate Fuel Oil			Jet Fuel		
	Imports	Exports	Net Imports	Imports	Exports	Net Imports	Imports	Exports	Net Imports
1970.....	66	1	65	147	2	145	144	6	138
1971.....	59	1	58	153	8	145	180	4	176
1972.....	68	1	67	182	3	179	194	3	191
1973.....	134	4	130	392	9	383	212	4	208
1974.....	204	2	202	289	2	287	163	3	160
1975.....	184	2	182	155	1	154	133	2	131
1976.....	131	3	128	146	1	145	76	2	74
1977.....	217	2	215	250	1	249	75	2	73
1978.....	190	1	189	173	3	170	86	1	85
1979.....	181	(s)	181	193	3	190	78	1	77
1980.....	140	1	139	142	3	139	80	1	79
1981.....	157	2	155	173	5	168	38	2	36
1982.....	197	20	177	93	74	19	29	6	23
1983.....	247	10	237	174	64	110	29	6	23
1984.....	299	6	293	272	51	221	62	9	53
1985.....	381	10	371	200	67	133	39	13	26
1986.....	326	33	293	247	100	147	57	18	39
1987.....	384	35	349	255	66	189	67	24	43
1988.....	405	22	383	302	69	233	90	28	62
1989.....	369	39	330	306	97	209	106	27	79
1990.....	342	55	287	278	109	169	108	43	65
1991.....	297	82	215	205	215	(10)	67	43	24
1992.....	294	96	198	216	219	(3)	82	43	39

	Residual Fuel Oil			All Other			Total		
	Imports	Exports	Net Imports	Imports	Exports	Net Imports	Imports	Exports	Net Imports
1970.....	1528	54	1,474	210	182	28	2,095	245	1,850
1971.....	1583	36	1,547	270	174	96	2,245	222	2,023
1972.....	1,742	33	1,709	339	182	157	2,525	222	2,303
1973.....	1,853	23	1,830	421	189	232	3,012	229	2,783
1974.....	1,587	14	1,573	392	197	195	2,635	218	2,417
1975.....	1,223	15	1,208	256	184	72	1,951	204	1,747
1976.....	1,413	12	1,401	260	197	63	2,026	215	1,811
1977.....	1,359	6	1,353	292	181	111	2,193	193	2,000
1978.....	1,355	13	1,342	204	186	18	2,008	204	1,804
1979.....	1,151	9	1,142	334	224	110	1,937	237	1,700
1980.....	939	33	906	345	220	125	1,646	258	1,388
1981.....	800	118	682	431	240	191	1,599	367	1,232
1982.....	776	209	567	530	270	260	1,625	579	1,046
1983.....	699	185	514	573	310	263	1,722	575	1,147
1984.....	681	190	491	697	285	412	2,011	541	1,470
1985.....	510	197	313	736	290	446	1,866	577	1,289
1986.....	669	147	522	746	333	413	2,045	631	1,414
1987.....	565	186	379	733	302	431	2,004	613	1,391
1988.....	644	200	444	854	342	512	2,295	661	1,634
1989.....	629	215	414	807	339	468	2,217	717	1,500
1990.....	504	211	293	891	330	561	2,123	748	1,375
1991.....	453	226	227	822	319	503	1,844	885	959
1992.....	375	193	182	838	310	528	1,805	861	944

(s) = Less than 500 barrels per day.

Note: Totals may not equal sum of components due to independent rounding.

Source: Energy Information Administration, *Petroleum Supply Annual*, Vol. 1, 1981 - 1992, Tables S1 and S4 - S7, and predecessor reports.

barrels per day of net imports. U.S. net imports gradually declined until, in 1982, they were 62 percent below the 1973 level, with most of the decline in residual fuel oil. Net imports of residual fuel oil declined further until, by 1985, 313,000 barrels per day represented only 25 percent of the total net imports of petroleum products. During the 1980's, net imports of motor gasoline and distillate fuel oil were rising to fill the growing demand for these products. Net imports of these products declined during the early 1990's, however, as overseas markets opened up to U.S. product exports and gross imports declined. Net imports of residual fuel oil dropped to only 182,000 barrels per day in 1992 and were 90 percent below the 1973 level.

Gross Imports

U.S. gross imports of petroleum products constitute only about 11 percent of U.S. total product use, yet are important supplements to domestic supplies from refinery production. Gross imports of petroleum products peaked in 1973 at 3.0 million barrels per day. By 1981, U.S. product imports had fallen 47 percent. Refinery output was providing increasing quantities of refined products during the intervening years, helping to allay concern about price spikes and short supplies in the aftermath of the 1973 oil supply disruptions.

Because few products were being exported in significant quantities prior to 1981, gross product imports followed a similar pattern to net imports, with residual fuel oil claiming the dominant share. Residual fuel oil imports accounted for an average 65 percent of all product imports and 42 percent of heavy product demand during the 1970's. Imports of motor gasoline, jet fuel, and distillate fuel oil together accounted for about 21 percent of the volumes entering the country between 1970 and 1975. These imports averaged 4 percent of light product demand during that time. While imports of distillate fuel oil remained relatively stable after 1975, jet fuel imports declined as domestic refinery production increased. Imports of motor gasoline tripled between 1972 and 1974 before moderating through 1982.

When the U.S. economic recession ended in 1982 and demand for light petroleum products began to escalate, their imports also began to grow. By 1983, motor gasoline, distillate fuel oil, and jet fuel imports totaled 450,000 barrels per day, still well below residual at 699,000 barrels per day. Over the next decade, the mix of product imports turned more toward light products. As fuel oil was replaced by natural gas, light-product imports overtook heavy products. By 1992, imports of motor gasoline, distillate, and jet fuel together comprised 33 percent of all product imports and still represented 4 percent of light product demand. Residual fuel oil imports were 21 percent of total gross product imports in 1992, and accounted for only 18 percent of the demand for heavy products.

During the early 1990's, there were fewer imports of both light and heavy products because of slack demand during the recent recession and changes in world supply patterns. Declines from

Central and South America accounted for about 46 percent of the drop in total product imports between 1989 and 1992 (**Table 11**).

Exports

Between 1973 and 1981, U.S. petroleum prices were controlled and were much lower than overseas prices. Petroleum product exports were restricted during this period. U.S. product exports during the 1970's were generally a little above 200,000 barrels per day, and were primarily specialty products such as petroleum coke and lubricants.

The lifting of the export restrictions in 1981 opened the way for exports of major products to escalate (**Figure 16**). Residual fuel oil exports picked up after 1980, and were almost 600 percent higher in 1991 than in 1980.

In recent years, new markets for U.S. light products emerged (**Table 12**). During the early 1990's, economic expansion in Mexico, Central and South America, and the Far East increased their petroleum needs and attracted U.S. exports of light products to these areas. The disruption of petroleum supplies from Kuwait and lower exports from the former Soviet Union also created new markets for U.S. light products. U.S. product exports grew because they were lower-cost than alternative sources of supply. They reached an all-time high in 1990 at 885,000 barrels per day.

U.S. Regional Import and Export Patterns

PAD District I (East Coast)

Refined product exports from the East Coast are modest, but large volumes of product imports are needed to meet demand. In addition to unfinished oils, substantial imports of the major products are needed. Residual fuel oil imports were particularly important in the past, when the East Coast relied more heavily on fuel oils for electric power generation and for industrial uses. When imports into PAD²⁸ District I peaked in 1973 at 2.5 million barrels per day, 71 percent was residual fuel oil. In 1992, residual fuel oil comprised 28 percent of the 1.1 million barrels per day imported.

The East Coast is the natural market for products from Central and South America, but some imports arrive from the Middle East and Canada.

PAD District II (Midwest)

Propane has been the only product imported into PAD District II in significant quantities (about 50,000 barrels per day). Used widely in the Midwest for heating and for agriculture, propane imports arrive in the Midwest via pipeline from Canada.

Refined products exported from the Midwest accounted for a very small portion of U.S. product exports during the past 23 years.

²⁸ Petroleum Administration for Defense.

Table 11. U.S. Petroleum Imports by Major Source, Selected Products and Years
(Thousand Barrels per Day)

Source	Year	Crude Oil	Petroleum Products						Total	Total Imports
			Motor Gasoline	Distillate Fuel Oil	Jet Fuel	Liquefied Petroleum Gases	Residual Fuel Oil	All Other		
North America	1970	672	2	14	(s)	49	39	32	137	809
	1975	671	11	5	6	83	66	77	247	918
	1980	706	14	1	1	199	50	17	281	988
	1985	1,183	51	51	6	165	48	94	415	1,598
	1989	1,346	45	69	22	138	40	38	352	1,698
	1990	1,331	54	57	19	143	40	46	359	1,690
	1991	1,502	68	59	8	116	39	49	339	1,841
	1992	1,584	61	55	4	111	30	54	315	1,899
Central and S. America	1970	291	65	124	132	3	1,321	115	1,759	2,050
	1975	572	143	124	96	14	1,011	59	1,447	2,019
	1980	331	110	134	62	9	782	95	1,192	1,523
	1985	477	116	131	25	2	334	197	805	1,282
	1989	796	170	187	60	8	379	197	1,001	1,797
	1990	934	149	185	67	3	310	194	908	1,842
	1991	927	114	145	56	5	295	250	865	1,792
	1992	1,092	114	155	74	4	235	230	812	1,904
Western Europe	1970	0	(s)	6	7	(s)	152	1	166	166
	1975	17	13	9	3	(s)	51	4	77	94
	1980	318	2	2	7	2	13	1	28	343
	1985	310	148	5	2	6	26	48	235	545
	1989	290	110	23	10	4	81	80	308	598
	1990	252	97	13	8	2	49	129	298	550
	1991	183	77	1	0	3	33	103	217	400
	1992	319	82	4	(s)	1	23	125	235	554
E. Europe and Former USSR.....	1970	0	0	4	0	0	7	0	11	11
	1975	0	4	4	0	0	25	0	33	33
	1980	0	(s)	0	0	0	2	(s)	2	2
	1985	(s)	10	3	0	0	1	42	56	56
	1989	0	5	10	0	0	7	53	75	75
	1990	1	3	7	1	0	8	40	59	60
	1991	1	0	0	0	0	1	28	29	30
	1992	5	4	1	(s)	(s)	1	12	18	23
Middle East.....	1970	170	0	0	5	(s)	4	5	14	184
	1975	1,122	7	12	9	11	2	4	45	1,167
	1980	1,533	(s)	1	(s)	3	1	7	12	1,545
	1985	245	33	1	0	3	3	48	88	333
	1989	1,791	37	3	9	7	7	72	135	1,926
	1990	1,858	37	4	13	8	13	102	177	2,035
	1991	1,770	34	(s)	4	6	4	64	112	1,882
	1992	1,640	29	0	3	8	11	116	167	1,807
Africa	1970	122	0	(s)	0	0	4	(s)	5	127
	1975	1,229	2	(s)	(s)	3	49	1	53	1,282
	1980	1,998	0	0	0	(s)	63	(s)	64	2,062
	1985	612	1	6	(s)	6	82	39	134	746
	1989	1,287	0	12	(s)	21	81	136	250	1,537
	1990	1,236	1	12	(s)	26	60	157	256	1,492
	1991	1,159	1	0	0	14	63	164	242	1,401
	1992	1,256	0	0	0	5	66	136	207	1,463
Far East and Oceania	1970	70	0	(s)	(s)	0	(s)	2	3	73
	1975	384	6	1	18	3	20	1	49	433
	1980	376	14	4	9	2	27	9	65	441
	1985	374	21	5	4	4	17	83	134	508
	1989	334	2	1	5	3	35	51	97	431
	1990	282	1	0	(s)	5	23	38	67	349
	1991	239	3	(s)	0	4	18	15	40	279
	1992	186	5	1	(s)	1	10	34	51	237
Total Imports.....	1970	1,324	67	147	144	52	1,528	157	2,095	3,419
	1975	3,995	186	155	132	114	1,224	146	1,951	6,056
	1980	5,262	140	142	80	215	938	129	1,646	6,909
	1985	3,201	380	202	37	186	511	551	1,866	5,067
	1989	5,844	369	305	106	181	630	627	2,217	8,061
	1990	5,894	342	278	108	187	503	706	2,123	8,018
	1991	5,781	297	205	68	148	453	673	1,844	7,627
	1992	6,083	294	216	82	131	375	707	1,805	7,888

(s) = Less than 500 barrels per day.

Note: Totals may not equal sum of components due to independent rounding.

Sources: Energy Information Administration, *Petroleum Supply Annual*, Vol. 1, 1985, Table 15, 1989 - 1992, Table 21, and predecessor reports.

Table 12. U.S. Petroleum Exports by Major Area of Destination, Selected Products and Years
(Thousand Barrels per Day)

Area of Destination	Year	Crude Oil	Petroleum Products							Total Exports
			Motor Gasoline	Distillate Fuel Oil	Jet Fuel	Liquefied Petroleum Gases	Residual Fuel Oil	All Other	Total	
North America	1970	1	1	2	(s)	24	20	21	69	70
	1975	(s)	(s)	(s)	1	25	14	25	65	65
	1980	84	1	3	1	19	3	25	52	136
	1985	53	3	8	9	48	21	27	116	169
	1989	8	15	16	6	28	71	38	174	182
	1990	11	26	8	12	32	62	30	170	181
	1991	5	52	5	8	20	49	30	164	170
	1992	3	71	6	8	28	43	31	187	189
Central and S. America.....	1970	12	1	1	6	1	1	16	26	38
	1975	6	2	(s)	0	(s)	1	15	18	24
	1980	203	(s)	1	(s)	(s)	18	18	37	240
	1985	151	5	16	1	9	41	9	82	233
	1989	132	16	42	4	4	40	12	117	249
	1990	97	12	37	4	4	47	13	116	213
	1991	111	20	62	3	9	46	12	151	262
	1992	85	16	68	5	15	40	11	155	240
Western Europe	1970	(s)	1	2	(s)	1	8	57	69	69
	1975	0	(s)	(s)	0	(s)	(s)	75	75	75
	1980	0	(s)	(s)	(s)	(s)	0	99	99	99
	1985	0	(s)	24	(s)	4	33	111	173	173
	1989	0	(s)	5	1	2	7	152	167	167
	1990	0	11	35	2	3	7	151	246	246
	1991	0	4	67	7	10	25	134	247	247
	1992	0	1	34	1	5	24	125	190	190
E. Europe and Former USSR	1970	0	0	0	0	0	0	0	0	0
	1975	0	0	0	0	0	0	0	0	0
	1980	0	0	0	0	0	0	2	2	2
	1985	0	0	(s)	0	0	2	4	6	6
	1989	0	0	1	0	0	(s)	2	3	3
	1990	0	0	1	0	0	(s)	2	4	4
	1991	0	0	(s)	0	0	(s)	2	2	2
	1992	0	0	1	0	(s)	2	1	4	4
Middle East	1970	0	0	(s)	0	0	0	0	0	0
	1975	0	0	(s)	(s)	(s)	(s)	3	3	3
	1980	0	0	(s)	0	(s)	(s)	3	3	3
	1985	0	0	(s)	0	(s)	0	3	3	3
	1989	0	0	(s)	3	(s)	1	5	8	8
	1990	0	1	2	2	(s)	1	8	13	13
	1991	0	(s)	4	6	(s)	(s)	8	19	19
	1992	0	(s)	1	(s)	(s)	1	7	9	9
Africa	1970	(s)	(s)	(s)	0	(s)	(s)	4	4	4
	1975	0	0	0	0	(s)	0	6	6	6
	1980	0	0	(s)	0	(s)	(s)	6	6	6
	1985	0	0	1	0	(s)	5	4	9	9
	1989	0	(s)	(s)	0	(s)	1	3	4	4
	1990	0	0	1	0	(s)	(s)	3	4	4
	1991	0	(s)	(s)	0	(s)	2	4	5	5
	1992	0	(s)	2	(s)	0	2	4	8	8
Far East and Oceania.....	1970	1	(s)	1	0	1	25	56	83	84
	1975	0	1	(s)	1	(s)	(s)	35	37	37
	1980	0	1	(s)	(s)	1	12	43	57	57
	1985	0	1	18	3	(s)	96	69	187	187
	1989	2	8	33	14	1	95	93	245	245
	1990	1	6	27	23	1	94	82	233	233
	1991	(s)	6	76	20	3	104	88	297	297
	1992	1	7	107	29	1	82	86	311	312
Total Exports	1970	14	4	6	6	27	54	153	250	264
	1975	6	2	1	1	26	15	158	204	209
	1980	287	1	3	1	21	33	197	258	544
	1985	204	10	67	13	62	197	227	577	781
	1989	142	39	97	27	35	215	303	719	859
	1990	109	55	109	43	40	211	289	749	857
	1991	116	82	215	44	41	226	277	885	1,001
	1992	89	96	219	43	49	194	263	862	950

(s) = Less than 500 barrels per day.

Note: Totals may not equal sum of components due to independent rounding.

Sources: Energy Information Administration, *Petroleum Supply Annual*, Vol. 1, 1985, Table 17, 1989 - 1992, Table 28, and predecessor reports.

Figure 16. Components of U.S. Domestic Demand, and Petroleum Product Exports, 1970 - 1992

Notes: Other supply includes field production, crude used directly as fuel, and stock change less refinery inputs. Domestic Demand is the sum of refinery production, other supply, and net imports.

Source: Energy Information Administration, *Petroleum Supply Annual*, Vol. 1, 1992, and predecessor reports. See Tables 3, 8, and 10 for corresponding data.

PAD District III (Gulf Coast)

Unfinished oils and petrochemical feedstocks have been the leading products imported into the Gulf Coast, reflecting the concentration of the refining and petrochemical industries in the region. Venezuela and Saudi Arabia were the primary suppliers of unfinished oils, while Algeria supplied nearly all of the petrochemical feedstock imports between 1970 and 1992. Unfinished oils and petrochemical feedstocks together accounted for 34 percent of PAD District III product imports in 1980. Since then, increased imports of these products have been needed to replace declines in their output from U.S. refineries. In 1992, unfinished oils and petrochemical feedstocks together represented 76 percent of the 541,000 barrels per day of petroleum products imported into the Gulf Coast.

The Gulf Coast has also been a significant exporter of petroleum products. Prior to 1982, unfinished oils, LPG's, and residual fuel oil were the primary products exported from PAD District III. Exports of unfinished oils were phased out after 1982. During the 1990's, exports of distillate fuel oil increased, and in 1992 comprised 27 percent of the 435,000 barrels per day of petroleum products exported from the Gulf Coast. The main market for Gulf Coast distillate fuel oil and petroleum coke exports was Europe in 1992. The primary destination for residual fuel oil and motor gasoline was Mexico.

PAD District IV (Rocky Mountain)

The modest product imports into PAD District IV primarily consisted of LPG's from Canada between 1970 and 1992, but exports from PAD District IV were very small. The region's lack of port facilities and the availability of only a few pipeline links with other regions limit movements of product into and out of the region. Refineries in the region, while relatively small, are designed to meet most product needs.

PAD District V (West Coast)

During the 1970's, a wide array of products were imported into PAD District V. After refineries were built to accommodate Alaskan crude oil, imports declined. In 1992, imports were primarily motor gasoline, residual fuel oil, and blending components.

The West Coast exported small amounts of residual fuel oil and petroleum coke prior to 1981. Then, exports of these products expanded, accounting for 56 percent in 1992. Exports of distillate fuel oil increased in the early 1990's, and comprised 26 percent of the 367,000 barrels per day of petroleum products exported from PAD District V in 1992. The natural markets for these products were the Far East, Canada, and Mexico.

Figure 17. U.S. Inter-Regional Movement of Crude Oil and Petroleum Products by Water and Pipeline, 1992

Note: Arrows vary in size to show the relative difference in inter-regional shipments.

Source: Energy Information Administration, *Petroleum Supply Annual*, Vol. 1, 1981-1992 and predecessor reports. See Table A3 for corresponding data.

Transportation and Storage

The U.S. petroleum distribution system links the importing and refining centers with consumption areas through a complex system of transportation and storage facilities. Each region (PAD District) of the United States is unique in its petroleum transportation and storage configurations. Distribution of crude oil and petroleum products between regions is primarily by pipeline or water (Figure 17).

Primary crude oil and petroleum product stocks are held at tank farms, refineries, natural gas liquids plants, bulk terminals, and pipelines throughout the distribution system. Since 1977, crude oil purchased by the Federal Government for use in emergencies has been stored in the U.S. Strategic Petroleum Reserve (SPR) in PAD District III. The SPR contained 575 million barrels at the end of 1992 (Figure 18).

End-of-year stocks of crude oil (excluding the SPR) peaked in 1981 at 363 million barrels, then declined to 321 million barrels by the end of 1985. After that, crude oil stocks fluctuated

moderately (Figure 19). Crude oil stocks stood at 318 million barrels at the end of 1992.

End-of-year total product stocks peaked at 964 million barrels in 1977, then generally declined through 1992. Crude oil accounted for 26 percent of total petroleum stocks (excluding the SPR) at the end of 1977. As total product stocks declined, crude oil stocks accounted for a higher share of total petroleum stocks, excluding the SPR. At the end of 1989, when total product stocks were low at 660 million barrels, crude oil accounted for 34 percent of total petroleum stocks, excluding the SPR (Table 13).

Distillate fuel oil stocks declined more than stocks of any other product after 1978 (Figure 20). In all probability, the decline reflects decreasing use of distillate fuel oil for heat and power.

U.S. Regional Transportation Patterns

Total inter-regional movements of crude oil have hovered around 2.4 million barrels per day since 1985, the earliest complete data available (See Appendix Tables A3 and A4 for regional data).

Figure 18. End-of-Year U.S. Primary Stocks of Petroleum, Selected Years

Note: SPR is the Strategic Petroleum Reserve.

Source: Energy Information Administration, *Petroleum Supply Annual*, Vol. 1, 1981-1992 and predecessor reports. See Table 13 for corresponding data.

Inter-regional movements of petroleum products have held steady at around 4.3 million barrels per day since 1980.

The opening of the All-American crude oil pipeline in 1987 led to the replacement of an average 110,000 barrels per day of crude oil movements that had been shipped by tanker and barge from the West Coast to the Gulf Coast. Additional changes in pipeline movements were a decline in crude oil deliveries from the Rocky Mountain area to the Midwest during the mid-1980's because of production declines. Pipeline reversals and expansions opened the way for increased volumes of crude oil to be shipped from the Gulf Coast to the Midwest in the mid-to-late 1980's.

Pipeline deliveries of products from the Gulf Coast to the East Coast displaced some movements by tanker and barge by 1980, as the Colonial Pipeline opened and expansions were completed on the Plantation Pipeline System.

PAD District I (East Coast)

Of the five U.S. regions, PAD District I was the largest consumer of oil between 1970 and 1992. However, its share declined from 40 percent in 1970 to 29 percent in 1992. East Coast demand peaked in 1973 at 6.7 million barrels per day; in 1992 it was 5.0 million barrels per day.

Because refinery output is well below the level needed to meet product demand, the East Coast is dependent on imports and shipments from Gulf

Figure 19. Total U.S. Primary Petroleum Stocks at End of Year, 1970 - 1992

Source: Energy Information Administration, *Petroleum Supply Annual*, Vol. 1, 1981-1992 and predecessor reports. See Table 13 for corresponding data.

Figure 20. End-of-Year U.S. Primary Stocks of Selected Petroleum Products, 1970 - 1992

Source: Energy Information Administration, *Petroleum Supply Annual*, Vol. 1, 1981-1992 and predecessor reports. See Table 13 for corresponding data.

Table 13. U.S. Primary Stocks of Petroleum at End of Year, 1970 - 1992
(Million Barrels)

Year	Crude Oil			Petroleum Products							Total Petroleum
	SPR ¹	Other	Total	Motor Gasoline ²	Distillate Fuel Oil	Liquefied Petroleum Gases	Jet Fuel	Residual Fuel Oil	Other Products ³	Total	
1970.....	--	276	276	209	195	67	28	54	188	741	1,018
1971.....	--	260	260	219	191	95	28	60	193	784	1,044
1972.....	--	246	246	213	154	86	25	55	179	713	959
1973.....	--	242	242	209	196	99	29	53	179	766	1,008
1974.....	--	265	265	218	200	113	29	60	188	809	1,074
1975.....	--	271	271	235	209	125	30	74	188	862	1,133
1976.....	--	285	285	231	186	116	32	72	188	826	1,112
1977.....	7	340	348	258	250	136	35	90	195	964	1,312
1978.....	67	309	376	238	216	132	34	90	191	901	1,278
1979.....	91	339	430	237	229	111	39	96	200	911	1,341
1980.....	108	358	466	261	205	120	42	92	206	926	1,392
1981.....	230	363	594	253	192	135	41	78	191	890	1,484
1982.....	294	350	644	235	179	94	37	66	175	786	1,430
1983.....	379	344	723	222	140	101	39	49	180	731	1,454
1984.....	451	345	796	243	161	101	42	53	160	760	1,556
1985.....	493	321	814	223	144	74	40	50	174	705	1,519
1986.....	512	331	843	233	155	103	50	47	162	750	1,593
1987.....	541	349	890	226	134	97	50	47	163	718	1,607
1988.....	560	330	890	228	124	97	44	45	170	707	1,597
1989.....	580	341	921	213	106	80	41	44	176	660	1,581
1990.....	586	323	908	220	132	98	52	49	162	712	1,621
1991.....	569	325	893	219	144	92	49	50	170	724	1,617
1992.....	575	318	893	216	141	89	43	43	168	699	1,592

¹SPR = Strategic Petroleum Reserve.

²Includes motor gasoline blending components.

³Includes pentanes plus, other hydrocarbons and alcohol, unfinished oils, and all finished petroleum products except motor gasoline, distillate fuel oil, residual fuel oil, jet fuel, and liquefied petroleum gases.

-- = Not Applicable.

Note: Totals may not equal sum of components due to independent rounding.

Sources: Energy Information Administration, *Petroleum Supply Annual*, Vol 1, 1992, Tables S1, S2, and S4 - S8, and predecessor reports.

Coast and Midwest refineries. In 1992, 79 percent of the 2.8 million barrels per day of petroleum products delivered to the East Coast were by pipeline.

PAD District II (Midwest)

Midwest petroleum demand has been approximately one-fourth of the U.S. total since 1970. Demand fluctuated between 4.0 and

5.2 million barrels per day. Refinery output provided about 80 percent of the total demand.

Indigenous crude oil production, which represented 16 percent of Midwest product demand in 1992, is supplemented by direct imports from Canada. Pipeline shipments from the Gulf Coast and Rocky Mountain area provide most of the additional crude oil needed in PAD District II.

Crude oil and products move into PAD District II from surrounding areas, but the region also supplies some crude oil and products to the Gulf Coast, Rocky Mountain, and East Coast. In 1992, 94 percent of the petroleum movements into or from PAD District II were by pipeline, and the rest by water. Pipeline reversals and expansions since 1988 have displaced some tanker and barge movements from the Gulf Coast.²⁹

Despite declines in inter-regional petroleum movements by water in PAD District II, the Mississippi River and the Tennessee-Tombigbee river system are important routes for petroleum deliveries within the Midwest and other PAD Districts.

The Tennessee-Tombigbee Waterway. Opened in 1985 as a parallel route to the Mississippi River for transporting goods between Illinois and the Gulf of Mexico, the Tennessee-Tombigbee system proved essential in keeping petroleum and other goods moving during the 1988 drought that disrupted Mississippi River traffic. Though much smaller than the Mississippi River, the Tennessee-Tombigbee system maintained its normal 9-foot depth throughout the drought because of its system of 10 locks and dams that are used to regulate its flow at a constant level.

Petroleum shipments on the Tennessee-Tombigbee waterway jumped from an average 118,000 barrels per month during the first 5 months of 1988 to over 600,000 barrels in June. The waterway moved 1.8 million barrels of petroleum in July before the 1988 drought eased and Mississippi River traffic returned to normal.³⁰ The river system returned to a slower pace after the drought, resuming its previous growth rate for transporting petroleum and other goods.

PAD District III (Gulf Coast)

PAD District III has the largest concentration of U.S. refining capacity and storage, both for crude oil and for petroleum products. The Gulf Coast accounts for about half of the Nation's primary stocks of crude oil, all of the SPR stocks, and about one-third of the petroleum product stocks.

The Gulf Coast has been the predominant supplier of petroleum to other regions since 1970. The Gulf Coast furnishes crude oil and/or refined products to the East Coast, the Midwest, and the West Coast. The region also receives smaller amounts of crude oil and products from the Midwest, the Rocky Mountain area, and the West Coast. By 1980, some product movements that had been by water to the East Coast were displaced by pipeline shipments after large product pipelines were built or expanded. Between 1975 and 1980, pipelines' share of petroleum product movements from PAD District III to I increased from 52 percent to 67 percent. By 1987, pipelines were claiming 80 percent of the petroleum products transported from PAD District III to I. In 1992, pipelines

carried 86 percent of the petroleum entering or leaving PAD District III.

Petroleum demand in the Gulf Coast increased from 2.5 to 4.5 million barrels per day from 1970 to 1992. Its share of U.S. demand also grew, from 17 percent in 1970 to 26 percent in 1992.

Although PAD District III produces more crude oil than any other region (**Figure 21**), it replaced PAD District I as the largest importer of crude oil in 1976, and in 1992 accounted for 65 percent of U.S. crude oil imports. Although some of the crude oil imports are used in the region, large amounts also pass through the Gulf Coast by pipeline to refineries in PAD District II.

The Louisiana Offshore Oil Port. Until 1981, most crude oil imports into PAD District III were offloaded at ports along the Texas and Louisiana coasts. However, because many ports cannot handle large crude carriers, crude oil had to be transferred from very large and ultra-large tankers to smaller ships. The opening of the Louisiana Offshore Oil Port (LOOP) in 1981 reduced the need for lightering of crude oil tankers. Located 18 miles south of Louisiana, the LOOP is the Nation's only deepwater port that can accommodate ultra-large tankers.³¹ The LOOP has the capacity for unloading 1.4 million barrels of oil per day. Pipelines link the LOOP to major refineries in Louisiana, Texas, and the Midwest.³²

PAD District IV (Rocky Mountain)

PAD District IV is geographically isolated, with no access to water and only a few pipelines. All the movements in and out of the area are by pipeline. The Rocky Mountain area supplies petroleum products and/or crude oil to the Midwest, the Gulf Coast, and the West Coast. The area also receives crude oil and products from the Midwest. Declining crude oil production in the late 1980's caused shipments from PAD District IV to drop. By decreasing shipments out of the region, the balance between crude oil supply and product demand in PAD District IV was preserved.

Despite the isolation of PAD District IV, the economics driving supply and demand in the region are not appreciably different from those in the rest of the country. PAD District IV accounts for only about 3 percent of total U.S. demand, but its crude oil supplies are about in balance with product demand. Although the Rocky Mountain area refineries tend to be small, they are relatively sophisticated and produce a wide range of products specially suited to the region.

PAD District V (West Coast)

PAD District V, which accounted for about 15 percent of U.S. demand in 1992, has been essentially self-sufficient both in crude oil production and in refined product production. Since the mid-1980's, refinery production in PAD District V has exceeded demand, and product imports have accounted for only a small portion of supply. Small amounts of petroleum products have also

²⁹Energy Information Administration, "Proposed Projects Underscore Need for Imports and Pipeline Capacity in PAD District II," *Petroleum Supply Monthly*, April 1991, pp. xvi and xvii.

³⁰U.S. Army Corps of Engineers, *Tenn-Tom Waterway Traffic by Commodity*, Historical Summary, August 1988.

³¹"LOOP expects profit for 3rd time in history," *The Advocate*, August 20, 1992, p. 1D.

³²"LOOP Sees October Drop in Crude Imports," *Bloomberg Oil Buyers Guide*, September 28, 1992, p. 3.

Figure 21. Selected Components of U.S. Regional Petroleum Supply and Demand, 1970 - 1992

Demand and Refinery Production

Imports and Exports of Petroleum Products

Crude Oil Production, Imports, and Exports

Petroleum Receipts From, and Shipments To Other U.S. Districts

Petroleum Stocks

Source: Energy Information Administration, *Petroleum Supply Annual*, Vol. 1, 1981-1992 and predecessor reports. See Table A4 for corresponding data.

Figure 22. Alaska: Major Producing Areas and Crude Oil Flow

Source: Energy Information Administration, *Petroleum Supply Annual*, Vol. 1, 1992, and Form EIA-810, "Refinery Report;" Pennwell Publishing Company, *International Petroleum Encyclopedia*, 1991.

arrived from PAD Districts III and IV. In 1992, 59 percent of the petroleum movements into or out of the West Coast were by pipeline.

Transporting Alaskan North Slope Crude Oil. Completion of the 818-mile Trans-Alaska Pipeline (TAPS) in 1977 made up to 2 million barrels per day of Alaskan North Slope (ANS) crude oil accessible to other areas (Figure 22). Because of export restrictions on U.S. crude oil, most of the ANS crude oil goes to the U.S. West Coast, where it is refined or shipped to other areas.

Transporting ANS crude oil involves a complex shipping network. Except for the oil being shipped to the U.S. Virgin Islands, all of the oil is transported in U.S. flag vessels to comply with the Jones Act of 1920.

Since the opening of the All American Pipeline in 1988, ANS crude oil for use beyond PAD District V can be transported by pipeline from California, or can go by the traditional route to Panama. At Panama, ANS oil is transferred to the Trans-Panama Pipeline (opened in 1983) or is lightered to smaller ships and sent

through the Panama Canal. On the Caribbean side of the Isthmus, the oil is transferred to other U.S. flag vessels to travel on to Puerto Rico or ports on the mainland.

The crude oil being shipped to the Virgin Islands is not under Jones Act restrictions. At competitive costs, foreign flag tankers transport ANS crude oil from Valdez, Alaska, around the tip of South America (over twice the distance via Panama).

Tanker shipments of crude oil from PAD District V to other districts rose from virtually zero in 1970 to 707,000 barrels per day in 1983. As ANS crude oil production has declined in recent years, so have shipments from PAD District V to other districts.

After peaking in 1988 at 2.0 million barrels per day, ANS production declined by 15 percent over the following 4 years. Despite the decline, ANS production accounted for about 23 percent of the total 1992 U.S. crude oil production and 63 percent of PAD District V production (Table 14).

Pipelines From the West Coast. Although more than half of the petroleum deliveries from PAD District V to other districts are by

Table 14. Alaskan North Slope Crude Oil Production and Refinery Receipts, 1981 - 1992
(Thousand Barrels per Day)

Year	Crude Oil Production	Refinery Receipts			Total
		PAD Districts		Puerto Rico and Virgin Islands	
		I-IV	V ¹		
1981	1,524	326	843	161	1,330
1982	1,621	534	823	184	1,541
1983	1,646	629	863	101	1,593
1984	1,662	542	969	122	1,633
1985	1,779	531	950	10	1,491
1986	1,818	401	1,131	106	1,638
1987	1,917	466	1,228	127	1,821
1988	1,974	404	1,362	127	1,893
1989	1,832	236	1,428	132	1,796
1990	1,743	186	1,434	96	1,716
1991	1,756	153	1,438	110	1,700
1992	1,672	138	1,405	85	1,629

¹Includes Hawaiian Foreign Trade Zone receipts for 1981-1986.

Sources: Energy Information Administration, *Petroleum Supply Annual*, Vol. 1, 1981-1988, Table 9, 1989-1992, Table 14, and Form EIA-810, "Refinery Report," 1981-1992.

tanker, shipments by pipeline have grown. In the 1970's, the Four Corners Pipeline and the Texas-New Mexico Pipeline were used to transport small amounts of crude oil (55,000 barrels per day to 70,000 barrels per day) from California to Texas. In late 1987, the All American Pipeline was completed, with the capacity to carry 300,000 barrels per day of crude oil to Texas (Figure 23).³³ Since

1988, shipments of crude oil by pipeline from PAD District V have averaged about 113,000 barrels per day, comprised of crude oil from Alaska and the San Joaquin Valley of California. The All American Pipeline has no facility on the California coast for receiving waterborne shipments of ANS crude oil. The limited capacity of the Four Corners Pipeline that connects the All American Pipeline with ports at Long Beach, California, has contributed to the relatively low volumes transported. An additional constraint is that San Joaquin Valley crude oils are too heavy to be shipped on the unheated All American line unless blended with lighter crude oils.

Figure 23. Crude Oil Pipelines: California to Texas

Source: Pennwell Publishing Company, *Crude Oil Pipelines of the United States and Canada*, 1992.

Crude Oil Supplies

Domestic supplies of petroleum, including crude oil and smaller amounts of natural gas liquids (NGL's) and other hydrocarbons, are augmented by imports to meet demand. The United States always has been one of the world's largest producers of crude oil, and for many years was the largest.³⁴ Nevertheless,

³³Energy Information Administration, "Crude Oil Pipelines: California to Texas," *Petroleum Supply Monthly*, December 1987, p. xiv.

³⁴American Petroleum Institute, *Basic Petroleum Data Book*, Vol. XII, Number 3, September 1993, Section IV, Table 1.

since at least 1949, the United States has been a net importer of crude oil.

U.S. dependence on foreign petroleum has increased since 1970, when domestic crude oil production was at its peak (**Figure 24**) and accounted for 66 percent of U.S. oil demand. By 1992, domestic crude oil's share had fallen to 42 percent. Crude oil imports have compensated for the decline in domestic production. From a 9-percent share of demand in 1970, crude oil net imports (excluding the SPR) grew and accounted for 36 percent in 1977 before falling off in the late 1970's and early 1980's. Since 1985, however, net crude oil imports have accounted for a growing portion of demand and in 1992 again approached the 1977 share, reaching 35 percent.

One aim of the Energy Policy Act of 1992 is to reduce consumption of imported oil through the use of alternative transportation fuels and the development of new technologies to increase energy efficiency. Success of these programs will likely reduce petroleum consumption over time.³⁵ At the same time, domestic crude oil production will continue to fall, barring any large discoveries of the magnitude of Alaska's giant Prudhoe Bay field. It remains to be seen whether these programs will result in a major reduction in crude oil imports.

Figure 24. U.S. Petroleum Supply and Related Events, 1970 - 1992

Source: Energy Information Administration, *Petroleum Supply Annual*, Vol. 1, 1981-1992 and predecessor reports. See Table 15 for corresponding data.

State Allowables

In the early 1970's, production capacity was peaking and rapid growth in demand was beginning to outpace domestic production (**Table 15**). One indication of the tightening supply situation in 1970 was the virtual elimination of the State allowables. Originally enacted by State governments in the 1930's to conserve resources and keep prices stable, the allowables dictated the amount of crude oil that could be produced from a producing property under a prorationing order.³⁶ Prorationing tended to restrict full production, but with production peaking, the need for prorationing became obsolete. U.S. supplies tightened further after the 1973 Arab Oil Embargo, when the cost of foreign crude oil tripled.

The Importance of Price

The two-tiered pricing system implemented under the 1973 Emergency Petroleum Allocation Act (EPAA) discouraged new domestic oil exploration and production by controlling the price of domestic crude oil. From 1973 to 1974, while the refiner acquisition cost of imported crude oil jumped from about \$4 to more than \$12 per barrel, the comparable cost of domestic crude oil rose from around \$4 to just \$7 per barrel (**Table 16**). The Energy Policy and Conservation Act of 1975 extended price controls over even larger portions of domestic production.

Between 1970 and 1982, U.S. production in the Lower 48 States, both onshore and offshore, fell by about 25 percent. Price controls

³⁵ Congressional Research Service, *Alternate Transportation Fuels: Are They Reducing Oil Imports?*, January 15, 1993, Summary and p. CRS-4.

³⁶ U.S. Department of Energy, Office of the Secretary for Conservation and Solar Operations, *An Analysis of Federal Incentives Used to Stimulate Energy Production*, June 1978, p. 207.

Table 15. U.S. Petroleum Production, Net Imports, and Demand, 1970 - 1992
(Thousand Barrels per Day)

Year	Production						Total Production
	Lower 48		Crude Oil		Percent of Demand	Other ¹	
	Offshore	Onshore	Alaskan	Total			
1970.....	1,385	8,023	229	9,637	65.6	1,677	11,314
1971.....	1,503	7,742	218	9,463	62.2	1,709	11,172
1972.....	1,486	7,756	199	9,441	57.7	1,771	11,212
1973.....	1,446	7,564	198	9,208	53.2	1,767	10,975
1974.....	1,324	7,257	193	8,774	52.7	1,724	10,498
1975.....	1,197	6,987	191	8,375	51.3	1,670	10,045
1976.....	1,115	6,844	173	8,132	46.6	1,642	9,774
1977.....	1,040	6,741	464	8,245	44.7	1,668	9,913
1978.....	1,011	6,467	1,229	8,707	46.2	1,621	10,328
1979.....	962	6,189	1,401	8,552	46.2	1,627	10,179
1980.....	946	6,034	1,617	8,597	50.4	1,617	10,214
1981.....	956	6,007	1,609	8,572	53.4	1,658	10,230
1982.....	1,044	5,909	1,696	8,649	56.5	1,603	10,252
1983.....	1,135	5,839	1,714	8,688	57.0	1,611	10,299
1984.....	1,228	5,929	1,722	8,879	56.5	1,675	10,554
1985.....	1,210	5,936	1,825	8,971	57.0	1,665	10,636
1986.....	1,212	5,601	1,867	8,680	53.3	1,609	10,289
1987.....	1,134	5,253	1,962	8,349	50.1	1,659	10,008
1988.....	1,052	5,071	2,017	8,140	47.1	1,678	9,818
1989.....	992	4,747	1,874	7,613	43.9	1,606	9,219
1990.....	954	4,628	1,773	7,355	43.3	1,639	8,994
1991.....	1,023	4,596	1,798	7,417	44.4	1,751	9,168
1992.....	1,068	4,389	1,714	7,171	42.1	1,825	8,995

Net Imports							Total Production and Net Imports	Total Demand
Crude Oil			Petroleum Products	Total Net Imports	Percent of Demand			
SPR ²	Other	Total						
1970	--	1,310	1,310	1,850	3,160	21.5	14,474	14,697
1971	--	1,680	1,680	2,023	3,703	24.3	14,875	15,213
1972	--	2,215	2,215	2,303	4,518	27.6	15,730	16,367
1973	--	3,242	3,242	2,783	6,025	34.8	17,000	17,308
1974	--	3,474	3,474	2,417	5,891	35.4	16,389	16,653
1975	--	4,099	4,099	1,747	5,846	35.8	15,891	16,322
1976	--	5,279	5,279	1,811	7,090	40.6	16,864	17,461
1977	21	6,544	6,565	2,000	8,565	46.5	18,478	18,431
1978	162	6,036	6,198	1,804	8,002	42.5	18,330	18,847
1979	67	6,217	6,284	1,700	7,984	43.1	18,163	18,513
1980	44	4,932	4,976	1,388	6,364	37.3	16,578	17,056
1981	256	3,912	4,168	1,232	5,400	33.6	15,630	16,058
1982	165	3,087	3,252	1,046	4,298	28.1	14,550	15,296
1983	234	2,931	3,165	1,147	4,312	28.3	14,611	15,231
1984	197	3,048	3,245	1,470	4,715	30.0	15,269	15,726
1985	118	2,879	2,997	1,289	4,286	27.3	14,922	15,726
1986	48	3,976	4,024	1,414	5,438	33.4	15,727	16,281
1987	73	4,450	4,523	1,391	5,914	35.5	15,922	16,665
1988	51	4,901	4,952	1,634	6,586	38.1	16,404	17,283
1989	56	5,645	5,701	1,500	7,201	41.6	16,420	17,325
1990	27	5,758	5,785	1,375	7,160	42.1	16,154	16,988
1991	0	5,666	5,666	959	6,625	39.6	15,793	16,714
1992	10	5,984	5,994	944	6,938	40.7	15,933	17,033

¹ Includes natural gas liquids, other hydrocarbons, and alcohol.

² SPR = Strategic Petroleum Reserve.

-- = Not Applicable.

Source: Energy Information Administration, *Petroleum Supply Annual*, Vol. 1, 1981-1982, Tables 9 and 10, 1983-1988, Table 9, 1989-1992, Tables S1, S2, and 14, and predecessor reports.

**Table 16. U.S. Refiner Acquisition Cost of Crude Oil,
1970 - 1992**
(Dollars per Barrel)

Year	Domestic	Imported	Composite
1970.....	3.46	2.96	3.40
1971.....	3.68	3.17	3.60
1972.....	3.67	3.22	3.58
1973.....	4.17	4.08	4.15
1974.....	7.18	12.52	9.07
1975.....	8.39	13.93	10.38
1976.....	8.84	13.48	10.89
1977.....	9.55	14.53	11.96
1978.....	10.61	14.57	12.46
1979.....	14.27	21.67	17.72
1980.....	24.23	33.89	28.07
1981.....	34.33	37.05	35.24
1982.....	31.22	33.55	31.87
1983.....	28.87	29.30	28.99
1984.....	28.53	28.88	28.63
1985.....	26.66	26.99	26.75
1986.....	14.82	14.00	14.55
1987.....	17.76	18.13	17.90
1988.....	14.74	14.56	14.67
1989.....	17.87	18.08	17.97
1990.....	22.59	21.76	22.22
1991.....	19.33	18.70	19.06
1992.....	18.63	18.20	18.43

Source: Energy Information Administration, *Annual Energy Review 1992*, Table 5.20.

in effect during much of the period contributed to the decline. Imports filled the widening gap between domestic production and demand. From 1.3 million barrels per day in 1970, gross crude oil imports (including SPR) climbed steadily before reaching a historic high of 6.6 million barrels per day in 1977. OPEC³⁷ also achieved its strongest market penetration in the 1970's, increasing its share of U.S. crude oil imports from 46 percent in 1970 to 86 percent in 1976.

The world oil price escalation of 1978 to 1980 caused domestic, price-controlled crude oils to be undervalued against foreign crude oils on the world market. Domestic producers in the Lower 48 States, both onshore and offshore, lost the incentive to produce crude oil under these conditions, and production declined more rapidly.

However, with the completion of the Trans-Alaska Pipeline System (TAPS) in 1977, much of the decline in production in the Lower 48 States was offset by new Alaskan North Slope (ANS) production. Within a year of the opening of the TAPS, Alaskan production exceeded 1.2 million barrels per day, and by 1988, Alaskan output topped 2.0 million barrels per day.

The decontrol of oil prices in 1981 restored economic incentives and spurred production in the Lower 48 States. When combined with the growing ANS production, the increase temporarily reversed the decline in domestic crude oil supplies. By 1985, domestic crude oil production recovered to 9.0 million barrels per day, 9 percent above the 1977 level.

These trends and declining demand resulted in a steep drop in crude oil imports. From 1977 to 1985, gross imports of crude oil fell to 3.2 million barrels per day, a decrease of 52 percent. The U.S. dependence on OPEC oil also declined (Table 17). In the early 1980's, large-scale development projects in the North Sea, Mexico, and other non-OPEC countries began adding significantly to world supplies, forcing OPEC to cut output to defend its official price. Consequently, OPEC's share of U.S. crude oil imports slipped from a high of 86 percent in 1976 to 41 percent in 1985. At the same time, non-OPEC countries such as Canada, Mexico, Norway, and the United Kingdom accounted for a growing portion of U.S. crude oil supply.

The 1986 price collapse that resulted from OPEC production increases and netback pricing damaged the U.S. exploration and production sector. From 1985 to 1992, crude oil production in the Lower 48 States fell 24 percent. In addition, production from Alaska also declined after 1988. In 1992, domestic crude oil production dropped to 7.2 million barrels per day, its lowest level since 1960.

These events led to a rapid rise in crude oil imports. Gross crude oil imports of 6.1 million barrels per day in 1992 were 90 percent higher than in 1985. Countries with excess production capacity, primarily Saudi Arabia but also including other Persian Gulf states, were the primary beneficiaries of the 1986 price collapse. This is evident in the rise in OPEC's share of U.S. gross crude oil imports, which rebounded from 41 percent in 1985 to 60 percent in 1990.

The U.S. crude oil production decline was interrupted during the Persian Gulf crisis in 1990 and 1991, when efforts were being made in major world producing areas to increase output to offset the embargoed crude oil production from Iraq and Kuwait. Crude oil prices rose sharply after the U.N. embargo was enforced. Between August 1 and October 11, 1990, the spot market price for West Texas Intermediate (WTI), the U.S. benchmark crude oil, rose from \$21.59 per barrel to \$41.07 per barrel.³⁸

Prices remained relatively high until January 16, 1991. The initial success of the allied air attack on Iraq, combined with reports of uninterrupted loadings at Saudi Arabian ports and the announced release of SPR oil, calmed world markets.³⁹ The spot price for WTI crude oil experienced a record one-day drop, from \$32.25 per barrel on January 16 to \$21.48 per barrel on January 17.⁴⁰

³⁷ Organization of Petroleum Exporting Countries, composed of 13 member nations until December 31, 1992, when Ecuador withdrew. Between 1970 and 1992, Arab members of OPEC included Algeria, Iraq, Kuwait, Libya, Qatar, Saudi Arabia, and the United Arab Emirates. Other OPEC members included Ecuador, Gabon, Indonesia, Iran, Nigeria, and Venezuela.

³⁸ *Reuter's News Service*, daily issues for the period.

³⁹ Energy Information Administration, "Initial Allied Attack Calms Oil Markets," *Petroleum Supply Monthly*, January 1991, pp. xvii and xviii.

⁴⁰ *Reuter's News Service*, daily issues for the period.

Table 17. U.S. Crude Oil Imports, 1970 - 1992
(Thousand Barrels per Day)

Year	OPEC				Non-OPEC		Total Imports
	Arab	Other	Total	Percent of Total	Total	Percent of Total	
1970	189	420	609	46.0	715	54.0	1,324
1971	301	614	915	54.4	766	45.6	1,681
1972	487	811	1,298	58.6	919	41.5	2,216
1973	838	1,257	2,095	64.6	1,149	35.4	3,244
1974	713	1,827	2,540	73.1	937	26.9	3,477
1975	1,330	1,882	3,211	78.2	893	21.8	4,105
1976	2,378	2,167	4,545	86.0	742	14.0	5,287
1977	3,136	2,507	5,643	85.3	971	14.7	6,615
1978	2,930	2,254	5,184	81.6	1,172	18.4	6,356
1979	3,002	2,110	5,112	78.4	1,407	21.6	6,519
1980	2,503	1,361	3,864	73.4	1,399	26.6	5,263
1981	1,774	1,149	2,922	66.5	1,474	33.5	4,396
1982	736	998	1,734	49.7	1,754	50.3	3,488
1983	533	944	1,477	44.4	1,853	55.7	3,329
1984	634	878	1,512	44.1	1,914	55.9	3,426
1985	300	1,012	1,312	41.0	1,888	59.0	3,201
1986	854	1,259	2,113	50.6	2,065	49.4	4,178
1987	965	1,435	2,400	51.3	2,274	48.7	4,674
1988	1,415	1,281	2,696	52.8	2,411	47.2	5,107
1989	1,794	1,582	3,376	57.8	2,467	42.2	5,843
1990	1,864	1,650	3,514	59.6	2,381	40.4	5,894
1991	1,754	1,622	3,377	58.4	2,405	41.6	5,782
1992	1,660	1,746	3,406	56.0	2,676	44.0	6,083

Note: Totals may not equal sum or components due to independent rounding

Sources: Energy Information Administration, *Petroleum Supply Annual*, Vol. 1, 1992, Table S3, and predecessor reports.

Table 18. U.S. Merchandise Trade Value, 1974 - 1992
(Million Dollars)

Year	Exports			Imports			Trade Balance	
	Petroleum	Total Merchandise	Petroleum as percent of Total	Petroleum	Total Merchandise	Petroleum as percent of Total	Petroleum	Total Merchandise
1974	792	99,437	0.8	24,668	103,321	23.9	(23,876)	(3,884)
1975	907	108,856	0.8	25,197	99,305	25.4	(24,289)	9,551
1976	998	116,794	0.9	32,226	124,614	25.9	(31,228)	(7,820)
1977	1,276	123,182	1.0	42,368	151,534	28.0	(41,093)	(28,353)
1978	1,561	145,847	1.1	39,526	176,052	22.5	(37,965)	(30,205)
1979	1,914	186,363	1.0	56,715	210,285	27.0	(54,801)	(23,922)
1980	2,833	225,566	1.3	78,637	245,262	32.1	(75,803)	(19,696)
1981	3,696	238,715	1.5	76,659	260,982	29.4	(72,963)	(22,267)
1982	5,947	216,442	2.7	60,458	243,952	24.8	(54,511)	(27,510)
1983	4,557	205,639	2.2	53,217	258,048	20.6	(48,659)	(52,409)
1984	4,470	223,976	2.0	56,924	330,678	17.2	(52,454)	(106,703)
1985	4,707	218,815	2.2	50,475	336,526	15.0	(45,768)	(117,712)
1986	3,640	227,159	1.6	35,142	365,438	9.6	(31,503)	(138,279)
1987	3,922	254,122	1.5	42,285	406,241	10.4	(38,363)	(152,119)
1988	3,693	322,426	1.1	38,787	440,952	8.8	(35,094)	(118,526)
1989	5,021	363,812	1.4	49,704	473,211	10.5	(44,683)	(109,399)
1990	6,901	393,592	1.8	61,583	496,088	12.4	(54,682)	(102,496)
1991	6,954	421,730	1.6	51,350	488,453	10.5	(44,396)	(66,723)
1992	6,412	448,164	1.4	51,217	532,665	9.6	(44,805)	(84,501)

Notes: • The U.S. import statistics reflect both government and nongovernment imports of merchandise from foreign countries into the U.S. customs territory, which comprises the 50 States, the District of Columbia, Puerto Rico, and the Virgin Islands. • Totals may not add to sum of components due to independent rounding.

Source: Energy Information Administration, *Monthly Energy Review*, June 1993, Table 1.6.

Exploration in Former USSR

The breakup of the Soviet Union at the end of 1991 opened new areas of exploration to U.S. and other crude oil producers. Despite myriad uncertainties about the direction that policies will take in the former Soviet Union with regard to these opportunities, some U.S. producing firms have entered into joint ventures to explore, develop, and export petroleum from this oil-rich area.⁴¹

Imports, Exports, and the Balance of Oil Trade

The United States has run trade deficits in petroleum for many years, but data have only been available since 1974 (Table 18). The value of crude oil imports is the principal component of the total petroleum trade balance, but both crude oil and petroleum products contribute to it.

Net Oil Imports

The size of the U.S. petroleum trade deficit is essentially a function of two variables: net volume and price. These variables often move in opposite directions, and their effects on the petroleum trade deficit often counterbalance one another. For instance, although the average cost of net petroleum imports fell by nearly one-half in 1986, the petroleum trade deficit fell by only about one-third. An increase in net import volumes, of 1.2 million barrels per day, offset much of the decrease in price.

The petroleum trade deficit rose steadily from 1974 to 1980. Much of the increase reflects the steep rise in prices that resulted from the two oil shocks of the 1970's. In 1980, the average cost per barrel of net petroleum imports was nearly three times higher than in 1974, and the value of petroleum imports peaked at \$75.8 billion. This was more than triple the value of net petroleum imports in 1974.

In contrast to the preceding 8 years, 1982 to 1985 were years of comparative price stability between foreign and domestic crude oils. However, the high cost of petroleum during these years led to increased fuel-switching and conservation. As a result, net petroleum imports fell by one-third from 1980. Largely as

a result of the decline in import volumes, the oil deficit in 1985 declined to \$45.8 billion, a decrease from 1980 of 40 percent.

From 1986 to 1992, price change again had a pronounced influence on the petroleum trade deficit. In 1986, tumbling world oil prices⁴² brought the value of net petroleum imports to \$31.5 billion, the lowest level since 1976 (Figure 25). After 1986, fluctuations in the value of petroleum imports generally tracked movements in price.

Oil Exports

Although oil exports have not figured prominently in the trade balance over the years, their dollar value has grown substantially since the mid-1970's. Most of the value of oil exports is captured from refined products because exports of crude oil are restricted by Federal law.⁴³ A large increase in product exports, which received a boost during the Persian Gulf crisis in 1990 and 1991, was primarily responsible for the rebound in oil export value in the late 1980's and early 1990's. In 1991, the value of all petroleum exports reached a high of \$7.0 billion.

Figure 25. U.S. Net Petroleum Imports and Merchandise Trade Value, 1974 - 1992

Source: Energy Information Administration, *Monthly Energy Review*, June 1993, and *Petroleum Supply Annual*, Vol. 1, 1981-1992 and predecessor reports. See Tables 15 and 18 for corresponding data.

⁴¹Energy Information Administration, "Russia's Oil Industry Undergoes Restructuring," *Petroleum Supply Monthly*, February 1992, pp. xxx-xxxiii.

⁴²Energy Information Administration, *Weekly Petroleum Status Report*, August 6, 1986, pp. 18 and 19.

⁴³Energy Information Administration, "Petroleum Exports," *Petroleum Supply Monthly*, August 1987, pp. xix and xx.

3. Chronology of Events

National security and environmental quality concerns were important forces affecting the U.S. petroleum industry during the past 23 years. Much of the Federal legislation on petroleum was directly or indirectly associated with limiting petroleum imports or reducing petroleum-related pollution (**Figure 26**). Several political and economic events that occurred between 1970 and 1992 were critical because of the Nation's dependence on petroleum imports.

These events created broad changes in the way petroleum is produced, imported, stored, transported, and consumed in the United States. The petroleum industry's course as it responded to the events, and the impact on the U.S. economy, are described in this chapter.

The information for each event in the chronology is organized, with bullets emphasizing the major points, in the following manner:

Description of the Event illustrates what happened.

Industry Action/Reaction describes how the U.S. petroleum industry dealt with the effects of the event.

Results describe the impacts of the event and petroleum industry action/reaction on domestic and/or foreign petroleum prices, consumption patterns, and other related economic activity.

Figure 26. Critical Petroleum-Related Events and U.S. Refiner Acquisition Cost of Crude Oil, 1970 - 1992

Source: Energy Information Administration, *Annual Energy Review 1992* and Office of Oil and Gas. See Table 16 for corresponding data.

Clean Air Act Amendments of 1970

Description:

- The 1970 Clean Air Act (CAA) Amendments significantly expanded the role of the Federal Government in controlling air pollution. It established National Ambient Air Quality Standards (NAAQS). The Environmental Protection Agency (EPA) developed the NAAQS and in 1971 established standards for sulfur dioxide, nitrous oxides, carbon monoxide, oxidants (ozone), non-methane hydrocarbons, and total suspended particulates. A lead standard was adopted in 1978.
 - Sulfur dioxide emissions from electric utilities and industrial plants were restricted by the requirement that distillate and residual fuel oil used at these facilities be low-sulfur.
- The 1970 CAA also permitted the regulation of fuel additives. It established a schedule for reducing lead additives and required automobile manufacturers to design and construct vehicles that could run on low-lead and unleaded fuel. The legislation required that all gasoline stations of specific sizes offer at least one grade of unleaded gasoline (minimum 87 octane) by July 1, 1974.
 - The allowable lead in gasoline was reduced to 1.1 grams per gallon in 1982, and a system of waivers was established that allowed refiners to build up lead credits. Further reductions in July 1985 and on January 1, 1986, brought the allowable lead to a maximum of 0.1 grams per gallon. The lead credit program was ended on December 31, 1987, when a maximum lead content of 0.1 grams per gallon was strictly enforced. All grades of gasoline must be completely lead-free as of January 1, 1996.
- Refiners increased the use of and constructed more downstream conversion units to produce high-octane (anti-knock) blending components to replace the lost lead. In addition, new catalysts were developed to enhance the ability of refiners to generate larger volumes of high-octane gasoline components. High-octane lead substitutes, such as MTBE, also have been developed to maintain octane quality. Other motor gasoline additives also began to be developed and used to maintain the lubricating qualities previously obtained from lead.⁴⁶
- Desulfurization processing units were constructed at refineries in the 1970's to meet the increased demand for low-sulfur fuels. Refiners also increased the use of catalysts to remove sulfur from fuel oil.
- The most significant change in refinery output as a result of the 1970 CAA was the increase in unleaded gasoline. During the 6 years following its introduction in 1974, unleaded gasoline production grew, comprising 27 percent of the motor gasoline produced in the United States by 1980.⁴⁷ Production increased each year and, in 1992, 98 percent of the gasoline produced in the United States was unleaded.

Results:

- The catalytic converter, introduced in 1973 to reduce tailpipe emissions, is deactivated by leaded gasoline but is compatible with the unleaded product.⁴⁸ Within 10 years of the introduction of the catalytic converter, unleaded gasoline comprised 55 percent of the motor gasoline consumed in the United States.
- The air pollution abatement projects installed during the 1970's resulted in much lower emissions of air pollutants at refineries, per barrel of crude oil run. By 1979, carbon monoxide (CO) emissions were 68 percent lower, emissions of total suspended particulates were 50 percent lower, sulfur dioxide was 19 percent lower, and nitrogen oxide emissions were 18 percent lower than in 1970.⁴⁹ Emissions of various atmospheric pollutants were reduced further during the 1980's.⁵⁰

Industry Action/Reaction:

- Lead has been used since the 1920's to boost gasoline octane. During the early 1970's, when the maximum allowable lead in gasoline was 4.0 grams per gallon, 2.5 grams per gallon were typically blended into gasoline.⁴⁴ Producing high-octane gasoline without lead required greater use of complex refining techniques to increase the octane of gasoline blending components, which increased production costs. Downstream units, such as catalytic reformers, were operated under severe conditions.⁴⁵

⁴⁴Energy Information Administration, *The Motor Gasoline Industry: Past, Present, and Future*, January 1991, p. 12.

⁴⁵Energy Information Administration, "What is Motor Gasoline?," *Petroleum Supply Monthly*, February 1984, p. xii.

⁴⁶Energy Information Administration, *The U.S. Petroleum Refining Industry In the 1980's*, October 11, 1990, p. 12.

⁴⁷Energy Information Administration, Form EIA-810, "Refinery Report."

⁴⁸Energy Information Administration, "Recent Motor Gasoline Trends," *Petroleum Supply Monthly*, February 1984, p. xi.

⁴⁹National Petroleum Council, *Environmental Conservation*, 1982, Table 33.

⁵⁰U.S. Department of Energy, Office of Transportation Technologies, *Transportation Energy Data Book*, Edition 13, March 1993, Table 3.45.

Arab Oil Embargo of 1973

Industry Action Reaction

- The refining industry moved to develop technology and processing methods to reduce fuel consumption and to increase operating efficiency.⁵²

Results:

- The embargo caused sudden price hikes and short-term shortages of refined products after decades of ample supplies and growing consumption. Tight supplies caused lines to form at gasoline stations. All petroleum products were much more costly. From 1972 to 1975, when OPEC restored output to pre-embargo levels, consumers were paying approximately 57 percent more for leaded regular gasoline and 91 percent more for home heating oil.⁵³ These increases reflect the increase in world oil prices over the period. The large jump in energy prices is widely considered to be a cause of the economic recession that occurred in 1974 and 1975, though some recent economic studies indicate that other factors may have contributed.⁵⁴

- Various efforts were undertaken to conserve energy and to switch from petroleum to less expensive alternative fuels. Petroleum consumption declined both in 1974 and 1975 as a result of conservation efforts.⁵⁵ Large volumes of distillate fuel oil and residual fuel oil were replaced by alternative fuels in some industrial and electric utility facilities.
- To plan for future supply disruptions and to establish secure stable supplies, the United States joined with 20 other nations in 1974 to form the International Energy Agency (IEA). Member nations, including the United States, developed plans to establish strategic reserves for use in any future supply disruptions.⁵⁶
- Legislation was put in place over the next several years that had a significant impact on all aspects of the petroleum industry.

Emergency Petroleum Allocation Act of 1973

Description:

- The principle aims of the Emergency Petroleum Allocation Act (EPAA) were to ensure equitable distribution of available products, to establish equitable prices, and to preserve the independent segments of the oil industry. EPAA established a two-tiered pricing system for domestic crude oil. "Old" oil, designated as crude oil from properties producing at or below their 1972 production levels, was subject to a price ceiling while "new" oil, stripper oil, and "released oil" (added as an incentive for increased production from old fields) was allowed to be sold at market prices. The price of imported oil remained unregulated.

The increase in the world price of crude oil resulting from the Arab oil embargo created a significant disparity between the cost of old and new oil. Before long, major problems with the two-tiered system developed, and additional regulatory programs were instituted. These included the Supplier-Purchaser Rule, the Buy-Sell Program, and the Entitlements Program.

- The Supplier-Purchaser Rule froze buyer-seller relationships as of 1972 among domestic petroleum producers, refiners, resellers, and retailers. Its purpose was to stop refiners from engaging in transactions to gain access to additional quantities of price-controlled "old" oil.

- The Buy-Sell Program required refiners with access to proportionately above-average amounts of less expensive crude oil to sell (at controlled prices) crude oil to other refiners. Originally applicable to all refiners, after several months the program was limited to only the 15 largest integrated refiners, who were required to sell, and to small refiners who were allowed to buy.
- The Crude Oil Entitlements Program was established to equalize crude oil costs across domestic refiners including imported oil. In essence, those with above-average access to lower priced old oil were required to buy rights to their supplies from those with below-average access. A special provision of this program was the "small refinery bias." The bias provision was established to compensate small refineries for the relatively higher operating and capital costs by providing them with guaranteed access to low-priced crude oil.

Industry Action/Reaction:

- In response to changing regulations, growth in domestic exploration slowed and production was curtailed as the price of U.S. crude oil was kept well below world prices by Federal controls.
- The small refinery bias provision made it progressively more profitable to operate a small, inefficient refinery. Consequently, reactivation and construction of small

⁵²U.S. Department of the Interior, Bureau of Mines, *Crude Petroleum, Petroleum Products, and Natural Gas Liquids*, Final Summary, 1973, Table 22, and 1975, Table 23.

⁵³Energy Information Administration, *Annual Energy Review 1991*, Table 73.

⁵⁴Douglas R. Bohi, *Energy Price Shocks and Macroeconomic Performance*, Resources for the Future 1989, pp. 1, 3, and 83 - 87.

⁵⁵Energy Information Administration, *Energy Consumption Indicators, 1984 Annual Report*, Figures 14, 24, 40, and 43.

⁵⁶"The IEA Charts A Global Course," *Petroleum Intelligence Weekly*, October 5, 1992, p. 8.

refineries increased sharply during the 1970's. The bulk of these were hydroskimming plants with less than 30,000 barrels per day of distillation capacity and little or no downstream conversion capacity.⁵⁷ Between 1973 and 1981, the number of operable refineries in the United States rose from 281 to a record high of 324.

- Crude oil distillation capacity grew dramatically through the entire decade as many small, unsophisticated refineries were built. The regulatory protection afforded by Federal controls enabled capacity to continue increasing even after U.S. oil demand peaked in 1978. Crude oil distillation capacity grew from 13.7 million barrels per day at the beginning of 1973 to 18.6 million barrels per day at the beginning of 1981.
- Many refiners operated at low utilization rates since their market positions were protected by the regulations in place. Moreover, since the entitlements program subsidized imports of crude oil, distillate fuel oil, and residual fuel oil, some refiners increased imports of these products. As a result, inefficiencies developed in the production and marketing of petroleum.

- Crude oil imports more than doubled from 1973 to 1977, reaching a record level of 6.6 million barrels per day in 1977.
- Under price and allocation controls, exports were restricted, further distorting the domestic market. Only petroleum coke and lubricating oils were exported during this period in significant quantities.

Results:

- As price controls held down domestic petroleum prices, demand increased to record levels in 1978. Demand for distillate and residual fuel oils increased as artificially low prices generated by Federal controls enhanced their competitive positions *vis-a-vis* natural gas and coal.⁵⁸ In the vessel bunkering market, U.S.-produced residual fuel oil enjoyed a marked price advantage over foreign competition, resulting in increasing domestic sales of vessel bunkering fuel.⁵⁹
- Residual fuel oil imports declined sharply during the 1970's. After 1973, residual fuel oil imports were increasingly replaced by production from new entitlements refineries. By 1980, gross imports accounted for 37 percent of residual fuel oil, down from 66 percent in 1973. The volume of imports also fell significantly during this period.

Energy Policy and Conservation Act of 1975

Description:

- The Energy Policy and Conservation Act (EPCA) of 1975 was enacted to achieve a number of goals. These included, but were not limited to: increasing oil production through price incentives, establishing a Strategic Petroleum Reserve (SPR), and increasing automobile fuel efficiency. Specifically, the EPCA:
 - Sought to roll back the price of domestic crude oil. Old oil was to be priced at the May 15, 1973, price plus \$1.35 per barrel. New oil and stripper oil prices were set at the September 30, 1975, new oil price less \$1.32 per barrel. In addition, the released oil program was dropped.
 - Authorized the creation of the Strategic Petroleum Reserve for the storage of up to 1 billion barrels of oil.
 - Established the Corporate Average Fuel Economy (CAFE) standards that mandated increases in average automobile fuel-economy. The standards set a corporate sales-fleet average of 18 miles per gallon beginning with

the 1978 model year, and established a schedule for attaining a fleet goal of 27.5 miles per gallon by 1985. The CAFE standards apply separately to domestic and imported sales fleets.

Industry Action/Reaction:

- The two-tiered price system established under EPAA and later modified under EPCA was intended to encourage domestic production and exploration. However, the roll-back of new oil prices and the inclusion of new oil in the entitlements program actually served as a mild incentive to oil companies to increase purchases of imported crude oil.⁶⁰ EPCA did little to slow the decline in production in the Lower 48 States, which fell from 8.2 million barrels per day in 1975 to 7.0 million barrels per day in 1980.
- Automobile manufacturers built and sold more subcompact and compact cars to meet the CAFE standards. From 1977 to 1991, the combined market share of new minicompact, subcompact, compact, and midsized cars (both domestic and foreign) rose from 73 percent to 85 percent. In contrast,

⁵⁷American Petroleum Institute, *Entry & Exit in U.S. Petroleum Refining 1948-1992*, January 1993, Table 7.

⁵⁸Energy Information Administration, *State Energy Price and Expenditure Report 1970-1981*, p. 3.

⁵⁹Energy Information Administration, "Trends In Petroleum Product Consumption," *Petroleum Supply Monthly*, January 1984, p. xvi.

⁶⁰U.S. Department of Energy, Office of the Secretary for Conservation and Solar Operations, *An Analysis of Federal Incentives Used to Stimulate Energy Production*, June 1978, pp. 211 and 212.

over the same period the combined market share of new large cars fell from 25 percent to 14 percent.⁶¹

Results:

- The Federal Government began filling SPR in 1977. Over the years, its fill rate has varied considerably, reaching a high of 336,000 thousand barrels per day in 1981. Imports make up most of the crude oil stored in SPR. At the end of 1992, SPR contained 575 million barrels of crude oil.
- The early impact of CAFE was largely overshadowed by a pronounced decrease in gasoline use caused by price and availability factors related to the Iranian Revolution in 1978-1979 and the Iran-Iraq War which began in 1980. An additional constraint on the effects of CAFE on gasoline consumption has come from the influx of gasoline-powered light trucks and recreational vehicles since 1977. CAFE standards for light trucks are lower than for automobiles

(19.5 miles per gallon for 1985 model trucks compared with 27.5 miles per gallon for 1985 model cars).⁶² Nevertheless, the impact of CAFE has grown as older cars have been gradually replaced by fuel-efficient new cars. From 1977 to 1991, average automobile fuel economy increased 57 percent, from 13.8 miles per gallon to 21.7 miles per gallon. This was more than enough to offset a 26-percent increase in the number of automobiles registered and a 9-percent increase in the average number of miles driven per automobile. As a result, motor gasoline demand in 1991 was about the same as in 1977.

- In response to automobile manufacturers' difficulty in meeting the 27.5 mile-per-gallon CAFE standard, the standard was lowered in 1986 to 26.5 miles per gallon. In 1989, the standard was restored to 27.5 miles per gallon. The light truck sales fleet in 1992 was required to meet a standard of 20.2 miles per gallon.⁶³

Department of Energy Organization Act of 1977

Description:

- The creation of the U.S. Department of Energy (DOE) in 1977 consolidated many energy-related functions of the Federal Government into a single, Cabinet-level organization. Primarily, the Department of Energy merged the energy-related functions of several Federal agencies.
 - Until the 1970's, fuel-specific programs were handled by several Federal departments: the Department of the Interior managed most Federal programs affecting the coal and oil industries, the Federal Power Commission regulated natural gas prices, and the Atomic Energy Commission (AEC) oversaw the development of nuclear power.
 - The energy crises of the 1970's accelerated the reorganization of the energy-related programs of the

Federal government. In addition to the replacement of the AEC with two new agencies, the Federal Energy Administration (FEA) was created in 1974 to administer programs that included crude oil price and allocation, the SPR, replacement of natural gas and oil with coal, and energy conservation.

Results:

- The petroleum-related functions of DOE were originally to formulate comprehensive energy policy. Energy management became the primary role of the agency in the early 1980's. Energy shocks and public sensitivity have molded DOE's role over the past 16 years. Evolving issues include energy conservation, development of alternative fuels, reduced oil consumption, national security, and energy prices.⁶⁴

Airline Deregulation Act of 1978

Description:

- In 1978, passage of the Airline Deregulation Act (ADA) altered the rules by which airlines compete in the marketplace. In particular, ADA removed restrictions on market entry, service routes, and prices, and allowed increased competition among commercial air carriers.

Industry Action/Reaction:

- To meet demand increases related to airline deregulation, refinery operations were modified to increase yields of kerosene-type jet fuel. Yields had remained around 5.4 percent during the 1970's until 1979, when they began to rise. Yields of kerosene-type jet fuel reached 9.4 percent in

⁶¹ U.S. Department of Energy, Office of Transportation Technologies, *Transportation Energy Data Book*, Edition 13, March 1993, Table 3.18, and Edition 10, September 1989, Table 3.9.

⁶² U.S. Department of Energy, Office of Transportation Technologies, *Transportation Energy Data Book*, Edition 13, March 1993, Table 3.36.

⁶³ U.S. Department of Energy, Office of Transportation Technologies, *Transportation Energy Data Book*, Edition 13, March 1993, Table 3.36.

⁶⁴ Donald R. Whitnah, editor-in-chief, "Government Agencies," *The Greenwood Encyclopedia of American Institutions*, 1983, pp. 110-114.

1990 before declining slightly in recent years. During the Persian Gulf War, yields of kerosene-type jet fuel routinely exceeded 10 percent.

Results:

- Airline deregulation at first prompted the formation of many new airlines. Increased competition made airfares more affordable, and air travel increased. However, with fuel accounting for as much as 30 percent of an airline's

operating costs,⁶⁵ airlines were vulnerable to rapid price rises. With little capacity to store fuel as a hedge against price increases or supply disruptions, many airline consolidations and bankruptcies occurred during the 1980's.

- Continued competition among airlines often resulted in low airfares throughout the 1980's and early 1990's. As a result, demand for kerosene-type jet fuel escalated.

Powerplant and Industrial Fuel Use Act of 1978

Description:

- The Powerplant and Industrial Fuel Use Act (PIFUA), passed in 1978, restricted the construction of powerplants that use petroleum or natural gas as their primary fuels. The main purpose of the law was to promote national energy security by encouraging the use of coal and alternative fuels in new electric powerplants.

Industry Action/Reaction:

- Although PIFUA's primary impact was expected to be on future residual fuel oil demand growth, it was only slightly effective in reducing residual fuel oil demand. After the 1973 oil price shock, electric utilities saw a need to reduce reliance on petroleum.⁶⁶ Most of the new utility plants

announced after 1975 were coal and nuclear facilities.⁶⁷ As a result, a large portion of the oil-fired capacity in the late 1970's and early 1980's was reserved for peak load periods or for emergencies and turnarounds.

Results:

- In small part due to PIFUA, but primarily due to new plant construction and higher oil prices in the late 1970's and early 1980's, the use of residual fuel oil at electric utilities declined substantially. From a peak of 1.7 million barrels per day in 1978,⁶⁸ oil consumption at electric utilities fell to 475,000 barrels per day in 1985.
- PIFUA was repealed in 1987.

Iranian Revolution of 1978-1979

Description:

- The Iranian Revolution, which began in late 1978, resulted in a drop of 3.9 million barrels per day of crude oil production from Iran from 1978 to 1981. World supplies appeared to be tight, although much of this lost production was offset initially by increases in output from other OPEC members, particularly from Iran's Persian Gulf neighbors.⁶⁹ In 1980, the Iran-Iraq War began and many Persian Gulf countries reduced output as well. OPEC crude oil prices increased to unprecedented levels between 1979 and 1981. By 1981, OPEC production declined to 22.8 million barrels per day, 7.0 million barrels per day below its level for 1978.

Industry Action/Reaction:

- At the same time OPEC was trimming output, companies and governments began to stockpile oil and build reserve

supplies. Those actions, combined with the cuts in production, put upward pressure on oil prices. The world price of crude oil⁷⁰ jumped from around \$14 per barrel at the beginning of 1979 to more than \$35 per barrel in January 1981 before stabilizing. Prices did not drop appreciably until 1983, when the world price stabilized between \$28 and \$29 per barrel.⁷¹

- The high cost of crude oil stimulated exploration and production operations in non-OPEC countries, prolonged the productive life of marginal wells, and made secondary and tertiary production techniques profitable. In addition to these trends, development projects in the North Sea, Mexico, and the North Slope of Alaska began to contribute significantly to world crude oil supplies. By 1985, non-OPEC production comprised 69 percent of total world

⁶⁵Energy Information Administration, "Persian Gulf Situation and Petroleum Markets," *Petroleum Supply Monthly*, July 1990, p. xxxiv.

⁶⁶Energy Information Administration, *The Changing Structure of the Electric Power Industry 1970-1991*, March 1993, pp. 11, 21, and Table C6.

⁶⁷Energy Information Administration, *Fuel Choice in Steam Electric Generation: Historical Overview*, August 1985, Table 3.

⁶⁸Energy Information Administration, *Electric Power Annual*, 1981, Table 41, and 1986, Table 10.

⁶⁹Energy Information Administration, *International Energy Annual*, 1982, Table 8.

⁷⁰The weighted average international price of internationally traded crude oil only. The average price (FOB) is weighted by the estimated export volume.

⁷¹Energy Information Administration, *Weekly Petroleum Status Report*, January 2 and December 12, 1981, p. 20, and December 20 and 27, 1985, p. 19.

production, up from 50 percent in 1978. These trends allowed U.S. refiners to tap new sources of non-OPEC supply.

- The rapid increase in non-OPEC production caused OPEC, led by Saudi Arabia, to defend its official price of \$34.00 per barrel⁷² by cutting output further. Between 1978 and 1985, OPEC production fell from 29.9 million barrels per day to 16.6 million barrels per day. Over the same period, as U.S. refiners imported proportionately more crude oil from Canada, Mexico, the United Kingdom, and other non-OPEC countries, OPEC's share of U.S. crude oil imports fell from 82 percent to 41 percent.

Results:

- The higher oil prices depressed U.S. petroleum consumption and encouraged fuel-switching and energy conservation. Other fuels replaced petroleum in many applications, and industrial processes, appliances, equipment, and motors were made more efficient. These developments had a large impact on U.S. petroleum demand, which from 1978 to 1983 fell from 18.8 to 15.2 million barrels per day, the lowest level since 1971.

- World demand for petroleum also fell steeply in response to the rising crude oil prices. From 63.1 million barrels per day in 1980, world petroleum demand slid to 60.1 million barrels per day in 1985, a drop of 5 percent.
- Western Europe, with petroleum demand almost as high as U.S. levels, reacted with equally strong reductions. Distillate and residual fuel oils, the primary components of Western European demand when it reached its peak in 1979, showed the greatest declines.⁷³

In countries in the Far East and Oceania, declines in petroleum use as a result of conservation and fuel-switching were largely offset by other factors. China, Japan, and other countries with low-cost materials, labor, and in some cases more efficient production methods, were successfully competing with the United States in energy-intensive industries. As a result, in the Far East, there was a growing demand for petroleum for use in steel production, petrochemicals, metals mining, and other energy-intensive industries.⁷⁴

Petroleum Price and Allocation Decontrol in 1981

Description:

- In early 1981, the U.S. Government responded to the oil crisis of 1978-1980 by removing price and allocation controls on the oil industry. For the first time since the early 1970's, market forces replaced regulatory programs and domestic crude oil prices were allowed to rise to a market-clearing level. Decontrol also set the stage for the relaxation of export restrictions on petroleum products.

day. Unfinished oils continued to rise and in 1992 were 440,000 barrels per day.

Industry Action/Reaction:

- Soon after deregulation, many small refineries and older, inefficient plants could no longer compete and were forced to shut down. Between the beginning of 1981 and 1985, the number of refineries operating in the United States declined by 101 to 223, and operable crude oil distillation capacity fell 3.0 million barrels per day to 15.7 million barrels per day.
- The loss of so many small, low-conversion refineries, which were a large source of unfinished oils, sent many sophisticated refiners overseas for intermediate oil supplies. From 1980, the last full year of price and allocation controls, to 1981, imports of unfinished oils more than doubled, jumping from 55,000 barrels per day to 112,000 barrels per

- With fewer refineries in operation, refinery utilization increased between 1981 and 1985 despite the lower overall level of refinery inputs over this period. Since 1985, distillation capacity has remained fairly stable and changes in refinery inputs, not distillation capacity, have been the primary cause of changing utilization rates.

- Decontrol of crude oil prices allowed producers to raise prices to the market-clearing level for the first time since the early 1970's, and domestic crude oil prices became more closely aligned with foreign crude oil prices.⁷⁵ The production sector responded by increasing crude oil exploration and production in the Lower 48 States during the first half of the 1980's. However, sharply falling oil prices in 1986 reversed this upward trend in domestic exploration and production.

- Increases in Alaskan North Slope (ANS) production during this period aided the domestic crude oil situation. This helped to stem the flow of imported crude oil, greatly reducing U.S. reliance on OPEC crude oil. Imports remained low until crude oil prices collapsed in 1986.

⁷²Energy Information Administration, *Weekly Petroleum Status Report*, December 18, 1981, pp. 21 and 22.

⁷³Energy Information Administration, Office of Energy Markets and End Use, International Statistics Branch, 1992 revisions to world consumption data.

⁷⁴U.S. Department of Commerce, Bureau of the Census, *U.S. Imports for Consumption and General Imports*, 1981-1985, Table 1.

⁷⁵Energy Information Administration, *Weekly Petroleum Status Report*, December 24, 1982, p. 19.

Results:

- After decontrol, residual fuel oil prices were allowed to rise to market clearing levels,⁷⁶ and this accelerated fuel-switching and conservation at generating⁷⁷ and industrial facilities.⁷⁸ By 1985, demand for residual fuel oil of 1.2 million barrels per day was the lowest since the Second World War.^{79,80}
- Larger volumes of unfinished oils, motor gasoline, and distillate fuel oil began arriving from overseas and, by the mid-1980's, accounted for a larger share of imports than residual fuel oil. Imports of residual fuel continued to

decline in the 1990's, and in 1992 fell to 375,000 barrels per day, their lowest level since 1954.

- With the removal of export restrictions in late 1981, product exports began to expand, and the composition of these exports changed. Exports of all major light products increased markedly by the mid-1980's. Moreover, these products, along with petroleum coke and lubricants, were being shipped to a greater variety of nations. Countries in Central and South America and the Far East, which received little or no U.S. exports in 1973, were now purchasing U.S. products on a regular basis.

Crude Oil Price Collapse of 1986

Description:

- Faced with declining world oil demand and increasing non-OPEC production, OPEC cut output significantly in the first half of the 1980's to defend its official price. Saudi Arabia, which played the role of swing-producer in the cartel, bore most of the production cuts. In late 1985, Saudi Arabia abandoned its swing producer role, increased production, and aggressively moved to increase market share. Saudi Arabia tried a netback pricing concept, which tied crude oil prices to the value of refined petroleum products.⁸¹ This reversed traditional economic relationships by guaranteeing specific margins to refiners, thereby transferring risk from the crude oil purchaser to the producer.
- In response, other OPEC members also increased production and offered netback pricing arrangements to maintain market share and to offset declining revenues. These actions resulted in a glut of crude oil in world markets, and crude oil prices fell sharply in early 1986.⁸²

Industry Action/Reaction:

- By July 1986, the average per-barrel F.O.B. price for OPEC crude oil had dropped from \$23.29 in December 1985 to \$9.85, and prices for crude oil from non-OPEC countries were following a similar path.
- The collapse of crude oil prices in 1986 reversed the upward trend in U.S. production of the first half of the decade. Many high-cost wells, which became productive after the oil crisis

of 1978-1980, became unprofitable in 1986 and were shut in. Domestic crude oil production began dropping in early 1986. After the world price fell more than 50 percent between January and March 1986, drilling plummeted. Since then, excluding a few months in 1990 during the Persian Gulf Crisis, domestic drilling and production have declined dramatically.

- The net effect of the decline in domestic production beginning in 1986 was an increase in crude oil imports, which climbed from 3.2 million barrels per day in 1985 to 6.1 million barrels per day in 1992. Most of this increase was met by OPEC, whose share of total U.S. crude oil imports rose from 41 percent in 1985 to 60 percent in 1990, before dropping to 56 percent in 1992.
- Oil company investments began shifting to foreign oil exploration and production after the 1986 price drop.⁸³ Foreign fields are generally much larger than in the United States and average production costs are lower. Changes in policy in the former Soviet Union since 1991 have increased U.S. production investments there,⁸⁴ and recent moves toward foreign investments in Mexico have attracted American exploration and production companies.⁸⁵

Results:

- The sharp drop in crude oil prices pushed U.S. petroleum demand steadily higher in the second half of the decade. From 1985 to 1990, demand climbed from 15.7 million barrels per day to 17.0 million barrels per day.

⁷⁶Energy Information Administration, *Weekly Petroleum Status Report*, January 2, 1981 and January 8, 1982 issues, p. 23.

⁷⁷Energy Information Administration, *Fuel Choice in Steam Electric Generation: Historical View*, August 1985, Table 1.

⁷⁸Energy Information Administration, *Impacts of Lower World Oil Prices on Conservation*, June 1986, Table 7.

⁷⁹American Petroleum Institute, *Basic Petroleum Data Book*, Volume XII, Number 3, September 1992, Section VII, Table 6.

⁸⁰U.S. Department of the Interior, Bureau of Mines, *A Quarter Century of Fuel Oil Sales, 1926-1950*, Table 2.

⁸¹Energy Information Administration, "Year in Review," *Petroleum Marketing Annual 1986*, p. 7.

⁸²Energy Information Administration, *Weekly Petroleum Status Report*, February 25, 1986, p. 19.

⁸³"Salomon Reports Shift to Overseas Operations," *Bloomberg Oil Buyers Guide*, August 3, 1992, p. 3.

⁸⁴Energy Information Administration, "Russia's Oil Industry Undergoes Restructuring," *Petroleum Supply Monthly*, February 1992, pp. xxxii and xxxiii.

⁸⁵"Mexican Energy Law Developments," *Petroleum Economist*, July 1992, Energy Law Special Supplement.

Gasoline pump nozzles such as this style were replaced at many gasoline service stations after most Northeastern States mandated the use of anti-vapor gasoline pump nozzles in the late 1980's. Hydrocarbon emissions during refueling had increased as more butane and benzene were added to motor gasoline to replace lead.

- Until 1986, the value of U.S. petroleum imports comprised between 15 percent and 32 percent of all imported goods. The steep decline in petroleum prices in 1986 reduced petroleum's portion of the U.S. trade deficit.
- The economy expanded at a faster pace in 1987 and 1988. Low petroleum prices stimulated growth in industrial

production, employment increased,⁸⁶ and travel picked up. Temporary conservation measures that had been instituted during earlier oil price escalations were discontinued. The overall energy intensity of the economy (measured by the ratio of total energy consumption to the constant dollar level of the Gross Domestic Product), a reflection of energy conservation,⁸⁷ did not increase between 1986 and 1988.

Reid Vapor Pressure Regulations of 1989 and 1992

Description:

- To combat emissions of volatile organic compounds (VOC's) and other ozone precursors, the EPA implemented a two-phased program limiting summertime motor gasoline volatility in some U.S. urban areas in the spring of 1989. VOC's react photochemically in the atmosphere and are a major component of smog. Concentrations are reduced by

lowering the vapor pressure of motor gasoline. At warm temperatures and high altitudes, gasoline evaporates more readily, increasing the amount of VOC's released to the atmosphere. Alaska and Hawaii are exempt from the volatility restrictions.

- Phase I summer volatility standards went into effect in 1989. This phase mandated that the average summer

⁸⁶ Council of Economic Advisors, *Economic Indicators*, June 1993, pp. 4, 11, and 17.

⁸⁷ Energy Information Administration, *Impacts of Lower World Oil Prices on Energy Conservation*, June 1986, p. 13.

RVP in motor gasoline be reduced from 11.5 psi to a maximum of 10.5 psi RVP, and as low as 9.0 psi RVP in certain areas of the country.

- Phase II summer volatility standards were implemented in 1992 and will stay in effect through the summer of 1994. In 1995, RVP requirements will change again with the implementation of the reformulated gasoline program. Phase II set a nationwide maximum summer RVP standard of 9.0 psi. Gasoline sold in southern cities that do not meet Federal ozone standards must meet an even stricter standard of 7.8 psi RVP (**Figure 27**).

Industry Action/Reaction:

- Refiners met the Phase I standards by reducing the amount of normal butane blended into motor gasoline. Butane is a lower-cost gasoline blending component that has a relatively high RVP and high octane. To compensate for the loss in volume and octane in motor gasoline when butane was removed, refiners increased crude oil inputs and the use of catalytic cracking and alkylation units.⁸⁸
- The more stringent Phase II standards increased requirements for downstream processing. Some refiners

made large capital investments to produce high-octane, lower RVP blending components, to meet these standards.

- To assure that the distribution system was in full compliance by the May 1, 1992 deadline for meeting the more stringent 1992 RVP restrictions, pipeline operators adjusted shipping schedules.
 - In some cases, lower RVP gasoline was shipped well in advance of the deadline.
 - In areas where both attainment and non-attainment areas share markets, some pipelines shipped six or more grades of gasoline, using breakout tankage to divert products so that a compatible product could go through.⁸⁹
 - Other adjustments, such as blending additives at destination terminals and exchanging products between suppliers, reduced the number of grades of gasoline being shipped.

Results:

- Some reduction in ambient smog levels was observed after this program went into effect.⁹⁰

⁸⁸Energy Information Administration, "Changing Requirements for Motor Gasoline Volatility: Production and Market Responses," *Petroleum Supply Monthly*, July 1992, xviii and xix.

⁸⁹Energy Information Administration, "Pipelines Prepare to Ship Low RVP Gasoline," *Petroleum Supply Monthly*, March 1992, pp. xxiv and xxv.

⁹⁰U.S. Department of Energy, Office of Transportation Technologies, *Transportation Energy Data Book*, Edition 13, March 1993, Table 3.45.

Figure 27. U.S. Regional Retail RVP Requirements for Motor Gasoline, June 1 - September 15, 1992

Source: Federal Register Vol. 55, No. 112, Page 23659, June 11, 1990, Federal Register Vol. 56, No. 239, Page 64704, December 12, 1991.

Figure 28. U.S. Areas Subject to Clean Air Requirements

Source: Environmental Protection Agency, Office of Air Quality Planning and Standards, *Ozone and Carbon Monoxide Areas Violating the National Ambient Air Quality Standards and Status of 1988 & 1989 Calls for State Implementation Plan Revisions* (September 12, 1990)

Clean Air Act Amendments of 1990

Description:

- Strict new controls to reduce mobile sources of air pollution were mandated under the CAA Amendments of 1990. The Amendments contain six provisions to be implemented by the EPA in stages between November 1, 1992, and January 1, 2000. Four major programs to reduce harmful emissions from highway fuel go into effect between November 1, 1992, and January 1, 1996. These programs include:
 - **Oxygenated Fuels Program.** As of November 1, 1992, all motor gasoline sold in most of the 39 areas of the country designated as carbon monoxide (CO) nonattainment areas (**Figure 28**) must contain a minimum of 2.7 percent oxygen by weight during at least 4 winter months. Adding oxygenates to motor gasoline lowers the level of carbon monoxide produced during gasoline combustion. Concern over poisonous nitrogen oxide emissions from the higher winter oxygen content resulted in a winter maximum of 2.0 percent oxygen by weight in California's CO nonattainment areas.⁹¹
 - **Highway Diesel Fuel Program.** As of October 1, 1993, the sulfur content of highway diesel fuel must be reduced

from the current maximum of 0.25 percent to 0.05 percent by weight. In addition, the cetane index, which measures the self-ignition quality of diesel fuel, must be maintained at a minimum of 40. Small refineries (those with *bona fide* crude oil throughput of less than 18,250 thousand barrels per year) will get relief from the sulfur limit in the form of tradeable credits until December 31, 1999.

- **Reformulated Gasoline Program.** As of January 1, 1995, reformulated gasoline will be required in the nine metropolitan areas with the worst ozone problems. Other areas may "opt in" to the program by applying to the EPA. The "opt-in" provision may be delayed for up to 3 years if EPA determines that not enough reformulated gasoline is available.

Reformulated gasoline must meet specific composition and emission performance criteria. The core composition requirements limit benzene to a maximum of 1.0 volume percent, mandate an oxygen content of at least 2.0 weight percent, prohibit lead and manganese, and require deposit control additives. The core emission

⁹¹Congressional Research Service, *Alternative Transportation Fuels: Are They Reducing Oil Imports?*, January 15, 1993, p. CRS-5.

Table 19. Number and U.S. Production Capacity of Operable Oxygenate Plants by PAD District, January 1, 1993
(Thousand Barrels Per Calendar Day)

PAD District	Number of Operable Plants	Oxygenate Capacity						Other ¹
		Fuel Ethanol	ETBE	Methanol	MTBE	TAME	TBA	
I.....	7	1	1	10	5	0	0	0
II.....	35	84	0	4	11	0	0	0
III.....	44	4	10	105	143	5	32	6
IV.....	7	1	0	3	4	0	0	0
V.....	7	1	0	0	7	0	0	0
U.S.Total	100	90	10	123	170	5	32	6

¹ Includes other aliphatic alcohols and ethers intended for motor gasoline blending (e.g., isopropyl ether (IPE) or n-propanol).

Note: Operable production capacity is the sum of operating and idle capacity. Totals may not equal sum of components due to independent rounding.

Source: Energy Information Administration' *Petroleum Supply Annual*, Vol. 1, 1992, Table 48.

Table 20. U.S. Supplies of Selected Oxygenates for Motor Gasoline Blending, by Quarter, 1992
(Thousand Barrels per Day, Except Where Noted)

Item	Quarter				1992 Average
	1	2	3	4	
Fuel Ethanol					
Production.....	70	67	68	74	70
Blended*	66	62	57	89	63
Ending Stocks (Thousand Barrels)	1,462	1,941	2,973	1,791	--
MTBE					
Production.....	94	86	99	124	101
Imports	W	W	W	W	W
Blended	47	45	67	213	70
Ending Stocks (Thousand Barrels)	13,966	18,887	22,853	13,818	--

W = Withheld to avoid disclosure of individual company data.

* Quantities of fuel ethanol blended into motor gasoline are calculated by the Energy Information Administration. This quantity is equal to production plus imports, minus stock change.

Sources: Energy Information Administration, *Weekly Petroleum Status Report*, 1992 editions, Table B1, and *Petroleum Supply Monthly*, May 1993, Tables D2 and D3.

requirements for 1995 to 1999 prohibit any increase in nitrous oxides emissions and mandate a year-round reduction of toxic air pollutants (TAP's) and a summertime reduction of VOC's of 15 percent below 1990 "baseline" gasoline. By 2000, TAP and VOC emissions are to be reduced by a minimum of 20 percent. If technically feasible, a 25-percent cut will be mandated.

- **Leaded Gasoline Removal.** Sales of leaded motor gasoline are prohibited after 1995.

Industry Action/Reaction:

- Construction of oxygenate production facilities escalated in recent years in preparation for the implementation of the program. At least 33 refineries had facilities for producing oxygenates from refinery streams in 1992.⁹² This was in

addition to oxygenate capacity from nonrefinery standalone units that produce ethanol from grain and MTBE from field butane streams and from methanol that was produced from natural gas. At the beginning of 1991, total U.S. production capacity for oxygenates from all these sources was 338,000 barrels per day. By the beginning of 1993, production capacity for oxygenates was 59 percent higher at 536,000 barrels per day (Table 19). Production of fuel ethanol is concentrated in the Midwest cornbelt area, whereas MTBE production facilities are primarily along the Gulf Coast.

Capacity increases continued in 1992 in the United States. Canada and countries in Western and Eastern Europe, South America, and the Far East were also increasing production capacity.⁹³

⁹²"Worldwide refiners making big move into modernization," *Oil and Gas Journal*, December 21, 1992, p. 48.

⁹³MTBE/Oxygenates/New Fuels, October 22, 1992, p. 1, and November 5, 1992, pp. 1 and 2.

- Primary U.S. stocks of oxygenates, mainly fuel ethanol and MTBE, were built up during the summer of 1992 (Table 20). Blending to accommodate winter oxygenated gasoline requirements began in August 1992.
- Shipment of oxygenated gasoline for the Oxygenated Fuels Program also began in August 1992, to assure that product would be in place by November 1. Motor gasoline containing MTBE is transported to the consuming areas through the normal distribution network, primarily by pipeline.
- Motor gasoline containing fuel ethanol is susceptible to water solubility problems during pipeline transportation.⁹⁴ Therefore, ethanol is often shipped across country and then blended with motor gasoline at terminals for local distribution.
- Spillover of oxygenated gasoline into attainment areas was kept to a minimum.⁹⁵
- Construction of desulfurization downstream units, in particular catalytic hydrocracking and hydrotreating units, accelerated after 1980 as heavier, higher-sulfur crude oils became available to U.S. refiners. More projects are underway to increase desulfurization capacity to remove sulfur from products and to comply with the 1990 CAA Amendment's on-highway diesel fuel regulations.⁹⁶

Small refineries lacking the desulfurization equipment for removing sulfur may choose to produce only distillate fuel oil for non-highway use, or they may modify current refinery processes.⁹⁷

- Highway diesel fuel and home heating oil are currently compatible products. However, by October 1, 1993, transportation and storage systems will need to have separate facilities for heating oil and on-highway diesel fuel. Distillate fuel oil and diesel fuel that are not for highway use will be marked with a dye to prevent the illegal sale of the higher sulfur distillate fuel oil for highway use.

- To comply with requirements of the reformulated gasoline program, components of gasoline will need to be upgraded to reduce the aromatic and VOC emissions from light-duty vehicles.⁹⁸ The use and/or severity of catalytic reforming, a process used to convert naphthas into primarily aromatic compounds, could be reduced by the requirement to significantly limit total aromatics and, in particular, benzene. Benzene was found to be a toxic carcinogen. Hydrotreating units will become even more essential to meet the lower sulfur specifications. The reduction in reforming, a hydrogen producer, and the increase in hydrotreating, which uses hydrogen, adversely affects the refinery hydrogen balance.

Results:

- About 31 percent of total gasoline sales were affected during the 1992-1993 winter oxygenated gasoline season. The national average price spread between gasoline for nonattainment areas and that for attainment areas grew to approximately 5 cents per gallon between early October 1992 and early January 1993.⁹⁹
- Prior to the startup of the oxygenated gasoline program, updated information on CO pollution indicated that 13 of the 39 designated CO nonattainment areas had reduced emissions to acceptable levels in 1990 and 1991.¹⁰⁰ Before these areas can leave the program, each must develop a maintenance plan covering a 10-year period. The plan would include computer modeling of air pollution patterns, taking into account factors such as urban growth.
- Highway diesel fuel has comprised a growing portion of distillate fuel oil demand since 1970, when it accounted for 16 percent; in 1991, its portion was 46 percent.¹⁰¹ The EPA estimates that the low-sulfur highway diesel fuel will reduce the amount of cancer-causing exhaust particulates by about 90 percent.
- The 9 U.S. metropolitan areas that will be directly affected by the implementation of the reformulated gasoline program represent about 22 percent of the U.S. gasoline market.¹⁰²

⁹⁴ National Petroleum Council, *Petroleum Refining in the 1990's, Meeting the Challenges of the Clean Air Act*, June 1991, p. 30.

⁹⁵ Energy Information Administration, "Update on Oxygenated Gasoline Markets," *Short Term Energy Outlook*, First Quarter 1993, p. 11.

⁹⁶ Energy Information Administration, "Refineries Upgrade in Response to Clean Air Act," *Petroleum Supply Monthly*, May 1992, pp. xix and xx.

⁹⁷ Energy Information Administration, "Effects of the Clean Air Act's Highway Diesel Fuel Oil Provisions," *Petroleum Supply Monthly*, June 1991, p. xiii.

⁹⁸ National Petroleum Council, *Petroleum Refining in the 1990s, Meeting the Challenges of the Clean Air Act*, June 1991, pp. 12 and 13.

⁹⁹ Energy Information Administration, *Short Term Energy Outlook*, Second Quarter 1992, p. 12, and First Quarter 1993, p. 11.

¹⁰⁰ "No Quick Exit Seen From Oxygenated Fuels Program, Officials Say," *The Oil Daily*, November 13, 1992, p. 2.

¹⁰¹ Energy Information Administration, *Fuel Oil and Kerosene Sales 1991*, Table 13, and predecessor reports.

¹⁰² American Petroleum Institute, *Meeting the Oxygenate Requirements of the 1990 Clean Air Act Amendments*, June 1991, p. 35.

Persian Gulf Crisis of 1990-1991

Description:

- Iraq invaded Kuwait on August 2, 1990, causing crude oil and product prices to rise suddenly and sharply for the third time in 17 years. After the United Nations approved an embargo on all crude oil and products originating from either country, fears of shortfalls similar to the magnitude of those in 1979 caused the rapid price escalation. Between the end of July and August 24, 1990, the world price of crude oil climbed from about \$16 per barrel to more than \$28 per barrel. The price escalated further in September, reaching about \$36 per barrel.¹⁰³
- When the United Nations approved the use of force against Iraq in October 1990, prices began falling. This was after only 2 months of price escalation, even though the crisis led to a 2-month war that lasted from January to March 1991. The cutoff of about 4.3 million barrels per day of Iraqi and Kuwaiti petroleum tested modern petroleum markets. Since 1979, these markets had become more global and had controls in place that were intended to keep the logistics of world supply and demand more balanced.¹⁰⁴

Industry Action/Reaction:

- Non-OPEC countries in Central America, Western Europe, the Far East, and even the United States, supplemented OPEC production increases to offset the 7-percent shortfall in world supplies.¹⁰⁵
- Refinery upgrades had been made during the 1980's to convert heavy, sour crude oils into light petroleum products in non-OPEC countries in Central and South America, Western Europe, Africa, and the Far East. These areas were well-positioned to shift petroleum supply patterns to accommodate those countries that had relied on Iraq and Kuwait for crude oil¹⁰⁶ or refined products. Excess operable refining capacity in many of these areas was sufficient to supply additional petroleum products.
- Permanent energy efficiency improvements had been made to U.S. automobiles, housing, and industrial machinery since the Iranian Revolution. The development of multifuel boilers had enhanced industrial and electric utility plants' ability to switch from petroleum when its price relative to natural gas became too high.

- The strong need felt during the 1970's to build up stocks in anticipation of market tightness or uncertainty had been reduced. This resulted from the realization that SPR oil could be available if supply shortages occurred, and from the utilization of the futures market to hedge against large swings in price. Participants in the futures market in the 90 days following the invasion were mostly refiners, airlines, and chemical companies who used oil and wanted to guarantee prices for their customers. There was no apparent increase in speculative activity, and the futures market did not contribute to the run-up in prices or to price volatility.¹⁰⁷ The rise in crude oil and petroleum product prices occurred because of uncertainties regarding the spread of the invasion and replacement of supplies. After peaking in mid-October, domestic and worldwide prices dropped substantially by the end of 1990.¹⁰⁸
- European supplies were tight after Kuwait's petroleum product exports to Europe and the Far East ceased. The United States began exporting motor gasoline to countries in Western Europe that had previously been sources of imports. Exports of distillate fuel oil and kerosene-type jet fuel to Canada and the Far East escalated, also. Product exports from Kuwait had not returned to pre-crisis levels by the end of 1992.¹⁰⁹

Results:

- The International Energy Agency planned the release of 2 million barrels per day from government-held stocks for 30 days. As part of this plan, the United States offered to release 1.1 million barrels per day, Japan pledged 350,000 barrels per day, and European countries 250,000.¹¹⁰
- The success of the Allied air strike on January 16, 1991, caused a record 1-day drop in oil prices¹¹¹ as fears of a cutoff in Middle East crude oil production were allayed. As a result, only about one-third of the pledged strategic stocks were sold, and the sales were spread over 2 months. The United States sold 17.3 million of the 33.8 million barrels originally offered.¹¹²
- Saudi Arabia and Iran also released stocks as a means of gaining revenue during the war. The releases served to calm oil markets.

¹⁰³Energy Information Administration, *Weekly Petroleum Status Report*, March 1, 1991, Figure 9.

¹⁰⁴Energy Information Administration, "Iraq Invasion of Kuwait Felt in U.S. Petroleum Market," *Petroleum Supply Monthly*, June 1990, p. xxi.

¹⁰⁵Energy Information Administration, *International Energy Annual*, 1991, Table 1.

¹⁰⁶Energy Information Administration, *Monthly Energy Review*, December 1992, Table 10.1b.

¹⁰⁷Energy Information Administration, *Petroleum Prices and Profits In the 90 Days Following the Invasion of Kuwait*, November 1990, pp. vii and 3-11.

¹⁰⁸Reuters's News Service, daily issues for the period.

¹⁰⁹Energy Information Administration, *International Petroleum Statistics Report*, June 1993, Table 4.16.

¹¹⁰"Release Of Strategic Stocks Comes From All Sides," *Global Stocks and Balances*, February 1991, p. 12.

¹¹¹Reuters's News Service, daily issues for January, 1991.

¹¹²Energy Information Administration, "Energy Department Accepts Bids for SPR Crude Oil," *Petroleum Supply Monthly*, February 1991, p. xxxii.

Oil Pollution Liability and Compensation Act of 1990

Description:

- The *Exxon Valdez* grounding in Prince William Sound in March 1989, followed by several smaller oil spills from tankers near U.S. shores, focused attention on oil spill prevention, tanker safety, and protection of U.S. coastal areas. Prior legislation on oil pollution liability was enacted in 1972, when petroleum imports were restricted and U.S. waters were less crowded. The Oil Pollution Liability and Compensation Act of 1990 increased liability from \$150 to \$1,200 per gross ton, with a minimum liability of \$10 million for vessels larger than 3,000 gross tons, and a minimum liability of \$2 million for smaller vessels.¹¹³ Before passage of the 1990 Act, liability was capped at \$14 million.

The Act allows unlimited liability against tanker owners where gross negligence or willful misconduct is involved, and does not preclude states from imposing their own unlimited liability requirements. Most of the 24 coastal states have no limit on damage liability. Offshore and onshore facilities and ports are also liable for huge damages.

In addition to the liability provisions, the Act requires that, over a 15-year phase-in period, double hulls be used for all new tankers and for vessels trading with the United States.

Industry Action/Reaction:

- Several oil companies and independent tanker owners stopped delivering oil to U.S. ports other than the Louisiana Offshore Oil Port (LOOP). Prior to enactment of the law, ships owned by these companies delivered less than 10 percent of U.S. petroleum imports, and at least 33 percent of these imports were delivered to the LOOP.¹¹⁴
- Many U.S. oil companies are increasing their double-hulled foreign-flag tanker fleets. Double-hulled barges for inland marine use have replaced some single-hulled barges since 1990, also.¹¹⁵ Most of these are unmanned, unpowered barges requiring no documentation as to foreign or domestic registry. Worldwide, about 5 percent of the operating tankers have double hulls.¹¹⁶

¹¹³ U.S. Department of Energy, Office of Domestic and International Energy Policy, *Transporting U.S. Oil Imports: The Impact of Oil Spill Legislation on the Tanker Market*, June 1992, pp. 25-27.

¹¹⁴ Energy Information Administration, "President Bush Signs Oil Spill Bill," *Petroleum Supply Monthly*, July 1990, p. xxxiv.

¹¹⁵ Energy Information Administration, "Tanker Industry Responds to Oil Pollution Act of 1990," *Petroleum Supply Monthly*, May 1992, p. xix.

¹¹⁶ "The Trouble With Tankers," *Los Angeles Times*, January 12, 1993, p. A1.

Since 1981, bouys, hoses, and pipeline have been used to transport crude oil from the ultra large tankers at the Louisiana Offshore Oil Port in the Gulf of Mexico. This system has reduced the need to transfer crude oil to smaller ships.

- Financial risks of providing insurance coverage were increased by the expanded scope of potential claimants for pollution clean-up costs provided by the Act. International protection and indemnity clubs were particularly vulnerable, as about 75 percent of the petroleum imported into the United States is transported in tankers they insure.¹¹⁷

Results:

- Fears of unlimited U.S. liabilities caused some major international oil companies to charter high-quality ships and to do their own tanker safety inspections.

- In 1992, the proliferation of large oil spills overseas, many from substandard ships, prompted the European Community to speed up work to tighten maritime safety controls, including increased use of escorts through narrow passages.¹¹⁸
- The International Maritime Organization, charged with creating common international regulations, will require double hulls on all new ships built after June 1993.¹¹⁹

Dissolution of the Soviet Union in 1991

Description:

- As 1991 ended, the Soviet Union, one of the three largest crude oil producers in the world, collapsed and dissolved into several nations, including among others, Russia, the Ukraine, Azerbaijan, and Kazakhstan. Concern focused on the availability of supplies of crude oil and refined products previously provided to the international market by the former Soviet Union. Exports from the former Communist entity included large amounts of crude oil and refined products to countries in Latin America and Western Europe, and crude oil to the Far East.¹²⁰

Industry Action/Reaction:

- The legal and economic complexities of moving from the controlled economy of a single sovereign socialist state to free market economies of multiple democratic nations has caused Western and Japanese oil companies to proceed with caution in establishing joint ventures with the governments of these new nations. Although the economic incentives appear to be great and business ventures abound, progress

in forging actual agreements and initiating operations has been slow. Recently, however, several joint production development projects involving American companies have been agreed upon. One includes Chevron Corporation and the Tengiz oil field in Kazakhstan,¹²¹ and another involves the Amoco Corporation and the Azeri oil field in the Caspian Sea.¹²²

Results:

- In the world market, the decline in petroleum supplies from the former Soviet Union has been offset by exports from other countries, including the United States.¹²³
- The Russian Government is struggling to develop its legal framework for foreign investment and encourage greater independence for oil producers.¹²⁴
- The U.S. Export-Import Bank and the World Bank have agreed to make large investments for the rehabilitation of Russian oil fields.

Energy Policy Act of 1992

Description:

- The provisions of the Energy Policy Act of 1992 are aimed at restructuring energy markets in the United States. Energy efficiency programs, the use of alternative fuels and renewable energy, research and development programs, and

various tax credits and exemptions are mandated in the Act.¹²⁵ Programs that will have the greatest impact on petroleum include the following:

- **Alternative Minimum Tax Exemption.** As of January 1993, independent oil and gas producers can take greater

¹¹⁷Energy Information Administration, "Tanker Industry Responds to Oil Pollution Act of 1990," *Petroleum Supply Monthly*, May 1992, p. xviii.

¹¹⁸"The Trouble With Tankers," *Los Angeles Times*, January 12, 1993, p. A1.

¹¹⁹"Oil Spill in the Shetlands," *Financial Times*, January 7, 1993, p. 11.

¹²⁰"Russia's Oil Industry Undergoes Restructuring," *Petroleum Supply Monthly*, February 1992, pp. xxx-xxxiii.

¹²¹"Russia Grappling With Economic And Political Challenges," *Oil and Gas Journal*, August 2, 1993, pp. 58-62.

¹²²"Conoco Among U.S. Leader in Advancing Russian Oil Projects," *The Oil Daily*, January 23, 1992, p. 2.

¹²³Energy Information Administration, *International Petroleum Statistics Report*, June 1993, Table 2.1.

¹²⁴"Russia Grappling With Economic And Political Changes," *Oil and Gas Journal*, August 2, 1993, p. 61.

¹²⁵A comprehensive discussion of the Energy Policy Act's impact on future energy markets is included in the EIA report, *Annual Energy Outlook 1993*.

Petroleum product deliveries by tanker, such as this arrival at Boston Harbor, will continue to be an important means of satisfying domestic demand, at least for the remainder of the century.

deductions against the alternative minimum tax for percentage depletion and intangible drilling costs. This encourages domestic exploration, and could increase U.S. oil production slightly.

- **Alternative Transportation Fuels.** The mandate to phase in alternative fuels in government and private automobile and truck fleets will eventually cut into petroleum use for transportation. The Act sets a national goal of 30 percent penetration of non-petroleum fuels in the light-duty vehicle market by 2010.¹²⁶ Natural gas, electricity, methanol, ethanol, and coal-derived liquid fuels are among those set to replace petroleum in vehicle fleets. The fleets of four or more automobiles alone in 1991 comprised 9 percent of the automobiles in operation.¹²⁷ Additional displacement by truck fleets will further impact petroleum use.
- **Energy Efficiency Standards.** The Act requires the Secretary of Energy to set efficiency standards for all new Federal buildings and new buildings with federally backed mortgages. Efficiency standards for commercial and industrial equipment are required also. The primary effect of these standards on petroleum will be a reduction in consumption of petroleum heating fuels.
- **Research and Development.** Programs to reduce consumption of imported oil include the development of

oil shale and advanced oil-recovery techniques as methods of increasing domestic oil production. Research into high-efficiency heat engines and high temperature superconducting electric power systems are intended to lower dependence on oil imports by reducing petroleum product consumption. Research into the development of renewable energy technologies for the production of electricity could also reduce petroleum consumption.

Industry Action/Reaction:

- While the number of exploratory oil wells drilled for November 1992 through February 1993 was up 7 percent from the same period a year earlier, it is too soon to know whether domestic oil exploration will increase substantially as a result of the Energy Policy Act.

Results:

- All sectors of the economy will, in time, see shifts in the type of energy used and the amount needed. The provisions of the Act that will have the most impact on petroleum will take many years to develop. Petroleum imports will continue to be an important part of the Nation's supply for the remainder of the century, as domestic crude oil production will likely decline more rapidly than substitutes for petroleum products can be developed and used.

¹²⁶Congressional Research Service, *Alternative Transportation Fuels: Are They Reducing Oil Imports?*, January 15, 1993, p. CRS-4.

¹²⁷U.S. Department of Energy, Office of Transportation Technologies, *Transportation Energy Data Book*, Edition 13, September 1992, Tables 3.11 and 3.34.

Appendix Supplemental Data

Table A1. U.S. and Foreign Operable Crude Oil Distillation Capacity, Refinery Crude Oil Inputs, and Petroleum Demand, 1970 - 1992
(Million Barrels per Day)

Year	Operable Capacity ¹			Crude Oil Inputs			Demand		
	United States	Foreign	Total World	United States	Foreign	Total World	United States	Foreign	Total World
1970	12.86	39.05	51.91	10.87	34.65	45.52	14.70	32.11	46.81
1971	13.29	41.84	55.13	11.20	36.89	48.09	15.21	34.21	49.42
1972	13.64	44.56	58.20	11.70	38.77	50.47	16.37	36.72	53.09
1973	14.36	48.79	63.15	12.43	42.50	54.93	17.31	39.93	57.24
1974	14.96	51.56	66.52	12.13	42.29	54.42	16.65	40.03	56.68
1975	15.24	54.69	69.93	12.44	40.46	52.90	16.32	39.88	56.20
1976	16.40	58.72	75.12	13.42	43.27	56.69	17.46	42.21	59.67
1977	17.05	60.41	77.46	14.60	43.23	57.83	18.43	43.40	61.83
1978	17.44	61.14	78.58	14.74	45.24	59.98	18.85	45.31	64.16
1979	17.99	61.86	79.85	14.65	46.96	61.61	18.51	46.75	65.26
1980	18.62	62.94	81.56	13.48	45.83	59.31	17.06	46.01	63.07
1981	17.89	62.74	80.63	12.48	44.20	56.68	16.06	44.81	60.87
1982	16.86	60.35	77.21	11.77	42.52	54.29	15.30	44.17	59.47
1983	16.14	59.28	75.42	11.69	42.31	54.00	15.23	43.46	58.69
1984	15.66	59.46	75.12	12.04	42.91	54.95	15.73	44.05	59.78
1985	15.46	57.10	72.56	12.17	42.78	54.95	15.73	44.37	60.10
1986	15.57	57.00	72.57	12.72	44.02	56.74	16.28	45.23	61.51
1987	15.92	57.65	73.57	12.85	44.12	56.97	16.67	46.10	62.77
1988	15.65	57.69	73.34	13.28	45.04	58.32	17.28	47.22	64.50
1989	15.57	58.29	73.86	13.40	45.94	59.34	17.33	47.70	65.03
1990	15.68	59.08	74.76	13.41	47.79	61.20	16.99	49.17	66.16
1991	15.70	59.65	75.34	13.30	47.23	60.53	16.71	49.89	66.60
1992	15.12	NA	NA	13.41	NA	NA	17.03	49.53	66.56

NA = Not Available.

Note: Operable refining capacity data are per calendar day as of January 1 of the following year.

¹ Totals may not equal sum of components due to independent rounding.

Sources: • Energy Information Administration, *Annual Energy Review 1991 and 1992*, Tables 11.9 and 11.10, *Petroleum Supply Annual*, Vol. 1, 1992, Tables S2 and 36, and *International Energy Annual 1992*, Table 21. • American Petroleum Institute, *Basic Petroleum Data Book*, September 1992, Section VIII, Table 2 revised.

Table A2. U.S. Refinery Yields of Major Petroleum Products, 1970 - 1992
(Percent)

Year	Motor Gasoline			Distillate Fuel Oil	Kerosene-Type Jet Fuel	Residual Fuel Oil	Other
	Leaded	Unleaded	Total				
1970	44.9	0	44.9	22.4	5.4	6.4	20.9
1971	45.8	0	45.8	22.0	5.3	6.6	20.3
1972	45.9	0	45.9	22.2	5.4	6.8	19.7
1973	45.3	0	45.3	22.5	5.4	7.7	19.1
1974	--	--	45.6	21.8	5.2	8.7	18.7
1975	--	--	46.2	21.3	5.6	9.9	17.0
1976	--	--	45.3	21.8	5.4	10.3	17.2
1977	--	--	43.2	22.4	5.4	12.0	17.0
1978	--	--	43.9	21.4	5.4	11.3	18.0
1979	--	--	42.8	21.5	5.7	11.5	18.5
1980	23.5	21.0	44.5	19.7	6.0	11.7	18.1
1981	22.3	22.2	44.5	20.5	6.1	10.4	18.5
1982	21.8	24.3	46.1	21.5	6.4	8.8	17.2
1983	21.2	26.2	47.4	20.5	6.8	7.1	18.2
1984	18.5	28.0	46.5	21.5	7.4	7.1	17.5
1985	16.2	29.4	45.6	21.6	7.9	7.1	17.8
1986	14.2	31.5	45.7	21.2	8.3	6.7	18.1
1987	11.3	35.1	46.4	20.5	8.5	6.6	18.0
1988	8.6	37.4	46.0	20.8	8.5	6.7	18.0
1989	5.0	40.7	45.7	20.8	8.6	6.9	18.0
1990	2.4	43.2	45.6	20.9	9.4	6.8	17.3
1991	1.6	44.1	45.7	21.3	9.1	6.7	17.2
1992	1.4	44.6	46.0	21.2	8.9	6.4	17.5

-- = Not available.

Note: Yields are based on crude oil input and net reruns of unfinished oils.

Sources: Energy Information Administration, *The U.S. Petroleum Refining Industry in the 1980's*, Table C5, and *Petroleum Supply Annual*, Vol. 1, 1990-1992, Tables 17 and 19, and predecessor reports.

Table A3. U.S. Inter-Regional Movements of Crude Oil and Petroleum Products, 1970 - 1992
(Thousand Barrels per Day)

PAD Districts	Year	Pipeline			Tanker and Barge			Total Inter-Regional Movements		
		Crude Oil	Products	Total	Crude Oil	Products	Total	Crude Oil	Products	Total
I to II	1970	NA	120	NA	0	NA	NA	NA	NA	NA
	1975	NA	176	NA	0	NA	NA	NA	NA	NA
	1980	NA	196	NA	3	73	76	NA	269	NA
	1981	NA	196	NA	1	65	66	NA	261	NA
	1982	NA	191	NA	0	70	70	NA	261	NA
	1983	NA	184	NA	1	73	74	NA	258	NA
	1984	NA	199	NA	0	89	89	NA	288	NA
	1985	0	200	200	0	84	84	0	284	284
	1986	0	218	218	0	2	2	0	220	221
	1987	0	222	222	1	3	5	1	225	227
	1988	0	231	231	0	4	4	0	235	235
	1989	0	235	235	0	5	5	0	240	240
	1990	1	233	234	0	4	4	1	237	238
	1991	3	233	236	1	3	4	4	236	240
	1992	2	243	245	(s)	4	4	2	247	249
I to III	1970	NA	0	NA	0	NA	NA	NA	NA	NA
	1975	NA	0	NA	0	NA	NA	NA	NA	NA
	1980	NA	0	NA	8	24	32	NA	24	NA
	1981	NA	0	NA	1	22	24	NA	22	NA
	1982	NA	0	NA	0	19	19	NA	19	NA
	1983	NA	0	NA	0	10	10	NA	10	NA
	1984	NA	0	NA	2	8	10	NA	8	NA
	1985	0	0	0	0	4	4	0	4	4
	1986	0	0	0	0	6	6	0	6	6
	1987	0	0	0	0	5	5	0	5	5
	1988	0	0	0	0	8	8	0	8	8
	1989	0	0	0	0	8	8	0	8	8
	1990	0	0	0	0	8	8	0	8	8
	1991	0	0	0	0	4	4	0	4	4
	1992	0	0	0	0	3	3	0	3	3
II to I	1970	NA	56	NA	0	31	31	NA	87	NA
	1975	NA	86	NA	0	51	51	NA	137	NA
	1980	NA	67	NA	3	14	17	NA	81	NA
	1981	NA	70	NA	2	15	18	NA	85	NA
	1982	NA	74	NA	1	18	19	NA	92	NA
	1983	NA	82	NA	3	20	22	NA	102	NA
	1984	NA	82	NA	1	19	20	NA	101	NA
	1985	2	89	91	3	15	18	5	104	109
	1986	2	81	83	3	63	66	5	144	149
	1987	1	81	82	3	61	64	4	142	146
	1988	0	73	73	4	57	61	4	130	135
	1989	1	67	68	4	49	53	5	116	121
	1990	(s)	70	70	3	60	63	3	130	133
	1991	(s)	71	71	3	53	56	3	124	127
	1992	(s)	74	74	4	51	55	4	125	129
II to III	1970	NA	72	NA	0	NA	NA	NA	NA	NA
	1975	NA	79	NA	0	NA	NA	NA	NA	NA
	1980	NA	135	NA	0	45	45	NA	180	NA
	1981	NA	150	NA	0	39	39	NA	189	NA
	1982	NA	151	NA	0	30	30	NA	181	NA
	1983	NA	180	NA	1	11	12	NA	191	NA
	1984	NA	181	NA	0	7	7	NA	188	NA
	1985	70	151	221	0	23	23	70	174	244
	1986	68	147	215	0	9	9	68	156	224
	1987	75	185	260	0	11	11	75	196	271
	1988	81	163	243	0	12	12	81	175	256
	1989	82	164	245	0	15	15	82	179	260
	1990	67	164	231	(s)	19	19	67	183	250
	1991	59	165	224	0	24	24	59	189	248
	1992	57	161	218	0	21	21	57	183	240

See footnotes at end of table.

Table A3. U.S. Inter-Regional Movements of Crude Oil and Petroleum Products, 1970 - 1992 (Continued)
(Thousand Barrels per Day)

PAD Districts	Year	Pipeline			Tanker and Barge			Total Inter-Regional Movements		
		Crude Oil	Products	Total	Crude Oil	Products	Total	Crude Oil	Products	Total
II to IV.....	1970	NA	0	NA	0	0	0	NA	0	NA
	1975	NA	13	NA	0	0	0	NA	13	NA
	1980	NA	78	NA	0	0	0	NA	78	NA
	1981	NA	82	NA	0	0	0	NA	82	NA
	1982	NA	78	NA	0	0	0	NA	78	NA
	1983	NA	72	NA	0	0	0	NA	72	NA
	1984	NA	74	NA	0	0	0	NA	74	NA
	1985	23	73	96	0	0	0	23	73	96
	1986	22	79	102	0	0	0	22	79	102
	1987	20	70	90	0	0	0	20	70	90
	1988	23	59	82	0	0	0	23	59	82
	1989	18	64	82	0	0	0	18	64	82
	1990	18	57	75	0	0	0	18	57	75
	1991	16	80	96	0	0	0	16	80	96
	1992	8	94	102	0	0	0	8	94	102
III to I.....	1970	NA	1,442	NA	646	1,328	1,974	NA	2,770	NA
	1975	NA	1,637	NA	65	1,266	1,331	NA	2,903	NA
	1980	NA	2,027	NA	20	987	1,007	NA	3,014	NA
	1981	NA	2,013	NA	15	846	861	NA	2,859	NA
	1982	NA	1,989	NA	13	786	799	NA	2,774	NA
	1983	NA	1,908	NA	12	733	745	NA	2,641	NA
	1984	NA	1,942	NA	10	667	677	NA	2,609	NA
	1985	0	1,941	1,941	10	611	621	10	2,552	2,562
	1986	0	2,074	2,074	10	580	590	10	2,654	2,664
	1987	0	2,070	2,070	10	509	519	10	2,579	2,589
	1988	0	2,083	2,083	15	514	530	15	2,597	2,612
	1989	0	2,093	2,093	13	537	550	13	2,631	2,644
	1990	0	2,102	2,102	15	532	547	15	2,634	2,649
	1991	0	2,075	2,075	1	474	475	1	2,549	2,550
	1992	0	2,127	2,127	0	517	517	0	2,645	2,645
III to II.....	1970	NA	322	NA	49	213	262	NA	535	NA
	1975	NA	461	NA	36	167	203	NA	628	NA
	1980	NA	500	NA	36	115	151	NA	615	NA
	1981	NA	572	NA	34	97	131	NA	670	NA
	1982	NA	654	NA	42	87	130	NA	742	NA
	1983	NA	697	NA	47	91	139	NA	788	NA
	1984	NA	812	NA	37	84	121	NA	896	NA
	1985	1,220	756	1,976	0	86	86	1,220	842	2,062
	1986	1,338	835	2,173	0	117	117	1,338	953	2,291
	1987	1,418	734	2,152	0	137	137	1,418	871	2,290
	1988	1,495	735	2,230	0	136	136	1,495	872	2,367
	1989	1,659	751	2,410	0	137	137	1,659	888	2,547
	1990	1,782	693	2,475	(s)	126	126	1,782	819	2,601
	1991	1,722	594	2,316	0	108	108	1,722	702	2,424
	1992	1,736	650	2,386	0	107	107	1,736	758	2,494
III to IV.....	1970	NA	27	NA	0	0	0	NA	27	NA
	1975	NA	27	NA	0	0	0	NA	27	NA
	1980	NA	0	NA	0	0	0	NA	0	NA
	1981	NA	0	NA	0	0	0	NA	0	NA
	1982	NA	0	NA	0	0	0	NA	0	NA
	1983	NA	0	NA	0	0	0	NA	0	NA
	1984	NA	0	NA	0	0	0	NA	0	NA
	1985	0	0	0	0	0	0	0	0	0
	1986	0	0	0	0	0	0	0	0	0
	1987	0	0	0	0	0	0	0	0	0
	1988	0	0	0	0	0	0	0	0	0
	1989	0	0	0	0	0	0	0	0	0
	1990	0	(s)	0	0	0	0	0	0	0
	1991	0	(s)	0	0	0	0	0	0	0
	1992	0	0	0	0	0	0	0	0	0

See footnotes at end of table.

Table A3. U.S. Inter-Regional Movements of Crude Oil and Petroleum Products, 1970 - 1992 (Continued)
(Thousand Barrels per Day)

PAD Districts	Year	Pipeline			Tanker and Barge			Total Inter-Regional Movements		
		Crude Oil	Products	Total	Crude Oil	Products	Total	Crude Oil	Products	Total
III to V	1970	NA	51	NA	0	9	9	NA	60	NA
	1975	NA	50	NA	0	22	22	NA	72	NA
	1980	NA	46	NA	0	16	16	NA	62	NA
	1981	NA	39	NA	0	26	26	NA	65	NA
	1982	NA	51	NA	0	29	29	NA	80	NA
	1983	NA	54	NA	0	12	12	NA	65	NA
	1984	NA	55	NA	0	10	10	NA	66	NA
	1985	0	51	51	0	4	4	0	55	55
	1986	0	52	52	0	7	7	0	58	58
	1987	0	56	56	0	4	4	0	60	60
	1988	0	58	58	0	6	6	0	63	63
	1989	0	54	54	0	9	9	0	63	63
	1990	0	53	53	0	6	6	0	59	59
	1991	0	58	58	0	3	3	0	61	61
	1992	0	70	70	0	6	6	0	76	76
IV to II	1970	NA	21	NA	0	0	0	NA	21	NA
	1975	NA	25	NA	0	0	0	NA	25	NA
	1980	NA	39	NA	0	0	0	NA	39	NA
	1981	NA	37	NA	0	0	0	NA	37	NA
	1982	NA	36	NA	0	0	0	NA	36	NA
	1983	NA	50	NA	0	0	0	NA	50	NA
	1984	NA	56	NA	0	0	0	NA	56	NA
	1985	263	54	317	0	0	0	263	54	317
	1986	232	49	281	0	0	0	232	49	281
	1987	198	47	245	0	0	0	198	47	245
	1988	175	43	218	0	0	0	175	43	218
	1989	129	48	177	0	0	0	129	48	177
	1990	106	47	153	0	0	0	106	47	153
	1991	98	53	151	0	0	0	98	53	151
	1992	99	51	150	0	0	0	99	51	150
IV to III	1970	NA	0	NA	0	0	0	NA	0	NA
	1975	NA	9	NA	0	0	0	NA	9	NA
	1980	NA	0	NA	0	0	0	NA	0	NA
	1981	NA	0	NA	0	0	0	NA	0	NA
	1982	NA	1	NA	0	0	0	NA	1	NA
	1983	NA	15	NA	0	0	0	NA	15	NA
	1984	NA	26	NA	0	0	0	NA	26	NA
	1985	108	31	139	0	0	0	108	31	139
	1986	73	30	102	0	0	0	73	30	102
	1987	59	33	92	0	0	0	59	33	92
	1988	79	47	126	0	0	0	79	47	126
	1989	54	42	96	0	0	0	54	42	96
	1990	49	42	91	0	0	0	49	42	91
	1991	46	46	92	0	0	0	46	46	92
	1992	43	48	91	0	0	0	43	48	91
IV to V	1970	NA	50	NA	0	0	0	NA	50	NA
	1975	NA	44	NA	0	0	0	NA	44	NA
	1980	NA	30	NA	0	0	0	NA	30	NA
	1981	NA	29	NA	0	0	0	NA	29	NA
	1982	NA	36	NA	0	0	0	NA	36	NA
	1983	NA	36	NA	0	0	0	NA	36	NA
	1984	NA	37	NA	0	0	0	NA	37	NA
	1985	0	38	38	0	0	0	0	38	38
	1986	0	40	40	0	0	0	0	40	40
	1987	0	41	41	0	0	0	0	41	41
	1988	0	47	47	0	0	0	0	47	47
	1989	0	43	43	0	0	0	0	43	43
	1990	0	45	45	0	0	0	0	45	45
	1991	0	48	48	0	0	0	0	48	48
	1992	0	41	41	0	0	0	0	41	41

See footnotes at end of table.

Table A3. U.S. Inter-Regional Movements of Crude Oil and Petroleum Products, 1970 - 1992 (Continued)
(Thousand Barrels per Day)

PAD Districts	Year	Pipeline			Tanker and Barge			Total Inter-Regional Movements		
		Crude Oil	Products	Total	Crude Oil	Products	Total	Crude Oil	Products	Total
V to I	1970	NA	0	NA	1	5	6	NA	5	NA
	1975	NA	0	NA	0	1	1	NA	1	NA
	1980	NA	0	NA	64	6	70	NA	6	NA
	1981	NA	0	NA	78	13	91	NA	13	NA
	1982	NA	0	NA	83	5	88	NA	5	NA
	1983	NA	0	NA	133	2	135	NA	2	NA
	1984	NA	0	NA	100	1	102	NA	1	NA
	1985	0	0	0	96	1	97	96	1	97
	1986	0	0	0	79	0	79	79	0	79
	1987	0	0	0	46	0	46	46	0	46
	1988	0	0	0	41	0	41	41	0	41
	1989	0	0	0	10	0	10	10	0	10
	1990	0	0	0	2	0	2	2	0	2
	1991	0	0	0	0	0	0	0	0	0
	1992	0	0	0	0	3	3	0	3	3
V to III	1970	NA	0	NA	0	0	0	NA	0	NA
	1975	NA	0	NA	0	3	3	NA	3	NA
	1980	NA	0	NA	209	8	217	NA	8	NA
	1981	NA	0	NA	312	6	318	NA	6	NA
	1982	NA	0	NA	527	8	534	NA	8	NA
	1983	NA	0	NA	574	3	577	NA	3	NA
	1984	NA	0	NA	474	2	477	NA	2	NA
	1985	50	0	50	538	1	539	588	1	589
	1986	20	0	20	508	2	510	528	2	530
	1987	20	0	20	539	1	540	558	1	560
	1988	103	0	103	430	1	431	532	1	534
	1989	109	0	109	281	1	282	390	1	391
	1990	113	0	113	166	2	168	279	2	281
	1991	112	0	112	172	2	174	284	2	286
	1992	125	0	125	152	1	153	277	1	278
Total.....	1970	NA	2,161	NA	696	NA	NA	NA	2,161	NA
	1975	NA	2,607	NA	101	NA	NA	NA	2,607	NA
	1980	NA	3,118	NA	343	1,288	1,631	NA	4,406	NA
	1981	NA	3,189	NA	443	1,130	1,573	NA	4,319	NA
	1982	NA	3,261	NA	667	1,051	1,718	NA	4,312	NA
	1983	NA	3,278	NA	771	955	1,726	NA	4,233	NA
	1984	NA	3,464	NA	625	888	1,513	NA	4,353	NA
	1985	1,736	3,384	5,120	647	829	1,476	2,383	4,213	6,596
	1986	1,755	3,605	5,360	600	786	1,386	2,355	4,391	6,746
	1987	1,791	3,540	5,331	600	733	1,332	2,391	4,272	6,663
	1988	1,955	3,538	5,493	490	740	1,230	2,445	4,278	6,723
	1989	2,051	3,562	5,613	309	760	1,069	2,360	4,322	6,682
	1990	2,136	3,506	5,642	186	757	943	2,322	4,263	6,585
	1991	2,056	3,423	5,479	177	671	848	2,233	4,094	6,327
	1992	2,070	3,559	5,629	156	712	868	2,226	4,274	6,500

NA=Not Available.

Notes: • Totals may not add to sum of components due to independent rounding. • Pipeline movements of crude oil were not collected by the Energy Information Administration prior to 1985, and tanker and barge shipments from PAD District I and from PAD Districts II to III were not collected prior to 1980.

Sources: Energy Information Administration, *Petroleum Supply Annual*, Vol. 1, 1981-1982, Tables 23-25, 1983, Tables 19-21, 1984-1988, Tables 20-22, and 1989-1992, Tables 32-34, and predecessor reports.

Table A4. Selected Components of U.S. Regional Supply and Demand, 1970 - 1992
(Thousand Barrels Per Day Unless Otherwise Noted)

Year and PAD District	Crude Oil Production	Refinery Output	Receipts from Other Districts	Shipments to Other Districts	Imports		Exports		Demand	Stocks (Million Barrels)		
					Crude Oil	Products	Crude Oil	Products		Crude Oil		Products
										SPR ¹	Other	
PAD District I												
1970	31	1,503	3,546	120	579	1,867	0	21	5,884	0	19	224
1971	36	1,536	3,440	120	691	1,962	0	19	6,078	0	17	218
1972	66	1,526	3,280	150	969	2,164	0	21	6,459	0	14	189
1973	108	1,674	3,073	228	1,277	2,469	0	17	6,688	0	18	212
1974	119	1,576	2,988	246	1,174	2,114	0	17	6,232	0	17	209
1975	133	1,535	3,171	277	1,237	1,603	0	15	5,983	0	16	233
1976	139	1,710	3,389	312	1,415	1,718	1	14	6,488	0	15	220
1977	144	1,775	3,380	367	1,518	1,850	0	15	6,522	0	16	266
1978	147	1,820	3,371	373	1,487	1,708	0	13	6,506	0	18	255
1979	146	1,691	3,361	408	1,432	1,517	4	19	6,169	0	20	267
1980	133	1,556	3,309	419	1,342	1,250	5	24	5,619	0	21	254
1981	117	1,484	3,053	286	1,116	1,124	0	24	5,250	0	21	242
1982	93	1,379	2,968	280	958	1,036	0	24	4,942	0	18	226
1983	77	1,241	2,892	269	817	1,157	0	28	4,864	0	15	188
1984	63	1,307	2,822	299	944	1,345	0	23	4,871	0	17	211
1985	57	1,369	2,767	289	977	1,159	0	23	4,796	0	16	192
1986	47	1,483	2,892	227	1,081	1,373	0	25	5,183	0	16	211
1987	41	1,521	2,782	232	1,111	1,404	0	18	5,295	0	16	183
1988	38	1,594	2,788	244	1,175	1,560	0	22	5,447	0	16	172
1989	35	1,576	2,775	248	1,201	1,527	0	26	5,447	0	13	151
1990	30	1,546	2,784	246	1,209	1,359	0	56	5,113	0	15	183
1991	26	1,549	2,678	243	1,209	1,147	1	46	4,867	0	15	186
1992	27	1,588	2,776	252	1,222	1,087	0	38	4,979	0	14	181
PAD District II												
1970	1,169	3,384	2,405	183	317	54	1	11	4,009	0	79	199
1971	1,098	3,464	2,487	190	376	63	0	11	4,099	0	75	213
1972	1,050	3,612	2,571	163	468	109	0	10	4,462	0	67	192
1973	969	3,808	2,708	218	714	150	0	10	4,626	0	67	217
1974	916	3,652	2,617	252	687	140	0	10	4,479	0	80	225
1975	883	3,724	2,594	286	774	136	0	12	4,510	0	83	240
1976	896	3,949	2,617	376	1,000	132	6	9	4,831	0	83	211
1977	892	4,124	2,643	374	1,416	144	43	15	4,996	0	91	269
1978	874	4,125	2,639	353	1,354	128	75	14	5,207	0	77	242
1979	871	4,043	2,445	417	1,526	189	69	15	4,986	0	87	246
1980	926	3,596	2,234	483	1,119	188	83	16	4,485	0	87	243
1981	974	3,363	1,005	359	681	192	45	35	4,268	0	84	217
1982	1,020	3,157	1,081	352	580	187	36	36	4,115	0	78	189
1983	1,038	3,073	1,147	379	530	181	19	37	4,084	0	73	184
1984	1,076	3,088	1,295	363	499	177	16	30	4,227	0	77	191
1985	1,052	3,046	2,663	448	590	156	21	28	4,245	0	72	161
1986	956	3,174	2,793	475	784	108	16	35	4,150	0	83	169
1987	865	3,164	2,762	508	870	107	16	26	4,092	0	73	171
1988	825	3,247	2,821	472	948	125	10	33	4,259	0	72	166
1989	765	3,226	2,964	464	1,067	118	7	29	4,266	0	70	156
1990	742	3,346	2,992	459	1,123	102	11	29	4,233	0	68	163
1991	721	3,376	2,814	473	1,119	106	1	20	4,174	0	73	168
1992	679	3,425	2,893	469	623	107	3	21	4,352	0	69	155

See footnotes at end of table.

Table A4. Selected Components of U.S. Regional Supply and Demand, 1970 - 1992 (Continued)
(Thousand Barrels Per Day Unless Otherwise Noted)

Year and PAD District	Crude Oil Production	Refinery Output	Receipts from Other Districts	Shipments to Other Districts	Imports		Exports		Demand	Stocks (Million Barrels)		
					Crude Oil	Products	Crude Oil	Products		Crude Oil		Products
										SPR ¹	Other	
PAD District III												
1970	6,508	5,001	82	5,507	0	61	12	98	2,478	0	126	211
1971	6,485	5,156	88	5,534	56	54	1	103	2,578	0	111	240
1972	6,540	5,472	94	5,428	77	49	0	104	2,851	0	108	217
1973	6,336	5,750	178	5,295	399	154	1	103	3,200	0	109	226
1974	5,969	5,762	212	5,109	795	170	3	99	3,281	0	110	258
1975	5,600	5,867	213	5,231	1,198	55	6	97	3,129	0	113	268
1976	5,374	6,308	276	5,453	1,780	48	1	118	3,253	0	129	277
1977	5,122	6,980	346	5,430	2,541	51	0	97	3,755	7	150	306
1978	4,856	7,053	463	5,328	2,865	24	0	93	3,955	67	139	292
1979	4,556	6,944	547	5,117	2,969	79	0	110	4,183	91	160	282
1980	4,367	6,482	643	4,789	2,334	87	4	126	3,870	108	171	307
1981	4,217	6,354	530	3,642	2,269	161	0	167	3,586	230	161	308
1982	4,183	6,208	736	3,651	1,722	271	0	315	3,429	294	160	260
1983	4,182	6,118	794	3,554	1,734	266	0	281	3,458	379	163	251
1984	4,291	6,393	702	3,617	1,747	354	0	255	3,706	451	155	247
1985	4,238	6,405	975	4,679	1,419	409	0	275	3,701	493	147	247
1986	4,094	6,792	862	5,012	2,073	414	0	298	3,854	512	146	265
1987	3,827	6,777	928	4,939	2,431	388	0	284	4,130	541	157	256
1988	3,642	6,892	923	5,042	2,718	484	0	303	4,296	560	151	255
1989	3,418	7,053	755	5,253	3,236	479	0	336	4,357	580	162	244
1990	3,340	7,045	632	5,309	3,255	576	0	367	4,380	586	151	256
1991	3,419	6,998	632	5,035	3,196	515	0	480	4,445	569	155	258
1992	3,331	7,099	612	5,214	3,951	541	0	435	4,513	575	151	255
PAD District IV												
1970	675	412	45	436	48	9	0	0	373	0	14	16
1971	640	438	64	390	46	20	0	0	421	0	14	18
1972	635	444	53	410	39	46	0	0	436	0	14	17
1973	673	464	57	414	44	45	0	0	457	0	13	21
1974	689	474	61	433	45	39	0	0	469	0	16	21
1975	683	482	67	407	44	34	0	0	484	0	17	20
1976	657	492	58	375	54	32	0	0	531	0	17	21
1977	662	518	63	363	44	30	2	0	544	0	17	21
1978	647	522	58	352	50	24	4	0	548	0	16	17
1979	608	510	63	333	65	23	2	0	535	0	17	19
1980	576	474	85	298	39	23	1(	(s)	507	0	17	20
1981	596	434	82	67	29	22	0	0	544	0	14	21
1982	554	431	78	74	40	20	0	0	523	0	13	21
1983	565	431	72	101	38	21	0	0	507	0	14	18
1984	594	455	74	119	33	24	0	0	513	0	14	19
1985	628	458	96	494	39	25	0	0	519	0	12	17
1986	594	456	102	424	54	21	0	0	517	0	13	17
1987	561	460	90	379	65	19	0	1	513	0	13	17
1988	554	480	82	391	64	19	0	1	525	0	12	18
1989	514	485	82	316	72	13	0	0	531	0	12	18
1990	498	491	75	290	76	13	0	1	531	0	12	17
1991	480	491	96	292	86	17	1	1	550	0	12	18
1992	458	466	102	282	78	13	0(	(s)	549	0	11	17

See footnotes at end of table.

Table A4. Selected Components of U.S. Regional Supply and Demand, 1970 - 1992 (Continued)
(Thousand Barrels Per Day Unless Otherwise Noted)

Year and PAD District	Crude Oil Production	Refinery Output	Receipts from Other Districts	Shipments to Other Districts	Imports		Exports		Demand	Stocks (Million Barrels)		
					Crude Oil	Products	Crude Oil	Products		Crude Oil		Products
										SPR ¹	Other	
Pad District V												
1970	1,254	1,813	192	24	380	104	1	115	1,953	0	38	92
1971	1,204	1,904	192	37	512	146	0	89	2,037	0	43	95
1972	1,150	2,026	182	29	663	157	1	87	2,159	0	42	98
1973	1,122	2,159	167	28	810	194	1	99	2,337	0	35	90
1974	1,081	2,035	185	23	776	172	0	92	2,192	0	42	95
1975	1,076	2,078	180	24	852	124	0	80	2,216	0	43	101
1976	1,066	2,218	161	20	1,038	96	0	74	2,359	0	42	98
1977	1,424	2,476	135	68	1,096	118	5	66	2,614	0	66	102
1978	2,185	2,447	159	316	600	125	79	84	2,631	0	59	94
1979	2,371	2,575	131	321	528	129	159	91	2,638	0	56	96
1980	2,595	2,513	95	376	429	97	194	92	2,575	0	62	102
1981	2,667	2,353	94	411	302	101	183	140	2,410	0	84	102
1982	2,798	2,215	117	622	188	111	201	203	2,287	0	81	90
1983	2,825	2,275	111	714	210	97	146	229	2,317	0	80	90
1984	2,854	2,435	103	596	203	111	165	233	2,409	0	83	92
1985	2,995	2,472	94	685	177	116	184	251	2,465	0	74	89
1986	2,989	2,618	99	608	187	129	138	273	2,576	0	73	87
1987	3,055	2,704	101	606	197	86	134	284	2,635	0	90	91
1988	3,081	2,810	110	574	201	108	145	301	2,756	0	80	96
1989	2,881	2,835	106	401	267	80	134	326	2,724	0	83	91
1990	2,746	2,845	104	283	232	73	98	294	2,731	0	76	94
1991	2,770	2,842	109	287	171	61	113	338	2,679	0	69	94
1992	2,675	2,821	117	281	209	57	86	367	2,639	0	73	92
U.S. Total												
1970	9,637	12,113	0	0	1,324	2,095	14	245	14,697	0	276	741
1971	9,463	12,498	0	0	1,681	2,245	1	222	15,213	0	260	784
1972	9,441	13,080	0	0	2,216	2,525	1	222	16,367	0	246	713
1973	9,208	13,854	0	0	3,244	3,012	2	229	17,308	0	242	766
1974	8,774	13,498	0	0	3,477	2,635	3	218	16,653	0	265	809
1975	8,375	13,685	0	0	4,105	1,951	6	204	16,322	0	271	862
1976	8,132	14,677	0	0	5,287	2,026	8	215	17,461	0	285	826
1977	8,245	15,874	0	0	6,615	2,193	50	193	18,431	7	340	964
1978	8,707	15,966	0	0	6,356	2,008	158	204	18,847	67	309	901
1979	8,552	15,763	0	0	6,519	1,937	235	236	18,513	91	339	911
1980	8,597	14,622	0	0	5,263	1,646	287	258	17,056	108	358	926
1981	8,572	13,990	0	0	4,396	1,599	228	367	16,058	230	363	890
1982	8,649	13,391	0	0	3,488	1,625	236	579	15,296	294	350	786
1983	8,688	13,138	0	0	3,329	1,722	164	575	15,231	379	344	731
1984	8,879	13,679	0	0	3,426	2,011	181	541	15,726	451	345	760
1985	8,971	13,750	0	0	3,201	1,866	204	577	15,726	493	321	705
1986	8,680	14,522	0	0	4,178	2,045	154	631	16,281	512	331	750
1987	8,349	14,626	0	0	4,674	2,004	151	613	16,665	541	349	718
1988	8,140	15,022	0	0	5,107	2,295	155	661	17,283	560	330	707
1989	7,613	15,175	0	0	5,843	2,217	142	717	17,325	580	341	660
1990	7,355	15,272	0	0	5,894	2,123	109	748	16,988	586	323	712
1991	7,417	15,256	0	0	5,782	1,844	116	885	16,714	569	325	724
1992	7,171	15,398	0	0	6,083	1,805	89	861	17,033	575	318	699

¹ Strategic Petroleum Reserve.

Note: Totals may not equal sum of components due to independent rounding.

Sources: Energy Information Administration, *Petroleum Supply Annual*, Vol. 1, 1981-1982, Tables 2-9, 14, 18, 20, and 26, 1983-1988, Tables 2-9, 14, 16, and 23, 1989-1992, Tables 2-12, 14, 20, 27, and 35, and predecessor reports, and *Supply, Demand, and Stocks of All Oils by Petroleum Administration for Defense District and Imports Into the United States by Country*, 1976-1980, Table 1, and predecessor reports.

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