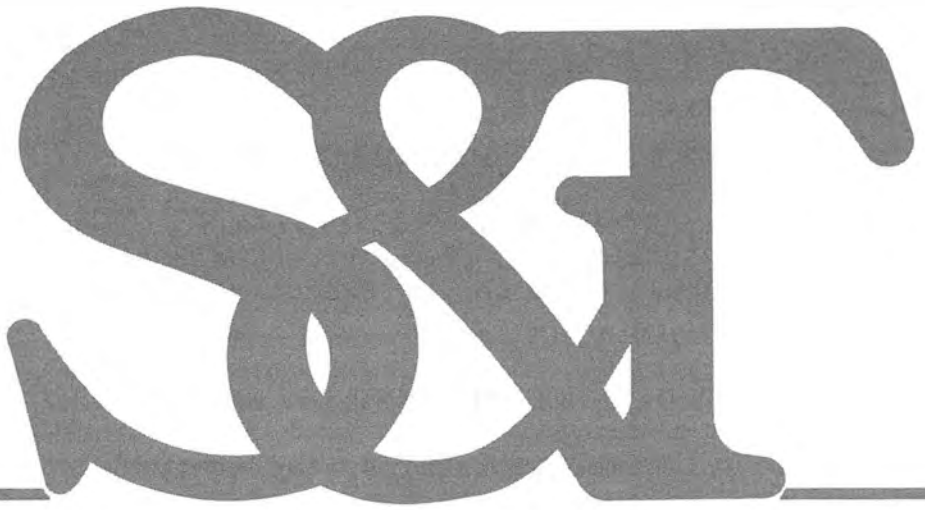
Petroleum Inventories and Storage

Petroleum Storage & Transportation

National Petroleum Council • April 1989

This volume is dedicated to the memory of
Donald M. Prenowitz
who passed away during the course of this study.
Don was associated with Shell Oil Company
for almost 32 years. A member of previous task groups,
as well as a member of the task group
that prepared this volume,
Don willingly contributed his experience,
practical insight, and good humor.
He will be missed.



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William E. Swales, Chairman, Committee on Petroleum Storage & Transportation

NATIONAL PETROLEUM COUNCIL

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The National Petroleum Council is a federal advisory committee to the Secretary of Energy.

The sole purpose of the National Petroleum Council is to advise, inform, and make recommendations to the Secretary of Energy on any matter requested by the Secretary relating to petroleum or the petroleum industry.

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VOLUME IV

PETROLEUM INVENTORIES AND STORAGE

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INTRODUCTION

The National Petroleum Council (NPC), at the Secretary of Energy's request, has completed its study of petroleum inventory, storage, and transportation capacities. In his letter of February 20, 1987, the Secretary of Energy specifically requested that:

> ...the Council...undertake a comprehensive new study on petroleum inventory, storage, and transportation capacities updating the Council's earlier studies as necessary. Emphasis should be given to the reexamination of minimum operating inventory levels, the location of storage facilities and availability of inventories in relation to local demand, and the capabilities of distribution networks to move products from refining centers to their point of consumption particularly during periods of stress.

The full text of the Secretary's request letter, a description of the National Petroleum Council, and a roster of the Council membership are provided in Appendix A.

The NPC established the Committee on Petroleum Storage & Transportation to develop a comprehensive response to the Secretary's request. This Committee was chaired by Mr. William E. Swales, Vice Chairman - Energy, USX Corporation. The Secretary designated Dr. H. A. Merklein, Administrator, Energy Information Administration (EIA), to represent him and to provide coordination between the Department of Energy (DOE) and the Council by serving as the Government Cochairman of the Committee. To assist in responding to the Secretary's request, the Committee established a Coordinating Subcommittee and four task groups: System Dynamics, Natural Gas Transportation, Liquids Transportation, and Inventories and Storage.

The Council's overall report, Petroleum Storage & Transportation, is contained in five volumes:

- Volume I - Executive Summary
- Volume II - System Dynamics
- Volume III - Natural Gas Transportation
- Volume IV - Petroleum Inventories and Storage
- Volume V - Petroleum Liquids Transportation.

In addition, detailed profiles of the companies that participated in the natural gas transportation and petroleum pipeline surveys are available from the NPC.

The Inventories and Storage Task Group was chaired by Bruce D. Frolich, Vice President, Supply & Distribution, Chevron U.S.A. Inc. James M. Diehl, Chief, Fuels Analysis Branch, Petroleum Supply Division, Energy Information Administration, served as Government Cochairman of the Task Group. (Rosters of the study

groups responsible for the development of this volume are contained in Appendix B.) This volume updates and expands the NPC's 1984 report, Petroleum Inventories and Storage Capacity. In the new report, all three physical systems (primary, secondary, tertiary) involved with petroleum storage capacity and inventories are analyzed. In addition, the effects of the petroleum futures markets and the Strategic Petroleum Reserve (SPR) on petroleum inventories are described and evaluated. Highlights of the report appear in the Executive Summary, details in Chapter Two.

The NPC has undertaken and published 10 inventory studies since 1948 to assist the federal government in emergency preparedness planning. These studies were principally designed to determine both the volume of petroleum that could be available from the primary distribution system in the event of an emergency, and the total storage capacity of the primary system. Additionally, the last three studies (1974, 1979, 1984) estimated the minimum operating inventory of crude oil and principal petroleum products. This minimum operating inventory estimate represents an inventory level below which product shortages and operating problems would begin to appear.

The primary distribution system remains the principal focus of this volume. However, much greater emphasis than before has been placed on the secondary distribution system and tertiary storage segment, due to their close interrelationship with the primary system and the significant storage volumes contained in these segments.

DATA DEVELOPMENT AND METHODOLOGY

Primary Distribution System

The NPC sent survey questionnaires to the companies that report primary inventory data to the EIA. To ensure the confidentiality of the data, an independent accounting firm, Deloitte Haskins & Sells, received and tabulated the survey results. (See Appendix C for survey methodology, Appendix D for the primary survey questionnaire, and Appendix E for tabulated survey results.) In addition to information on storage capacity and inventory, companies in the primary system were surveyed about the use of petroleum futures markets and their effect on inventory levels. They also were sent a questionnaire designed to obtain an industry assessment of the impact of the SPR on inventories held in the private sector. Finally, comments on the DOE plan for use of the SPR during stress situations were solicited. (See Appendix F for survey returns on petroleum futures and Appendix G for responses to the SPR survey.)

Data were collected by Petroleum Administration for Defense Districts (PADDs), and by sub-PADDs in PADD I. This breakdown was necessary to reflect regional differences in seasonal and system-related (i.e., primary, secondary) petroleum demands. Further, the analysis of system dynamics under stress conditions

required a regional approach to demand, inventory, and storage, since petroleum supply and transportation systems are geographically integrated. For this purpose, PADDs I-IV are shown combined, while PADD V, which generally operates independently from PADDs I-IV, is shown separately. (Figure 1 shows the five PADD districts.)

Figure 1. Petroleum Administration for Defense Districts (PADDs).

The primary system survey did not include all petroleum products, only crude oil and the principal petroleum products. Also, the survey did not cover crude oil and products located in U.S. possessions and territories or in Caribbean transshipment facilities. (For a discussion of Caribbean facilities, see Appendix H.)

As a basis for comparison and trend interpretation, historical data are given for refining-capacity utilization (Appendix I) and for petroleum demand and inventories in the primary distribution system (Appendix J).

Secondary Distribution System

Survey questionnaires were also used to gather data in the secondary distribution system for inventories and storage capacities in bulk petroleum storage plants. Recipients of this questionnaire were asked as well about petroleum futures. The secondary survey relied on a statistical sampling of secondary

bulk plant operators, and survey results were expanded to totals for the entire bulk plant population. The results of the survey were received, tabulated, and expanded by Deloitte Haskins & Sells.

Data on the retail sector of the secondary system were developed from published information and from discussions with industry representatives. Where possible, PADDs I-IV data and PADD V data are presented separately. (For the methodologies, see Appendix K.)

Tertiary Storage Segment

Tertiary segment storage capacities and inventories were estimated from published data, surveys, and the consensus experience of industry representatives. A review of the methodologies used for each consumer sector (Appendix L) will provide insight into the accuracy of the estimates.

The principal objective of this Inventories and Storage report is to analyze all three physical systems (primary, secondary, tertiary) related to petroleum inventories and storage capacity.

This study was designed to determine both the volumes of petroleum that could be available in the event of an emergency and the total storage capacity in the three physical systems. Minimum operating inventories for crude oil and principal petroleum products have been estimated.

While the primary distribution system is the main focus, greater emphasis than in the past has been placed on the secondary distribution system and tertiary storage segment. This reflects their close interrelationship with the primary system and permits estimation of the significant storage volumes represented by these non-primary systems.

PRIMARY DISTRIBUTION SYSTEM

The objectives of the primary distribution system analysis were to estimate the minimum operating inventory for crude oil and the principal petroleum products; to analyze the volumes of inventory that the system held on September 30, 1987 and March 31, 1988; and to determine the amount of storage capacity in the system.

Minimum Operating Inventory

The data resulting from the NPC's "1988 Survey of Petroleum Inventories and Storage Capacities in the United States" reveal varying trends in minimum operating inventory levels. For crude oil, motor gasoline, and kerosine-type jet fuel (kero-jet fuel), the minimums have increased since the last estimate, while the minimums have decreased for distillate fuel oil and residual fuel oil. In contrast, the 1983 survey showed that minimum operating inventory levels fell for all product classes compared to 1979.

Minimum operating inventory is defined as the level below which operating problems and shortages would begin to appear in a given distribution system. However, in stress situations, inventories can drop below this level for short periods without significant supply disruptions, but with increased operating costs. Unlike the 1983 situation, where lower demand was the driving force for an across-the-board decrease in minimum operating inventories, the 1988 estimates must be interpreted in light of opposing trends.

Several facts suggest the need for higher minimum operating inventories. The United States is once again becoming more

dependent on foreign crude oil. As domestic production continues to decline, the United States must rely on delivery of foreign crude oil in large ships from long distances. Further, the demand for petroleum is increasing. These conditions both dictate higher minimum inventories. On the other hand, the oil industry has continued to restructure during the 1983-1988 period, removing significant amounts of refining, pipeline, and tankage capacity from the system. NPC estimates of the 1988 minimum operating inventories for crude oil and the principal petroleum products are shown in Table 1.

TABLE 1

NPC MINIMUM OPERATING INVENTORY ESTIMATES FOR THE PRIMARY DISTRIBUTION SYSTEM*
(Millions of Barrels)

	1988			Change in Total U.S., 1983-1988
	PADDs I-IV	PADD V	Total	
Crude Oil§	230	70	300	+15
Motor Gasoline	178	27	205	+5
Kero-Jet Fuel	25	5	30	+5
Distillate Fuel Oil	77	8	85	-20
Residual Fuel Oil	25	5	30	-10
Total¶	535	115	650	-5

*The NPC estimates of minimum operating inventory were developed through an interactive decision-making process. In order to arrive at a consensus, individual judgments were considered with the aid of operating experience and relevant statistical data.

§Excludes SPR. Alaskan crude oil in transit by water was included in PADD V to be consistent with the EIA reporting system.

¶Totals include crude oil and surveyed petroleum products only. They do not include kerosine, which was estimated to be 5 million barrels in 1984.

No estimate of total minimum operating inventory for the entire primary distribution system has been made. Rather, it is important to note that the NPC minimum operating inventory total of 650 million barrels represents the sum of only those products surveyed. Although kerosine, asphalts, lubricating oils, and "other oils" play a key role in the U.S. petroleum picture, data

for these products were not collected; and naphtha-based jet fuel was excluded from the 1988 survey at the request of DOE, which stated that the 1983 data were still sufficient for their needs.

Total Inventory and Inventory Above Minimum

March 31, 1988 inventories of the major products held in the primary distribution system have been reduced since 1983, as can be seen in Table 2.

The major reason for the decrease was a substantial drop in distillate fuel oil inventory. Tax law changes that altered procedures for collecting the Federal Diesel Fuel Tax, effective April 1, 1988, particularly depressed primary distillate inventories. This tax had the one-time effect of moving stocks from the primary distribution system to the secondary system and tertiary segment. However, it is important to note that distillate inventories are routinely lower now than in the 1970s and early 1980s, due to reduced distillate demand and seasonality. The

TABLE 2

INVENTORY OF CRUDE OIL AND
THE PRINCIPAL PETROLEUM PRODUCTS
IN THE PRIMARY DISTRIBUTION SYSTEM
(Millions of Barrels)

	March 31, 1988			Change from
	PADDs I-IV	PADD V	Total	March 31, 1983
Crude Oil*	263	80	343	-1
Motor Gasoline	203	29	231	+8
Kero-Jet Fuel	33	6	40	+5
Distillate Fuel Oil	80	9	89	-29
Residual Fuel Oil	35	9	44	-2
Total§	614	133	747	-19

*Excludes SPR and 10.6 million barrels of lease stocks adjustment. Alaskan crude oil in transit by water was included in PADD V to be consistent with the EIA reporting system.

§Totals include crude oil and surveyed petroleum products only. Totals may not equal the sum of components due to independent rounding.

Source: Energy Information Administration, Petroleum Supply Monthly, March 1988, and Petroleum Supply Annual, Vol. 2, 1983.

principal factors leading to reduced distillate inventories are: (1) increased use of diesel motor fuel, moderating seasonal inventory swings, (2) reduced demand for seasonal home heating fuel, due to the substitution of natural gas, and (3) increased seasonal use of imported distillate cargoes, due to better-developed price hedging techniques. Other factors that have led to decreased inventory levels are the relative cost of storing inventory, volatility of product prices, and continued competitive pressures to reduce costs. Motor gasoline and kero-jet fuel levels increased only minimally, considering the gains in demand that have occurred since 1983 (see Appendix J).

Days' supply of inventory calculations must take account of minimum operating inventories, since the minimums do not change proportionally with demand. Moreover, minimum operating inventories are not routinely available for use without causing shortages, but can be used for short periods of time at higher operating costs. Therefore, days' supply of inventory calculations based on total inventory do not present a valid indication of the adequacy of inventory levels. A better way to judge the adequacy is to consider accessibility, i.e., the volume of inventory above the minimum that is required to run the system:

$$\frac{\text{total inventory - minimum operating inventory}}{\text{current daily demand}} = \text{days' supply of inventory above minimum}$$

With this method, March 31, 1988 data for motor gasoline would result in 3.6 days' supply, rather than the 31.6 days' supply derived from the total inventory calculation:

$$\frac{231 \text{ MMB} - 205 \text{ MMB} = 26 \text{ MMB}}{7.3 \text{ MMB/D}} = \text{3.6 days' supply of inventory above minimum}^1$$

versus $\frac{231 \text{ MMB}}{7.3 \text{ MMB/D}}$ = 31.6 days' supply of total inventory

Based on both these methods, a comparison was made of the days' supply of inventory for March 31, 1983, and the days' supply of inventory for March 31, 1988 (see Table 3). The days' supply of primary inventory above minimum, clearly a lower number than days' supply of total inventory, is a more realistic measure of available supply. The inventories above minimum are, in general, lower in the 1988 calculation than in 1983. For kero-jet fuel, growth in demand and an increase in the estimated minimum combine for a significant reduction in the days' supply above minimum operating inventory. For distillate fuel oil, the sharp

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[1] MMB = million barrels; MMB/D = million barrels per day.

TABLE 3

DAYS' SUPPLY OF INVENTORY
IN THE PRIMARY DISTRIBUTION SYSTEM

	March 31, 1983		March 31, 1988	
	Total Inventory	Inventory Above Minimum*	Total Inventory	Inventory Above Minimum§
Crude Oil¶	33	6	27	4
Motor Gasoline	33	3	32	4
Kero-Jet Fuel	44	12	33	8
Distillate Fuel Oil	40	4	25	1
Residual Fuel Oil	29	4	31	10

*The NPC's 1983 estimate using 1983 minimum operating inventories.

§The NPC's 1988 estimate using 1988 minimum operating inventories.

¶Excludes SPR, which on March 31, 1988, held 545 million barrels, or 114 days' supply of crude oil imports.

Source: National Petroleum Council "1988 Survey of U.S. Petroleum Inventories and Storage Capacities (Primary Distribution System);" and Energy Information Administration, Petroleum Supply Monthly, March 1988, and Petroleum Supply Annual, Vol. 2, 1983.

drop in inventory volume is important: it must be noted that the very low distillate days' supply is due both to seasonal pattern and the one-time effect of the diesel tax change. Residual fuel oil exhibits a sharply different pattern from the norm -- days' supply above minimum is higher in 1988 than it was in 1983. The change results primarily from the large relative drop in the estimated minimum operating inventory.

A seemingly low number of days' supply above minimum should not cause concern in times of normal operations. Also, it must be stressed that no seasonal component is built into the minimum operating inventory numbers. Products that exhibit seasonal demand patterns, such as distillate fuel oil, require higher operating inventory levels going into peak demand periods. The overall flexibility of the supply, refining, and distribution system provides ample ability to meet all but the most extreme demand peaks over time. The potential drawdown of inventory in

the secondary distribution system and tertiary storage segment provides additional flexibility in times of tight supply.

Since 1983, the percentage of crude oil supplied to refiners from domestic sources has fallen from approximately 75 percent to to about 64 percent. So while the primary distribution system is somewhat more vulnerable than in 1983 because of imported crude oil, several factors mitigate any potential disruption in product supply:

- A significant proportion of imported crude oil has a long in-transit time (30-50 days), allowing sufficient time to locate alternative, nearby crude oil and products as import replacements.

- The combined systems holding U.S. petroleum product inventories (primary, secondary, tertiary) are available to moderate short-term "demand surges" and supply transients.

- In the past five years, substantial capital investments have been made in downstream refining capacity, such as vacuum distillation, thermal and catalytic cracking, coking, and catalytic hydrocracking and hydrotreating. Thus, the system's flexibility in handling various grades of crude oil and producing a greater percentage of light products has improved.

- Finally, in the event of a severe disruption, the SPR stocks are intended, and available, for drawdown and use.

Storage Capacity

The primary system survey examined the total storage capacity in operation for crude oil and the principal products. At 1,419 million barrels, storage capacity has decreased slightly since 1983 for the total of all products surveyed. Among the reasons:

- Refinery, pipeline, and terminal shutdowns

- Pipeline shifts to alternative service (i.e., natural gas)

- Removal of tankage not retrofitted to meet environmental regulations

- Removal of tankage that has physically deteriorated.

Tankage idle but available within 90 days, tankage in operation, and tankage under construction together constitute total tankage available to the system. The shell capacity of these categories appears in Tables 4 and 5. Some of the idle tankage can be restored to service, but much of it is scattered

TABLE 4

SHELL CAPACITY OF TANKAGE IN OPERATION
AND TANKAGE UNDER CONSTRUCTION
IN THE PRIMARY DISTRIBUTION SYSTEM
(Millions of Barrels)

	March 31, 1983		March 31, 1988	
	Tankage in Operation	Tankage Under Construction	Tankage in Operation	Tankage Under Construction
Crude Oil*	499	10	508	§
Motor Gasoline	456	3	451	1
Kero-Jet Fuel	68	§	82	§
Distillate Fuel Oil	295	1	261	§
Residual Fuel Oil	143	4	117	0
Total¶	1,462	18	1,419	2

*Excludes SPR and a portion of lease stocks tankage. Reported inventories of lease stocks are 11 million barrels in both 1983 and 1988.

§Less than 0.5 million barrels

¶Totals include tankage for crude oil and surveyed petroleum products only. Totals may not equal the sum of components due to independent rounding.

Source: National Petroleum Council "1988 Survey of U.S. Petroleum Inventories and Storage Capacities (Primary Distribution System)."

in small volumes across the nation. Relying on a substantial portion of this tankage for emergency preparedness planning is not realistic.

Table 6 shows the percentage utilization of tank capacity over the 40-year span of the NPC series of inventory reports. Over this period, inventory in tankage has averaged about 46 percent of storage capacity and has ranged from a high of 53 percent in 1969 to 40 percent in 1983. Although tanks do fluctuate between minimum and maximum operating levels during the operating cycle, the average has varied little over time.

TABLE 5

POTENTIALLY AVAILABLE TANKAGE
IN THE PRIMARY DISTRIBUTION SYSTEM AS OF MARCH 31, 1988,
THAT IS IDLE BUT CAN BE REACTIVATED WITHIN 90 DAYS
(Millions of Barrels)

Crude Oil	18
Motor Gasoline	17
Kero-Jet Fuel	4
Distillate Fuel Oil	19
Residual Fuel Oil	7
Total*	66

*Total includes tankage for crude oil and surveyed petroleum products only. Total may not equal the sum of components due to independent rounding.

Source: National Petroleum Council "1988 Survey of U.S. Petroleum Inventories and Storage Capacities (Primary Distribution System)."

TABLE 6

PERCENTAGE UTILIZATION OF TANK CAPACITY
IN THE PRIMARY DISTRIBUTION SYSTEM, 1948-1988

NPC Survey Date	Inventory as a Percentage of Tank Capacity
March 31, 1948	42
June 30, 1950	45
March 31, 1952	45
March 31, 1954	48
March 31, 1957	45
September 30, 1962	50
September 30, 1969	53
September 30, 1973	48
September 30, 1978	48
March 31, 1983	40
March 31, 1988	41

Source: National Petroleum Council Surveys, 1948 to 1988.

With product demand once again on the rise and with refineries running at high utilization rates, it is anticipated that there will be very little change in storage capacity during the next few years.

In an attempt to quantify the impact of that SPR on industry inventory levels, survey respondents were asked if the existence of the SPR has contributed to a decrease in stock levels. Without exception, respondents said that the SPR did not affect their company's inventory levels.

The primary distribution system has changed considerably since 1983. Refineries have continued to close, refinery capacity utilization is higher, U.S. dependence on foreign crude oil has grown, and product demand is up while storage capacity is down slightly. All these factors point to a system whose capacity is more fully utilized. The system has demonstrated its improved flexibility in the face of refinery consolidations and increased product demand by performing in the 1983-1988 period without any significant supply disruptions.

SECONDARY DISTRIBUTION SYSTEM

The NPC's second survey, designed to develop more accurate estimates of storage capacity and inventory levels in the secondary distribution system, defined total storage capacities as of March 31, 1988, and major product inventory levels as of September 30, 1987 and March 31, 1988.

The secondary system, that portion of the distribution network operating between the primary distribution system and end-users of petroleum products, consists of two major components:

- Bulk Plants -- storage facilities that have total storage capacity of less than 50,000 barrels and that do not receive product deliveries via barge, ship, or pipeline
- Retail Motor Fuel Outlets -- facilities that dispense motor fuel to end-users, including service stations, truck stops, and convenience stores.

Bulk Plants

In 1988, approximately 15,000 companies owned and/or operated bulk plants in the United States, down from around 18,000 in 1983. A sample of 1,995 companies was selected for study in an effort to estimate total U.S. bulk plant inventory and storage capacity. These data are presented in Table 7.

Retail Outlets

Government and private sources were analyzed in developing estimates of the total number of retail motor fuel outlets in the

TABLE 7

ESTIMATED STORAGE CAPACITY AND INVENTORY
AT BULK PLANTS IN THE SECONDARY DISTRIBUTION SYSTEM
AS OF MARCH 31, 1983 AND 1988
(Millions of Barrels)

	Capacity		Inventory	
	1983	1988	1983	1988
Motor Gasoline	22	17	9	8
Diesel/ Distillate Fuel Oil	37	29	8	11
Residual Fuel Oil	6	4	2	2
Total*	65	50	19	22

*Totals include surveyed petroleum products only and may not equal the sum of components due to independent rounding.

Source: National Petroleum Council "1988 Survey of U.S. Petroleum Inventories and Storage Capacities (Secondary Distribution System)."

TABLE 8

ESTIMATED STORAGE CAPACITY AND INVENTORY
AT RETAIL MOTOR FUEL OUTLETS
AS OF MARCH 31, 1983 AND 1988
(Millions of Barrels)

	Capacity		Inventory	
	1983	1988	1983	1988
Motor Gasoline	79	75	26	40
Diesel/ Distillate Fuel Oil	5	8	2	4
Total*	84	83	28	44

*Totals include surveyed petroleum products only.

Source: NPC estimate.

United States, their storage capacities, and their inventory levels. As of March 31, 1988, an estimated 170,000 retail motor fuel outlets were operating in the United States. Total storage capacity at those retail motor fuel outlets was estimated at 83 million barrels, with inventories of 44 million barrels (see Table 8).

For estimated overall storage capacity and inventory in the secondary distribution system, see Table 9.

TERTIARY STORAGE SEGMENT

For study purposes, the tertiary storage segment, the ultimate consumers, has been divided into seven sectors: Agricultural, Commercial, Electric Utilities, Industrial, Military/Government, Residential, and Transportation. Estimated storage capacity and inventory in these sectors, as of March 31, 1988, are shown in Table 10.

PETROLEUM FUTURES

Results of the NPC survey of the primary distribution system and bulk plant operators indicated that 87 percent of respondents felt that the futures markets had not affected their inventory

TABLE 9

ESTIMATED STORAGE CAPACITY AND INVENTORY
IN THE SECONDARY DISTRIBUTION SYSTEM
AS OF MARCH 31, 1983 AND 1988
(Millions of Barrels)

	Capacity		Inventory	
	1983	1988	1983	1988
Motor Gasoline	101	92	35	48
Diesel/ Distillate Fuel Oil	42	37	10	15
Residual Fuel Oil	6	4	2	2
Total*	149	133	47	66

*Totals include surveyed petroleum products only.

Source: NPC estimate.

TABLE 10

ESTIMATED STORAGE CAPACITY AND INVENTORY
IN THE TERTIARY STORAGE SEGMENT
AS OF MARCH 31, 1983 AND 1988
(Millions of Barrels)

	Capacity		Inventory	
	1983	1988	1983	1988
Sector				
Agricultural	41	40	14	14
Commercial	37	33	8	7
Electric Utilities	213	175	91	61
Industrial	61	52	17	10
Military/Government	56	48	23	18
Residential	100	79	55	50
Transportation*	134	144	61	87
Total§	642	571	269	247
Product				
Motor Gasoline	103	109	42	63
Diesel/Distillate Fuel Oil	282	255	131	113
Kero-Jet Fuel	21	22	11	11
Residual Fuel Oil	237	185	86	60
Total§	642	571	269	247

*Includes on-board and fixed storage capacity and inventory for cars, buses, railroads, and aviation, but excludes payload storage (i.e., storage capacity and inventory for product being transported) of railroads, tank trucks, and marine vessels.

§Totals include surveyed petroleum products only. Totals may not equal the sum of components due to independent rounding.

Source: NPC estimate.

levels. Most participants in the market fulfill their contractual obligations to buy or sell through an opposite, offsetting transaction, rather than by delivering or taking delivery of "wet" barrels. Of the inventories held by respondents who used hedges, the volume-weighted average backed by hedges was 11 percent. Due to the size of the companies and their inventories, this percentage ranged from 1 to 100.

SYSTEM DYNAMICS

The petroleum distribution systems are a complex, integrated network of production, refining, storage, and transportation facilities. In studying the dynamics of this network, the NPC estimated total storage capacity and inventories for principal products and crude oil in all three systems for March 31, 1988. The findings are summarized in Table 11.

TABLE 11

ESTIMATED STORAGE CAPACITY AND INVENTORY
IN THE PETROLEUM DISTRIBUTION SYSTEMS AS OF MARCH 31, 1988
(Millions of Barrels)

	Primary		Secondary		Tertiary		Total	
	Cap.	Inv.	Cap.	Inv.	Cap.	Inv.	Cap.	Inv.
Motor Gasoline	451	231	92	48	109	63	652	342
Kero-Jet Fuel	82	40	--	--	22	11	104	51
Distillate Fuel Oil	261	89	37	15	255	113	553	217
Residual Fuel Oil	117	44	4	2	185	60	306	106
Total*	911	404	133	65	571	247	1615	716
Crude Oil	508	343§	--	--	--	--	508	343§

*Totals include surveyed petroleum products only. These inventory levels and utilization of storage capacity represent satisfactory levels under normal operating conditions. Totals may not equal the sum of components due to independent rounding.

§Excludes SPR and 10.6 million barrels of lease stocks.

Source: National Petroleum Council "1988 Survey of U.S. Petroleum Inventories and Storage Capacities (Primary Distribution System)," "1988 Survey of U.S. Petroleum Inventories and Storage Capacities (Secondary Distribution System)," and estimates.

The secondary and tertiary inventories act as buffers between primary inventories and end-use. Under normal conditions, these inventories represent a substantial safety cushion -- in addition to that provided by primary inventories -- for each product. This cushion is difficult to quantify though, because it is not possible to determine actual minimum operating inventories for the secondary system and tertiary segment. Moreover, the concept of minimum operating inventory as applied to the tertiary segment is somewhat different from the concept as applied to the other two systems. Nevertheless, some minimum volume of inventory is necessary to keep the tertiary segment operating. It is believed that minimum operating inventory for a given product in the secondary system or tertiary segment is a smaller fraction of storage capacity than that in the primary system, because there is less unavailable inventory, such as pipeline fill. Also, the sizes of receipts and deliveries of product are considerably smaller than in the primary system. In the secondary system, most movements are made by truck or rail, whereas in the primary system, the majority are by barge, pipeline, and tanker.

Motor gasoline is used here to demonstrate the dynamic nature of the petroleum distribution systems. Table 12 is based on the estimate that, for gasoline, minimum operating inventories in the secondary system and tertiary segment are 20 percent of capacity (a figure felt to be reasonable by the NPC). Note that these figures show an additional cushion of 30 million barrels of gasoline above minimum in the secondary system and 41 million barrels of gasoline above minimum in the tertiary segment. Hence, in this example, each of the secondary and tertiary inventories above minimum is greater than the 26 million barrels of cushion provided by the primary system alone. It should be recognized, however, that it is more difficult to redirect physical inventories in the secondary system and tertiary segment to other consumer sectors or geographic areas. However, working together with the primary system, many distribution needs can be met through exchanges. Similar calculations for distillate fuel oil and residual fuel oil show even greater cushions in the secondary system and tertiary segment. In the case of residual fuel oil, the cushion is considerable, since users such as utilities maintain large inventories.

Normally, inventories in the secondary system and tertiary segment represent additional volumes that can be used to maintain continuous supply of products for consumption. However, circumstances such as expectation of either a near-term substantial price increase or a crude oil shortage can cause very rapid increases in call for product. These increases may cause temporary supply dislocations in the primary system but should not lead to product disruptions to the end-user, because the inventories remain available for consumer use.

In the case of gasoline, a rapid surge in product call by the tertiary segment to fill the 46 million barrels of unused storage capacity could, potentially, almost drain the secondary

TABLE 12

MOTOR GASOLINE AS OF MARCH 31, 1988
(Millions of Barrels)

	Primary System	
Inventories Above Minimum Operating Inventory	26	
	Secondary System	**Tertiary Segment**
Shell Capacity	92	109
Inventory	48	63
Minimum Operating Inventory*	18	22
Inventory Above Minimum Operating Inventory	30	41
Unused Shell Capacity§	46	46

*Assumed to be 20 percent of shell capacity.

§Shell capacity less inventory.

Source: Derived from National Petroleum Council "1988 Survey of U.S. Petroleum Inventories and Storage Capacities (Primary Distribution System)," "1988 Survey of U.S. Petroleum Inventories and Storage Capacities (Secondary Distribution System)," and estimates.

system of its 30 million barrels of gasoline above the assumed minimum operating inventory, and the primary system of its 26 million barrels of gasoline above the minimum operating inventory. A surge in call by the secondary system, with its 46 million barrels of unused gasoline storage capacity, could also drain the primary system of its supply cushion. Based on experience, it is concluded that the overall system has sufficient flexibility to handle demand spikes in defined geographic areas as product is redirected to those areas via price-driven dynamics. Similar examples extracted from the survey data for distillate and residual fuel oils would appear even more extreme, but it should be noted that as of March 31, 1988, secondary system inventories of these heating fuels were low, and unused tankage capacity high.

Sudden product calls such as those illustrated above are possible and could appear to disrupt supply. However, several factors tend to mitigate the importance of sudden product calls and diminish the likelihood of disruption:

- The demand surge described above would not be a consumption surge. It would be simply a transfer of products from the primary system to the secondary system and/or the tertiary segment.

- Holders of secondary and tertiary inventories would not necessarily experience a demand surge for all products in all geographic areas at the same time. For example, seasonality of product demand would probably result in less surge for heating oil in spring than in the fall. Many electric utilities and industrial users have oil storage but burn natural gas, and would not necessarily want to fill their storage as long as gas was available.

- Refineries continually replenish the primary system.

- Finished products can be imported to meet temporary imbalances in the system.

The study data define the inventories and storage capacities as of a specific date -- March 31, 1988. Inventories fluctuate on a product-by-product basis, however, and will continue to do so as the system reacts to variations in supply, demand, prices, and other economic factors. This should be considered as one evaluates the findings.

The petroleum distribution systems are flexible and dynamic, changing to meet different supply and demand situations. As has been demonstrated by the industry over time, this capability has enabled the industry to minimize the effects of supply disruptions.

CHAPTER ONE

OVERVIEW OF THE PETROLEUM DISTRIBUTION SYSTEMS AND THE FUNCTION OF INVENTORY AND STORAGE CAPACITY

The U.S. petroleum distribution systems are comprised of networks of terminals, refineries, other storage facilities, pipelines, tankers, barges, tank cars, and tank trucks. These elements move crude oil from its source, convert it into consumer products, and deliver the products to consumers' facilities for their use. All of these components store oil. This overview of the various systems and the function of inventory and storage capacity is presented as an introduction to the analysis in Chapter Two of changes that have taken place in the petroleum distribution system.

THE PETROLEUM DISTRIBUTION SYSTEMS

As shown in Figures 2 and 3, the petroleum distribution systems are comprised of the primary distribution system, the secondary distribution system, and the tertiary storage segment. The primary system gathers crude oil, transports it to refineries, refines it into products, and delivers those products in bulk to the secondary distribution system. (In some cases, deliveries are made directly to the storage of large end-users, i.e., tertiary storage.) The secondary system distributes these bulk quantities in smaller lots to the receiving tanks of the end-users. The tertiary segment is the storage capacity and inventory held by all end-users. The gasoline stored in the tank of the family car is a common example. The inventory behavior of the secondary system and tertiary segment significantly affects the primary system's ability to operate smoothly. Each system is described in more detail in the following sections.

Crude Oil

For domestic crude oil, the primary crude oil distribution system begins with a lease tank in which oil from a producing well is accumulated. Small pipeline-gathering systems, tank cars, tank trucks, and barges collect the crude oil from these lease tanks and deliver it into intermediate storage for further movement to refining facilities or directly to refineries.

Crude oil from foreign sources enters the primary system via tankers at marine terminals and refineries or, in Canada's case, via pipeline and overland. Exports of crude oil are allowed only for: (1) crude oil derived from fields under the state waters of Alaska's Cook Inlet; (2) domestically produced crude oil destined for Canada; and (3) shipments to U.S. territories.

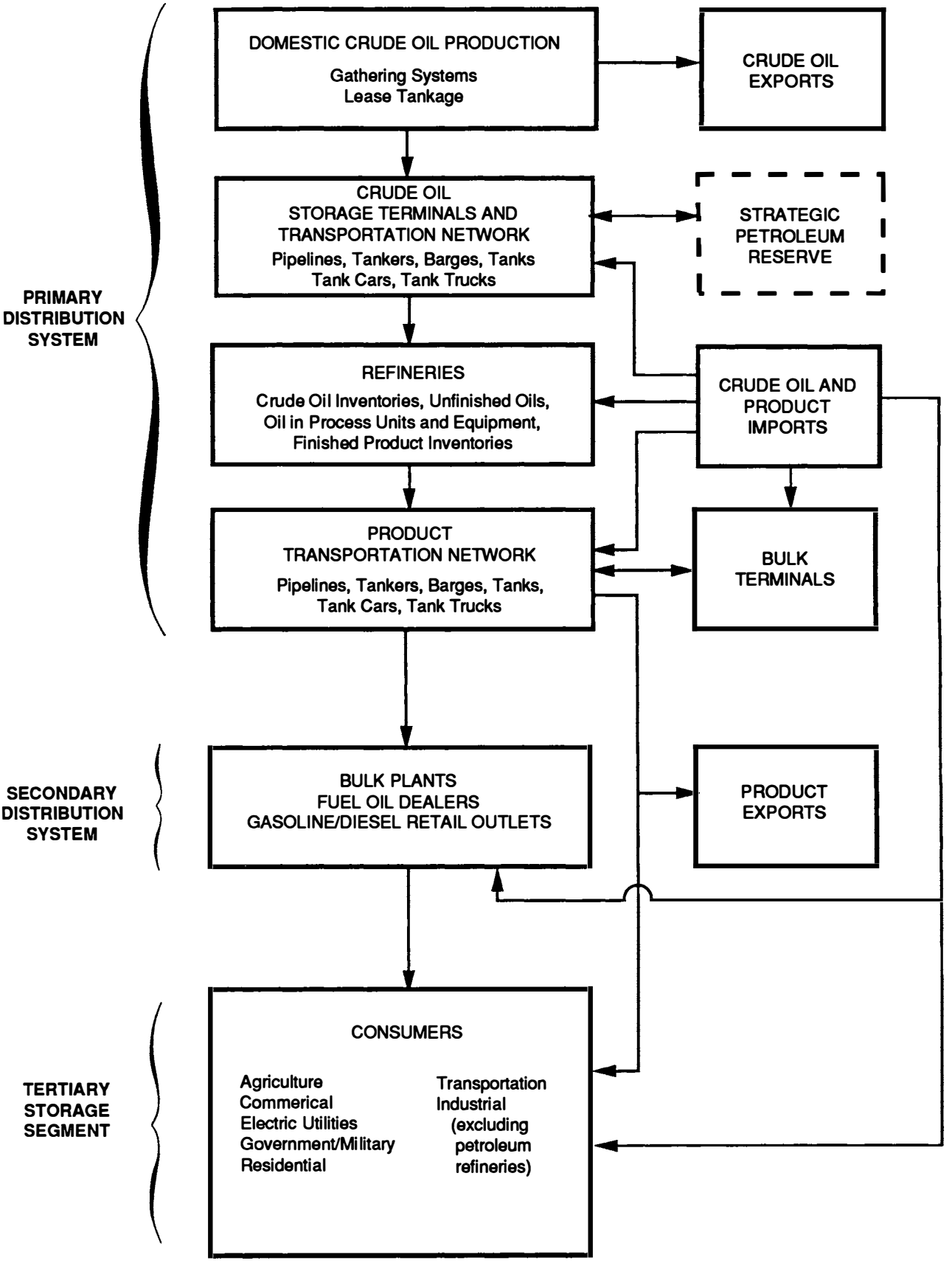

Figure 2. The Petroleum Distribution System.

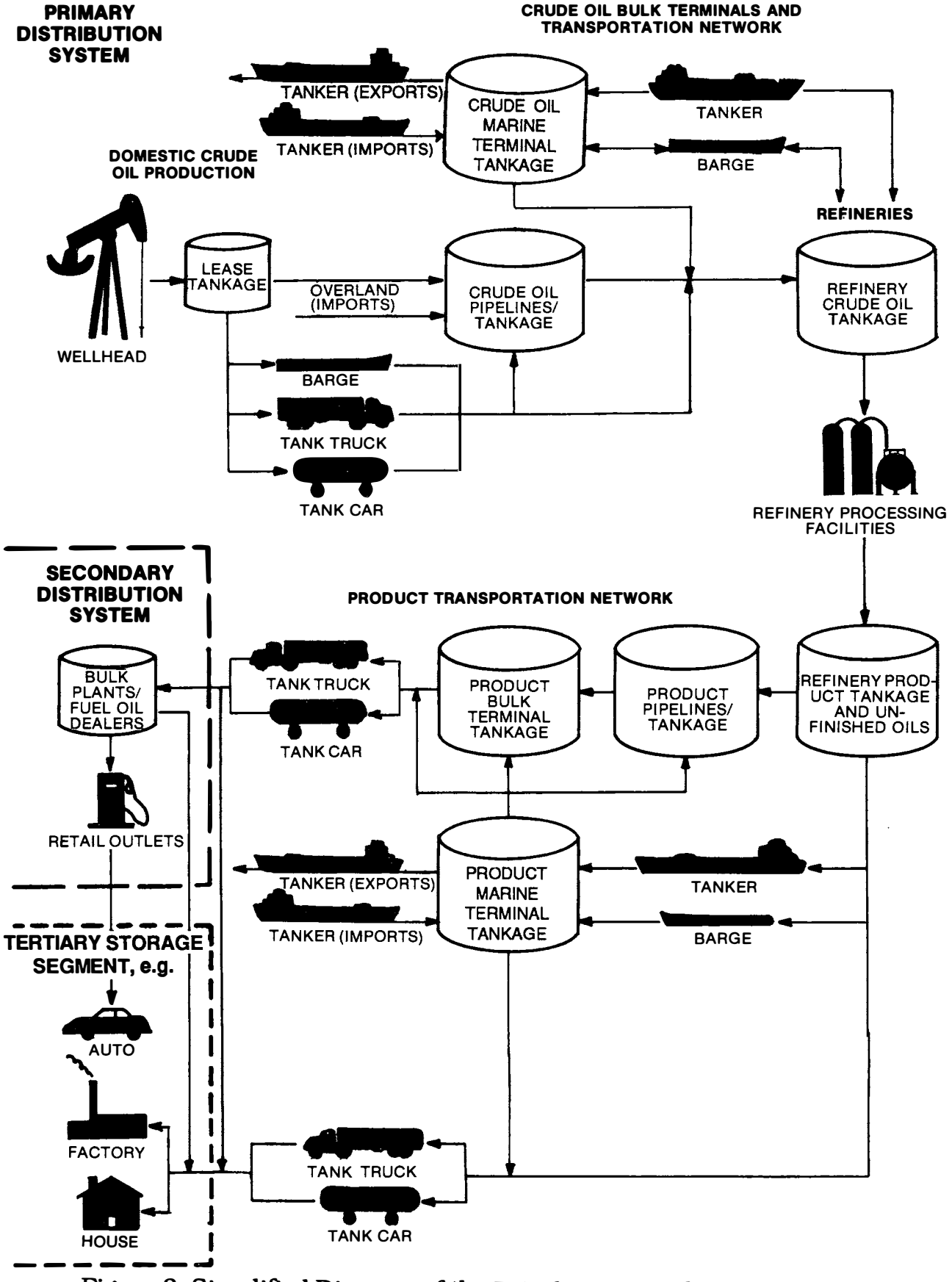

Figure 3. Simplified Diagram of the Petroleum Distribution System.

Major crude oil pipeline systems traverse the United States, linking gathering systems in producing areas to storage terminals and refineries. Large-diameter pipelines, called trunk lines, move large volumes of oil between major points or to terminals. Trunk lines are generally routed through focal points, or hubs, where a number of pipelines converge. At such points, transfers of crude oil to carriers with other destinations may be made. Examples of such locations are Midland and Odessa, in western Texas; Longview, in eastern Texas; Cushing, Oklahoma; Fort Laramie and Guernsey, Wyoming; and Patoka, Illinois. Such locations require a large storage capacity to accommodate crude oil from numerous producing regions, and to permit the segregation, batching, and storing that support the continuous movement of oil through the system. From these locations, smaller branch pipelines then move the crude oil to refineries. There were 213 operable refineries in the United States at the beginning of 1988. This compares to 258 operable refineries at the beginning of 1983. The reduction of approximately 1 MMB/D of operable capacity during this five-year period reflects a structural change in the primary distribution system due to increased marketplace competition, improved efficiency, and changes in government regulations.

A great deal of storage capacity is also needed at marine terminals to permit prompt discharge of cargo. This storage requirement applies also to refineries that accept marine shipments directly.

Because quality among crude oils varies substantially, they are generally segregated prior to transport. Segregation requirements, determined by quality characteristics that include sulfur content, specific gravity, asphalt content, pour point, and suitability for lube oil manufacturing, are usually dictated by the particular needs of the refineries being served. Tankage is required at refineries to receive and hold crude oil supplies, by grade, prior to processing. The size of marine vessels and the frequency of delivery also significantly affect the required storage capacity volume.

Crude oil stored by the U.S. government in the SPR is part of the primary distribution system but is intended only for use in emergency situations. (Appendix G summarizes the SPR's role.) There is also a significant volume of storage in the Caribbean at tanker transshipment terminals and at the refineries of several U.S. oil companies. (In Appendix H these facilities are discussed in more detail.)

Petroleum Products

Once delivered to a refinery, crude oil is converted to various products, including motor gasoline, jet fuel, distillate fuel oil, and residual fuel oil. Tankage is required at refineries to receive and hold both unfinished oils and finished products.

Finished products exit the refinery through the primary product distribution system, which consists of facilities similar to those in the crude oil distribution system: product pipelines, barges and tankers, and bulk terminals to store product for further distribution. Product imports and exports also flow through the primary distribution system.

While products are still in refinery tanks, there is usually a choice as to the location to which the products may move and the mode of transport. Once a product is on its way, it is committed to a geographic area, although some delivery options remain. For example, the Colonial Pipeline, which extends from the Houston-Beaumont, Texas, area to the New York Harbor area, passes through the Baton Rouge, Atlanta, Greensboro, Richmond, Washington, Baltimore, and Philadelphia areas. Products can be delivered at numerous locations along the pipeline route. Storage capacity for each of the products carried is provided at shipper bulk terminals, also located along the route.

The terminus of the primary product distribution system is usually a bulk terminal -- a nonconsumer facility, by EIA definition, has storage capacity of 50,000 barrels or more or receives products directly by barge, tanker, or pipeline. Products leave the primary system from these bulk terminals and, at this point, the ability to divert a product to another region becomes much more limited.

THE FUNCTION OF INVENTORY AND STORAGE CAPACITY

Primary Distribution System

The function of inventory and storage capacity in the primary petroleum distribution system is best understood by examining the following components, each of which plays an important role in the overall system (see Figure 4):

- Unavailable inventory
- Working inventory
- Minimum operating inventory
- Operating space
- Maximum operating inventory
- Contingency space
- Unavailable space.

Unavailable inventory (equipment fill and tank bottoms) and working inventory (inventory above unavailable necessary to support the operating cycle) together constitute the minimum operating inventory. Equipment fill is inventory within the operating equipment, excluding tanks, that is required for the refinery processing system to function normally. Tank bottoms are the portion that falls below the normal suction lines of the tank. For floating-roof tanks, it is the amount required to keep the legs of the roof from touching the tank bottom. The petroleum

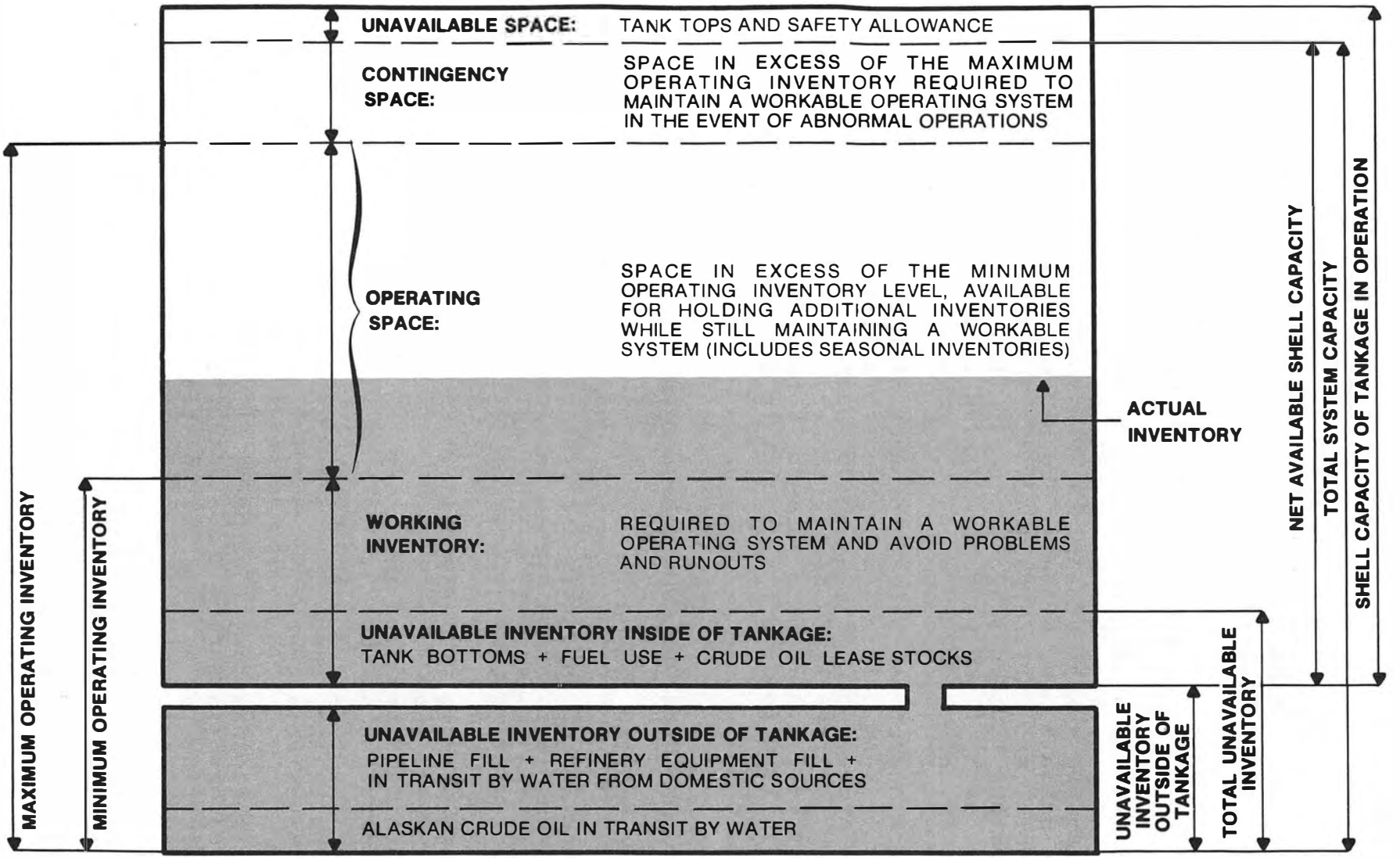

Figure 4. Simplified Diagram of Terms Describing Petroleum Inventories and Storage Capacities in the Primary Distribution System.

industry continues to develop and employ innovative techniques for reducing unavailable inventories.

The space available for maximum operating inventory is the total capacity of the system less the unavailable space (tank tops and safety allowance) and the contingency space (the empty space reserved to allow for smooth operation when inventories approach upper levels). The function and definition of unavailable inventory, working inventory, minimum operating inventory, operating space, and maximum operating inventory are discussed in greater detail as follows.

Unavailable Inventory

Unavailable inventory, the volume of oil contained in pipelines, refinery equipment, and tank bottoms, is unavailable without shutting down part of the system. It also includes inventory in transit to and from domestic sources by truck, tank car, barge, or tanker, as well as fuel set aside for use within the system and as crude oil lease stocks. More specifically, the three principal components of this inventory are:

- Pipeline Fill -- Initially, pipeline systems must be filled to operate. Subsequently, an equivalent volume of crude oil or product must remain in the line, unavailable for consumption, for normal operation.

- Refinery Fill -- Similarly, refinery equipment is filled to design levels with crude oil and various unfinished petroleum fractions. As the oil is processed, new oil is added. Consequently, the inventory volume within the process equipment remains unavailable when the refinery is in operation.

- Tank Bottoms -- In most cases, storage tanks are designed so that they cannot be totally emptied by the normal suction piping. This design prevents residue and water, which settle at the bottom, from being introduced into the crude oil or product streams.

  Some tanks are equipped with a floating roof, designed so that the roof adjusts to the level of oil in the tank. This prevents air from entering the tank as the oil is pumped out, and as the tank is filled, minimizes hydrocarbon emissions from the tank. A tank of this type is not permitted to reach a level that would allow the floating-roof legs to touch the tank bottom.

The inventory volumes cited above, inventory in transit by water, rail, and truck, fuel set aside for use within the system, and crude oil lease stocks are not available to the consumer and are thus classified "unavailable." These inventories are required to maintain the operation of the facility or transportation mode.

Working Inventory

Working inventory is the quantity of crude oil and refined products, above the unavailable inventory, needed to keep the primary distribution system functioning normally. It is the additional inventory necessary to support the operating cycle, handle unavoidable operating interruptions, and facilitate the blending of products to their final specifications. For all practical purposes, working inventory is also unavailable, but it can be used for a short time at higher operating costs. Descriptions of components of working inventory follow:

- Operating Cycles -- Typically, crude oil is delivered to a refinery by pipeline or tanker. The rate at which crude oil is delivered normally does not match the rate at which it is refined. For example, a refinery might take ten days to process the cargo that a tanker has taken two days to discharge. A varying quantity of crude oil inventory is held as a result of this imbalance. Immediately after the tanker has off-loaded, crude oil inventory in tankage is high. The inventory is gradually reduced as the refinery processes the crude oil and awaits the next delivery. Storage capacity must be provided for the maximum crude oil delivery and holdover inventories (operating margin for delayed delivery), although actual inventories will average substantially less than capacity.

  Product deliveries from a refinery operate similarly. Products manufactured in a refinery generally accumulate at rates slower than the outbound transportation facilities require. So sufficient working inventory must be on hand at all times to meet transportation system needs. For example, barge shipments of products from a refinery generally require that sufficient inventory be on hand to load a barge in less than a day. Batch shipments into pipelines are a similar example. Inventory will therefore be lowest just after a shipment, gradually increasing as the next shipment accumulates from refinery production.

- System Interruptions -- Delivery of crude oil to a refinery and shipment of products are subject to interruptions, due to unavoidable but recurring events. Inventories of both crude oil and products are held as protection against these interruptions. For example, to be prepared for an immediate crude oil runout caused by a pipeline shutdown or tanker delay, some additional crude oil will always be held in the refinery. This inventory is held not only because economics dictate continuous refinery operations, but also because it is operationally undesirable to shut down a refinery instantly; sufficient oil must be on hand to provide for an orderly shutdown. In addition, in the event of a refinery shutdown, sufficient inventory of finished

product is needed to continue to supply customers until the refinery is back in operation.

- Blending of Products -- Various unfinished products must be accumulated until sufficient quantities are available for blending in specific proportions to make finished products, such as different grades of gasoline and fuel oils.

Minimum Operating Inventory

Minimum operating inventory is the level of inventory that is necessary to maintain smooth operations and avoid runouts and below which operating problems and shortages would begin to appear in a defined distribution system. It is composed of unavailable inventory and working inventory and is normally not available for sale. The minimum operating inventory is a concept, not a precisely measurable quantity, that can be estimated more accurately for a company than for the industry as a whole. As used by the NPC, minimum operating inventory excludes the effects of seasonal product build-ups.

A company's minimum operating inventory is a function of many factors, including the location of both its supply and demand, the level of its demand, the availability of transportation and refining facilities, the mode of transportation, and the availability, size, and location of tankage. Its actual inventory may, at times, fall below the minimum operating level. In such a circumstance, a company may be able to avoid supply disruptions by special purchases of supply or by an exchange with another company, but only if these additional supplies are available. In the course of normal operations, companies do not plan on drawing down stocks below minimum operating inventories, due to the costs involved.

Estimating the minimum operating inventory on an industry-wide basis requires a complex and very difficult judgment. Merely totaling the minimum operating inventories for all companies, at a given time, may not truly represent the minimum operating inventory for the industry, because it is unlikely that all operators will reach their minimum operating levels simultaneously. It is clear that one or more companies may incur shortages and runouts before the estimated minimum operating inventory for the total industry is reached, as other companies in the system will be above their minimum. This enhances total system flexibility.

Operating Space

Although there are many purposes for maintaining certain inventory levels within the "operating space" (that space in excess of the minimum operating inventory available for holding additional inventories), this discussion will focus on two primary elements:

- Seasonal Demand -- Consumption of gasoline is greatest in summer months; consumption of heating oil is greatest in winter months. During a given season, refineries generally do not change the mix of gasoline and heating oil sufficiently to balance production with demand. Seasonal demand also results in changes in distribution patterns, such as changes in pipeline cycles and extra transportation by truck and barge. As a result, excess distillate fuel oil production in the summer may be held for winter demand, and excess gasoline production in the winter may be held for summer demand. This inventory is held in both the primary and secondary distribution systems to supply the shortfall between production capacity and peak demand. In the 1980s, while overall distillate inventories have declined, these inventories have proportionally shifted from primary bulk terminals back to the refineries. Figure 5 shows the trends in primary distillate inventory from 1977 to 1987.

- Planned Maintenance Periods -- Periodically, companies shut down refinery equipment for maintenance. To permit regular deliveries of product to customers during the shutdown, inventories must be built up ahead of time or alternative supply arrangements must be made. Since crude oil supplies cannot always be terminated on short notice, inventories at the refinery and/or in connecting pipeline terminals may increase during the shutdown period.

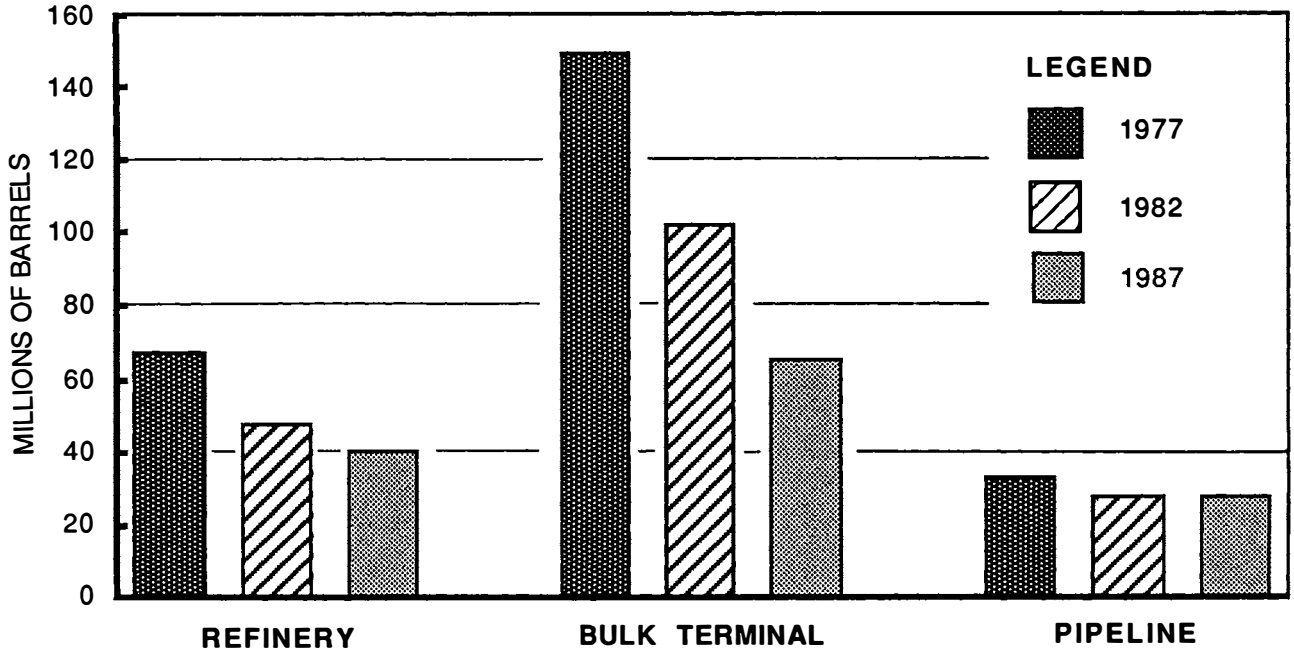

Figure 5. Primary Distillate Inventories by Location--December 31, 1977, 1982, 1987.

SOURCE: Energy Information Administration, Annual Petroleum Statement, 1977, and Petroleum Supply Annual, 1982, 1987.

Other factors affecting inventory levels within the operating space are price expectations and the perceived security of supplies.

Maximum Operating Inventory

Maximum operating inventory is the maximum quantity of petroleum that could be stored in a defined distribution system while still maintaining a workable operating system. The empty tank space above maximum operating inventory is the unavailable space (tank tops and safety allowance) and contingency space required for periods of high inventories (see Figure 4). This space is used to smooth out the operating cycles and to permit inventory build-ups during interruptions of refinery or other distribution facility operations. For example, if a product pipeline system fed by a refinery fails and the refinery tankage is full, the refinery runs the risk of shutdown. Contingency space reduces that risk. Like minimum operating inventory, maximum operating inventory is a concept, not a precisely measurable quantity.

Secondary Distribution System

The secondary distribution system links petroleum refiners with end-users of the various products. Product typically flows in bulk from the primary system into the secondary system before delivery in smaller quantities to consumers. A great deal of secondary product storage is located at bulk plants. These are wholesale storage facilities that have less than 50,000 barrels of storage capacity and, by definition, receive product only by tank car or truck, not by barge, ship, or pipeline. Also included in the secondary system is tankage at retail motor fuel outlets, such as service stations, truck stops, and convenience stores, as well as storage at retail fuel oil dealers. (See Figure 3.)

There are now approximately 15,000 companies that own and/or operate bulk plant facilities. This compares to approximately 18,000 companies in 1983. As in the primary distribution system, this reduction reflects a structural change in the secondary distribution system due to increased marketplace competition and improved distribution effiency. Bulk plant operators primarily serve a wholesale function in petroleum markets, storing product for resale at a later date. Many are also involved in the retail portion of the market, selling motor fuels and distillate fuels directly to the consumer or selling motor fuel through retail outlets.

An estimated 170,000 retail motor fuel outlets are also included in the secondary distribution system. This represents a reduction of approximately 40,000 retail motor fuel outlets from the estimated 210,000 outlets that existed in 1983; this is also due to increased marketplace competition and improved distribution efficiency. These outlets include service stations, truck stops, convenience stores, car washes, quick lube outlets, and

other automotive service facilities that sell motor gasoline and diesel fuel to consumers.

Although each facility in the secondary system tends to be much smaller than in the primary system, there are many more secondary distribution points. In addition, facilities in the secondary system are closer to the ultimate consumer and, in some instances, may be better placed to respond quickly to changes in market forces. Taken together, capacities and inventory levels in the secondary system are substantial.

Tertiary Storage Segment

The tertiary storage segment includes storage capacity and inventory of products held by end-users. The following shows the seven sectors into which the tertiary storage segment has been divided for this study, with examples:

- Agricultural -- Farm diesel fuel storage tanks
- Commercial -- Office building residual fuel oil tanks
- Electric Utilities -- Fuel tanks for electric generating plants
- Industrial -- Fuel tanks for boilers at factories
- Military/Government -- Government fuel depots
- Residential -- Home heating distillate fuel oil tanks
- Transportation -- Airline jet fuel storage; personal vehicle fuel tanks.

The amount of storage capacity and inventory in the tertiary segment is a significant portion of total U.S. capacity and product inventory, about 35 percent each. Because the tertiary segment is comprised exclusively of end-users of petroleum products, there is very little ability to relocate these inventories.

Petroleum products are usually transferred into the tertiary segment from the secondary system, although some product is supplied directly by the primary system. For example, while gasoline for automobiles generally comes from the secondary distribution system through retail gasoline service stations, commercial or rental fleet vehicles may be fueled from product storage that a company itself owns. Fuels used in the industrial sector may be supplied by jobbers or distributors (the secondary system) or, for larger companies, perhaps directly from the primary system via pipeline or barge deliveries. Similarly, many smaller airports are supplied with jet fuel by jobbers, while large commercial airlines frequently receive products directly by pipeline.

The size of their storage facilities and the inventory held by the different sectors of the tertiary segment can vary considerably. For some users, inventories remain relatively constant year-round. For others, the inventory of fuels changes greatly with the season. As an example, electric utilities that have considerable hydroelectric capacity in their systems maintain very large storage capacities and adequate inventories of residual fuel oil for power generation during drought conditions. Farms maintain low inventory levels of diesel fuel during the winter, but high levels for the planting and harvesting seasons.

CHAPTER TWO

ANALYSIS OF CHANGES IN THE PETROLEUM DISTRIBUTION SYSTEMS, 1983-1988

The U.S. petroleum industry has experienced significant economic and structural changes since the 1984 NPC report. Changes in product demand and crude oil and product prices have influenced the amount of inventory held in the primary and secondary distribution systems as well as in the tertiary segment. Despite increased demand, fundamental structural changes continue to improve the efficiency of the U.S. refining, supply, and distribution systems, at both the primary and secondary levels. The trends in NPC estimated minimum operating inventory levels have varied by product levels to reflect these structural changes. The 1988 crude oil, motor gasoline, and kero-jet fuel minimums have been increased from 1983, while distillate and residual fuel oil minimums have been reduced. Structural changes have also affected the maximum operating inventory levels, although the NPC has not estimated these upper limits.

In this chapter, historical data that reflect demand and economic changes in the industry from 1983 to 1987 are examined. Changes in the minimum operating and total inventory levels, in total storage capacity, and in tankage utilization are also examined. Final annual EIA petroleum demand data for 1988 were not available at the time this report was completed.

HISTORICAL TRENDS IN PETROLEUM INDUSTRY OPERATIONS -- PETROLEUM PRODUCT DEMAND, 1983-1987[1]

Following the decline in U.S. petroleum demand in the 1978-1982 period, demand for most products has increased, as indicated in Table 13. That overall trend continued through 1988, according to preliminary EIA data. The demand increase occurred as: (1) lower prices slowed fuel conservation and switching to other fuels, (2) the economic recovery increased consumption of most fuels, and (3) federal conservation requirements, such as improved fuel efficiency for new car fleets, were relaxed by adjustments and technical corrections.

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[1]In this report, petroleum demand is defined as withdrawals from primary stocks. Consumption is defined as the utilization of the product by an end-user.

TABLE 13

U.S. PETROLEUM PRODUCT DEMAND, 1983-1987
(Millions of Barrels per Day)

	1983	1984	1985	1986	1987	Percentage Change,* 1983-1987
Motor Gasoline	6.6	6.7	6.8	7.0	7.2	+ 8
Kero-Jet Fuel	0.8	1.0	1.0	1.1	1.2	+41
Distillate Fuel Oil	2.7	2.8	2.9	2.9	3.0	+10
Residual Fuel Oil	1.4	1.4	1.2	1.4	1.3	-12
Other	3.7	3.9	3.8	3.8	4.0	+ 9
Total§	15.2	15.7	15.7	16.3	16.6	+ 9

*Calculated using unrounded numbers.

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

Source: Energy Information Administration, Petroleum Supply Annual, 1987, 1986, 1985, 1984, 1983.

Influence of Prices on Demand

The price of crude oil and petroleum products decreased from 1983 to 1987, plunging during the latter part of this period (see Table 14). This followed a dramatic rise in oil prices during 1978-1982, the period covered by the NPC's previous report. That increase resulted from reaction to the Iranian revolution (1979-1980) and the subsequent Iran-Iraq war, which limited crude oil production from those countries. Additionally, price controls remained in effect in the United States during most of the 1978-1982 period, with complete decontrol occurring in late January 1981. Under price controls, U.S. petroleum prices had been permitted to rise to world levels and peaked in 1981, when the average annual U.S. refiner crude oil acquisition cost exceeded $35 per barrel.

As price controls were removed, fears of major supply disruptions lessened, due to (1) OPEC's inability to restrain production, (2) the increase in non-OPEC crude oil production, and (3) the decrease in world oil demand. Crude oil supply surpluses developed and crude oil prices, although subject to fluctuation, began retreating from the high levels experienced during 1978-1982. In 1986, when Saudi Arabia relinquished its role as OPEC's "swing producer" -- in order to regain lost market

share, encourage greater world oil consumption, and discourage the development and use of alternative fuels -- the price of crude oil went into a dramatic decline. In July 1986, for example, the average U.S. refiner crude oil acquisition cost fell to $11.26 per barrel, the lowest level since November 1976.

Data indicating general levels of U.S. crude oil and wholesale product prices since the 1983 NPC study are shown in Table 14. These lower oil costs slowed conservation of petroleum fuels in some sectors and increased demand in others, as indicated in Table 15. Lower fuel prices also helped to stimulate economic growth. During 1983-1987, the total economic growth (GNP) was 17.3 percent (4.1 percent per year).

As the price of petroleum products dropped, consumers increased thermostat settings and reduced the rate of switching from heating oil to natural gas. Industrial demand increased in response to lower fuel prices and the resurgence of the economy, but more energy-efficient plants and the increasing emphasis on less energy-intensive industries (e.g., light manufacturing and services) modified demand growth in this sector.

Lower prices also stimulated greater demand in the transportation sector. Despite continued improvements in the average

TABLE 14

U.S. PETROLEUM PRICES -- ANNUAL AVERAGE, 1983-1987

	1983	1984	1985	1986	1987	Percentage Change, 1983-1987
U.S. Refiner Crude Oil Acquisition Cost ($/bbl)	28.99	28.63	26.75	14.55	17.91	-38
New York Harbor Unleaded Regular Gasoline (¢/gal.)	85.3	77.8	78.4	44.3	51.6	-40
New York Harbor No. 2 Distillate Fuel Oil (¢/gal.)	79.6	79.9	76.5	45.2	51.9	-35
New York Harbor 1 % Sulfur, Low Pour Residual Fuel Oil ($/bbl)	27.22	29.11	25.12	14.46	17.93	-34

Sources: Crude oil acquisition cost, Energy Information Administration, Monthly Energy Review, March 1988; others, Platt's Monthly Oil Data.

TABLE 15

U.S. PETROLEUM DEMAND BY SECTOR, 1983-1987
(Millions of Barrels per Day)

	1983		1984		1985		1986		1987		Percentage Change, 1983-1987*
	Quantity	%	Quantity	%	Quantity	%	Quantity	%	Quantity	%	
Industrial§ (Includes Agriculture)	3.8	25	4.1	26	4.0	25	4.1	25	4.3	26	+12
Residential/ Commercial¶	1.3	8	1.3	8	1.4	9	1.4	8	1.4	8	+5
Transportation	9.4	62	9.8	62	9.9	63	10.2	63	10.5	63	+11
Electricity	0.7	5	0.6	4	0.5	3	0.6	4	0.6	3	-29
Total**	15.2	100	15.7	100	15.7	100	16.3	100	16.7	100	+9

*Calculated using unrounded numbers.

§Includes petrochemical feedstock demand.

¶Includes military/government sector.

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

Source: Energy Information Administration, Monthly Energy Review, March 1988.

fuel efficiency of the U.S. passenger car fleet, the rate of improvement slowed during 1985-1987, with the renewed emphasis on higher performance engines and modification of the 55 mile-per-hour speed limit on rural interstate highways. In addition, the overall number of passenger vehicle registrations increased, as did the number of miles traveled per vehicle. Diesel fuel demand increased as more heavy trucking was required to support the expanding economy. Aviation fuel demand has increased dramatically since 1983 in response to deregulation of the airline industry, with more passengers taking advantage of lower air fares due, in part, to lower fuel prices.

Petroleum demand in the electric utility sector continued to stagnate as energy demand growth in this sector was more than satisfied by the increased use of coal and nuclear energy.

Table 16 illustrates the trend in U.S. demand for energy, by type, since 1983.

Impact of Government Actions on Demand

Government actions have contributed to and, in some cases, initiated several system changes. Such actions by the government are aimed at specific societal goals, but produce several economic effects that must be recognized. While difficult to determine quantitatively, the NPC believes that the effects of these actions have been to increase industry and consumer costs, and thereby decrease product demand. Some of these actions include: motor gasoline lead phasedown and deregulation of the airline and trucking industries. Other actions that have been proposed by government or mentioned in the press include: additional automobile emissions controls; future environmental controls of diesel fuel quality; and increases in tariffs and taxes on raw materials and motor fuels. Table 17 highlights some of these government actions and the actual or likely effects on product demand.

Structural Change in the Petroleum Industry

The petroleum industry has undergone substantial structural change in all areas during the 1980s. The relationship between demand and economic activity has been altered, as well as the behavior of the individual products (behavior refers to overall demand, seasonality of demand, interchangeability of products, etc.) The number of firms in the industry declined as some companies merged or were acquired and many firms left the business. Production of crude oil from fields in the United States declined by over 300 thousand barrels per day (MB/D) between 1983 and 1987. The decline from the peak production year of 1985 was over 600 MB/D. Oil exporting countries tried a number of approaches in an effort to retain market share, including partial acquisition of downstream (i.e., refining and marketing) assets.

TABLE 16

U.S. ENERGY DEMAND BY TYPE OF ENERGY, 1983-1987
(Millions of Barrels of Oil Equivalent per Day)

	1983		1984		1985		1986		1987		Percentage Change, 1983-1987*
	Quantity	%	Quantity	%	Quantity	%	Quantity	%	Quantity	%	
Oil	15.2	43	15.7	42	15.7	42	16.3	43	16.7	43	+9
Natural Gas	8.8	25	9.4	25	9.0	24	8.5	23	8.7	23	- 1
Coal	8.0	22	8.6	23	8.9	24	8.7	23	9.1	24	+13
Nuclear	1.6	4	1.8	5	2.0	5	2.3	6	2.5	6	+53
Other	2.0	6	2.0	5	1.8	5	1.8	5	1.7	4	-18
Total[§]	35.7	100	37.5	100	37.4	100	37.6	100	38.7	100	+ 8

*Calculated using unrounded numbers.

[§]Totals may not equal sum of components due to independent rounding.

Source: Energy Information Administration, Monthly Energy Review, March 1988.

TABLE 17

GOVERNMENT IMPACT ON PETROLEUM PRODUCT DEMAND

Action	Effect on Product Demand
Lead phasedown	Steep drop in demand for leaded gasoline; additional gasoline segregations; introduction of a "mid-grade" unleaded gasoline; reduced industry inventory flexibility; increased raw material use for a given level of product output
Deregulation of airline/ trucking industries	Substantial increase in demand for jet fuel and diesel fuel
Proposed Action	**Likely Effect on Product Demand**
Proposed controls on hydrocarbon emissions (gasoline vapor pressure reduction)	Reduction in demand for butane in gasoline; production of high octane blending components to replace butane; increased raw material use to maintain gasoline octane
Proposed reduction of sulfur and aromatics in diesel fuel	A substantial investment in new refining facilities, with this cost reflected in higher consumer prices; increased prices, promoting conservation and demand reduction
Items impacting crude oil cost - Tariffs - Superfund	Reduction of petroleum product demand as a result of increasing crude oil cost
Motor fuel excise tax increases	Downward pressure on motor fuel consumption (gasoline and diesel), depending on the level of the tax increase

Early in the decade, because of declining demand, U.S. refiners reduced runs by 3.0 MMB/D from peak levels of 14.7 MMB/D set in 1978 to 11.7 MMB/D in 1983. Initially, this reduction in runs was not balanced by a reduction in capacity. However, operable crude oil distillation capacity was reduced by 2.7 MMB/D after 1980, declining from 18.6 MMB/D in January 1981 to 15.9 MMB/D in January 1988. The decrease in refining activity and fall in output of crude oil production in the United States caused the volume of crude oil and products transported by pipeline to decrease from 564 billion ton-miles in 1981 to 556 billion ton-miles in 1983. However, this trend was reversed in 1984.

The drop in product demand early in the decade and uncertainties relating to the actions of OPEC led to a decline in inventory and storage capacity between 1983 and 1988. Uncertainty about the trend in prices after 1985 caused many firms to intensify efforts to hold stocks to a minimum. For example, the ratio of stocks above minimum operating inventory to consumption (referred to as days of supply) for distillate fuel oil declined from four days on March 31, 1983, to only one day on March 31, 1988. This reduction was influenced, in part, by the April 1988 tax increase discussed previously.

In addition, new financial markets, including futures and forward markets, new contractual mechanisms, and options were developed. These markets enable firms to reduce the financial risk associated with purchasing petroleum, thus allowing a reduction in average inventory levels.

PRIMARY DISTRIBUTION SYSTEM ANALYSIS

Minimum Operating Inventory Levels in the Primary Distribution System, 1983 and 1988

The industry-wide minimum operating inventory is the inventory level below which operating problems and shortages would begin to appear in a defined distribution system. (See Chapter One for a description of inventory terms.) Minimum operating inventory includes pipeline fill, tank bottoms, and other unavailable inventory, plus the amount of working inventory needed to keep the distribution system operating without supply disruptions. Much of this working inventory is in the unavailable category. Thus, as demand for a product declines, its minimum operating inventory would not be expected to decline proportionally. Unavailable inventory will decline to the extent that some refineries and pipelines, no longer needed, are removed from the system, and/or tankage utilization becomes so low that some tankage is idled. Inventory held above minimum will vary more directly with changes in demand, price, interest rates, and security of supply.

Changes in the Minimum Operating Inventory Levels, 1983 to 1988

The estimated minimum operating inventory levels for crude oil and the petroleum products surveyed in this study are 5 million barrels lower than those reported in the 1983 study, as shown in Table 18. This reduction in the minimum operating level is due to the decline in the estimated minimum necessary for distillate and residual fuel oils, which dropped below their earlier minimum operating inventories several times between 1983 and 1988, with little effect. Minimum operating levels for crude oil, motor gasoline, and kero-jet fuel increased as a result of increased demand, and in the case of crude oil, as a result of greater dependence on imports with their larger-volume shipments. This contrasts with the 1979-1983 period, when a drop in minimum operating inventory levels was largely due to a decline in demand

TABLE 18

NPC MINIMUM OPERATING INVENTORY ESTIMATES* FOR THE PRIMARY DISTRIBUTION SYSTEM
(Millions of Barrels)

	1988			Change in Total U.S., 1983-1988
	PADDs I-IV	PADD V	Total	
Crude Oil§	230	70	300	+15
Motor Gasoline	178	27	205	+5
Kero-Jet Fuel	25	5	30	+5
Distillate Fuel Oil	77	8	85	-20
Residual Fuel Oil	25	5	30	-10
Total¶	535	115	650	-5

*The NPC estimates of minimum operating inventory were developed through an interactive decision-making process. In order to arrive at a consensus, individual judgments were considered with the aid of operating experience and relevant statistical data.

§Excludes SPR. Alaskan crude oil in transit by water is included in PADD V to be consistent with the EIA reporting system.

¶Totals include crude oil and surveyed petroleum products only, but not kerosine, which was estimated to be 5 million barrels in 1984.

for petroleum products fostered by a decrease in general economic growth, a significant increase in the price of petroleum, and consumer conservation practices including fuel switching. The changing demands for petroleum products are causing fundamental structural changes in the refining, supply, and distribution patterns of the U.S. petroleum industry. These industry changes are dynamic, as product demand patterns are still changing. As a result, minimum operating inventory is a dynamic, rather than static, figure that will continue to change in response to factors affecting the industry.

It is important to note that the NPC minimum operating inventory total represents the sum of only those products included in its survey. Although kerosine, asphalt, lubricating oils, and "other oils" play a key role in the U.S. petroleum picture, data for these products were not collected. Naphtha-based jet fuel was also excluded from the 1988 survey. Consequently, this report presents no estimate of a total minimum operating inventory for all petroleum products. Seasonality of demand was not considered in determining minimum operating inventory levels, despite the fact that certain products, such as distillate fuel oil, are subject to seasonal variations during the year.

The EIA's Weekly Petroleum Status Report publishes an "observed minimum" (the lowest end-of-month total petroleum inventory level during the recent 36-month period) for comparison with the current total petroleum inventories it reports weekly. Data users are cautioned that the NPC's estimated minimum operating inventories for crude oil and selected products can be compared meaningfully only with the EIA's inventories for the same commodities.

Methodology Used in Estimating the 1988 Minimum Operating Inventory Levels

As in previous NPC estimates of the minimum operating inventory levels, the 1988 estimates were developed through an interactive decision-making process in which industry expert views were solicited. In order to arrive at a consensus, individual judgments were discussed in the context of operating experience and relevant data. The data used were: (1) the sum of the individual company minimum operating inventories as reported in the 1988 NPC survey, (2) industry-wide estimates of minimum operating inventory levels as reported in the 1988 NPC survey,[2] and (3) historical inventory data. The NPC survey data are reported in Appendix E; the historical inventory data are shown graphically in Appendix J.

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[2]These estimates were used for general reference only, as only a few estimates were reported.

The historical inventory data provide a means of testing the reasonableness of the previous minimum operating inventory levels by determining whether any spot shortages or distribution problems occurred when stocks were above or below the 1983 NPC minimum operating inventory levels. Those problems can then be explained in the context of the increased NPC estimates of minimum operating inventory since the last NPC study.

Crude Oil

Total crude oil inventories remained above the minimum operating level of 285 million barrels estimated in the NPC's 1983 study without any significant physical shortages. Therefore, no physical test of the estimate has occurred. However, because of increased refinery inputs of crude oil, declining U.S. crude oil production, and increased dependence on imports from foreign countries, the NPC increased its estimate of minimum operating inventory to 300 million barrels, an increase amounting to slightly over one-day's requirement for refinery processing. The NPC estimate of minimum operating inventory is greater than the sum of the individual company responses of minimum operating inventory; this was also true in 1983.

The 1988 minimum operating inventory estimate includes 21.6 million barrels of Alaskan crude oil in transit by water, versus 31.2 million barrels in the 1983 estimate. This Alaskan volume is not strictly a minimum, since these in-transit stocks are often lower than 20 million barrels. They fluctuate with Alaskan North Slope (ANS) production, West Coast consumption of ANS, and pipeline and terminal operations. This decrease in in-transit ANS crude oil, however, was offset by the increased quantities of imported crude oil. Imported crude oil generally moves in batch sizes five to ten times greater than domestic crude oil and, hence, has a larger effect on the working inventory component of minimum operating inventory.

The survey results show that total inventory (excluding ANS in transit and EIA lease stock adjustments) on March 31, 1988, was about 8 million barrels above the level on March 31, 1983. This is about equal to the increase in pipeline fill and the pipeline construction that has occurred during the past five years.

The survey results also show that between 1983 and 1988, crude oil stock holders have made more efficient use of storage capacity. This is reflected in a higher ratio of inventory held to total operating system capacity and a lower ratio of tank bottoms, tank top, and safety allowance to capacity.

Tankage under construction in 1988 amounted to 0.4 million barrels compared to 10.0 million barrels in 1983.

Motor Gasoline

At the national level, motor gasoline inventories have not dipped below the 1983 estimate of minimum operating inventory. Gasoline inventories came close to the minimum operating inventory in the spring of 1986 and again in the summer of 1988, but no significant regional shortages developed in the primary distribution system. However, because motor gasoline demand increased 600 MB/D during the 1983-1987 period, and in response to the survey results, the minimum operating inventory for motor gasoline has been increased from 200 million barrels to 205 million barrels.

Total operating system capacity for motor gasoline was 459 million barrels as of March 31, 1988, increasing slightly from 456 million barrels in 1983. Although demand for motor gasoline has increased approximately 9 percent, inventories have not changed proportionally. March 31, 1988 inventories were 231 million barrels, up from 223 million barrels as of March 31, 1983. Competitive pressures have forced the industry to be more efficient in its overall production, distribution, and inventory-holding patterns.

Idle tankage has increased from 1983, while tankage under construction has dropped.

Kerosine-Type Jet Fuel

On a national level, the actual inventories of kerosine-type jet fuel (kero-jet fuel) have not fallen below the minimum operating inventory levels established in the 1983 study. However, kero-jet fuel inventories came close to minimum levels in early 1984. No actual shortages of this product were known to exist during the 1983-1988 period. Hence, no critical test of the 1983 minimum operating inventory figures has occurred. Based on this operating experience, the increased demand for this product, and the increased volume of pipeline fill, the NPC's previous estimate of the kero-jet fuel minimum operating level has been increased from 25 to 30 million barrels.

A number of changes in storage capacities and inventories for kero-jet fuel are highlighted by the latest NPC survey results. Both the amount of storage capacity and total inventory increased since the previous NPC survey. Total primary shell capacity in kero-jet fuel service increased by almost 21 percent from 1983 to 1988. Total inventories increased by 14 percent during that period. These increases primarily reflect the substantial increase in kero-jet fuel demand experienced during the five-year period.

In contrast to these increases, the adjusted minimum operating inventory reported in the survey actually decreased by 8 percent during the 1983-1988 period. This decrease is the result of fundamental changes in the way kero-jet fuel is supplied to commercial air carriers. More domestic refiner-

suppliers now participate in the market. In addition, whereas almost 100 percent of airline demand was met under contract by refiner-suppliers five years ago, only about 70 percent of demand is now supplied under such contracts. Kero-jet fuel demand has increasingly been met through nontraditional contract and spot purchases by the airlines, and these volumes are typically handled through non-refiner terminal tankage. (The airlines, in addition, now control more storage in the tertiary segment, having purchased airport tankage and related distribution systems formerly controlled by major refiners.)

Thus, it is not surprising that minimum operating inventories have decreased during the period since refiners, who formerly carried nearly all primary kero-jet fuel inventories for contract supply, are now responsible for supplying only 70 percent of total demand by contractual arrangement. Additionally, these companies are operating with lower inventories to reduce working capital requirements. Furthermore, it is believed that the individual non-refiner storage companies who store kero-jet fuel for the airlines did not report minimum operating inventories higher than tank bottoms.

In the same vein, the increase in primary shell capacity dedicated to kero-jet fuel service can also be explained, in part, by the increased amount of tankage held by independent (i.e., non-refiner) storage companies for airlines or airline consortiums wishing to avail themselves of spot purchase opportunities on a regular basis. Also, this increase in shell capacity can be attributed to the larger number of domestic refiner-suppliers now participating in the market.

These considerations help to explain the increase in storage capacity and decrease in minimum operating inventory as reported by individual companies. However, the overall NPC minimum operating inventory increase for kero-jet fuel is considered to be valid based upon the significant increase in total demand for this product and the increase in pipeline fill.

Distillate Fuel Oil

Distillate fuel oil inventories fell well below the previous minimum operating levels in almost every year since 1983. Inventories were tight, but shortages did not occur. The sum of the individual company minimum operating inventories and the fact that inventories have been below the minimum operating inventory without widespread shortages support the Council's reduction of the minimum operating inventory estimates from 105 million barrels to 85 million barrels.

Total inventories of distillate fuel oil were 89.3 million barrels on March 31, 1988, down substantially from the level reported in 1983, having fallen more sharply than the inventory of any of the other surveyed products. The decline reflects both structural changes in the industry and demand patterns. Changes in supply management -- a broadened trading environment, the

increasing sophistication of the independent marketer, and additional sources of imports, for instance -- enhance supply options, making it easier and less risky to run on lower inventories. On the demand side, the growth of on-highway diesel use has reduced the seasonality of distillate stocks, eliminating the need for as extensive an inventory cushion to meet weather-induced demand surges. (As noted in the subsequent discussion of total primary inventories, March 31, 1988 distillate inventories were also depressed by the change in the collection point for diesel fuel excise taxes.)

The reduced seasonality and increased supply options are also reflected in the lower share of inventories held in bulk terminals. The trend toward lower bulk terminal stocks began before the last NPC report. On March 31, 1988, bulk terminals in the primary system held 45 percent of the stocks reported to EIA, compared to 54 percent on March 31, 1980, a decline of 56 million barrels.

The survey results show that distillate has the highest volume of idle tankage, 19 million barrels, of the petroleum products surveyed, even though total storage capacity has declined by 34 million barrels since the 1983 survey. Because of regulatory constraints on building new tankage, especially in areas such as the Northeast, companies may be slower to deactivate tanks. The decrease in overall distillate capacity appears to be due to switching of distillate tankage to jet fuel and motor gasoline service.

Residual Fuel Oil

The residual fuel oil market is still undergoing significant changes that affect working inventory requirements. Therefore, the residual fuel oil minimum operating inventory estimate was developed with a lower degree of confidence than those of the other products. Residual fuel oil inventories dropped below the 1983 estimate of minimum operating inventory in the spring of 1986 and 1987. Shortages did not occur, for example, because electric utilities carry adequate residual fuel oil inventories. The strong residual fuel oil inventories in the electric utility sector and the significant reduction in residual fuel oil demand due to fuel switching support the reduction in minimum operating inventory for residual fuel oil from 40 million barrels to 30 million barrels.

Existing refinery downstream conversion capacity was more fully utilized and additional capacity added in the United States to convert residual fuel oil to light products. While total operating system capacity for residual fuel oil decreased by almost 20 percent since 1983, total inventories of petroleum product dropped by only 5 percent. The relatively small drop in residual fuel oil inventory as compared to storage capacity can be attributed to: (1) residual fuel oil suppliers continuing to carry adequate primary inventories of residual fuel to compete with natural gas and (2) the storage capacity reductions.

There was about 42 percent less idle tankage available for residual fuel oil in 1988 than in 1983 (7.2 million barrels in 1988 versus 12.4 million barrels in 1983). The NPC believes that most of this tankage was converted to crude oil or other product service while a smaller proportion was likely deactivated. While there were 3.7 million barrels of residual fuel oil capacity under construction in 1983, no tankage was reported as under construction in 1988 for this product.

Days' Supply of Inventory Calculations

The NPC again examined how the concept of days' supply of inventory might provide a misleading picture of inventory levels. Minimum operating inventory levels do not decline proportionally with demand. Moreover, minimum operating inventories are not routinely available for use without causing shortages, but can be used for short periods of time at higher operating costs. Therefore, days' supply of inventory calculations based on total inventory do not present a valid indication of the adequacy of inventory levels. A better way to judge the adequacy of inventory levels is to look at how much inventory is accessible above the minimum required to run the system:

$$\frac{\text{total inventory - minimum operating inventory}}{\text{current daily demand}} = \text{days' supply of inventory above minimum}$$

By using this method, March 31, 1988 data for motor gasoline would indicate 3.6 days' supply of that product, as displayed below, compared to 31.6 days' supply when calculated on the basis of total inventory:

$$\frac{231 \text{ MMB} - 205 \text{ MMB} = 26 \text{ MMB}}{7.3 \text{ MMB/D}} = \text{3.6 days' supply of inventory above minimum}$$

versus $\frac{231 \text{ MMB}}{7.3 \text{ MMB/D}}$ = 31.6 days' supply of total inventory

Table 19 compares the days' supply of inventory for March 31, 1983 with March 31, 1988, when calculated on the basis of total inventory and inventory above minimum. Clearly, the days' supply of inventory above minimum is a much lower number than the days' supply of total inventory. The former is more indicative of available supply, however, and is therefore more useful for emergency preparedness planning. A seemingly low number of days' supply above minimum should not be of concern in times of normal operations. The flexibility inherent in the petroleum supply and distribution systems, together with ample crude oil supply, refining capacity, and transportation facilities, ensures the ability of the systems to meet product demand over time. While total inventories have decreased since 1983,

TABLE 19

DAYS' SUPPLY OF INVENTORY
IN THE PRIMARY DISTRIBUTION SYSTEM

	March 31, 1983		March 31, 1988	
	Total Inventory	Inventory Above Minimum*	Total Inventory	Inventory Above Minimum§
Crude Oil¶	33	6	27	4
Motor Gasoline	33	3	32	4
Kero-Jet Fuel	44	12	33	8
Distillate Fuel Oil	40	4	25	1
Residual Fuel Oil	29	4	31	10

*The NPC's 1983 estimate using 1983 minimum operating inventories.

§The NPC's 1988 estimate using 1988 minimum operating inventories.

¶Excludes SPR, which on March 31, 1988 held 545 million barrels, or 114 days' supply of crude oil imports.

Source: National Petroleum Council "1988 Survey of U.S. Petroleum Inventories and Storage Capacities (Primary Distribution System)."

the amount of inventory above minimum (in terms of days' supply) is generally consistent with the 1983 level. The potential drawdown of inventory held by the secondary system and certain sectors of the tertiary storage segment provides substantial additional flexibility in times of tight supply.

Since 1983, the percentage of crude oil supplied to refiners from domestic sources has fallen from approximately 75 percent to about 64 percent. While the primary distribution system is somewhat more vulnerable than in 1983 with regard to imported crude oil, there are several factors that mitigate any potential disruption in product supply.

- A significant proportion of imported crude oil has a long in-transit time (30-50 days). Sufficient time is available to locate alternative nearby crude oil and products as import replacements.

- The combined systems holding U.S. petroleum product inventories (primary, secondary, tertiary) are

available to moderate short-term "demand surges" and supply transients.

- In the past five years, substantial capital investments have been made in downstream refining capacity, such as vacuum distillation, thermal and catalytic cracking, coking, and catalytic hydrocracking and hydrotreating. Thus, the system's flexibility to handle various grades of crude oil and to produce a greater percentage of light products has improved.

- Finally, in the event of a severe disruption, the SPR stocks are intended, and available, for drawdown and use.

Total Inventory Levels in the Primary Distribution System, 1983 and 1988

The total inventory level of crude oil and the principal petroleum products has decreased since the previous study, as shown in Table 20. Almost all the decline occurred in distillate fuel oil. The aggregate amount of inventory actually held above minimum operating inventory levels has remained relatively constant.

In the primary system, the amount of inventory held above minimum operating inventory is largely determined by the level of product demand, price expectations, the cost of storing products and crude oil, the perceived security of crude oil and product supply, and the seasonal storage and maintenance factors discussed in Chapter One.

Seasonality of Petroleum Product Demand

The petroleum products historically exhibiting the greatest seasonality of demand (distillate fuel oil and residual fuel oil) are becoming less seasonal. As seasonality declines, less product must be held in inventory to ensure supplies during peak periods of demand. Demand and inventory levels for the surveyed products for the years 1983 to 1987 are found in Appendix J.

Effect of Price Expectations

As noted above, inventory held above minimum is stored primarily to meet demand. In a free-market environment, a company's expectations regarding future petroleum prices also influence the level of inventory it holds. For example, increasing worldwide demand experienced in late 1987 and early 1988 created significant upward price expectations in the spring of 1988; accordingly, companies were increasing their crude oil inventory levels.

Cost of Storing Product

The price of oil and level of interest rates are the two major factors affecting the cost of holding inventory. The

TABLE 20

TOTAL INVENTORY OF CRUDE OIL AND PRINCIPAL PETROLEUM PRODUCTS IN THE PRIMARY DISTRIBUTION SYSTEM
(Millions of Barrels)

	March 31, 1983			March 31, 1988		
	PADDs I-IV	PADD V	Total¶	PADDs I-IV	PADD V	Total¶
Crude Oil*	269	86	355	263	80	343
Motor Gasoline§	197	26	223	203	29	231
Kero-Jet Fuel	28	6	35	33	6	40
Distillate Fuel Oil	107	11	118	80	9	89
Residual Fuel Oil	37	9	46	35	9	44
Total¶	639	138	777	614	133	747

	September 30, 1982			September 30, 1987		
	PADDs I-IV	PADD V	Total¶	PADDs I-IV	PADD V	Total¶
Crude Oil*	258	82	341	261	76	337
Motor Gasoline§	206	28	234	198	31	230
Kero-Jet Fuel	27	6	33	38	6	44
Distillate Fuel Oil	151	10	161	116	11	127
Residual Fuel Oil	51	10	62	35	9	44
Total¶	694	137	831	648	134	782

*Excludes SPR and 10.6 million barrels of lease stocks adjustments. Alaskan crude oil in transit by water is included in PADD V (31.2 million barrels in 1983; 21.6 million barrels in 1988).

§Motor gasoline stocks data represent finished motor gasoline and motor gasoline blending components.

¶Totals include crude oil and surveyed petroleum products only. Totals may not equal the sum of components due to independent rounding.

Source: Energy Information Administration, Petroleum Supply Annual, Vol. 2. 1982, 1983, and 1987, and Petroleum Supply Monthly, March 1988.

estimated cost of holding one gallon of gasoline in inventory, which was about 14¢ per gallon per year in 1982 is about 4¢ per gallon per year in 1988. As shown in Table 21, the estimated total annual holding and tankage cost of gasoline has declined from 1983 to 1988. However, firms in the petroleum industry continue to manage their inventories so that no more than the minimum economic levels are held.

Security of World Crude Oil and Petroleum Product Supply

Perceived security of world crude oil and petroleum product supply is another factor in determining how much inventory is held above minimum operating inventory levels. The dependence of the United States on net petroleum imports (excluding SPR fill) increased from 27 percent in 1982 to 35 percent in 1987. Imports are currently higher than 1982 levels, and forecasters predict that U.S. import requirements will, over the longer term, continue to increase. However, even in light of increasing imports, today's concerns about short-term security of supply have eased significantly since the 1984 NPC report. This is principally because world crude oil is now in oversupply due to increases in total OPEC and non-OPEC production above worldwide petroleum demand. OPEC production of crude oil and natural gas liquids in 1987 was 19.5 MMB/D versus 20.0 MMB/D in 1982, while non-OPEC production including the Eastern Block was 41.1 MMB/D versus 37.1 MMB/D in 1982.

TABLE 21

ESTIMATED GASOLINE STORAGE COST

	1982	1985	1988
Product Value (¢/gal.)*	90.9	78.4	51.6
Interest Rate (%)§	14.9	9.3	8.6
Holding Cost (¢/gal./yr.)	14	7	4
Tankage Cost (¢/gal./yr.)¶	7	6	7
Total Storage Cost (¢/gal./yr.)	21	13	11

*Data taken from Platt's Oil Price Handbook and Oilmanac, 1988.

§Average prime rate for year, as cited in The Federal Reserve Board Bulletin.

¶Estimated cost of commercial storage space.

The Strategic Petroleum Reserve

The SPR held 545 million barrels of crude oil as of March 31, 1988, versus 312 million barrels of crude oil as of March 31, 1983. That reserve is held by the U.S. government to reduce major adverse effects of disruptions in petroleum supplies. The SPR drawdown capability is currently 3.5 MMB/D; however, current pipeline throughput limitations restrict distribution capability to 3.0 MMB/D. Distribution/drawdown capability was 1.7 MMB/D in 1983. The SPR facility development program is currently designed to provide a cumulative storage capacity of 750 million barrels and a drawdown/distribution capability of 4.5 MMB/D by 1992.

All respondents to the NPC's questionnaire concerning the Strategic Petroleum Reserve indicated that the SPR has not influenced the amount of oil they routinely hold in inventory. About two-thirds of those who responded to the SPR questionnaire favored early drawdown of the SPR during an emergency. About one-third of the companies responding to the SPR questionnaire were familiar with and had opinions concerning the DOE's Drawdown Plan for the SPR; most of these were refiners who favored restricting SPR purchases to U.S. refiners. (See Appendix D for a copy of the SPR questionnaire and Appendix G for more detailed information concerning the SPR and results of the SPR questionnaire.)

Spare Refining Capacity

Since 1983, in response to the shift in demand from heavy low-value products, such as residual fuel oil, toward lighter products, such as motor gasoline and diesel fuel, refiners have significantly increased crude oil processing flexibility by upgrading downstream refining capacity. Between 1983 and 1987, the industry increased this downstream capacity by over 1,400 MB/D (see Table 22).

During this time, U.S. crude oil distillation capacity was reduced by 1 MMB/D while refinery input to crude oil distillation increased by 1.1 MMB/D and demand for petroleum products increased by roughly 1.5 MMB/D. These factors have led to a significant reduction in spare crude oil distillation capacity in the United States. However, the 1987 utilization rate of 83 percent is still lower than the 84 to 94 percent utilization rate of the 1970s and is just approaching the 85 to 90 percent utilization rate for which most refineries are designed for greatest efficiency. (See Appendix I for an historical perspective on refinery capacity and utilization.)

The U.S. refining industry continues to be the most sophisticated in the world. During the 1983-1987 period, about 88 percent of total U.S. product demand and about 95 percent of U.S. gasoline and distillate fuel oil demand were supplied from U.S. refinery production. The balance of the gasoline and distillate fuel oil demand is primarily supplied from secure Western Hemisphere sources. Additionally, the United States produces

TABLE 22

INCREASE IN DOWNSTREAM REFINING CAPACITY, 1983-1988

	Capacity Increase (MB/D)	% Increase
Vacuum Distillation	18	0.3
Thermal Cracking/Coking	365	21.3
Catalytic Cracking	(84)	-1.4
Catalytic Hydrocracking	319	36.1
Catalytic Hydrotreating	816	9.8
Total*	1,434	6.0

*Includes 71 MB/D additional, resulting from inclusion of Hawaiian Independent Refinery in the U.S. total, beginning in 1987.

Source: EIA, Petroleum Supply Annual, 1987.

about 60-70 percent of its residual fuel oil requirements, with the balance also supplied from traditional secure import sources. (See Appendix H.) Unused operating, plus idle crude oil distillation capacity can be used to make substantial quantities of additional residual fuel oil if necessary.

Petroleum Futures Markets

Petroleum futures (as traded on the New York Mercantile Exchange and London's International Petroleum Exchange) may be perceived by some companies as a way to reduce inventory and ensure supplies. The results of the 1988 NPC survey of the primary and secondary distribution systems suggest that, at present, petroleum futures do not significantly affect the level of inventories held in the primary system (see Appendix F). Eighty-seven percent of the survey respondents indicated that the futures markets had not affected the level of physical inventories held. Of the inventories held by respondents who used hedges, the volume-weighted average typically backed by hedges was 11 percent. Due to the size of the companies and their inventories, this percentage ranged from 1 to 100.

Most participants in the market fulfill their contractual obligations to buy or sell through an opposite, offsetting futures transaction, rather than by delivering or taking delivery of "wet" barrels.

Maximum Operating Inventory in the Primary Distribution System

The maximum operating inventory is the maximum quantity that could be stored in a defined distribution system while still maintaining a workable operating system.

The NPC recognizes that the limits of the industry-wide maximum operating inventories have not been tested in the same sense as have the minimum operating inventories. Therefore, the NPC cannot estimate valid limits for maximum operating inventories on an industry-wide basis. Further, the NPC is concerned that a quantification of the maximum limits might imply the same degree of confidence as that inherent in the estimation of the minimum limits.

The survey results of the sum of the individual company maximum operating inventory levels and the industry-wide estimates are shown in Appendix E. The NPC urges caution in the interpretation of these data. Facility location and access to transportation networks, refining centers, and markets all affect the upper limits of petroleum industry operations.

Total Storage Capacity in the Primary Distribution System

The total capacities of tankage in operation and tankage under construction in 1983 and 1988 are shown in Table 23. The grand total for both categories of storage capacity for crude oil and the petroleum products surveyed declined by about 4 percent since the 1984 report. However, tankage for crude oil remained constant during that same period. While a number of refineries closed (particularly early on), crude oil capacity increased in the remaining refineries as a result of the upturn in overall demand for petroleum (particularly during the latter part of the period) and to accommodate the larger vessel cargoes associated with rising crude oil imports.

Tankage for motor gasoline decreased slightly from 1983 to 1988, reflecting greater efficiency in tankage utilization to meet increased demand for this product. Kero-jet fuel tankage increased substantially during the period in response to the significant increase in demand for this product. Tankage for distillate and residual fuel oils declined significantly during the 1983-1988 period, due primarily to the declining seasonality of demand for distillate fuel oil and decreased consumption of residual fuel oil.

As noted, the total tankage in operation on March 31, 1988, was slightly less than that on March 31, 1983. Besides varying trends in tankage capacity for the different products, as discussed above, there appear to be three other reasons for the overall reduction in tankage: the reduction in crude oil and product demand in the late 1970s and early 1980s, causing further refinery and terminal shutdowns and tankage consolidation subsequent to March 31, 1983; the deletion from service of tankage that was not retrofitted to meet environmental regulations; and

TABLE 23

SHELL CAPACITY OF TANKAGE IN OPERATION
AND TANKAGE UNDER CONSTRUCTION
IN THE PRIMARY DISTRIBUTION SYSTEM
(Millions of Barrels)

	March 31, 1983		March 31, 1988	
	Tankage in Operation	Tankage Under Construction	Tankage in Operation	Tankage Under Construction
Crude Oil*	499	10	508	§
Motor Gasoline	456	3	451	1
Kero-Jet Fuel	68	§	82	§
Distillate Fuel Oil	295	1	261	§
Residual Fuel Oil	143	4	117	0
Total¶	1,461	18	1,419	2

*Excludes SPR and a portion of lease stocks tankage. Reported inventories of lease stocks were 11 million barrels in both 1983 and 1988.

§Less than 0.5 million barrels

¶Totals include tankage for crude oil and surveyed petroleum products only. Totals may not equal the sum of components due to independent rounding.

Source: National Petroleum Council "1988 Survey of U.S. Petroleum Inventories and Storage Capacities (Primary Distribution System)."

the physical deterioration of tankage. To bring some of that tankage back into service, environmental regulations would have to be waived or tankage systems upgraded. Tankage idle but available within 90 days' notice is shown in Table 24. This tankage, the tankage in operation, and tankage under construction together provide an estimate of the total tankage available to the system.

Although the idle tankage can be restored to service, much of it is dispersed in relatively small volumes throughout the nation. Therefore, relying on any substantial part of this tankage for emergency preparedness planning is not practical.

Table 25 compares the percentage utilization of tank capacity in the primary distribution system over the 40-year

TABLE 24

POTENTIALLY AVAILABLE TANKAGE
IN THE PRIMARY DISTRIBUTION SYSTEM AS OF MARCH 31, 1988,
THAT IS IDLE BUT CAN BE REACTIVATED WITHIN 90 DAYS
(Millions of Barrels)

Crude Oil	18
Motor Gasoline	17
Kero-Jet Fuel	4
Distillate Fuel Oil	19
Residual Fuel Oil	7
Total*	66

*Total includes tankage for crude oil and surveyed petroleum products only. Total may not equal the sum of components due to independent rounding.

Source: National Petroleum Council "1988 Survey of U.S. Petroleum Inventories and Storage Capacities (Primary Distribution System)."

TABLE 25

PERCENTAGE UTILIZATION OF TANK CAPACITY
IN THE PRIMARY DISTRIBUTION SYSTEM, 1948-1988

NPC Survey Date	Inventory as a Percentage of Tank Capacity
March 31, 1948	42
June 30, 1950	45
March 31, 1952	45
March 31, 1954	48
March 31, 1957	45
September 30, 1962	50
September 30, 1969	53
September 30, 1973	48
September 30, 1978	48
March 31, 1983	40
March 31, 1988	41

Source: National Petroleum Council Surveys, 1948 to 1988.

history of the NPC inventory reports. Inventory in tankage has averaged about 46 percent of storage capacity over the period and has ranged from a high of 53 percent in 1969 to a low of 40 percent in 1983. During the operating cycle, tanks do fluctuate between the minimum and maximum operating levels. However, the average has varied little. Table 26 shows the utilization of storage capacity by surveyed product as of March 31, 1988. With product demand once again increasing and with refineries running at high utilization rates, it is anticipated that very little storage capacity will be deactivated during the next few years.

In summary, the NPC has concluded that the minimum operating inventory for crude oil, motor gasoline, and kero-jet fuel has increased, and decreased for distillate fuel oil and residual fuel oil. These changes in minimum operating inventory reflect structural changes in the distribution system, increased consumption of certain products, reduced U.S. crude oil production with an increase in crude oil imports, and continued economic pressures to hold inventories at minimum levels.

The primary distribution system has also undergone considerable system change in the past five years: petroleum demand has grown, segregation of refined proucts has increased, refineries have continued to close, and U.S. dependence on foreign crude oil has grown. The most significant system change has been the shutdown and consolidation of uneconomical or obsolete refineries following government decontrol. Increased competition has tended to reduce petroleum prices. Resultant facility shutdowns have decreased storage capacity; lower prices have reduced domestic crude oil production and increased imports; refinery capacity is more fully utilized.

SECONDARY DISTRIBUTION SYSTEM ANALYSIS

Analysis of storage levels and capacity in the secondary distribution system is similar in objective to that of the primary system. Emphasis is placed on developing estimates of storage capacity and inventories for major petroleum products in the secondary system as of March 31, 1988.

The secondary system presents analytical difficulties, however, particularly since its population is much larger and sometimes difficult to define. It is, nevertheless, an important element of the overall product distribution system, and one that is often overlooked. This study represents the NPC's second survey-based effort designed to improve the availability and accuracy of information about secondary inventories and storage capacities.

The secondary system is that portion of the overall distribution network that falls between producers and end-users. It is generally defined to include bulk plants, which store motor fuels, heating fuels, and other products primarily for wholesalers, as well as retail motor fuel outlets.

TABLE 26

UTILIZATION OF STORAGE CAPACITY
IN THE PRIMARY DISTRIBUTION SYSTEM
AS OF MARCH 31, 1988*
(Millions of Barrels)

	Crude Oil	Gasoline	Kero-Jet Fuel	Distillate Fuel Oil	Residual Fuel Oil	Total
Actual Inventory Reported to NPC	283.1	203.1	38.5	75.7	31.9	632.3
Less: Inventory Outside of Tankage	72.2	37.0	8.6	14.5	0.8	133.1
Inventory in Tankage	210.9	166.1	29.9	61.2	31.1	499.2
Shell Capacity of Tankage Reported to NPC	447.2	396.5	79.5	221.1	84.8	1,229.1
Percentage Utilization	47	42	38	28	37	41
1983 Utilizations	45	40	39	34	32	40

*Data are as reported by survey respondents and have not been adjusted to reflect non-respondent companies.

Source: National Petroleum Council, "1988 Survey of U.S. Petroleum Inventories and Storage Capacities (Primary Distribution System)."

The NPC surveyed a sample of bulk plant operators and fuel oil dealers to develop inventory and capacity data for the U.S. bulk plant population. Data on retail motor fuel outlets were developed using available government and private sources, trade publications, and the expertise of various industry representatives. See Appendix K for methodologies and survey results.

Bulk Plants

Bulk plants are an important link in the petroleum distribution network, and account for a large portion of total storage capacity and inventory in the secondary sector. Approximately 17,000 companies, from refiners to independent wholesalers, operate in the secondary system, and about 15,000 are involved in the operation of bulk plant facilities. Product typically flows from the primary sector through bulk plants before delivery to retail outlets or ultimate end-users.

As illustrated in Table 27, total bulk plant storage capacity totaled an estimated 50 million barrels as of March 31, 1988. This represents a decline of 15 million barrels or 23 percent compared with total storage capacity reported five years ago. The capacity to store motor gasoline declined from 22 million barrels to 17 million barrels, while distillate capacity dropped from 37 million barrels to 29 million barrels, and residual fuel oil capacity decreased from 6 million barrels to 4 million barrels.

Shrinking bulk plant capacity over the past five years is related more to industry restructuring than to changes in consumption patterns. While petroleum demand has been on the rise, economic factors have forced companies to seek new ways to remain competitive. Firms have focused on streamlining operations and have divested uneconomical facilities. In addition, this period has been characterized by unprecedented merger and acquisition activity. One direct result of both factors has been the closure of a large number of older, less economical bulk plant operations and the idling of obsolete tankage. This process has been accelerated by the advent of even more stringent environmental regulations at the local, state, and federal levels, a trend that is expected to continue.

However, while storage capacities declined, the total quantity of major products held at bulk plants increased. As illustrated in Table 28, total inventories increased from 19 million barrels on March 31, 1983, to 22 million barrels on March 31, 1988. This is the result of a 38 percent increase in distillate inventories, which rose from 8 million barrels to 11 million barrels over the same period. Inventories of motor gasoline and residual fuel oil remained flat.

The increase in distillate is particularly noticeable since it occurred at the end of the heating season, the normal trough for stock levels. This apparent anomaly is explained by an

TABLE 27

BULK PLANT STORAGE CAPACITY
IN THE SECONDARY DISTRIBUTION SYSTEM, 1983-1988
(Millions of Barrels)

	March 31, 1983	March 31, 1988
Motor Gasoline	22	17
Diesel/Distillate Fuel Oil	37	29
Residual Fuel Oil	6	4
Total*	65	50

*Totals include surveyed petroleum products only.

Source: National Petroleum Council, "1988 Survey of U.S. Petroleum Inventories and Storage Capacities (Secondary Distribution System)."

TABLE 28

BULK PLANT INVENTORY LEVELS
IN THE SECONDARY DISTRIBUTION SYSTEM, 1983-1988
(Millions of Barrels)

	March 31, 1983	March 31, 1988
Motor Gasoline	9	8
Diesel/Distillate Fuel Oil	8	11
Residual Fuel Oil	2	2
Total*	19	22

*Totals include surveyed petroleum products only and may not equal the sum of the components due to independent rounding.

Source: National Petroleum Council, "1988 Survey of U.S. Petroleum Inventories and Storage Capacities (Secondary Distribution System)."

April 1 change in the law governing diesel excise tax collections, which in effect encouraged stockbuilding at the secondary and tertiary levels.

The rationalization that has taken place in the industry over the past five years is reflected in increased capacity utilization rates. In March 1983, total inventories amounted to 29 percent of tank capacity. In March 1988, utilization had increased to 43 percent, largely as a result of tank closures and decreased capacities.

Secondary storage levels vary by type of product, by type of business, and by geographic location. Bulk plant inventories are particularly sensitive to deviations from the norm in factors such as seasonal demand patterns but may be affected by a host of other influences.

Retail Outlets

There were approximately 170,000 retail motor fuel outlets in the United States in March 1988. It is estimated that the combined storage capacity is 83 million barrels, holding a total inventory of 44 million barrels. This compares to storage capacity and inventory of 84 million barrels and 28 million barrels, respectively, for 1983.

In summary, the secondary distribution system stores and transports products between producers and end-users, and includes bulk plants and retail motor fuel outlets as its two major components. The secondary system comprises 66 million barrels of inventory, representing about 9 percent of total U.S. inventory and storage capacity for products surveyed. These significant volumes of inventory are vital as buffers between primary system inventories and end-use consumers. While the flexibility to redirect product inventories from the secondary system is somewhat limited, secondary inventory volumes will be needed to handle disruptions.

In the secondary system, considerable consolidation has occurred: the number of bulk plant operators has decreased from 18,000 to 15,000, and the number of retail outlets has decreased from 210,000 to 170,000. Shrinking bulk plant capacity is related more to industry restructuring than to changes in consumption patterns. While petroleum demand has increased, economic factors have forced companies to seek new ways to remain competitive.

TERTIARY STORAGE SEGMENT ANALYSIS

The storage capacity and inventories of petroleum products held by end-users represent the tertiary storage segment of the petroleum distribution system. Only the major fuel products -- motor gasoline, kero-jet fuel, distillate fuel oil, and residual fuel oil -- are included in the following discussions. These are

the same products that were considered for the primary and secondary distribution systems. The amount of storage capacity and inventory in the tertiary segment is a significant portion of total U.S. capacity and product inventory, about 35 percent each.

The tertiary storage segment has been broken down into seven different sectors for analysis, and the methodologies used to develop the estimates for storage capacity and inventory in each sector vary considerably. In most tertiary sectors, several different estimating techniques were reviewed; those selected for developing the sector estimates are considered to be the most reasonable and accurate, based on data availability. The individual sector methodologies are discussed in detail in Appendix L.

While estimates for storage and inventory are presented by product, there is less confidence in the individual product breakdowns than in the aggregate product volumes. Also, in all sectors, storage capacity and inventory for kerosine is aggregated with that of diesel/distillate fuels.

The overall estimates of storage capacity and inventory for the tertiary storage segment are shown in Table 29. Individual sector estimates are included with the discussion of each particular tertiary sector.

Agricultural Sector

The agricultural sector includes all farms, ranches, and similar operations in the United States. Petroleum storage and inventory for this sector include motor gasoline and diesel fuel used in vehicles and equipment. Distillate fuels used for residential heating are included in the residential sector analysis.

Trends in U.S. agriculture (and consequently fuel storage capacity and inventory) are often obscured by government policy and external events. The acreage under cultivation has fallen erratically since the 1981 peak when over 363 million acres were in principal crops. Contributing to the decline have been production-limiting programs such as the Payment-in-Kind program and the strong dollar of the mid-1980s. Low or no-tillage programs, fostered in part by high energy prices through 1985, are now associated more with soil conservation programs. While such methods reduce the number of trips that farm equipment makes over cultivated land, total fuel consumption is not reduced proportionally because more machinery is required for each trip.

The federally sponsored Conservation Reserve Program aims to retire 45 million acres of highly erodible land by 1990. Already 23 million acres have been placed in reserve, a significant amount when compared to the 305 million acres of principal crops in cultivation in 1987.

The net effect of both the Conservation Reserve Program and conservation tillage is to reduce fuel demands. However, there

TABLE 29

ESTIMATED STORAGE CAPACITY AND INVENTORY
IN THE TERTIARY STORAGE SEGMENT
AS OF MARCH 31, 1983 AND 1988
(Millions of Barrels)

	Capacity		Inventory	
	1983	1988	1983	1988
Sector				
Agricultural	41	40	14	14
Commercial	37	33	8	7
Electric Utilities	213	175	91	61
Industrial	61	52	17	10
Military/Government	56	48	23	18
Residential	100	79	55	50
Transportation*	134	144	61	87
Total§	642	571	269	247
Product				
Motor Gasoline	103	109	42	63
Diesel/Distillate Fuel Oil	282	255	131	113
Kero-Jet Fuel	21	22	11	11
Residual Fuel Oil	237	184	86	60
Total§	642	571	269	247

*Includes on-board and fixed storage capacity and inventory for cars, buses, railroads, and aviation, but excludes payload storage (i.e., storage capacity and inventory for product being transported) of railroads, tank trucks, and marine vessels.

§Totals include surveyed petroleum products only. Totals may not equal the sum of components due to independent rounding.

Source: NPC estimate.

are no data available at this time to estimate a reduction of inventory or storage capacity.

Demand and inventory levels for petroleum products in the agricultural sector tend to be lower in the winter season and higher during the planting and harvesting seasons. The inventory shown in Table 30 for March 31, 1988, represents a "trend" projected level, and does not include the impact on March 31 of the change in collection point (from producer to consumer) of federal diesel fuel tax. That change caused March primary inventories to be lower than normal, and secondary and tertiary inventories to be higher than normal, presumably reflecting consumer filling of inventory before the change.

Commercial Sector

The commercial sector includes the storage capacity and inventory necessary for the heating requirements of commercial establishments such as office buildings, nursing homes, banks, shopping centers, real estate offices, car dealerships, and apartment complexes with more than four units. It excludes commercial transportation (see Transportation Sector), residential heating (see Residential Sector), industrial manufacturing facilities (see Industrial Sector), and public schools (see Military/Government Sector).

The commercial sector storage capacity is estimated to be 33 million barrels. In the commercial sector, many divergent trends have occurred between 1983 and 1987, such as the 17.3 percent real (inflation-adjusted) increase in gross national product (GNP), the increase in the number of large shopping centers, and the trend away from oil heating, particularly the replacement of residual fuel oil burners with cleaner-burning natural gas and distillate fuel oil burners in urban areas. It is estimated that tankage capacity and oil inventory dropped slightly during this period.

Storage capacity and inventories in the commercial sector are shown in Table 31.

Electric Utility Sector

The electric utility sector includes electric power generating stations operated by commercial electric companies. It excludes powerplants that generate electricity within an industrial site (see Industrial Sector).

Storage capacity in the electric utility sector is estimated to be about 175 million barrels in 1988, down from the estimated level of 213 million barrels in 1983. The decline in the demand for petroleum as electric power generation fuel has caused most of the reduction in storage capacity as utilities have taken tankage out of service. The use of petroleum for electric power generation has declined by over 18 percent from 1983 despite an increase in total net generation. This is shown in Table 32.

TABLE 30

AGRICULTURAL SECTOR
ESTIMATED STORAGE CAPACITY AND INVENTORY
AS OF MARCH 31, 1988
(Millions of Barrels)

	Capacity		Inventory	
	1983	1988	1983	1988
Motor Gasoline	19	20	7	7
Diesel/Distillate Fuel Oil	22	20	8	7
Total	41	40	15	14

Source: NPC estimate.

TABLE 31

COMMERCIAL SECTOR
ESTIMATED STORAGE CAPACITY AND INVENTORY
AS OF MARCH 31, 1988
(Millions of Barrels)

	Capacity		Inventory	
	1983	1988	1983	1988
Distillate Fuel Oil	22	26	5	6
Residual Fuel Oil	15	7	3	1
Total	37	33	8	7

Source: NPC estimate.

The decline in the use of petroleum for electric power generation from 1983 to 1985 is due primarily to the relative cost of petroleum versus other fuels. The increase over 1985 levels in the use of petroleum in 1986 and 1987 is due to the improved competitiveness of oil as a boiler fuel relative to coal and natural gas. The changes in the use of petroleum products as electric power generating fuels have been most apparent in residual fuel oil use; 1983 residual fuel oil use by utilities

TABLE 32

U.S. NET ELECTRICITY GENERATION
(1,000 Gigawatt-hours)

Year	Total	Petroleum	Percent Petroleum
1983	2,310	144	6.3
1984	2,416	120	5.0
1985	2,470	100	4.1
1986	2,487	137	5.5
1987	2,572	118	4.6

Source: Energy Information Administration, Electric Power Monthly, March 1988, Table 4.

was about 627 MB/D declining to about 500 MB/D in 1987 (a decline of over 20 percent) while distillate fuel oil use declined from 45 MB/D in 1983 to 42 MB/D in 1987 (a decline of about 10 percent).

Inventories of residual fuel oil and distillate fuel oil held at electric utilities stood at 61 million barrels of oil on March 31, 1988, down from 91 million barrels in 1983. The decrease in part reflects the increased availability of alternative (non-oil) fuels for electric power generation. Many utilities that have the ability to generate electricity with oil or gas are currently using gas as the primary boiler fuel. These utilities will have some oil on hand; but at reduced levels from 1983.

Estimated storage capacity and inventory for petroleum products at electric utilities is shown in Table 33.

Industrial Sector

The industrial sector includes plants and factories in the United States, but excludes retail and service firms (see Commercial Sector). In this analysis, construction and off-highway non-transportation uses (e.g., logging and mining) are also included in the industrial sector. For the purpose of this discussion, petroleum refineries and electric utilities are not considered in the industrial sector, because fuel for refinery use is part of the primary system, while utilities are reported as a separate tertiary sector.

The industrial sector uses petroleum products primarily for space or process heating and to power machinery either directly or through steam generation. Some industrial consumers, particularly those in the chemical industry, use petroleum products as raw material in manufacturing processes; also, some unfinished hydrocarbons may be used in the blending of finished products. The storage capacity and inventories of feedstocks and unfinished blending stocks are outside the scope of this study; only finished products used for fuel in the industrial sector (motor gasoline, diesel/distillates (including kerosine), and residual fuel oil) have been considered.

Industrial petroleum product use declined from 1983 to 1988, following the trend observed between 1978 and 1982 as reported in NPC's 1984 study. It is believed that this consumption decrease resulted not only from plant closings in energy-intensive industries, but also from continued energy conservation efforts and fuel-switching. Even considering that industrial users of switchable natural gas continue to have storage facilities capable of handling their complete liquid fuel needs, it is estimated that storage capacity declined between 1983 and 1988.

Industrial inventories exhibit a close relationship to demand and also to the volume of storage capacity in service. Since it is estimated that both these elements have declined since 1983, there is support for the estimate that inventory levels have also declined in the past five years.

TABLE 33

ELECTRIC UTILITIES
ESTIMATED STORAGE CAPACITY AND INVENTORY
AS OF MARCH 31, 1988
(Millions of Barrels)

	Capacity*		Inventory§	
	1983	1988	1983	1988
Distillate Fuel Oil	36	41	22	13
Residual Fuel Oil	177	134	70	48
Total	213	175	91	61

*NPC estimate.

§Energy Information Administration, Electric Power Monthly, March 1988, adjusted by the NPC to exclude stocks held in the primary distribution system for electric utilities.

Industrial production for those facilities operating has continued to increase since 1986, the last year for which detailed petroleum consumption data are available. The Federal Reserve Board Index of manufacturing capacity utilization has risen from 79.6 (1986's average) to 82.5 (March 1988).

The inventory volume for March 31, 1988, is a "trend" projected level, and does not represent the impact of the change in collection point (from producer to consumer) of the federal diesel fuel tax on April 1, 1988. That change caused March 1988 secondary and tertiary inventories to be higher, presumably reflecting consumer filling of inventory before the tax change became effective.

Storage capacity and inventory estimates for the industrial sector are shown in Table 34.

TABLE 34

INDUSTRIAL SECTOR
ESTIMATED STORAGE CAPACITY AND INVENTORY
AS OF MARCH 31, 1988
(Millions of Barrels)

	Capacity		Inventory	
	1983	1988	1983	1988
Motor Gasoline	*	1	*	0.5
Distillate Fuel Oil/Kerosine	30	22	9	4.5
Residual Fuel Oil	31	29	8	5.0
Total	61	52	17	10.0

*Less than 0.5 million barrels.

Source: NPC estimate.

Military/Government Sector

The military/government sector includes federal, state, and local governments and all branches of the U.S. military located in the United States.

Of the 48 million barrels of storage capacity in this sector, 32 million barrels are held by the U.S. military. The reported capacity includes storage held by both the Defense Fuel Supply Center and the armed forces. The trend in U.S. military storage represents a reduction of about 15 percent, or 6 million barrels between 1983 and 1988. Mainly, this reduction reflects the closing of some military installations.

Of the remaining government storage, 10 million barrels represent local government capacity for heating public schools and municipal buildings and for fueling police cars and other municipal cars and trucks. State and federal government storage capacity is 4 million barrels for heating and 2 million barrels for transportation. Based on the 1988 analysis, there appears to have been a 10 percent reduction, or about a 2 million barrel drop, in storage capacity during the last five years, as government, like the private sector, improves storage efficiency in the transportation sector and replaces old residual-fuel-oil burning units.

Storage capacity and inventories in the military/government sector are shown in Table 35.

TABLE 35

MILITARY/GOVERNMENT SECTOR
ESTIMATED STORAGE CAPACITY AND INVENTORY
AS OF MARCH 31, 1988
(Millions of Barrels)

	Military*		Government§		Total	
Capacity	1983	1988	1983	1988	1983	1988
Motor Gasoline	1	1	6	5	8	6
Kero-Jet Fuel	10	11	*	¶	11	11
Distillate Fuel Oil	24	18	4	5	29	23
Residual Fuel Oil	3	2	7	6	9	8
Total	38	32	17	16	57	48
Inventory						
Motor Gasoline	1	1	3	3	4	3
Kero-Jet Fuel	5	5	*	¶	5	5
Distillate Fuel Oil	9	5	2	1	10	7
Residual Fuel Oil	1	1	2	2	3	3
Total	16	12	7	6	22	18

*Actual March 31, 1988 data from Defense Fuel Supply Center.

§NPC estimate.

¶Less than 0.5 million barrels.

Residential Sector

Storage for residential heating fuel includes tankage for single-family homes and multi-family dwellings of up to four units. Storage for large apartment buildings is part of the commercial sector.

As of 1983, the latest available data, the 13 million oil-heated units accounted for 15 percent of the total occupied U.S. housing stock, according to the Bureau of the Census. Of these, 9.5 million units fall under the definition for the residential sector: oil-heated single-family homes numbered 7.9 million, and there were approximately 1.6 million units in multi-family structures of up to four units (garden apartments, two-family houses, etc.).

The single-family homes and small multi-family structures are generally heated with No. 2 oil, not the residual fuel oil that would be used in the larger apartment buildings discussed in the section on the commercial sector. In addition, kerosine heated 327,000 single-family houses and small multi-family structures. A further group of residential housing units, perhaps as many as 3 million according to DOE data, used fuel oil or kerosine as a secondary fuel.

The share of oil-heated homes peaked in the 1960s. Oil heat is now used primarily in the Northeast, the only region where it continues to capture a significant share of the new home market. More than half of the single-family homes heated with fuel oil and more than 80 percent of the small multi-family units heated with fuel oil are located in the Northeast. By contrast, the kerosine-heated units are concentrated in the South.

The size of fuel tanks in the residential sector varies from 55-gallon drums mounted on outdoor stands to 2,000-gallon underground tanks. Most homes, however, have tanks ranging in capacity from 250 gallons (275 gallons is a standard tank size for a single family home) to 800 gallons.

In the NPC's 1984 report, residential distillate inventories for March 31, 1983, were estimated at 55 million barrels, or 55 percent of the existing tank capacity of 100 million barrels. The earlier estimate included an average tank size of 360 gallons. The estimates for March 31, 1988, shown on Table 36, reflect a somewhat larger tank size (380 gallons), with a higher utilization (63 percent) but a smaller number of oil-heated units and oil storage tanks.

Transportation Sector

The transportation tertiary storage sector includes fixed storage for railroads, buses, trucks, aircraft, marine use, taxicab fleets, and rental cars. Additionally, the data presented cover on-board storage for the fuel consumed in these vehicles and private automobiles. For this study, the payload storage

TABLE 36

RESIDENTIAL SECTOR
ESTIMATED STORAGE CAPACITY AND INVENTORY
AS OF MARCH 31, 1988
(Millions of Barrels)

	Capacity		Inventory	
	1983	1988	1983	1988
Distillate Fuel Oil/Kerosine	100	79	55	50

Source: NPC estimate.

TABLE 37

TRANSPORTATION SECTOR
ESTIMATED STORAGE CAPACITY AND INVENTORY
AS OF MARCH 31, 1988
(Millions of Barrels)

	Capacity		Inventory	
	1983	1988	1983	1988
Subsector				
Railroad	12	9.6	7	5.0
Aviation	10	10.6	6	5.8
Marine	11	12.3	5	6.2
Marine Pleasure Craft	6	6.0	2	4.5
Motor Vehicle Fleet*	96	105.8	42	65.6
Total	134	144.3	61	87.1
Product				
Gasoline	75	82.3	30	52.3
Kero-Jet Fuel	10	10.6	6	5.8
Diesel/Kerosine	44	44.2	23	25.4
Residual Fuel Oil	5	7.2	2	3.6
Total	134	144.3	61	87.1

*Includes fixed and on-board storage for buses, private vehicles, taxicabs, rental cars, and trucks.

capacity of vehicles that transport petroleum, such as tank trucks, tank cars, and barges, is excluded because these are transportation media and do not constitute storage for end-use by the transportation sector.

Table 37 summarizes storage capacity and inventories for each component of the transportation sector. A comparison with of the 1984 report shows that the transportation sector's fuel storage capacity and inventory have increased by about 7-8 percent. Only the railroad industry showed a decline, but this was more than offset by increases across the motor vehicle fleet. In particular, on-board storage in cars and trucks, which was estimated to be 96 million barrels in the 1984 study, increased to 106 million barrels in 1988. The increase is primarily the result of a larger number of vehicles, particularly light trucks. The increase in storage and inventory capacity of the motor vehicle fleet roughly parallels GNP growth during the 1983-1988 time frame.

Appendices

APPENDIX A

STUDY REQUEST LETTER AND DESCRIPTION OF THE NATIONAL PETROLEUM COUNCIL

The Secretary of Energy
Washington, DC 20585

February 20, 1987

Mr. Ralph E. Bailey
Chairman
National Petroleum Council
1625 K Street, N. W.
Washington, D. C. 20006

Dear Mr. Bailey:

The National Petroleum Council has prepared numerous studies in the past on the nation's petroleum inventory, storage, and transportation systems. The Council's last comprehensive study on this subject was completed in 1979. The principal objectives of that study were to analyze current inventories, estimate minimum operating inventory levels, determine the total storage capacity of the primary petroleum distribution system, and provide detailed information on the nation's transportation system for oil and natural gas. In 1984, the Council issued a report updating and expanding the inventories and storage capacity portions of the 1979 study.

These studies are the most current, comprehensive treatment of petroleum storage and transportation that are available for reference, with some data being nearly a decade old and the most recent from early 1983. Since the release of these studies, there have been major changes in the production and transportation of crude oil and natural gas, refinery operations, petroleum products distribution networks, and the markets they serve.

Accordingly, I am requesting the Council to undertake a comprehensive new study on petroleum inventory, storage, and transportation capacities updating the Council's earlier studies as necessary. Emphasis should be given to the reexamination of minimum operating inventory levels, the location of storage facilities and availability of inventories in relation to local demand, and the capabilities of distribution networks to move products from refining centers to their point of consumption particularly during periods of stress.

For the purpose of this study, I designate Dr. H. A. Merklein, Administrator, Energy Information Administration, to represent me and to provide the necessary coordination between the Department of Energy and the Council.

Yours truly,

John S. Herrington

John S. Herrington

DESCRIPTION OF THE NATIONAL PETROLEUM COUNCIL

In May 1946, the President stated that he had been impressed by the contribution made through government/industry cooperation to the success of the World War II petroleum program. He felt that this close relationship should be continued and suggested that the Secretary of the Interior establish an industry organization to provide advice on oil and gas matters. Pursuant to this request, Interior Secretary J. A. Krug established the National Petroleum Council (NPC) on June 18, 1946. In October 1977, the Department of Energy was established and the Council's functions were transferred to the new department.

The sole purpose of the NPC is to advise, inform, and make recommendations to the Secretary of Energy on any matter, requested by him, relating to petroleum or the petroleum industry. Matters that the Secretary would like to have considered by the Council are submitted as a request in the form of a letter outlining the nature and scope of the study. The Council reserves the right to decide whether it will consider any matter referred to it.

Examples of recent major studies undertaken by the NPC at the request of the Secretary include:

- Refinery Flexibility (1980)
- Unconventional Gas Sources (1980)
- Emergency Preparedness for Interruption of Petroleum Imports into the United States (1981)
- U.S. Arctic Oil & Gas (1981)
- Environmental Conservation -- The Oil & Gas Industries (1982)
- Third World Petroleum Development: A Statement of Principles (1982)
- Petroleum Inventories and Storage Capacity (1983, 1984)
- Enhanced Oil Recovery (1984)
- The Strategic Petroleum Reserve (1984)
- U.S. Petroleum Refining (1986)
- Factors Affecting U.S. Oil & Gas Outlook (1987)
- Integrating R&D Efforts (1988).

The NPC does not concern itself with trade practices, nor does it engage in any of the usual trade association activities. The Council is subject to the provisions of the Federal Advisory Committee Act of 1972.

Members of the National Petroleum Council are appointed by the Secretary of Energy and represent all segments of petroleum interests. The NPC is headed by a Chairman and a Vice Chairman, who are elected by the Council. The Council is supported entirely by voluntary contributions from its members.

NATIONAL PETROLEUM COUNCIL

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APPENDIX B

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APPENDIX C

PRIMARY DISTRIBUTION SYSTEM SURVEY METHODOLOGY

APPENDIX C

PRIMARY DISTRIBUTION SYSTEM SURVEY METHODOLOGY

OBJECTIVE

The National Petroleum Council's (NPC) "1988 Survey of Petroleum Inventories and Storage Capacities in the United States" was designed to determine:

- How much of the U.S. petroleum inventory is required for normal operation of the primary petroleum distribution system and is therefore not available for delivery to consumers
- The total primary storage capacity and tankage utilization
- The impact (if any) of petroleum futures, options, and cash forward markets on inventory management and selected other operating decisions
- The impact (if any) that the existence of the Strategic Petroleum Reserve (SPR) has on the level of inventories held in the private sector
- The effectiveness of the Department of Energy's (DOE) plan for use of the SPR in stress situations
- To provide base data for overall storage and distribution system stress analyses.

SCOPE OF THE SURVEY

Data for crude oil and certain refined products (motor gasoline, kerosine-type jet fuel, distillate fuel oil, and residual fuel oil) were requested.

To better define the seasonal change in inventories and to reflect seasonal shifts in tank utilization, two reporting dates, September 30, 1987, and March 31, 1988, were chosen for the refined products -- dates that provided the NPC with a consistent series for historical comparisons. Only one reporting date, March 31, 1988, was selected for crude oil because of its relative lack of seasonality.

The survey covered the 50 states, the District of Columbia, and all foreign trade zones, but excluded all U.S. territories and possessions.

Information on petroleum futures, options, cash forward markets, and the SPR was requested in order to provide the NPC with the necessary data to make qualified judgments on the impact of these elements on industry's physical inventory level.

The relevant questionnaires in the survey conform with Energy Information Administration (EIA) product definitions, with the exception of that for motor gasoline. For motor gasoline, respondents to the survey were asked to aggregate finished leaded gasoline, finished unleaded gasoline, and motor gasoline blending components. (See product definitions in Appendix M.)

DESCRIPTION OF QUESTIONNAIRES

The inventory information was requested by Petroleum Administration for Defense District (PADD), with PADD I subdivided into three parts: New England (IX), Central Atlantic (IY), and Lower Atlantic (IZ) states. The estimates of the respondents' minimum and maximum operating inventories and related questions were requested by broad geographic region, i.e., PADDs I-IV aggregated and PADD V.

The questionnaires addressing salient inventory and storage statistics were similar to those used in the 1983 NPC survey, with the following exceptions:

- Kerosine was eliminated because its volume was considered insignificant.
- Naphtha-jet fuel was eliminated on the advice of the DOE that the information contained in the 1983 survey was still adequate for its purposes.
- The differentiation between environmentally restricted idle tankage and other idle tankage was eliminated due to the inherent difficulty in many situations to pinpoint the reason for tankage to be idle.
- "Changes in stock level due to spare refining capacity" was eliminated due to the significant erosion of spare capacity between the two surveys.

The questionnaires on the SPR and the petroleum futures and other forward markets were significantly revamped and expanded from the 1983 surveys. For example, the futures questionnaire was expanded to take account of the markets' increased sophistication, participation, and acceptance.

Those holding primary inventory were asked to:

- Submit inventory information on crude oil and the refined products (including detailed information on unavailable inventories both in tankage [e.g., tank bottoms] and outside of tankage [e.g., pipeline fill])

- Estimate their minimum and maximum operating inventories

- Report the amount by which their inventories exceeded estimated minimum operating inventories and what portion of that amount was seasonal inventory, inventory held in anticipation of planned maintenance, and other operating inventory

- Provide the following data on tankage:

  - Shell capacity of tankage in operation

  - The design capacity of tankage that was idle on March 31, 1988 -- for reasons other than programmed maintenance with plans for immediate return to service -- but that could be available for service within 90 days

  - Tankage under construction.

Primary inventory respondents who analyze industry inventory levels were asked to provide estimates of minimum and maximum operating inventories for crude oil and the surveyed petroleum products for PADDs I-IV, PADD V, and the total United States.

The Strategic Petroleum Reserve Questionnaire requested specific data on the respondent company and its geographic area of operation, the impact of the SPR on the respondent's level of inventory, and the respondent's views on the DOE's Strategic Petroleum Reserve Drawdown Plan.

The Petroleum Futures and Other Forward Markets Questionnaire requested data on the respondent's participation in these markets and the impact of these markets on the respondent's physical level of inventory.

RESPONDENTS TO THE SURVEY

The survey was sent to refiners, bulk terminal operators, product pipeline operators, and holders of crude oil stocks who were required to file EIA Forms 810, 811, 812, and 813 as of September 1987 and March 1988. Although the EIA receives data from each unit of a company, the NPC collected information on a company-wide basis, asking that each company consolidate into a single report all of the data that its units reported separately to the EIA.

DISTRIBUTION AND RECEIPT OF QUESTIONNAIRES

The questionnaires were mailed by the NPC on March 17, 1988, to the 381 companies in the primary distribution system. The independent public accounting firm of Deloitte Haskins & Sells

was contracted by the NPC to receive and tabulate the survey responses. Deloitte Haskins & Sells tabulated all responses received through December 22, 1988, and transmitted the aggregated results to the NPC on February 14, 1989. In order to improve the level of survey participation, an intense "non-response follow-up" system was employed, with all non-respondent primary and secondary survey recipients encouraged to complete the survey. In keeping with its contract with the NPC, Deloitte Haskins & Sells did not release any individual company data to the NPC, the DOE, or any other organization, and has destroyed all the completed individual company questionnaires.

A series of edit checks was employed to ensure that appropriate questionnaire line items were completed, questionnaire arithmetical integrity was maintained, and questionnaire responses were reasonable.

If a responding company's data failed the edit checks, Deloitte Haskins & Sells contacted the company to discuss the data and made changes where appropriate. In situations where responses to questionnaires were incomplete or obviously incorrect and the respondent failed to provide Deloitte Haskins & Sells with the appropriate information, the questionnaire response was not included in the survey results. In addition, data previously submitted to the EIA by the NPC respondents on total inventories were provided by the EIA to Deloitte Haskins & Sells via the NPC in order to serve as a check on the reasonableness of the inventory data submitted on the survey.

RESULTS OF THE SURVEY

The NPC evaluated the levels of response to determine whether they were adequate for use in formulating conclusions based upon the survey results. The Council concluded that the coverage was sufficiently high to permit analysis of the results as reasonably representative of the manner in which inventory and tank capacity is managed by the primary distribution system. Therefore, responses to the NPC for key inventory and tankage items were adjusted upward by dividing by the volumetric percentage coverage, so that the individual line items were representative of the EIA universe. For example, the sum of the motor gasoline responses for the individual company inventory as of March 31, 1988, was 203,117 thousand barrels. To adjust to the universe, one divides 185,512 thousand barrels by 87.8 percent (the level of participation in the NPC study as benchmarked against counterpart EIA data), which yields 231,258 thousand barrels. For crude oil, however, certain modifications to EIA data on crude oil lease stocks and Alaskan crude oil in transit by water were made prior to the adjustment in order to ensure a consistency with Line Item 1 in Questionnaires 1-5. Table C-1 shows the inventories reported to the NPC, inventories reported to the EIA, and the percentage response to the NPC survey.

TABLE C-1

NPC SURVEY RESPONSES AS A PERCENTAGE OF INVENTORY REPORTED TO THE EIA

	NPC (Thousands of Barrels)			EIA (Thousands of Barrels)			Percentage		
	PADDs I-IV	PADD V	Total U.S.	PADDs I-IV	PADD V	Total U.S.	PADDs I-IV	PADD V	Total U.S.
	September 30, 1987								
Motor Gasoline	182,990	25,609	208,599	198,192	31,456	229,648	92.3	81.4	90.8
Kero-Jet Fuel	37,451	5,280	42,731	37,620	6,064	43,684	99.6	87.1	97.8
Distillate Fuel Oil	97,611	7,908	105,519	116,011	10,751	126,762	84.1	73.6	83.2
Residual Fuel Oil	26,441	6,235	32,676	35,402	9,015	44,417	74.7	69.2	73.6
	March 31, 1988								
Crude Oil	233,889	49,188	283,077	263,443	57,941	321,384	88.8	84.9	88.1
Motor Gasoline	180,650	22,467	203,117	202,582	28,676	231,258	89.2	78.4	87.8
Kero-Jet Fuel	32,884	5,582	38,466	33,061	6,487	39,548	99.5	86.0	97.3
Distillate Fuel Oil	68,275	7,375	75,650	80,137	9,175	89,312	85.2	80.4	84.7
Residual Fuel Oil	25,226	6,668	31,894	35,205	8,852	44,057	71.7	75.3	72.4

PROCEDURES USED IN ANALYZING THE SURVEY DATA

The NPC estimates of minimum operating inventory, discussed in Chapter Two, were developed through an interactive decision-making process. In order to arrive at a consensus, individual judgments were discussed with the aid of operating experience and relevant statistical data. The statistical data used were: (1) the sum of the individual company minimum operating inventories as reported in the 1988 NPC survey, (2) the industry-wide estimates of minimum operating inventory levels as reported in the 1988 NPC survey;[1] and (3) historical inventory data. The NPC survey data are reported in Appendix E; the historical inventory data are shown graphically in Appendix J.

The Council's conclusions regarding the impact on private primary inventories of the SPR and the petroleum futures markets were developed from the sum of the responses to the NPC survey.

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[1]These estimates were used for general reference only, as only a few estimates were reported.

APPENDIX D

NPC 1988 SURVEY OF U.S. PETROLEUM INVENTORIES AND STORAGE CAPACITIES (PRIMARY DISTRIBUTION SYSTEM)

- **Petroleum Inventories and Storage Capacities**
- **The Strategic Petroleum Reserve**
- **Petroleum Futures and Other Forward Markets**

Code Number*_____

NATIONAL PETROLEUM COUNCIL
1988 SURVEY OF

U.S. PETROLEUM INVENTORIES AND STORAGE CAPACITIES (PRIMARY DISTRIBUTION SYSTEM)

Reporting Company: _____

Address: _____

_____

_____ Zip Code: _____

Person in reporting company to be contacted if questions arise:

_____

Phone: (____)_____

Please check for each questionnaire that you have provided data:

_____ Questionnaire No. 1
_____ Questionnaire No. 2
_____ Questionnaire No. 3
_____ Questionnaire No. 4
_____ Questionnaire No. 5
_____ Questionnaire No. 6

Please submit your response to this survey by May 16, 1988, to: Deloitte Haskins & Sells
Suite 800
1101 15th Street, N.W.
Washington, D.C. 20005
ATTN: NPC Survey Team

If you have questions regarding this survey, please call Mr. Benjamin A. Oliver, Jr. at the National Petroleum Council office, (202) 393-6100.

*This entry, and other NPC Code spaces on subsequent pages, will be entered by the accounting firm for data tabulation purposes.

INTRODUCTION

At the request of the U.S. Department of Energy (DOE), the National Petroleum Council has agreed to update its 1984 report on petroleum inventories and storage capacities in the United States. The study has two primary objectives:

1) To determine how much of the U.S. petroleum inventory reported monthly to the Department of Energy is required for normal operation of the petroleum distribution system itself and is therefore not available for delivery to consumers.

2) To determine the total primary storage capacity and that portion required for normal industry operations.

The enclosed questionnaires are designed to provide the National Petroleum Council with the information it requires to respond to the DOE's request. These questionnaires request information on primary inventories and storage capacities relating to crude oil and the principal refined products. Most of the inventory data being requested have already been reported to the DOE by your company. These data will provide a measure of the overall response to the survey as well as assisting you in remaining within the scope of the instructions for the questionnaires.

These questionnaires are also contained on the enclosed PC diskette. Your cooperation by providing your responses on the diskette will eliminate the risk of transcription errors and will speed the processing of the surveys.

The National Petroleum Council has retained the services of the certified public accounting firm of Deloitte Haskins & Sells to collect and aggregate the data reported in this survey. Individual company data will not be released to industry or government representatives. Deloitte Haskins & Sells will provide data to the National Petroleum Council only in an aggregated form, and then only when sufficient responses have been obtained to preclude disclosure of individual company data. The original data forms will be destroyed at the completion of the study. A statement from Deloitte Haskins & Sells regarding its data collection and processing methodology is enclosed with this mailing.

GENERAL INSTRUCTIONS

1. Reporting of Data

a. Report all figures in **thousands** of 42-gallon barrels.

b. Provide data in each cell in the columns representing the geographic areas in which your company has inventory and storage (PADD, Region, U.S. Total). Enter zero where appropriate. In areas in which your company has no inventory and storage, leave the entire column blank.

c. Report on a company-wide basis; i.e., submit only one response for your company's primary operations. (See enclosed list of locations for which you submit monthly reports to the DOE.)

d. Report information in a manner consistent with your Petroleum Supply Reporting System (PSRS) reports filed with the DOE on current forms EIA-810 (Monthly Refinery Report), EIA-811 (Monthly Bulk Terminal Report), EIA-812 (Monthly Product Pipeline Report), and/or EIA-813 (Monthly Crude Oil Report). That is,

- Report on a custody basis regardless of ownership of the inventories or facilities.
- In the case of jointly owned tankage or pipelines, data should be provided by the operator.
- Report inventories less basic sediment and water (BS&W) corrected to 60 F.

e. Definitions -- The definitions for crude oil and petroleum products that are used in the survey are consistent with those of the DOE's Petroleum Supply Reporting System, except for the definition of motor gasoline, for which respondents to this survey should aggregate finished leaded gasoline (Product Code 132 in PSRS -- **in**cludes leaded gasohol), finished unleaded gasoline (Product Code 133 in PSRS -- **in**cludes unleaded gasohol), and motor gasoline blending components (Product Code 134 in PSRS -- **ex**cludes oxygenates [alcohols, ethers, MTBE], butanes, and pentanes plus).

f. Crude oil data -- Report as of March 31, 1988. Only one reporting date for crude oil has been chosen because crude oil inventories are not seasonal.

g. Refined product data -- Report refined product stocks only for locations that were reported to the DOE on September 30, 1987, and March 31, 1988, in you regular **monthly** reports to the DOE as described under (d) above. Two reporting dates for the principal products have been chosen to better define the seasonal changes in inventories, and to reflect seasonal shifts in tank utilization.

Report for the following principal products:

- Motor gasoline, including blending components
- Kerosine-type jet fuel
- Distillate fuel oil, including No. 4 fuel oil
- Residual fuel oil

h. The enclosed diskette contains programs which permit the survey to be completed on-line rather than by hand on paper. We request that, if possible, you utilize the on-line entry.

All that is required is an IBM compatible microcomputer with the MS DOS operating system. Because the responses to the survey will be entered on the enclosed disk, no other diskettes are required.

Setup

Insert the enclosed diskette in the A drive of your microcomputer. Bring up the A prompt.

A:

Enter:

<SURVEY>

2. Report by Petroleum Administration for Defense District (PADD)

a. Data for Puerto Rico, the U.S. Virgin Islands, and Guam **should not be reported**, except for Alaskan crude oil in transit by water to the above locations (see line item instructions for Line 15).

b. Information will be collected on a PADD basis, with PADD I subdivided into three areas for all refined products. PADD I is **not** subdivided for crude oil. Respondents should use the table below to determine the PADD classification for each state in which they have operations.

c. Data for crude oil are also reported on a Total U.S. basis as well as by PADD to provide for reporting of Alaskan crude oil in transit by water.

d. Respondents with operations in the New England, Central Atlantic, and Lower Atlantic states should submit their data as PADD IX, PADD IY, and PADD IZ, respectively.

PADD I	PADD II	PADD III
New England (PADD IX)	Illinois	Alabama
Connecticut	Indiana	Arkansas
Maine	Iowa	Louisiana
Massachusetts	Kansas	Mississippi
New Hampshire	Kentucky	New Mexico
Rhode Island	Michigan	Texas
Vermont	Minnesota	
	Missouri	**PADD IV**
Central Atlantic (PADD IY)	Nebraska	
Delaware	North Dakota	Colorado
District of Columbia	Ohio	Idaho
Maryland	Oklahoma	Montana
New Jersey	South Dakota	Utah
New York	Tennessee	Wyoming
Pennsylvania	Wisconsin	
		PADD V
Lower Atlantic (PADD IZ)		
Florida		Alaska
Georgia		Arizona
North Carolina		California
South Carolina		Hawaii
Virginia		Nevada
West Virginia		Oregon
		Washington

3. Do not report data in the shaded areas of the Questionnaires.

4. Completing Questionnaires 1-5

Specific line item instructions are provided for these questionnaires, beginning on Page 5.

5. Completing Questionnaire 6

It is possible that the sum of the companies' assessments of their own minimum and maximum operating inventories (Lines 2 and 21 on Questionnaires 1-5) will not be a true measure of the entire petroleum industry's minimum or maximum operating inventory. Questionnaire 6 is designed to capture your best estimate of these industry-wide values. If your company analyzes industry levels, provide your estimate of the minimum and maximum operating inventories of the U.S. petroleum industry. Enter estimates for PADDs I-IV, PADD V, and Total U.S., if available. If your company does not have some of the estimates requested in this questionnaire, leave those sections blank.

6. Other Instructions

a. Disregard those questionnaires in the survey that are not applicable to your company's operations, but return the survey intact.

b. Complete the cover page, leaving the code line blank, and send it along with the completed survey (on computer disk or hard copy) by May 16, 1988, to:

Deloitte Haskins & Sells
Suite 800
1101 15th Street, N.W.
Washington, D.C. 20005
ATTN: NPC Survey Team

c. Any questions regarding this questionnaire should be addressed to:

Benjamin A. Oliver, Jr.
Committee Coordinator
National Petroleum Council
1625 K Street, N.W.
Washington, D.C. 20006
(202) 393-6100

LINE ITEM INSTRUCTIONS
Questionnaires 1 - 5

Line 1. Total Inventory Reported to the Department of Energy

For crude oil, aggregate by PADD the inventories you report on Forms EIA-810 and EIA-813 as of March 31, 1988, except Alaskan crude oil in transit by water (Product Code 092 on Form EIA-813), which should **not** be included in this line entry.

For refined products, aggregate by PADD (sub-PADD in PADD I) the inventories you report on Forms EIA-810, 811, and 812 as of March 31, 1988, and September 30, 1987. Do **not** include data for U.S. territories and possessions.

Line 2. Minimum Operating Inventory

Data related to minimum operating inventory should be reported using your best estimates. These estimates should be on a custody basis and, therefore, **consistent with the number you report as actual Inventory on Line 1**. Do not include Alaskan crude oil in transit by water in your minimum operating inventory estimates. Data relating to minimum operating inventory are to be reported on a "system basis" for each product; that is, only in columns labeled Total PADDs I - IV, PADD V, and Total U.S. (in the case of crude oil), as specified on each questionnaire.

Runouts and shortages are likely to occur if inventory falls below the minimum operating level. This inventory is not available for consumer use because it is either "unavailable" or "required working" inventory.

"Unavailable" inventory includes:

- Pipeline fill (Line 7)
- Refinery lines and operating equipment fill (Line 8)
- Oil in transit by water from domestic sources, excluding Alaskan crude oil (Line 9)
- Tank bottoms (Line 11)
- Plant fuel and pipeline prime mover fuel (Line 12)
- Lease stocks (Line 13)
- Alaskan crude oil in transit (Line 15)

"Required working" inventory includes stocks necessary to:

- Facilitate blending to meet product specifications
- Support the normal operating cycle of shipments/receipts (e.g., pipeline tenders or barge/tanker cargoes)
- Provide a contingency to handle unavoidable but recurring emergencies (e.g., pipeline failure, extreme weather conditions that affect waterborne movements).

Line 3. Difference (Line1 Minus Line 2) or Total Inventory Minus Minimum Operating Inventory

A positive difference would indicate that you had oil in storage above that needed to meet minimum operating requirements. A negative difference would indicate that you were below the minimum level, and, hence, incurring operating problems. This difference may be zero, indicating that actual inventory was the amount needed to meet minimum operating needs.

Positive differences should be accounted for on Lines 4, 5, and 6, below.

Line 4. Seasonal Inventory

The amount on Line 3 that is seasonal inventory; that is, inventory that is not immediately needed to support current demand levels, but is maintained in anticipation of higher (seasonal) demand levels that cannot be met with then-current manufacturing or transportation capabilities. Seasonal inventories need not be stored in swing tankage.

Line 5. In Anticipation of Planned Maintenance

The various functions performed within the supply system extensively utilize sophisticated mechanical equipment. Such equipment must be refurbished regularly. Accordingly, companies generally plan for and manage stock levels in order to ensure continued supply to meet demand while equipment is under maintenance. Respondents should enter the amount of any stocks so dedicated as of the reporting dates for the various products.

Line 6. Other Operating Inventory

The balance of the excess on Line 3 -- **not** covered by Lines 4 and 5 -- that is statistically "surplus" to your needs but that is held in order to meet specific operating directives, recent changes in the variables implicit in the build-up of Line 2 that have not as yet been allowed for in Line 2, and/or a true "surplus" at this particular point in time.

Line 7. Pipeline Fill

Inventory located between the shipping and receiving tanks on a pipeline system.

Line 8. Refinery Lines and Operating Equipment Fill

Inventory within the refinery lines and operating equipment (excluding tanks) that is required for the refinery processing system to function normally.

Line 9. In Transit by Water from Domestic Sources (Excluding Crude Oil from Alaska), Including Domesticized Foreign Oils In Transit

Include all stocks reported on Line 1 that were in transit by water to bulk terminals and refineries, excluding crude oil in transit by water from Alaska reported on Form EIA-813. Include stocks of domestic origin, and stocks of foreign origin that have entered through U.S. Customs -- i.e., domesticized foreign oils.

In-transit inventory should only be reported in the same amounts and on the same basis as reported to the DOE on Line 1.

Line 10. Subtotal: Unavailable Inventory Outside of Tankage

This line is the sum of the data on Lines 7, 8, and 9.

Line 11. Tank Bottoms

Inventory that falls below the normal suction line of the tank. For floating roof tanks, the amount required to keep the legs of the roof from touching the tank bottom.

Line 12. Plant Fuel and Pipeline Prime Mover Fuel

Stocks set aside as plant fuel or pipeline prime mover fuel.

Line 13. Lease Stocks (Complete on Questionnaire 1 Only)

Include all lease stocks reported on Line 1 (Product Code 057 on Form EIA-813).

Line 14. Total

This line is the sum of the data on Lines 10, 11, 12, and 13.

Line 15. Alaskan Crude Oil In Transit by Water (Complete on Questionnaire 1 Only)

Include all stocks of Alaskan crude oil in transit by water that you reported to the DOE on Form EIA-813 (Product Code 092) as of March 31, 1988. These stocks are not to be included in Lines 1, 2, and 21 (see line item instructions for Lines 1, 2, and 21).

Although Form EIA-813 requests this information on a U.S. basis only, please report on this line not only the amount reported to EIA for the Total U.S., but also your best estimate of the intended destination, differentiating between PADDs I - IV and PADD V.

Please include in your estimate for PADDs I - IV the volume of Alaskan crude oil in transit to Puerto Rico and the Virgin Islands, and in your estimate for PADD V the volume in transit to Guam.

Line 16. Shell Capacity of Tankage In Operation

The design capacity of operating tanks located at refineries, bulk terminals, pipeline tank farms, and producer leases. Include capacity of swing tankage; ensure that swing tankage is included in only one product or crude oil category for each date. Tankage that was idle -- for reasons other than programmed maintenance with plans for immediate return to service -- on September 30, 1987, and/or March 31, 1988 (in the case of refined products) or March 31, 1988 (in the case of crude oil) should not be reported on this line.

Line 17. Tank Tops and Safety Allowance

The portion of the shell capacity at the top of the tank that is not utilized for oil storage. This includes the safety allowance that is needed to protect personnel and property from damage that could result from thermal expansion and/or overfilling the tanks.

Line 18. Subtotal: Net Available Shell Capacity

This line is the difference between Lines 16 and 17.

Line 19. Unavailable Inventory Outside of Tankage

Repeat the data that were reported on Line 10. **Do not** include the data reported on Line 15, which will be handled separately by the NPC.

Line 20. Total Operating System Capacity

This line is the sum of Lines 18 and 19.

Line 21. Maximum Operating Inventory

Report your best estimates of your maximum operating inventory. These estimates should be on a custody basis and, therefore, **consistent with the number you report as actual inventory on Line 1**. Do not include Alaskan crude oil in transit by water in your maximum operating inventory estimates. Report maximum operating inventory on a "system basis" for each product; that is, only in columns labeled Total PADDs I - IV, PADD V, and Total U.S. (in the case of crude oil), as specified on each questionnaire.

If inventory were to go above this level, there would not be enough empty space in the system to allow it to keep operating without a slowdown or interruption in the system. Space above this level is not available for storage because it is needed to maintain a workable operating system.

The maximum operating inventory represents the maximum quantity that could be stored in the assigned tankage and in other parts of the system such as pipelines, refinery lines, or in transit (unavailable inventory outside of tankage, Line 10) while still maintaining a workable operating system.

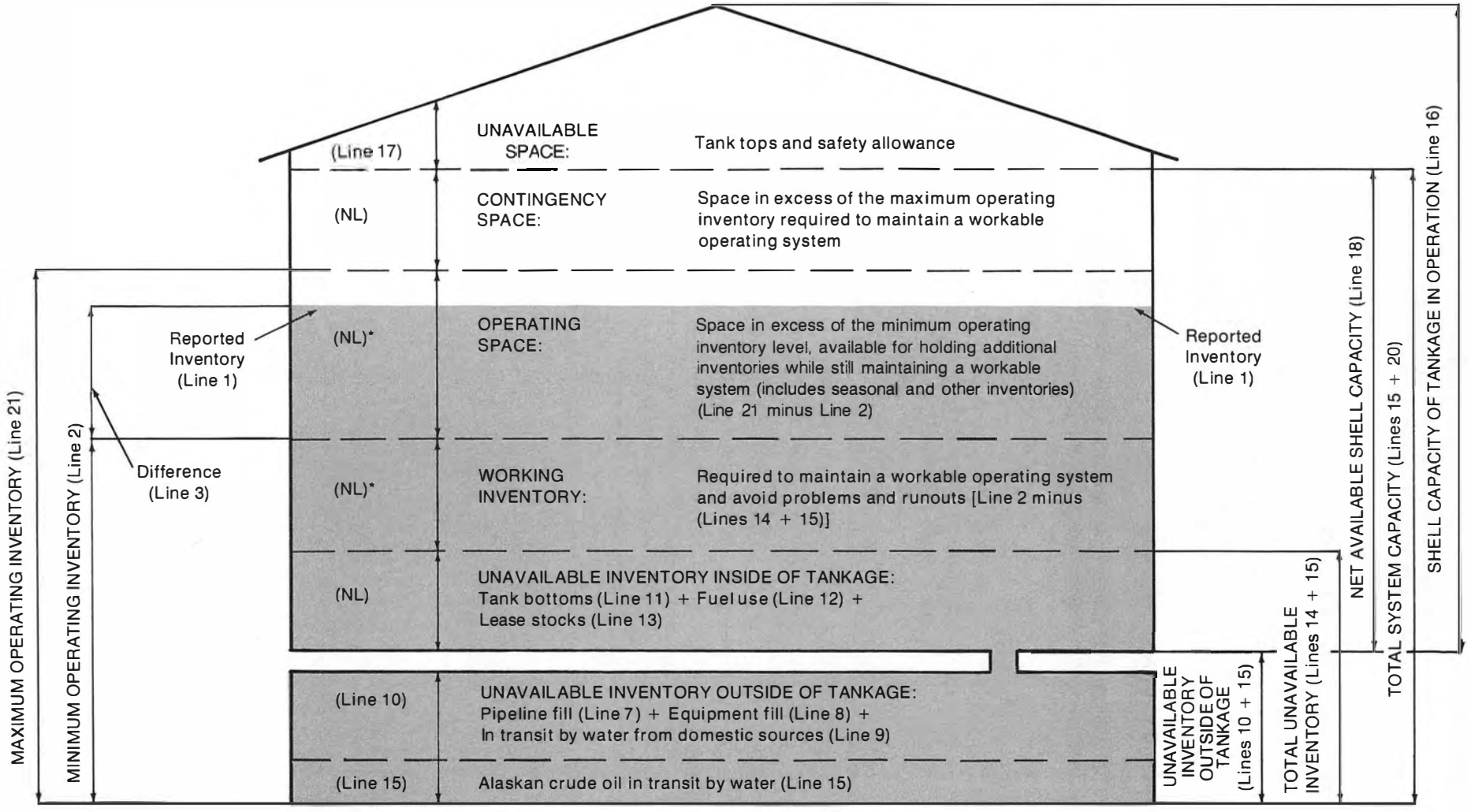
Line 22. Shell Capacity of Idle Tankage

The design capacity of tankage that was idle on March 31, 1988, for reasons other than programmed maintenance with plans for immediate return to service (included in Line 16). Line 22 tankage would be available for service within 90 days. Capacity should be reported in the same service as at the time of idling **unless** plans call for dedication to other service.

Line 23. Tankage Under Construction

The design shell capacity of tankage under construction (ground has been broken and the construction contract signed or major equipment ordered.)

SCHEMATIC OF TERMS DESCRIBING PETROLEUM INVENTORIES AND STORAGE CAPACITIES REQUESTED IN NPC QUESTIONNAIRES 1–6



*NL: No line referenced in the questionnaires

NATIONAL PETROLEUM COUNCIL
1988 SURVEY OF PETROLEUM INVENTORIES AND STORAGE CAPACITIES IN THE UNITED STATES

CRUDE OIL

Code: _____

As of March 31, 1988
(Report All Figures in **Thousands of Barrels**)

QUESTIONNAIRE NO. 1

DESCRIPTION	(1) PADD I	(2) PADD II	(3) PADD III	(4) PADD IV	(5) Total PADDS I-IV	(6) PADD V	(7) Total U.S.
(Deal only with those end-of-the-month stocks reported to the Department of Energy on Forms EIA-810 and EIA-813).	(1,000 bbl)	(1,000 bbl)	(1,000 bbl)	(1,000 bbl)	(1,000 bbl)	(1,000 bbl)	(1,000 bbl)
A. CRUDE OIL INVENTORY							
1. Total inventory reported to the Department of Energy							
2. Minimum operating inventory							
3. Difference (Line 1 minus 2)							
If greater than zero, estimate what volume was:							
4. Seasonal inventory							
5. In anticipation of planned maintenance							
6. Other operating inventory							
Memo Item: Unavailable inventory							
7. Pipeline fill							
8. Refinery lines and operating equipment fill							
9. Oil in transit by water from domestic sources (ex. Alaska)							
10. Subtotal: Unavailable inventory outside of tankage (Lines 7, 8, and 9)							
11. Tank bottoms							
12. Plant fuel and pipeline prime mover fuel							
13. Lease stocks							
14. Total (Lines 10, 11, 12, and 13)							
15. Alaskan crude oil in transit by water							
B. STORAGE CAPACITY ASSIGNED TO CRUDE OIL							
16. Shell capacity of tankage in operation							
17. Tank tops and safety allowance							
18. Subtotal: Net available shell capacity (Line 16 minus 17)							
19. Unavailable inventory outside of tankage (from Line 10 above)							
20. Total operating system capacity (Lines 18 and 19)							
21. Maximum operating inventory							
C. IDLE BUT USABLE CAPACITY/NEW CAPACITY							
22. Shell capacity of idle tankage							
23. Tankage under construction							

NATIONAL PETROLEUM COUNCIL
1988 SURVEY OF PETROLEUM INVENTORIES AND STORAGE CAPACITIES IN THE UNITED STATES

Code: _____

MOTOR GASOLINE, INCLUDING BLENDING COMPONENTS

As of September 30, 1987 and March 31, 1988
(Report All Figures in **Thousands of Barrels**)

QUESTIONNAIRE NO. 2

DESCRIPTION	(1) PADD I X		(2) PADD I Y		(3) PADD I Z		(4) PADD II	
(Deal only with those end-of-the-month stocks reported to the Department of Energy on Forms EIA-810, EIA-811, and EIA-812).	Sept. 30 (1,000 bbl)	Mar. 31 (1,000 bbl)	Sept. 30 (1,000 bbl)	Mar. 31 (1,000 bbl)	Sept. 30 (1,000 bbl)	Mar. 31 (1,000 bbl)	Sept. 30 (1,000 bbl)	Mar. 31 (1,000 bbl)
A. MOTOR GASOLINE INVENTORY, INCLUDING BLENDING COMPONENTS								
1. Total inventory reported to the Department of Energy								
2. Minimum operating inventory								
3. Difference (Line 1 minus 2)								
If greater than zero, estimate what volume was:								
4. Seasonal inventory								
5. In anticipation of planned maintenance								
6. Other operating inventory								
Memo Item: Unavailable inventory								
7. Pipeline fill								
8. Refinery lines and operating equipment fill								
9. Oil in transit by water from domestic sources (ex. Alaska)								
10. Subtotal: Unavailable inventory outside of tankage (Lines 7, 8, and 9)								
11. Tank bottoms								
12. Plant fuel and pipeline prime mover fuel								
13. Lease stocks								
14. Total (Lines 10, 11, 12, and 13)								
15. Alaskan crude oil in transit by water								
B. STORAGE CAPACITY ASSIGNED TO MOTOR GASOLINE, INCLUDING BLENDING COMPONENTS								
16. Shell capacity of tankage in operation								
17. Tank tops and safety allowance								
18. Subtotal: Net available shell capacity (Line 16 minus 17)								
19. Unavailable inventory outside of tankage (from Line 10 above)								
20. Total operating system capacity (Lines 18 and 19)								
21. Maximum operating inventory								
C. IDLE BUT USABLE CAPACITY/NEW CAPACITY								
22. Shell capacity of idle tankage								
23. Tankage under construction								

NATIONAL PETROLEUM COUNCIL
1988 SURVEY OF PETROLEUM INVENTORIES AND STORAGE CAPACITIES IN THE UNITED STATES

Code: _____

MOTOR GASOLINE, INCLUDING BLENDING COMPONENTS

As of September 30, 1987 and March 31, 1988
(Report All Figures in **Thousands of Barrels**)

QUESTIONNAIRE NO. 2

DESCRIPTION	(5) PADD III		(6) PADD IV		(7) Total PADDS I-IV		(8) PADD V	
(Deal only with those end-of-the-month stocks reported to the Department of Energy on Forms EIA-810, EIA-811, and EIA-812).	Sept. 30 (1,000 bbl)	Mar. 31 (1,000 bbl)	Sept. 30 (1,000 bbl)	Mar. 31 (1,000 bbl)	Sept. 30 (1,000 bbl)	Mar. 31 (1,000 bbl)	Sept. 30 (1,000 bbl)	Mar. 31 (1,000 bbl)
A. MOTOR GASOLINE INVENTORY, INCLUDING BLENDING COMPONENTS								
1. Total inventory reported to the Department of Energy								
2. Minimum operating inventory								
3. Difference (Line 1 minus 2)								
If greater than zero, estimate what volume was:								
4. Seasonal inventory								
5. In anticipation of planned maintenance								
6. Other operating inventory								
Memo Item: Unavailable inventory								
7. Pipeline fill								
8. Refinery lines and operating equipment fill								
9. Oil in transit by water from domestic sources (ex. Alaska)								
10. Subtotal: Unavailable inventory outside of tankage (Lines 7, 8, and 9)								
11. Tank bottoms								
12. Plant fuel and pipeline prime mover fuel								
13. Lease stocks								
14. Total (Lines 10, 11, 12, and 13)								
15. Alaskan crude oil in transit by water								
B. STORAGE CAPACITY ASSIGNED TO MOTOR GASOLINE, INCLUDING BLENDING COMPONENTS								
16. Shell capacity of tankage in operation								
17. Tank tops and safety allowance								
18. Subtotal: Net available shell capacity (Line 16 minus 17)								
19. Unavailable inventory outside of tankage (from Line 10 above)								
20. Total operating system capacity (Lines 18 and 19)								
21. Maximum operating inventory								
C. IDLE BUT USABLE CAPACITY/NEW CAPACITY								
22. Shell capacity of idle tankage								
23. Tankage under construction								

NATIONAL PETROLEUM COUNCIL
1988 SURVEY OF PETROLEUM INVENTORIES AND STORAGE CAPACITIES IN THE UNITED STATES

Code: _____

KEROSINE-TYPE JET FUEL

As of September 30, 1987 and March 31, 1988
(Report All Figures in **Thousands of Barrels**)

QUESTIONNAIRE NO. 3

DESCRIPTION	(1) PADD IX		(2) PADD IY		(3) PADD IZ		(4) PADD II	
(Deal only with those end-of-the-month stocks reported to the Department of Energy on Forms EIA-810, EIA-811, and EIA-812).	Sept. 30 (1,000 bbl)	Mar. 31 (1,000 bbl)	Sept. 30 (1,000 bbl)	Mar. 31 (1,000 bbl)	Sept. 30 (1,000 bbl)	Mar. 31 (1,000 bbl)	Sept. 30 (1,000 bbl)	Mar. 31 (1,000 bbl)
A. KEROSINE-TYPE JET FUEL INVENTORY								
1. Total inventory reported to the Department of Energy								
2. Minimum operating inventory								
3. Difference (Line 1 minus 2)								
If greater than zero, estimate what volume was:								
4. Seasonal inventory								
5. In anticipation of planned maintenance								
6. Other operating inventory								
Memo Item: Unavailable inventory								
7. Pipeline fill								
8. Refinery lines and operating equipment fill								
9. Oil in transit by water from domestic sources (ex. Alaska)								
10. Subtotal: Unavailable inventory outside of tankage (Lines 7, 8, and 9)								
11. Tank bottoms								
12. Plant fuel and pipeline prime mover fuel								
13. Lease stocks								
14. Total (Lines 10, 11, 12, and 13)								
15. Alaskan crude oil in transit by water								
B. STORAGE CAPACITY ASSIGNED TO KEROSINE-TYPE JET FUEL								
16. Shell capacity of tankage in operation								
17. Tank tops and safety allowance								
18. Subtotal: Net available shell capacity (Line 16 minus 17)								
19. Unavailable inventory outside of tankage (from Line 10 above)								
20. Total operating system capacity (Lines 18 and 19)								
21. Maximum operating inventory								
C. IDLE BUT USABLE CAPACITY/NEW CAPACITY								
22. Shell capacity of idle tankage								
23. Tankage under construction								

NATIONAL PETROLEUM COUNCIL
1988 SURVEY OF PETROLEUM INVENTORIES AND STORAGE CAPACITIES IN THE UNITED STATES

Code: _____

KEROSINE-TYPE JET FUEL

As of September 30, 1987 and March 31, 1988
(Report All Figures in **Thousands of Barrels**)

QUESTIONNAIRE NO. 3

DESCRIPTION	(5) PADD III		(6) PADD IV		(7) PADDS I-IV		(8) PADD V	
(Deal only with those end-of-the-month stocks reported to the Department of Energy on Forms EIA-810, EIA-811, and EIA-812).	Sept. 30 (1,000 bbl)	Mar. 31 (1,000 bbl)	Sept. 30 (1,000 bbl)	Mar. 31 (1,000 bbl)	Sept. 30 (1,000 bbl)	Mar. 31 (1,000 bbl)	Sept. 30 (1,000 bbl)	Mar. 31 (1,000 bbl)
A. KEROSINE-TYPE JET FUEL INVENTORY								
1. Total inventory reported to the Department of Energy								
2. Minimum operating inventory								
3. Difference (Line 1 minus 2)								
If greater than zero, estimate what volume was:								
4. Seasonal inventory								
5. In anticipation of planned maintenance								
6. Other operating inventory								
Memo Item: Unavailable inventory								
7. Pipeline fill								
8. Refinery lines and operating equipment fill								
9. Oil in transit by water from domestic sources (ex. Alaska)								
10. Subtotal: Unavailable inventory outside of tankage (Lines 7, 8, and 9)								
11. Tank bottoms								
12. Plant fuel and pipeline prime mover fuel								
13. Lease stocks								
14. Total (Lines 10, 11, 12, and 13)								
15. Alaskan crude oil in transit by water								
B. STORAGE CAPACITY ASSIGNED TO KEROSINE-TYPE JET FUEL								
16. Shell capacity of tankage in operation								
17. Tank tops and safety allowance								
18. Subtotal: Net available shell capacity (Line 16 minus 17)								
19. Unavailable inventory outside of tankage (from Line 10 above)								
20. Total operating system capacity (Lines 18 and 19)								
21. Maximum operating inventory								
C. IDLE BUT USABLE CAPACITY/NEW CAPACITY								
22. Shell capacity of idle tankage								
23. Tankage under construction								

NATIONAL PETROLEUM COUNCIL
1988 SURVEY OF PETROLEUM INVENTORIES AND STORAGE CAPACITIES IN THE UNITED STATES

Code: _____

DISTILLATE FUEL OIL, INCLUDING NO. 4 FUEL OIL

As of September 30, 1987 and March 31, 1988
(Report All Figures in **Thousands of Barrels**)

QUESTIONNAIRE NO. 4

DESCRIPTION	(1) PADD IX		(2) PADD IY		(3) PADD IZ		(4) PADD II	
(Deal only with those end-of-the-month stocks reported to the Department of Energy on Forms EIA-810, EIA-811, and EIA-812).	Sept. 30 (1,000 bbl)	Mar. 31 (1,000 bbl)	Sept. 30 (1,000 bbl)	Mar. 31 (1,000 bbl)	Sept. 30 (1,000 bbl)	Mar. 31 (1,000 bbl)	Sept. 30 (1,000 bbl)	Mar. 31 (1,000 bbl)
A. DISTILLATE FUEL OIL INVENTORY								
1. Total inventory reported to the Department of Energy								
2. Minimum operating inventory								
3. Difference (Line 1 minus 2)								
If greater than zero, estimate what volume was:								
4. Seasonal inventory								
5. In anticipation of planned maintenance								
6. Other operating inventory								
Memo Item: Unavailable inventory								
7. Pipeline fill								
8. Refinery lines and operating equipment fill								
9. Oil in transit by water from domestic sources (ex. Alaska)								
10. Subtotal: Unavailable inventory outside of tankage (Lines 7, 8, and 9)								
11. Tank bottoms								
12. Plant fuel and pipeline prime mover fuel								
13. Lease stocks								
14. Total (Lines 10, 11, 12, and 13)								
15. Alaskan crude oil in transit by water								
B. STORAGE CAPACITY ASSIGNED TO DISTILLATE FUEL OIL								
16. Shell capacity of tankage in operation								
17. Tank tops and safety allowance								
18. Subtotal: Net available shell capacity (Line 16 minus 17)								
19. Unavailable inventory outside of tankage (from Line 10 above)								
20. Total operating system capacity (Lines 18 and 19)								
21. Maximum operating inventory								
C. IDLE BUT USABLE CAPACITY/NEW CAPACITY								
22. Shell capacity of idle tankage								
23. Tankage under construction								

NATIONAL PETROLEUM COUNCIL
1988 SURVEY OF PETROLEUM INVENTORIES AND STORAGE CAPACITIES IN THE UNITED STATES

Code: _____

DISTILLATE FUEL OIL, INCLUDING NO. 4 FUEL OIL

As of September 30, 1987 and March 31, 1988
(Report All Figures in **Thousands of Barrels**)

QUESTIONNAIRE NO. 4

DESCRIPTION	(5) PADD III		(6) PADD IV		(7) PADDS I-IV		(8) PADD V	
(Deal only with those end-of-the-month stocks reported to the Department of Energy on Forms EIA-810, EIA-811, and EIA-812).	Sept. 30 (1,000 bbl)	Mar. 31 (1,000 bbl)	Sept. 30 (1,000 bbl)	Mar. 31 (1,000 bbl)	Sept. 30 (1,000 bbl)	Mar. 31 (1,000 bbl)	Sept. 30 (1,000 bbl)	Mar. 31 (1,000 bbl)
A. DISTILLATE FUEL OIL INVENTORY								
1. Total inventory reported to the Department of Energy								
2. Minimum operating inventory								
3. Difference (Line 1 minus 2)								
If greater than zero, estimate what volume was:								
4. Seasonal inventory								
5. In anticipation of planned maintenance								
6. Other operating inventory								
Memo Item: Unavailable inventory								
7. Pipeline fill								
8. Refinery lines and operating equipment fill								
9. Oil in transit by water from domestic sources (ex. Alaska)								
10. Subtotal: Unavailable inventory outside of tankage (Lines 7, 8, and 9)								
11. Tank bottoms								
12. Plant fuel and pipeline prime mover fuel								
13. Lease stocks								
14. Total (Lines 10, 11, 12, and 13)								
15. Alaskan crude oil in transit by water								
B. STORAGE CAPACITY ASSIGNED TO DISTILLATE FUEL OIL								
16. Shell capacity of tankage in operation								
17. Tank tops and safety allowance								
18. Subtotal: Net available shell capacity (Line 16 minus 17)								
19. Unavailable inventory outside of tankage (from Line 10 above)								
20. Total operating system capacity (Lines 18 and 19)								
21. Maximum operating inventory								
C. IDLE BUT USABLE CAPACITY/NEW CAPACITY								
22. Shell capacity of idle tankage								
23. Tankage under construction								

NATIONAL PETROLEUM COUNCIL
1988 SURVEY OF PETROLEUM INVENTORIES AND STORAGE CAPACITIES IN THE UNITED STATES

Code: _____

RESIDUAL FUEL OIL

As of September 30, 1987 and March 31, 1988
(Report All Figures in **Thousands of Barrels**)

QUESTIONNAIRE NO. 5

DESCRIPTION	(1) PADD IX		(2) PADD IY		(3) PADD IZ		(4) PADD II	
(Deal only with those end-of-the-month stocks reported to the Department of Energy on Forms EIA-810, EIA-811, and EIA-812).	Sept. 30 (1,000 bbl)	Mar. 31 (1,000 bbl)	Sept. 30 (1,000 bbl)	Mar. 31 (1,000 bbl)	Sept. 30 (1,000 bbl)	Mar. 31 (1,000 bbl)	Sept. 30 (1,000 bbl)	Mar. 31 (1,000 bbl)
A. RESIDUAL FUEL OIL INVENTORY								
1. Total inventory reported to the Department of Energy								
2. Minimum operating inventory								
3. Difference (Line 1 minus 2)								
If greater than zero, estimate what volume was:								
4. Seasonal inventory								
5. In anticipation of planned maintenance								
6. Other operating inventory								
Memo Item: Unavailable inventory								
7. Pipeline fill								
8. Refinery lines and operating equipment fill								
9. Oil in transit by water from domestic sources (ex. Alaska)								
10. Subtotal: Unavailable inventory outside of tankage (Lines 7, 8, and 9)								
11. Tank bottoms								
12. Plant fuel and pipeline prime mover fuel								
13. Lease stocks								
14. Total (Lines 10, 11, 12, and 13)								
15. Alaskan crude oil in transit by water								
B. STORAGE CAPACITY ASSIGNED TO RESIDUAL FUEL OIL								
16. Shell capacity of tankage in operation								
17. Tank tops and safety allowance								
18. Subtotal: Net available shell capacity (Line 16 minus 17)								
19. Unavailable inventory outside of tankage (from Line 10 above)								
20. Total operating system capacity (Lines 18 and 19)								
21. Maximum operating inventory								
C. IDLE BUT USABLE CAPACITY/NEW CAPACITY								
22. Shell capacity of idle tankage								
23. Tankage under construction								

NATIONAL PETROLEUM COUNCIL
1988 SURVEY OF PETROLEUM INVENTORIES AND STORAGE CAPACITIES IN THE UNITED STATES

Code: _____

RESIDUAL FUEL OIL

As of September 30, 1987 and March 31, 1988
(Report All Figures in **Thousands of Barrels**)

QUESTIONNAIRE NO. 5

DESCRIPTION	(5) PADD III		(6) PADD IV		(7) PADDS I-IV		(8) PADD V	
(Deal only with those end-of-the-month stocks reported to the Department of Energy on Forms EIA-810, EIA-811, and EIA-812).	Sept. 30 (1,000 bbl)	Mar. 31 (1,000 bbl)	Sept. 30 (1,000 bbl)	Mar. 31 (1,000 bbl)	Sept. 30 (1,000 bbl)	Mar. 31 (1,000 bbl)	Sept. 30 (1,000 bbl)	Mar. 31 (1,000 bbl)
A. RESIDUAL FUEL OIL INVENTORY								
1. Total inventory reported to the Department of Energy								
2. Minimum operating inventory								
3. Difference (Line 1 minus 2)								
If greater than zero, estimate what volume was:								
4. Seasonal inventory								
5. In anticipation of planned maintenance								
6. Other operating inventory								
Memo Item: Unavailable inventory								
7. Pipeline fill								
8. Refinery lines and operating equipment fill								
9. Oil in transit by water from domestic sources (ex. Alaska)								
10. Subtotal: Unavailable inventory outside of tankage (Lines 7, 8, and 9)								
11. Tank bottoms								
12. Plant fuel and pipeline prime mover fuel								
13. Lease stocks								
14. Total (Lines 10, 11, 12, and 13)								
15. Alaskan crude oil in transit by water								
B. STORAGE CAPACITY ASSIGNED TO RESIDUAL FUEL OIL								
16. Shell capacity of tankage in operation								
17. Tank tops and safety allowance								
18. Subtotal: Net available shell capacity (Line 16 minus 17)								
19. Unavailable inventory outside of tankage (from Line 10 above)								
20. Total operating system capacity (Lines 18 and 19)								
21. Maximum operating inventory								
C. IDLE BUT USABLE CAPACITY/NEW CAPACITY								
22. Shell capacity of idle tankage								
23. Tankage under construction								

Code: _____

NATIONAL PETROLEUM COUNCIL
1988 SURVEY OF PETROLEUM INVENTORIES AND STORAGE CAPACITIES IN THE UNITED STATES

ESTIMATED MINIMUM AND MAXIMUM OPERATING INVENTORIES FOR THE ENTIRE U.S. PETROLEUM INDUSTRY

QUESTIONNAIRE NO. 6

Complete this questionnaire only if your company analyzes industry inventory levels. (See NOTE, below.)

As of September 30, 1987 and March 31, 1988
(Report All Figures in **Thousands of Barrels**)

DESCRIPTION	Estimated Operating Inventories for the Entire U.S. Petroleum Industry											
	Minimum (1,000 bbl)						Maximum (1,000 bbl)					
	September 30, 1987			March 31, 1988			September 30, 1987			March 31, 1988		
	PADDS I-IV	PADD V	TOTAL U.S.	PADDS I-IV	PADD V	TOTAL U.S.	PADDS I-IV	PADD V	TOTAL U.S.	PADDS I-IV	PADD V	TOTAL U.S.
1. Crude oil												
2. Motor gasoline, including blending components												
3. Kerosine-type jet fuel												
4. Distillate fuel oil, including No. 4 fuel oil												
5. Residual fuel oil												

NOTE: It is possible that the sum of the companies' assessments of their own minimum and maximum operating inventories (Line 2 and 21 on Questionnaires 1–6) will not accurately reflect the entire petroleum industry's minimum or maximum operating inventory. If your company analyzes industry levels, provide your estimate of the minimum and maximum operating inventories of the U.S. petroleum industry. Enter estimates for PADDS I-IV, PADD V, and Total U.S. If your company does not have certain of the estimates requested in this questionnaire, leave those sections blank. If your company only performs this analysis for Total U.S., complete only those columns.

Code Number*_____

NATIONAL PETROLEUM COUNCIL
1988 SURVEY

THE STRATEGIC PETROLEUM RESERVE

Reporting Company: _____

Address: _____

_____

_____ Zip Code: _____

Person in reporting company to be contacted if questions arise:

_____

Phone: (____)_____

Please return this questionnaire by May 16, 1988, to: Deloitte Haskins & Sells
Suite 800
1101 15th Street, N.W.
Washington, D.C. 20005
ATTN: NPC Survey Team

If you have questions regarding this survey, please call Mr. Benjamin A. Oliver, Jr. at the National Petroleum Council office, (202) 393-6100.

*This entry, and other NPC Code spaces on subsequent pages, will be entered by the accounting firm for data tabulation purposes.

Code Number_____

THE STRATEGIC PETROLEUM RESERVE

The Strategic Petroleum Reserve (SPR) is now the key component in the nation's energy emergency response capability. It contains 540 million barrels of crude oil, which can be drawn down at a rate of 3.5 million barrels per day. The National Petroleum Council studied the physical characteristics and logistical limitations of the SPR facilities in its 1984 report, The Strategic Petroleum Reserve. The purpose of this questionnaire is:

a. To assess the impact (if any) that the existence of the SPR has on the level of inventories held in the private sector, and

b. To collect the industry's comments on DOE's plan for the use of the SPR oil that could have an impact on its effectiveness in stress situations.

---

1. Which of the following categories best characterizes your company's operation?

   _____ Refiner with more than 175,000 B/D capacity
   _____ Refiner with 175,000 B/D capacity or less
   _____ Petroleum products marketer
   _____ Public warehouse terminal operator
   _____ Pipeline
   _____ Other _____

2. What is the percentage of your company's crude oil consumption by PADD district? (Answers should total to 100 percent).

   _____% PADD I (East Coast)
   _____% PADD II (Midwest)
   _____% PADD III (Gulf Coast)
   _____% PADD IV (Rocky Mountains)
   _____% PADD V (West Coast)
   _____ No crude oil consumption

3. Has the existence of the SPR reduced the amount of oil you routinely hold in inventory?

   _____ No change
   _____ Yes
      _____ Decreased 10% or less
      _____ Decreased 10-30%
      _____ Decreased 30% or more

4. The Administration has indicated that in the event of a crude oil supply emergency, it intends to make an early release of large amounts of SPR oil through public auction. The buyer's use of the oil would be unrestricted. The DOE's current drawdown plan states:

   > The basic method of distribution of SPR oil will be by price competitive sale with awards going to the highest bidders....The sale would be open to all interested buyers, who will be required to sign a standard sales agreement as a condition of bidding. Measures will be included in the sales agreement to assure the financial and performance responsibilities of the successful buyers. It is intended that the universe of eligible buyers will be as large as possible to ensure efficient distribution of SPR oil.

Code Number_____

The DOE schedule to release SPR oil is summarized as follows:

Day	Action
0	President declares emergency
3	DOE issues Notice of Sale
10	Offers due from bidders
13	Notification of apparent successful bidders
18	Notification of awards
13-23	Vessel schedule data required
23-38	Detailed vessel schedules set
33-43	First delivery period

Further details on DOE's plan for sale and drawdown are contained in: Strategic Petroleum Reserve Drawdown Plan, Amendment No. 4., December 1, 1982. If a copy of the Plan is needed, please contact Mr. Benjamin A. Oliver, Jr., at the National Petroleum Council office, (202) 393-6100.

What are your company's views on the following:

a. Do you agree with early drawdown of SPR stocks during an energy emergency?

_____ Yes _____ No

b. Is your company likely to participate in an auction for SPR oil?

_____ Yes _____ No

c. Is your company familiar with and do they have an opinion on the DOE Drawdown Plan?

_____ Yes _____ No

If you answer "yes" to Question 4c, please provide comments that will help the National Petroleum Council assess the likely effectiveness of the SPR release program. (NOTE: All comments submitted below will be provided by Deloitte Haskins & Sells, without attribution, to the NPC Committee on Petroleum Storage & Transportation and will be public. The identity of the respondents will remain confidential.)

_____

_____

_____

_____

_____

_____

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_____

(If you need more space, please use additional sheets of paper)

Code Number*_____

NATIONAL PETROLEUM COUNCIL
1988 SURVEY

PETROLEUM FUTURES AND OTHER FORWARD MARKETS

Reporting Company:_____

Address:_____

_____

_____ Zip Code: _____

Person in reporting company to be contacted if questions arise:

_____

Phone: (___)_____

Please return this questionnaire by May 16, 1988, to: Deloitte Haskins & Sells
Suite 800
1101 15th Street, N.W.
Washington, D.C. 20005
ATTN: NPC Survey Team

If you have questions regarding this survey, please call Mr. Benjamin A. Oliver, Jr. at the National Petroleum Council office, (202) 393-6100.

*This entry, and other NPC Code spaces on subsequent pages, will be entered by the accounting firm for data tabulation purposes.

Code Number_____

PETROLEUM FUTURES AND OTHER FORWARD MARKETS

The petroleum futures, options, and cash forward markets, gaining in prominence in recent years, have provided companies with supply flexibility and some protection against price fluctuations. These markets may also influence such operating decisions as refinery runs and inventory management. This questionnaire attempts to assess the impact of these petroleum futures and forward markets on inventories.

NOTE: In answering these questions, please consider the stocks you own on land as well as those owned offshore stocks committed for U.S. supply, whether or not these stocks are actually in your custody. This is different from the inventory and storage questionnaires, which are on a custody basis.

1. Has there generally been a change in your physical inventory levels due to the presence of the petroleum futures and forward markets?

   _____ No change

   _____ Generally higher, by _____%

   _____ Generally lower, by _____%

   _____ May be higher or lower, depending on market economics, by

   _____ plus or minus 10% or less

   _____ plus or minus 10-25%

   _____ plus or minus more than 25%

2. Approximate the level of inventories owned (whether or not in custody, as noted above) and committed to the U.S. market on March 31, 1988:

   _____ Crude Oil (barrels)

   _____ Product (barrels)

3. a. Approximate the percentage of the March 31, 1988, inventories reported in Question 2 backed by hedges:

   _____% crude oil

   _____% petroleum products

   b. Typical percentage of your inventories backed by hedges:

   _____% crude oil

   _____ % petroleum products

4. Which of the folowing markets has your firm participated in (check all that apply):

   _____ Petroleum futures (NYMEX, IPE, etc.)

   _____ Petroleum options (NYMEX)

   _____ Cash forward (Brent or Dubai crude oils, product markets such as "Boston Bingo" for No. 2 oil, the forward Russian gasoil market)

5. Which oil commodities have you traded in these markets?

   _____ No. 2 oil/gasoil

   _____ Motor gasoline

   _____ Crude oil

APPENDIX E

PRIMARY DISTRIBUTION SYSTEM SURVEY DATA

NATIONAL PETROLEUM COUNCIL
1988 SURVEY OF PETROLEUM INVENTORIES AND STORAGE CAPACITIES IN THE UNITED STATES

CRUDE OIL
As of March 31, 1988 (Thousands of Barrels)

INVENTORY AND STORAGE CAPACITY	PADD I	PADD II	PADD III	PADD IV	Total PADDs I-IV	PADD V	Total U.S. NPC Total	Total U.S. Adjusted NPC Total
A. CRUDE OIL INVENTORY								
1. Total inventory reported by DOE	14,845	73,703	161,426	13,469	263,443	57,941	321,384	***
a. Total inventory reported to NPC	14,964	63,990	142,699	12,236	233,889	49,188	283,077	321,384
b. Percentage of line one	100.8	86.8	88.4	90.8	88.8	84.9	88.1	***
2. Minimum operating inventory					154,314	33,172	187,486	212,857
3. Difference (Line 1 minus 2)					79,575	16,016	95,591	108,527
If greater than zero, estimate what volume was:								
4. Seasonal inventory					1,596	822	2,418	2,745
5. In anticipation of planned maintenance					433	85	518	588
6. Other operating inventory					77,546	15,109	92,655	105,194
Memo Item: Unavailable inventory								
7. Pipeline fill	160	21,831	28,924	4,498	55,413	14,491	69,904	***
8. Refinery lines and operating equipment fill	*	*	*	*	1,316	455	1,771	***
9. Oil in transit by water from domestic sources (ex. Alaska)	*	*	*	*	517		517	***
10. Subtotal: Unavailable inventory outside of tankage (Lines 7, 8, and 9)	635	22,152	29,945	4,514	57,246	14,946	72,192	81,961
11. Tank bottoms	2,670	7,005	21,154	1,206	32,035	4,931	36,966	***
12. Plant fuel and pipeline prime mover fuel	*	*	*	*	203	289	492	***
13. Lease stocks	*	*	*	*	4,213	1,240	5,453	***
14. Total (Lines 10, 11, 12, and 13)	3,340	29,584	54,676	6,097	93,697	21,406	115,103	130,679
15. Alaskan crude oil in transit by water					11,725	6,606	18,331	21,611
B. STORAGE CAPACITY ASSIGNED TO CRUDE OIL								
16. Shell capacity of tankage in operation	26,529	89,331	241,246	16,024	373,130	74,094	447,224	507,744
17. Tank tops and safety allowance	2,404	6,858	17,015	975	27,252	5,454	32,706	37,132
18. Subtotal: Net available shell capacity (Line 16 minus 17)	24,125	82,473	224,231	15,049	345,878	68,640	414,518	470,612
19. Unavailable inventory outside of tankage (from Line 10 above)	635	22,152	29,945	4,514	57,246	14,946	72,192	81,961
20. Total operating system capacity (Lines 18 and 19)	24,760	104,625	254,176	19,563	403,124	83,586	486,710	552,573
21. Maximum operating inventory					349,543	65,689	415,232	471,423
C. IDLE BUT USABLE CAPACITY/NEW CAPACITY								
22. Shell capacity of idle tankage	1,405	1,728	9,441	590	13,164	2,991	16,155	18,341
23. Tankage under construction	0	*	*	*	*	*	387	439

*Data excluded to protect confidentiality

***Not applicable

NATIONAL PETROLEUM COUNCIL
1988 SURVEY OF PETROLEUM INVENTORIES AND STORAGE CAPACITIES IN THE UNITED STATES

MOTOR GASOLINE, INCLUDING BLENDING COMPONENTS
As of September 30, 1987 (Thousands of Barrels)

INVENTORY AND STORAGE CAPACITY	PADD IX	PADD IY	PADD IZ	Total PADD I	PADD II	PADD III	PADD IV	Total PADDs I-IV	PADD V	Total U.S. NPC Total	Total U.S. Adjusted NPC Total
A. MOTOR GASOLINE INVENTORY, INCLUDING BLENDING COMPONENTS											
1. Total inventory reported to the Department of Energy				64,412	61,244	66,429	6,107	198,192	31,456	229,648	***
a. Total inventory reported by DOE	4,238	28,057	27,573	59,868	57,108	61,007	5,007	182,990	25,609	208,599	229,648
b. Percentage of line one				92.9	93.2	91.8	82.0	92.3	81.4	90.8	***
2. Minimum operating inventory								128,173	17,054	145,227	159,881
3. Difference (Line 1 minus 2)								54,817	8,555	63,372	69,767
If greater than zero, estimate what volume was:											
4. Seasonal inventory								*	*	4,812	5,298
5. In anticipation of planned maintenance								*	*	408	449
6. Other operating inventory								51,359	6,793	58,152	64,020
Memo Item: Unavailable inventory											
7. Pipeline fill	75	2,415	6,945	9,435	10,175	9,884	799	30,293	1.985	32,278	***
8. Refinery lines and operating equipment fill	*	*	*	*	*	*	*	*	*	976	***
9. Oil in transit by water from domestic sources (ex. Alaska)	*	*	*	*	*	*	*	*	*	2,690	***
10. Subtotal: Unavailable inventory outside of tankage (Lines 7, 8, and 9)	473	2,844	7,544	10,861	10,963	10,950	821	33,595	2,349	35,944	39,571
11. Tank bottoms	*	*	*	*	*	*	*	*	*	30,623	***
12. Plant fuel and pipeline prime mover fuel	*	*	*	*	*	*	*	*	*	84	***
13. Lease stocks											
14. Total (Lines 10, 11, 12, and 13)	1,300	7,564	9,720	18,584	19,449	20,806	1,694	60,533	6,118	66,651	73,376
15. Alaskan crude oil in transit by water											
B. STORAGE CAPACITY ASSIGNED TO MOTOR GASOLINE, INCLUDING BLENDING COMPONENTS											
16. Shell capacity of tankage in operation	9,711	66,873	40,809	117,393	108,753	108,195	10,598	344,939	51,150	396,089	436,057
17. Tank tops and safety allowance	617	4,967	3,046	8,630	7,978	8,722	956	26,286	3,574	29,860	32,873
18. Subtotal: Net available shell capacity (Line 16 minus 17)	9,094	61,906	37,763	108,763	100,775	99,473	9,642	318,653	47,576	366,229	403,184
19. Unavailable inventory outside of tankage (from Line 10 above)	473	2,844	7,544	10,861	10,963	10,950	821	33,595	2,349	35,944	39,571
20. Total operating system capacity (Lines 18 and 19)	9,567	64,750	45,307	119,624	111,738	110,423	10,463	352,248	49,925	402,173	442,755
21. Maximum operating inventory								303,460	40,182	343,642	378,318
C. IDLE BUT USABLE CAPACITY/NEW CAPACITY											
22. Shell capacity of idle tankage	0	0	0	0	0	0	0	0	0	0	0
23. Tankage under construction	0	0	0	0	0	0	0	0	0	0	0

*Data excluded to protect confidentiality
***Not applicable

NATIONAL PETROLEUM COUNCIL
1988 SURVEY OF PETROLEUM INVENTORIES AND STORAGE CAPACITIES IN THE UNITED STATES

MOTOR GASOLINE, INCLUDING BLENDING COMPONENTS
As of March 31, 1988 (Thousands of Barrels)

INVENTORY AND STORAGE CAPACITY	PADD IX	PADD IY	PADD IZ	Total PADD I	PADD II	PADD III	PADD IV	Total PADDs I-IV	PADD V	Total U.S. NPC Total	Total U.S. Adjusted NPC Total
A. MOTOR GASOLINE INVENTORY, INCLUDING BLENDING COMPONENTS											
1. Total inventory reported to the Department of Energy				67,985	66,249	60,755	7,593	202,582	28,676	231,258	***
a. Total inventory reported by DOE	4,257	29,801	25,018	59,076	60,633	56,100	4,841	180,650	22,467	203,117	231,258
b. Percentage of line one				86.9	91.5	92.3	63.8	89.2	78.4	87.8	***
2. Minimum operating inventory								128,011	16,147	144,158	164,131
3. Difference (Line 1 minus 2)								52,639	6,320	58,959	67,127
If greater than zero, estimate what volume was:											
4. Seasonal inventory								*	*	7,011	7,982
5. In anticipation of planned maintenance								*	*	522	594
6. Other operating inventory								46,911	4,515	51,426	58,551
Memo Item: Unavailable inventory											
7. Pipeline fill	33	2,643	6,985	9,661	10,551	9,723	819	30,754	2,093	32,847	***
8. Refinery lines and operating equipment fill	*	*	*	*	*	*	*	*	*	1,035	***
9. Oil in transit by water from domestic sources (ex. Alaska)	*	*	*	*	*	*	*	*	*	3,149	***
10. Subtotal: Unavailable inventory outside of tankage (Lines 7, 8, and 9)	298	2,969	7,951	11,218	11,176	11,100	841	34,335	2,696	37,031	42,161
11. Tank bottoms	*	*	*	*	*	*	*	*	*	30,478	***
12. Plant fuel and pipeline prime mover fuel	*	*	*	*	*	*	*	*	*	84	***
13. Lease stocks											
14. Total (Lines 10, 11, 12, and 13)	1,116	7,513	10,121	18,750	19,709	20,995	1,745	61,199	6,394	67,593	76,958
15. Alaskan crude oil in transit by water											
B. STORAGE CAPACITY ASSIGNED TO MOTOR GASOLINE, INCLUDING BLENDING COMPONENTS											
16. Shell capacity of tankage in operation	9,711	66,545	40,527	116,783	108,752	109,327	10,708	345,570	50,966	396,536	451,474
17. Tank tops and safety allowance	617	4,985	3,057	8,659	8,030	8,774	967	26,430	3,540	29,970	34,122
18. Subtotal: Net available shell capacity (Line 16 minus 17)	9,094	61,560	37,470	108,124	100,722	100,553	9,741	319,140	47,426	366,566	417,352
19. Unavailable inventory outside of tankage (from Line 10 above)	298	2,969	7,951	11,218	11,176	11,100	841	34,335	2,696	37,031	42,161
20. Total operating system capacity (Lines 18 and 19)	9,392	64,529	45,421	119,342	111,898	111,653	10,582	353,475	50,122	403,597	459,513
21. Maximum operating inventory								304,199	38,873	343,072	390,603
C. IDLE BUT USABLE CAPACITY/NEW CAPACITY											
22. Shell capacity of idle tankage	111	3,121	1,357	4,589	3,984	5,651	0	14,224	833	15,057	17,143
23. Tankage under construction	0	*	0	*	0	*	*	*	*	614	699

*Data excluded to protect confidentiality
***Not applicable

NATIONAL PETROLEUM COUNCIL
1988 SURVEY OF PETROLEUM INVENTORIES AND STORAGE CAPACITIES IN THE UNITED STATES

KEROSINE-TYPE JET FUEL
As of September 30, 1987 (Thousands of Barrels)

INVENTORY AND STORAGE CAPACITY	PADD IX	PADD IY	PADD IZ	Total PADD I	PADD II	PADD III	PADD IV	Total PADDs I-IV	PADD V	Total U.S. NPC Total	Total U.S. Adjusted NPC Total
A. KEROSINE-TYPE JET FUEL INVENTORY											
1. Total inventory reported to the Department of Energy				10,729	9,038	17,041	812	37,620	6,064	43,684	***
a. Total inventory reported to NPC	603	5,528	4,137	10,268	8,807	17,565	811	37,451	5,280	42,731	43,684
b. Percentage of line one				95.7	97.4	103.0	99.9	99.6	87.1	97.8	***
2. Minimum operating inventory								21,376	3,103	24,479	25,025
3. Difference (Line 1 minus 2)								16,075	2,177	18,252	18,659
If greater than zero, estimate what volume was:											
4. Seasonal inventory								1,105	163	1,268	1,296
5. In anticipation of planned maintenance											
6. Other operating inventory								14,970	2,014	16,984	17,363
Memo Item: Unavailable inventory											
7. Pipeline fill	*	*	*	*	*	*	*	7,274	492	7,766	***
8. Refinery lines and operating equipment fill	*	*	*	*	*	*	*	146	43	189	***
9. Oil in transit by water from domestic sources (ex. Alaska)	*	*	*	*	*	*	*	620		620	***
10. Subtotal: Unavailable inventory outside of tankage (Lines 7, 8, and 9)	139	666	2,463	3,268	1,003	3,623	146	8,040	535	8,575	8,766
11. Tank bottoms	*	*	*	*	*	*	*	*	*	4,446	***
12. Plant fuel and pipeline prime mover fuel	*	*	*	*	*	*	*	*	*	8	***
13. Lease stocks											
14. Total (Lines 10, 11, 12, and 13)	237	1,184	2,790	4,211	2,249	5,103	250	11,813	1,216	13,029	13,319
15. Alaskan crude oil in transit by water											
B. STORAGE CAPACITY ASSIGNED TO KEROSINE-TYPE JET FUEL											
16. Shell capacity of tankage in operation	1,573	12,147	8,819	22,539	19,611	25,135	1,402	68,687	10,801	79,488	81,261
17. Tank tops and safety allowance	81	632	501	1,214	1,038	1,795	88	4,135	685	4,820	4,928
18. Subtotal: Net available shell capacity (Line 16 minus 17)	1,492	11,515	8,318	21,325	18,573	23,340	1,314	64,552	10,116	74,668	76,333
19. Unavailable inventory outside of tankage (from Line 10 above)	139	666	2,463	3,268	1,003	3,623	146	8,040	535	8,575	8,766
20. Total operating system capacity (Lines 18 and 19)	1,631	12,181	10,781	24,530	19,576	26,963	1,460	72,592	10,651	83,243	85,099
21. Maximum operating inventory								62,965	8,927	71,892	73,495
C. IDLE BUT USABLE CAPACITY/NEW CAPACITY											
22. Shell capacity of idle tankage	0	0	0	0	0	0	0	0	0	0	0
23. Tankage under construction	0	0	0	0	0	0	0	0	0	0	0

*Data excluded to protect confidentiality
***Not applicable

NATIONAL PETROLEUM COUNCIL
1988 SURVEY OF PETROLEUM INVENTORIES AND STORAGE CAPACITIES IN THE UNITED STATES

KEROSINE-TYPE JET FUEL
As of March 31, 1988 (Thousands of Barrels)

INVENTORY AND STORAGE CAPACITY	PADD IX	PADD IY	PADD IZ	Total PADD I	PADD II	PADD III	PADD IV	Total PADDs I-IV	PADD V	Total U.S. NPC Total	Total U.S. Adjusted NPC Total
A. KEROSINE-TYPE JET FUEL INVENTORY											
1. Total inventory reported to the Department of Energy				9,419	8,457	14,310	875	33,061	6,487	39,548	***
a. Total inventory reported to NPC	784	4,043	4,244	9,071	8,333	14,614	866	32,884	5,582	38,466	39,548
b. Percentage of line one				96.3	98.5	102.1	99.0	99.5	86.0	97.3	***
2. Minimum operating inventory								21,174	3,449	24,623	25,316
3. Difference (Line 1 minus 2)								11,710	2,133	13,843	14,232
If greater than zero, estimate what volume was:											
4. Seasonal inventory								400	163	563	579
5. In anticipation of planned maintenance								60		60	61
6. Other operating inventory								11,250	1,970	13,220	13,592
Memo Item: Unavailable inventory											
7. Pipeline fill	*	*	*	*	*	*	*	7,493	539	8,032	***
8. Refinery lines and operating equipment fill	*	*	*	*	*	*	*	148	45	193	***
9. Oil in transit by water from domestic sources (ex. Alaska)	*	*	*	*	*	*	*	404		404	***
10. Subtotal: Unavailable inventory outside of tankage (Lines 7, 8, and 9)	90	599	2,531	3,220	1,773	2,906	146	8,045	584	8,629	8,872
11. Tank bottoms	*	*	*	*	*	*	*	*	*	4,496	***
12. Plant fuel and pipeline prime mover fuel	*	*	*	*	*	*	*	*	*	8	***
13. Lease stocks											
14. Total (Lines 10, 11, 12, and 13)	187	1,105	2,854	4,146	3,063	4,385	250	11,844	1,289	13,133	13,502
15. Alaskan crude oil in transit by water											
B. STORAGE CAPACITY ASSIGNED TO KEROSINE-TYPE JET FUEL											
16. Shell capacity of tankage in operation	1,568	12,178	8,274	22,020	20,063	25,010	1,402	68,495	10,982	79,477	81,713
17. Tank tops and safety allowance	81	665	482	1,228	1,071	1,805	88	4,192	706	4,898	5,036
18. Subtotal: Net available shell capacity (Line 16 minus 17)	1,487	11,513	7,792	20,792	18,992	23,205	1,314	64,303	10,276	74,579	76,677
19. Unavailable inventory outside of tankage (from Line 10 above)	90	599	2,531	3,220	1,773	2,906	146	8,045	584	8,629	8,872
20. Total operating system capacity (Lines 18 and 19)	1,577	12,112	10,323	24,012	20,765	26,111	1,460	72,348	10,860	83,208	85,549
21. Maximum operating inventory								62,474	9,028	71,502	73,513
C. IDLE BUT USABLE CAPACITY/NEW CAPACITY											
22. Shell capacity of idle tankage	*	*	633	*	184	2,924	*	4,117	120	4,237	4,356
23. Tankage under construction	0	*	*	*	0	0	0	105	0	105	108

*Data excluded to protect confidentiality
***Not applicable

NATIONAL PETROLEUM COUNCIL
1988 SURVEY OF PETROLEUM INVENTORIES AND STORAGE CAPACITIES IN THE UNITED STATES

DISTILLATE FUEL OIL, INCLUDING No. 4 FUEL OIL
As of September 30, 1987 (Thousands of Barrels)

INVENTORY AND STORAGE CAPACITY	PADD IX	PADD IY	PADD IZ	Total PADD I	PADD II	PADD III	PADD IV	Total PADDs I-IV	PADD V	Total U.S. NPC Total	Total U.S. Adjusted NPC Total
A. DISTILLATE FUEL OIL INVENTORY											
1. Total inventory reported to the Department of Energy				52,438	31,508	29,417	2,648	116,011	10,751	126,762	***
a. Total inventory reported to NPC	5,790	24,013	11,072	40,875	29,320	25,729	1,687	97,611	7,908	105,519	126,762
b. Percentage of line one				77.9	93.1	87.5	63.7	84.1	73.6	83.2	***
2. Minimum operating inventory								55,125	4,362	59,487	71,643
3. Difference (Line 1 minus 2)								42,486	3,546	46,032	55,299
If greater than zero, estimate what volume was:											
4. Seasonal inventory								14,853	174	15,027	18,052
5. In anticipation of planned maintenance								418		418	502
6. Other operating inventory								27,215	3,372	30,587	36,745
Memo Item: Unavailable inventory											
7. Pipeline fill	*	*	*	*	4,712	4,326	*	13,434	1,009	14,443	***
8. Refinery lines and operating equipment fill	*	*	*	*	56	213	*	395	53	448	***
9. Oil in transit by water from domestic sources (ex. Alaska)	*	*	*	*	57	190	*	1,105		1,105	***
10. Subtotal: Unavailable inventory outside of tankage (Lines 7, 8, and 9)	174	1,859	3,108	5,141	4,825	4,729	239	14,934	1,062	15,996	19,216
11. Tank bottoms	*	*	*	*	*	*	*	*	*	12,172	***
12. Plant fuel and pipeline prime mover fuel	*	*	*	*	*	*	*	*	*	663	***
13. Lease stocks											
14. Total (Lines 10, 11, 12, and 13)	830	5,000	3,887	9,717	8,931	7,679	502	26,829	2,002	28,831	34,635
15. Alaskan crude oil in transit by water											
B. STORAGE CAPACITY ASSIGNED TO DISTILLATE FUEL OIL											
16. Shell capacity of tankage in operation	13,132	61,803	21,828	96,763	64,638	46,542	4,415	212,358	17,401	229,759	276,014
17. Tank tops and safety allowance	586	3,581	2,005	6,172	4,996	4,663	488	16,319	1,134	17,453	20,967
18. Subtotal: Net available shell capacity (Line 16 minus 17)	12,546	58,222	19,823	90,591	59,642	41,879	3,927	196,039	16,267	212,306	255,047
19. Unavailable inventory outside of tankage (from Line 10 above)	174	1,859	3,108	5,141	4,825	4,729	239	14,934	1,062	15,996	19,216
20. Total operating system capacity (Lines 18 and 19)	12,720	60,081	22,931	95,282	64,467	46,608	4,166	210,973	17,329	228,302	274,263
21. Maximum operating inventory								183,278	14,059	197,337	237,065
C. IDLE BUT USABLE CAPACITY/NEW CAPACITY											
22. Shell capacity of idle tankage	0	0	0	0	0	0	0	0	0	0	0
23. Tankage under construction	0	0	0	0	0	0	0	0	0	0	0

*Data excluded to protect confidentiality
*** Not applicable

NATIONAL PETROLEUM COUNCIL
1988 SURVEY OF PETROLEUM INVENTORIES AND STORAGE CAPACITIES IN THE UNITED STATES

DISTILLATE FUEL OIL, INCLUDING No. 4 FUEL OIL
As of March 31, 1988 (Thousands of Barrels)

INVENTORY AND STORAGE CAPACITY	PADD IX	PADD IY	PADD IZ	Total PADD I	PADD II	PADD III	PADD IV	Total PADDs I-IV	PADD V	Total U.S. NPC Total	Total U.S. Adjusted NPC Total
A. DISTILLATE FUEL OIL INVENTORY											
1. Total inventory reported to the Department of Energy				33,077	23,261	21,532	2,267	80,137	9,175	89,312	***
a. Total inventory reported to NPC	4,067	14,357	8,851	27,275	20,084	19,111	1,805	68,275	7,375	75,650	89,312
b. Percentage of line one				82.5	86.3	88.8	79.6	85.2	80.4	84.7	***
2. Minimum operating inventory								52,580	4,667	57,247	67,585
3. Difference (Line 1 minus 2)								15,695	2,708	18,403	21,727
If greater than zero, estimate what volume was:											
4. Seasonal inventory								2,754	146	2,900	3,424
5. In anticipation of planned maintenance								397		397	469
6. Other operating inventory								12,544	2,562	15,106	17,834
Memo Item: Unavailable inventory											
7. Pipeline fill	*	*	*	*	*	*	*	12,535	928	13,463	***
8. Refinery lines and operating equipment fill	*	*	*	*	*	*	*	444	52	496	***
9. Oil in transit by water from domestic sources (ex. Alaska)	*	*	*	*	*	*	*	550		550	***
10. Subtotal: Unavailable inventory outside of tankage (Lines 7, 8, and 9)	67	1,124	3,270	4,461	4,105	4,610	353	13,529	980	14,509	17,129
11. Tank bottoms	*	*	*	*	*	*	*	*	*	11,733	***
12. Plant fuel and pipeline prime mover fuel	*	*	*	*	*	*	*	*	*	695	***
13. Lease stocks											
14. Total (Lines 10, 11, 12, and 13)	725	4,003	4,051	8,779	8,214	7,466	619	25,078	1,859	26,937	31,802
15. Alaskan crude oil in transit by water											
B. STORAGE CAPACITY ASSIGNED TO DISTILLATE FUEL OIL											
16. Shell capacity of tankage in operation	12,861	60,374	20,022	93,237	64,384	45,502	789	203,932	17,128	221,060	260,982
17. Tank tops and safety allowance	595	3,349	1,100	5,044	5,072	4,572	488	15,176	1,137	16,313	19,259
18. Subtotal: Net available shell capacity (Line 16 minus 17)	12,266	57,025	18,922	88,213	59,312	40,930	301	188,756	15,991	204,747	241,723
19. Unavailable inventory outside of tankage (from Line 10 above)	67	1,124	3,270	4,461	4,105	4,610	353	13,529	980	14,509	17,129
20. Total operating system capacity (Lines 18 and 19)	12,333	58,149	22,192	92,674	63,417	45,540	654	202,285	16,971	219,256	258,852
21. Maximum operating inventory								179,571	13,986	193,557	228,512
C. IDLE BUT USABLE CAPACITY/NEW CAPACITY											
22. Shell capacity of idle tankage	1,942	4,722	935	7,599	5,029	2,795	11	15,434	799	16,233	19,165
23. Tankage under construction	0	*	0	*	0	*	*	363	0	363	429

*Data excluded to protect confidentiality
***Not applicable

NATIONAL PETROLEUM COUNCIL
1988 SURVEY OF PETROLEUM INVENTORIES AND STORAGE CAPACITIES IN THE UNITED STATES

RESIDUAL FUEL OIL
As of September 30, 1987 (Thousands of Barrels)

INVENTORY AND STORAGE CAPACITY	PADD IX	PADD IY	PADD IZ	Total PADD I	PADD II	PADD III	PADD IV	Total PADDs I-IV	PADD V	Total U.S. NPC Total	Total U.S. Adjusted NPC Total
A. RESIDUAL FUEL OIL INVENTORY											
1. Total inventory reported to the Department of Energy				21,190	2,877	10,898	437	35,402	9,015	44,417	***
a. Total inventory reported to NPC	1,119	10,733	1,025	12,877	2,996	9,841	727	26,441	6,235	32,676	44,417
b. Percentage of line one				60.8	104.1	90.3	166.4	74.7	69.2	73.6	***
2. Minimum operating inventory								10,135	2,995	13,130	17,848
3. Difference (Line 1 minus 2)								16,306	3,240	19,546	26,569
If greater than zero, estimate what volume was:											
4. Seasonal inventory								5,163	179	5,342	7,261
5. In anticipation of planned maintenance											
6. Other operating inventory								11,143	3,061	14,204	19,308
Memo Item: Unavailable inventory											
7. Pipeline fill	*	*	*	*	*	*	*	153	239	392	***
8. Refinery lines and operating equipment fill	*	*	*	*	*	*	*	201	90	291	***
9. Oil in transit by water from domestic sources (ex. Alaska)	*	*	*	*	*	*	*	116		116	***
10. Subtotal: Unavailable inventory outside of tankage (Lines 7, 8, and 9)	18	78	5	101	148	193	28	470	329	799	1,086
11. Tank bottoms	*	*	*	*	*	*	*	3,777	741	4,518	***
12. Plant fuel and pipeline prime mover fuel	*	*	*	*	*	*	*	318	123	441	***
13. Lease stocks											
14. Total (Lines 10, 11, 12, and 13)	187	1,701	304	2,192	737	1,530	106	4,565	1,193	5,758	7,827
15. Alaskan crude oil in transit by water											
B. STORAGE CAPACITY ASSIGNED TO RESIDUAL FUEL OIL											
16. Shell capacity of tankage in operation	2,690	28,517	4,747	35,954	7,697	28,396	1,402	73,449	10,486	83,935	114,094
17. Tank tops and safety allowance	90	1,900	202	2,192	547	1,467	83	4,289	603	4,892	6,650
18. Subtotal: Net available shell capacity (Line 16 minus 17)	2,600	26,617	4,545	33,762	7,150	26,929	1,319	69,160	9,883	79,043	107,444
19. Unavailable inventory outside of tankage (from Line 10 above)	18	78	5	101	148	193	28	470	329	799	1,086
20. Total operating system capacity (Lines 18 and 19)	2,618	26,695	4,550	33,863	7,298	27,122	1,347	69,630	10,212	79,842	108,530
21. Maximum operating inventory								58,696	8,897	67,593	91,880
C. IDLE BUT USABLE CAPACITY/NEW CAPACITY											
22. Shell capacity of idle tankage	0	0	0	0	0	0	0	0	0	0	0
23. Tankage under construction	0	0	0	0	0	0	0	0	0	0	0

*Data excluded to protect confidentiality
***Not applicable

NATIONAL PETROLEUM COUNCIL
1988 SURVEY OF PETROLEUM INVENTORIES AND STORAGE CAPACITIES IN THE UNITED STATES

RESIDUAL FUEL OIL
As of March 31, 1988 (Thousands of Barrels)

INVENTORY AND STORAGE CAPACITY	PADD IX	PADD IY	PADD IZ	Total PADD I	PADD II	PADD III	PADD IV	Total PADDs I-IV	PADD V	Total U.S. NPC Total	Total U.S. Adjusted NPC Total
A. RESIDUAL FUEL OIL INVENTORY											
1. Total inventory reported to the Department of Energy				17,653	2,871	14,320	361	35,205	8,852	44,057	***
a. Total inventory reported to NPC	1,044	7,905	1,850	10,799	2,934	10,847	646	25,226	6,668	31,894	44,057
b. Percentage of line one				61.2	102.2	75.7	178.9	71.7	75.3	72.4	***
2. Minimum operating inventory								12,889	2,991	15,880	21,936
3. Difference (Line 1 minus 2)								12,337	3,677	16,014	22,121
If greater than zero, estimate what volume was:											
4. Seasonal inventory								1,648	365	2,013	2,781
5. In anticipation of planned maintenance											
6. Other operating inventory								10,689	3,312	14,001	19,340
Memo Item: Unavailable inventory											
7. Pipeline fill	*	*	*	*	*	*	*	130	263	393	***
8. Refinery lines and operating equipment fill	*	*	*	*	*	*	*	198	96	294	***
9. Oil in transit by water from domestic sources (ex. Alaska)	*	*	*	*	*	*	*	140		140	***
10. Subtotal: Unavailable inventory outside of tankage (Lines 7, 8, and 9)	12	69	5	86	162	192	28	468	359	827	1,142
11. Tank bottoms	*	*	*	*	*	*	*	3,827	712	4,539	***
12. Plant fuel and pipeline prime mover fuel	*	*	*	*	*	*	*	373	151	524	***
13. Lease stocks											
14. Total (Lines 10, 11, 12, and 13)	187	1,779	311	2,277	780	1,488	123	4,668	1,222	5,890	8,136
15. Alaskan crude oil in transit by water											
B. STORAGE CAPACITY ASSIGNED TO RESIDUAL FUEL OIL											
16. Shell capacity of tankage in operation	2,926	28,003	5,727	36,656	7,889	28,152	1,402	74,099	10,723	84,822	117,169
17. Tank tops and safety allowance	99	1,770	280	2,149	576	1,491	83	4,299	632	4,931	6,811
18. Subtotal: Net available shell capacity (Line 16 minus 17)	2,827	26,233	5,447	34,507	7,313	26,661	1,319	69,800	10,091	79,891	110,358
19. Unavailable inventory outside of tankage (from Line 10 above)	12	69	5	86	162	192	28	468	359	827	1,142
20. Total operating system capacity (Lines 18 and 19)	2,839	26,302	5,452	34,593	7,475	26,853	1,347	70,268	10,450	80,718	111,500
21. Maximum operating inventory								59,461	8,655	68,116	94,093
C. IDLE BUT USABLE CAPACITY/NEW CAPACITY											
22. Shell capacity of idle tankage	526	954	20	1,500	135	3,098	0	4,733	531	5,264	7,271
23. Tankage under construction	0	0	0	0	0	0	0	0	0	0	0

*Data excluded to protect confidentiality
***Not applicable

APPENDIX F

THE IMPACT OF PETROLEUM FUTURES MARKETS ON INVENTORY LEVELS

APPENDIX F

THE IMPACT OF PETROLEUM FUTURES MARKETS ON INVENTORY LEVELS

Energy futures have grown dramatically in both usage and importance since the 1984 National Petroleum Council (NPC) report on inventories and storage capacity. Futures markets have provided a means for individuals and businesses to counter price volatility by transferring price risk. Crude oil futures, introduced in 1983, have matured in the past five years; crude oil options and heating oil options began trading in 1986 and 1987, respectively.

In addition, futures markets have provided both the industry and the public with price discovery and price transparency. Price discovery is the process through which value is determined via the collective competitive interaction of many individual buyers and sellers. Price transparency provides the price of each transaction quickly, with wide dissemination through many public information channels.

The world's largest market for trading energy futures and options is the New York Mercantile Exchange (NYMEX) where futures contracts for crude oil, heating oil, unleaded gasoline, and propane, and options contracts for crude oil and heating oil are offered and traded.

The International Petroleum Exchange of London trades futures in crude oil and gasoil, as well as options in gasoil. Energy futures trading on NYMEX began in 1978 with the introduction of heating oil futures. Gasoline futures were introduced in 1981 and crude oil futures began trading in 1983. Crude oil options were initiated in November 1986 and heating oil options started trading in June 1987.

In addition to these formal trading markets, there is active trading in informal energy forward markets such as the "Brent Cargo," and "Dubai Cargo" markets for crude oil, and the "Russian Gasoil," "Littlebrook Lottery," and "Boston Bingo" markets for petroleum products. There are significant differences between the structure of the formal futures versus the informal forward markets. Futures markets are subject to substantial regulation and oversight. In the United States, the Commodities Futures Trading Commission is the federal regulating agency. Forward markets operate outside of these regulatory strictures. Also, futures markets are required to fulfill the price discovery and price transparency roles discussed above. By the nature of their activity, forward markets can contribute to this, but they are not legally required to do so. However, many media services do report their impressions and knowledge of this information as it becomes available to them.

Futures and futures options markets exist primarily for the purpose of price-risk transfer, or hedging. This is accomplished by the buying and selling of futures and options contracts. Typically, hedgers shift actual or anticipated cash-market price-risk exposure to speculative traders, who make capital available to absorb this risk, or to other cash-market participants in futures and options markets who wish to hold opposing cash-market risk exposures.

Speculation, typically the attempt to buy low and sell high without involvement in physical markets, also motivates the trading of futures and options.

In cash, futures, and options markets, price is a function of supply and demand. Cash market prices are a function of supply and demand for the physical commodity. Futures and options prices are a function of supply and demand for futures and options contracts. In a typical market, however, futures and physical market prices converge, at least at the closing of futures trading for a particular contract month.

Futures represent a legally binding contract to make or take delivery of the commodity specified in the contract, and to honor all terms and obligations accepted when a position is initiated. The terms of all futures contracts, except price, are determined by the rules of the commodity exchange with, in the United States, the approval of the Commodity Futures Trading Commission. These terms include contract unit, quality specifications, and delivery location. For petroleum futures, the contract unit is the same for most contracts, 1,000 barrels, except for the gasoil contract on the International Petroleum Exchange of London, where the gasoil contract unit is 100 metric tons (approximately 746 barrels). Quality specifications and delivery points for each product vary among the exchanges.

Futures can be bought or sold; in the case of the former, if the contract is held to maturity, then the holder is required to accept delivery of the commodity specified in the contract according to all of the terms delineated in the futures contract. Should one sell a futures contract and hold it to maturity, then one becomes obligated to make delivery of the commodity specified according to all of the terms and conditions of the contract. Futures contracts, however, typically do not go to delivery. In fact, the volume of oil traded in futures markets far exceeds volumes traded in physical markets.

Options are contracts representing the right, not the obligation, to make or take delivery of the underlying future.

Both futures and options can be held to maturity or exercised, at which time all contractual terms and conditions must be honored.

INFORMATION FLOWS AND PRICE DISCOVERY

From the many transactions in the market, instantaneous (i.e., up-to-the-second) information on factors that determine a commodity value -- current and expected prices, cost of storage, handling, transportation, and a host of other elements -- enters the futures and options market. This information immediately is reflected in prices. This is the "price discovery" aspect of futures trading.

Futures and options prices, in turn, inform the market of commodity values, implied storage costs and interest rates, and uncertainty about future prices.

HEDGING ALTERNATIVES

Hedging with futures and options presents alternatives for managing the risk-reward trade-off that arises from price and volatility exposure.

Broadly speaking, a hedge is the assumption of a futures or options market exposure opposite an actual or anticipated cash-market exposure. Using futures or options, the firm can reduce its cash-market exposure to price changes and volatility changes to a minimum acceptable level, or eliminate it almost entirely.

A hedge can be designed with a larger corporate philosophy, for instance, to achieve a desired return, or with a transaction-by-transaction focus to minimize the firm's exposure to risk on each transaction.

PETROLEUM INDUSTRY ACTIVITY

Most oil companies active in the futures market operate as hedgers to reduce their business risk, rather than as speculators for financial gain. Tables F-1, F-2, and F-3 present the positions for gasoline, No. 2 fuel oil, and crude oil held by speculators and hedgers on NYMEX as of March 1988.

To better understand the extent of involvement in the petroleum futures market by different segments of the oil industry, the NPC surveyed primary distribution system companies and bulk plant operators in the secondary distribution system.

Most companies stated that the futures or forward markets did not affect their inventory levels. The results of the survey are shown in Table F-4.

Table F-5 shows the volume of contracts traded on NYMEX and the actual volumes delivered. The very small percentage of physical deliveries supports the contention that the futures and forward markets do not have a significant bearing on petroleum inventories.

TABLE F-1

NYMEX REGULAR UNLEADED GASOLINE POSITIONS
AS OF MARCH 1988

	Open Interest*			
	Long		Short	
	Number of Contracts	Number of Firms	Number of Contracts	Number of Firms
Reportable§				
Hedgers				
Refiners	5,413	15	9,863	18
Resellers	21,592	31	16,278	29
End-Users	2,561	3	7,562	8
Total Hedgers	29,566	49	33,703	55
Speculators	3,468	10	2,021	8
Total Reportable	33,034		35,724	
Non-Reportable¶	13,161		10,372	
Total Open Interest**	46,096		46,096	

*Number of contracts outstanding at the end of the trading month of March.

§Firms or individuals holding 25 contracts (1,000 barrels per contract) or more.

¶Firms or individuals holding fewer than 25 contracts. Estimated by NYMEX to be 60 percent speculators, 40 percent hedgers. Only brokers have access to this information.

**The total market exposure is less since many companies hold both long and short positions.

Source: New York Mercantile Exchange (NYMEX) Research Department.

TABLE F-2

NYMEX NO. 2 FUEL OIL POSITIONS
AS OF MARCH 1988

	Open Interest*			
	Long		Short	
	Number of Contracts	Number of Firms	Number of Contracts	Number of Firms
Reportable§				
Hedgers				
Refiners	1,634	6	8,908	15
Resellers	16,535	16	11,340	23
End-Users	1,699	4	2,906	6
Total Hedgers	19,918	26	22,969	43
Speculators	1,772	7	5,808	11
Total Reportable	21,690	33	28,777	54
Non-Reportable¶	22,561		15,239	
Total Open Interest**	44,201		44,201	

*Number of contracts outstanding at the end of the trading month of March.

§Firms or individuals holding 25 contracts (1,000 barrels per contract) or more.

¶Firms or individuals holding fewer than 25 contracts. Estimated by NYMEX to be 60 percent speculators, 40 percent hedgers. Only brokers have access to this information.

**The total market exposure is less since many companies hold both long and short positions.

Source: New York Mercantile Exchange (NYMEX) Research Department.

TABLE F-3

NYMEX CRUDE OIL POSITIONS
AS OF MARCH 1988

	Open Interest*			
	Long		Short	
	Number of Contracts	Number of Firms	Number of Contracts	Number of Firms
Reportable§				
Hedgers				
Refiners	37,230	30	44,110	34
Resellers	95,925	33	72,117	42
End-Users	6,049	6	3,087	3
Total Hedgers	139,204	69	119,314	79
Speculators	13,943	15	29,688	29
Total Reportable	153,147		149,002	
Non-Reportable¶	53,421		57,566	
Total Open Interest**	206,568		206,568	

*Number of contracts outstanding at the end of the trading month of March.

§Firms or individuals holding 25 contracts (1,000 barrels per contract) or more.

¶Firms or individuals holding fewer than 25 contracts. Estimated by NYMEX to be 60 percent speculators, 40 percent hedgers. Only brokers have access to this information.

**The total market exposure is less since many companies hold both long and short positions.

Source: New York Mercantile Exchange (NYMEX) Research Department.

TABLE F-4

PETROLEUM FUTURES AND OTHER FORWARD MARKETS

1. Has there generally been a change in your physical inventory levels due to the presence of the petroleum futures and forward markets?

Number of Respondents

No change: 355
Generally higher, by 38%: 3
Generally lower, by 36%: 10
May be higher or lower, depending on market economics: 36
by plus or minus 10% or less: 13
by plus or minus 10-25%: 12
by plus or minus more than 25%: 11

2. Approximate the level of inventories (in barrels) owned (whether or not in custody, as noted above) and committed to the U.S. market on March 31, 1988:

	Total	Average
Crude Oil	353,641,193	6,800,792
Product	417,035,006	2,558,497

3. a. Approximate the percentage of the March 31, 1988, inventories reported in Question 2 backed by hedges (in barrels):

	Total Amount	Amount Hedged	Percentage Hedged
Crude Oil	206,255,290	25,453,512	12.3
Product	149,457,777	9,222,638	6.2
Total	355,713,067	34,676,150	9.7

b. Typical percentage of your inventories backed by hedges (in barrels):

	Total Amount	Amount Hedged	Percentage Hedged
Crude Oil	206,255,290	27,153,496	13.2
Product	149,457,777	12,827,419	8.6
Total	355,713,067	39,980,915	11.2

4. Which of the following markets has your firm participated in (check all that apply):

Petroleum futures (NYMEX, IPE, etc.): 67
Petroleum options (NYMEX): 32
Cash forward (Brent or Dubai crude oils, product markets such as "Boston Bingo" for No. 2 oil, the forward Russian gasoil market): 20

5. Which oil commodities have you traded in these markets?

No. 2 oil/gasoil: 61
Motor gasoline: 51
Crude oil: 43

TABLE F-5

NYMEX DELIVERIES OF CRUDE OIL AND HEATING OIL
JANUARY-SEPTEMBER 1988
(Thousands of Barrels per Day)

Contract Month	Standard Deliveries	Alternative Delivery Procedures	Exchange for Physicals	Total Deliveries	Trading Volume (No. Contracts)	Deliveries as % of Cumulative Trading Volume
			Crude Oil			
Jan.	318	98	43,234	43,850	1,371,506	0.03
Feb.	849	1	41,092	41,942	1,520,630	0.08
Mar.	946	0	50,832	51,778	1,675,361	0.08
Apr.	925	3	52,608	53,836	1,519,084	0.08
May	753	297	55,784	56,814	1,663,987	0.07
Jun.	570	591	51,622	52,783	1,393,525	0.08
Jul.	521	624	46,648	47,790	1,245,338	0.10
Aug.	660	3	50,909	51,572	1,388,447	0.05
Sep.	357	13	47,028	47,398	1,749,649	0.02
			Heating Oil			
Jan.	1,231	504	20,768	22,503	531,055	0.33
Feb.	490	1,804	18,297	18,591	561,541	0.41
Mar.	355	314	15,513	18,182	459,742	0.15
Apr.	309	315	13,970	14,594	380,559	0.16
May	177	377	8,621	9,075	337,805	0.13
Jun.	396	159	9,621	10,176	298,859	0.19
Jul.	577	299	6,758	7,634	264,736	0.33
Aug.	570	268	6,748	9,584	329,744	0.25
Sep.	367	264	6,359	6,990	341,122	0.18

Source: New York Mercantile Exchange (NYMEX) Research Department.

APPENDIX G

THE STRATEGIC PETROLEUM RESERVE

APPENDIX G

THE STRATEGIC PETROLEUM RESERVE

The Strategic Petroleum Reserve Program was created by the Energy Policy and Conservation Act (P.L. 94-163), enacted on December 22, 1975. In the aftermath of the 1973-1974 Arab oil embargo, Congress declared it to be U.S. policy that a reserve of up to one billion barrels of crude oil and/or petroleum products be established to reduce the impact of disruptions in petroleum supplies or to carry out the obligations of the United States under the International Energy Program.

The Strategic Petroleum Reserve (SPR) may not be drawn down unless the President determines that a national energy supply shortage exists that is, or is likely to be, of significant scope and duration; is of an emergency nature; may cause major adverse impact on national safety and the national economy; and results, or is likely to result, from an interruption in imported petroleum supplies, sabotage, or an act of God.

The Energy Policy and Conservation Act required submission to the Congress of an SPR plan to detail the proposals for designing, constructing, and filling the Reserve. The SPR Plan, submitted on February 16, 1977, and effective on April 18, 1977, discusses the development and implementation of the Reserve.

The schedule for filling the Reserve was accelerated by SPR Plan Amendment No. 1, submitted to the Congress on May 25, 1977. Amendment No. 2 to the SPR Plan, submitted May 18, 1978, authorized an increase in the SPR size from 500 million barrels to one billion barrels of stored oil and detailed plans for government storage of 750 million barrels. On October 31, 1979, the Distribution Plan for the SPR, Plan Amendment No. 3, was submitted to Congress. This amendment was replaced on December 1, 1982, when a new "Drawdown" (Distribution) Plan (Amendment No. 4) for the use of the SPR was transmitted to Congress. This plan, required under the Energy Emergency Preparedness Act of 1982 and now in effect, provides for primary use of market procedures for the drawdown, sale, and distribution of crude oil from the SPR.

The SPR facility development program is currently designed to provide a cumulative storage capacity of 750 million barrels and a final drawdown/distribution capability of 4.5 million barrels per day (MMB/D).

Over the last 12 years, the SPR has acquired and developed six underground crude oil storage facilities in salt domes along the gulf coasts of Texas and Louisiana and a government-owned marine terminal on the Mississippi River at St. James, Louisiana. The six storage sites are Bayou Choctaw, Weeks Island, West Hackberry, and Sulphur Mines in Louisiana, and Bryan Mound and

Big Hill in Texas. These six storage sites are organized into three distribution systems (known as the Seaway, Texoma, and Capline Groups for the commercial pipeline systems they draw on) and are connected by Department of Energy (DOE) pipelines to commercial crude oil pipeline networks and marine terminal facilities for drawdown/distribution.

Table G-1 provides a summary of SPR inventories, storage capacities, and drawdown capabilities as of March 31, 1988, and

TABLE G-1

STRATEGIC PETROLEUM RESERVE
INVENTORY, CAPACITY, AND DRAWDOWN CAPABILITY
1988 AND PROJECTED 1992
(Millions of Barrels)

	March 31, 1988			Projected 1992		
SPR Sites	Stocks (bbl)	Storage Capacity (bbl)	Drawdown Rate* (B/D)	Stocks (bbl)	Storage Capacity (bbl)	Drawdown Rate (B/D)
Seaway Group						
Bryan Mound	204	226	1.10	226	226	1.10
Texoma Group						
West Hackberry	187	189	1.40	219	219	1.40
Sulphur Mines§	26	26	--	--	--	--
Big Hill¶	0	0	0.00	160	160	0.93
Capline Group						
Bayou Choctaw	52	56	0.48	72	72	0.48
Weeks Island	72	73	0.59	73	73	0.59
Pipelines & Tanks	4	--	--	--	--	--
Total System	545	570	3.57	750	750	4.5

*Distribution system constraints limit current drawdown capability.

§Sulphur Mines to be decommissioned by 1992.

¶Big Hill site currently under development.

Source: U.S. Department of Energy - Petroleum Reserves Office.

those projected for 1992 under current development plans. The current plans provide for the future (1992) decommissioning of the Sulphur Mines 26-million-barrel storage facility with replacement capacity through the expansion of two other storage sites, Big Hill and Bayou Choctaw.

Figure G-1 provides a schematic view of the current and planned SPR distribution system.

In late 1984, the SPR initiated a distribution enhancement program to ensure that the SPR distribution capability will adequately support the SPR drawdown performance. This program was prompted by a major decline in foreign crude oil demands by the Midwest refiners, resulting in the conversion to natural gas transmission of two major interstate pipelines to which the SPR was connected (Seaway and Texoma). The distribution enhancement program has been designed to increase the SPR's distribution capability from its 1986 level of 2.3 MMB/D to 4.5 MMB/D, and to provide waterborne access to at least two marine terminals within each storage group.

As of March 31, 1988, SPR inventory was 545 million barrels of crude oil in storage, an increase of 233 million barrels over the March 31, 1983 level of 312 million barrels as reported in the previous National Petroleum Council (NPC) study. SPR storage capacity increased 259 million barrels during the same period, to 580 million barrels on March 31, 1988, from 321 million barrels on March 31, 1983. The system's drawdown and distribution capabilities have also been improved since the previous NPC report; currently, SPR inventories can be drawn down at the rate of 3.5 MMB/D and distributed at a rate of 3.0 MMB/D compared to a drawdown/distribution rate of 1.7 MMB/D in 1983. The difference between drawdown rates and distribution rates currently is due to limitations on pipeline throughput. These limitations will be overcome by 1992.

QUESTIONNAIRE ON THE STRATEGIC PETROLEUM RESERVE

The NPC sent its questionnaire on the Strategic Petroleum Reserve to the 381 companies in the primary distribution system and received 99 responses (see Appendix D for a copy of the questionnaire). Each respondent said that the existence of the SPR has not reduced the amount of oil it routinely holds in inventory. In addition to this central conclusion, the questionnaire requested certain other information, and the responses provide additional insight into how the companies view the SPR program.

The questionnaire requested a characterization of the respondent: large refiner, small refiner, marketer, terminal operator, pipeline. Almost half of the respondents were refiners -- 16 of the 99 were refiners with more than 175,000 B/D capacity, and 32 were refiners with 175,000 B/D capacity or less. One-quarter of the respondents were petroleum products marketers.

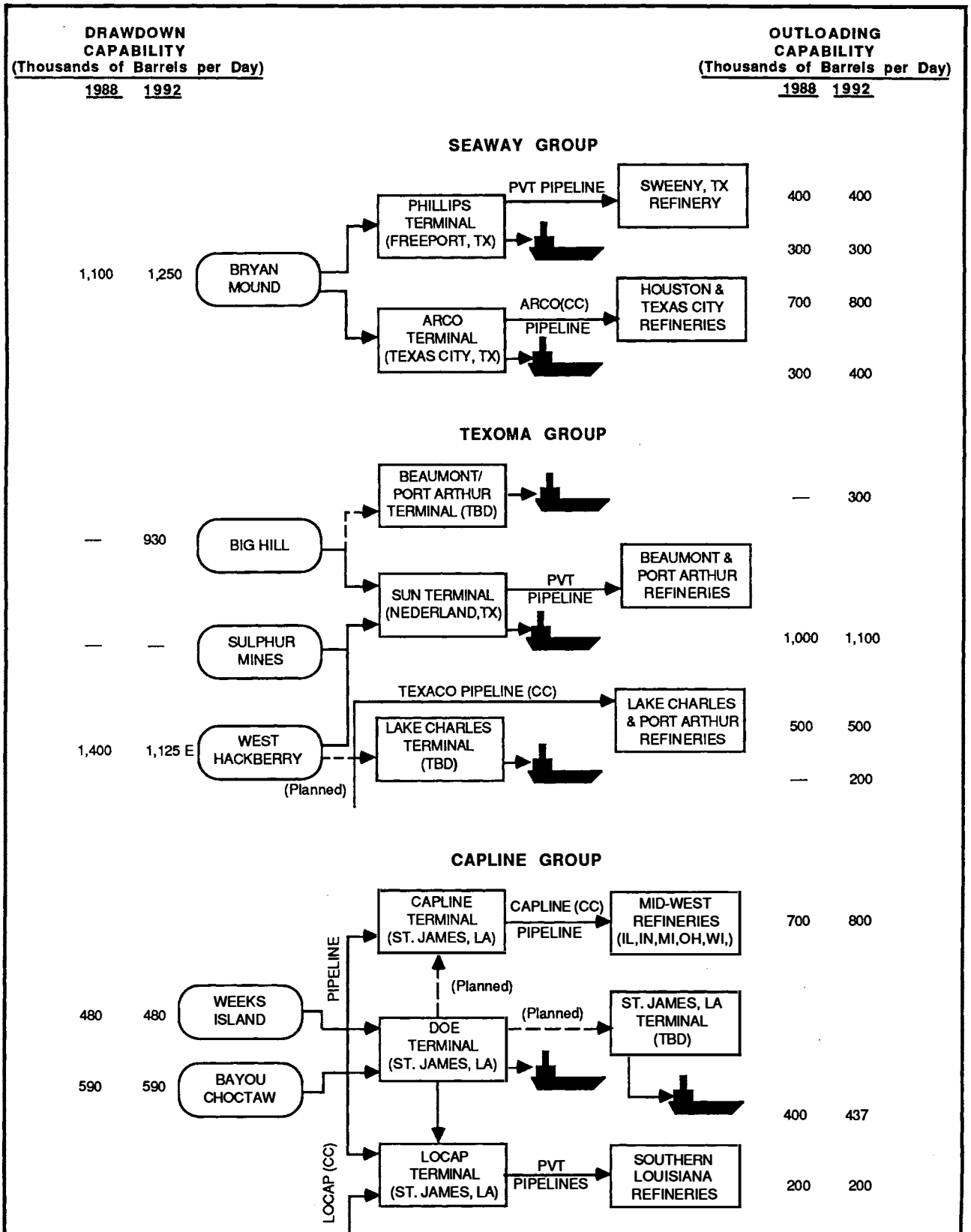

Figure G-1. Current and Planned Strategic Petroleum Reserve Distribution System for the Seaway, Texoma, and Capline Groups.

SOURCE: Department of Energy, *SPR Annual Report*, February 15, 1988, p. 18.

Concerning question 4a, "Do you agree with early drawdown of SPR stocks during an energy emergency?", nearly two-thirds of the respondents agreed, while 20 disagreed with the strategy and 16 had no opinion. Ninety percent of the refiners agreed with the strategy.

Question 4b asked, "Is your company likely to participate in an auction for SPR oil?" Over half of all respondents (52 of 99) answered "No," and another five offered no opinion. The companies that indicated that they would not participate were for the most part non-refiners, representing about 80 percent of the nonrefiner respondents (41 of 52). In contrast, nearly all of the large refiners and two-thirds of the small refiners answered that they would likely take part in an SPR auction. Put another way, 86 percent of the respondents likely to participate in an auction are refiners.

Question 4c, "Is your company familiar with and do they have an opinion of the DOE Drawdown Plan?" shows that generally refiners are familiar with the plan and other types of companies are unfamiliar with it. The question asked for further comments from those familiar with the plan, which are reproduced in the following pages. The comments, as submitted by 33 respondents, were provided to the National Petroleum Council by Deloitte Haskins & Sells, without attribution. As can be seen, many of the refiners commented that purchases of SPR oil should in some way be restricted to U.S. refiners.

The responses to the survey are shown in Table G-2, followed by the comments to question 4c.

TABLE G-2

RESULTS OF STRATEGIC PETROLEUM RESERVE SURVEY

1. Which of the following categories best categorize your companies operation?

	Number	Percent
Refiner with more than 175,000 B/D capacity	16	16.2
Refiner with 175,000 B/D capacity or less	32	32.3
Petroleum products marketer	25	25.3
Public warehouse terminal operator	10	10.1
Pipeline	8	8.1
Other	8	8.1
Total	99	100%

TABLE G-2 (Continued)

2. What is the distribution of your company's crude oil consumption by PADD?

	Reported Barrels from Questionnaire 1 - Crude Oil
PADD I	13,489
PADD II	53,031
PADD III	130,242
PADD IV	10,844
PADD V	41,590
No Crude Oil Consumption	45.2%

3. Has the existence of the SPR reduced the amount of oil you routinely hold in inventory?

100% of respondents reported no change.

4a. Do you agree with the early drawdown of SPR stocks during an emergency?

	Yes	No	Abstain
Refiner with more than 175,000 B/D capacity	14	1	1
Refiner with 175,000 B/D capacity or less	28	4	-
Petroleum products marketer	12	7	6
Public warehouse terminal operator	3	4	3
Pipeline	4	1	3
Other	2	3	3
Total	63	20	16

TABLE G-2 (Continued)

4b. Is your company likely to participate in an auction for SPR oil?

	Yes	No	Abstain
Refiner with more than 175,000 B/D capacity	15	-	1
Refiner with 175,000 B/D capacity or less	21	11	-
Petroleum products marketer	4	20	1
Public warehouse terminal operator	1	8	1
Pipeline	-	7	1
Other	1	6	1
Total	42	52	5

4c. Is your company familiar with and do they have an opinion on the DOE Drawdown Plan?

	Yes	No	Abstain
Refiner with more than 175,000 B/D capacity	14	1	1
Refiner with 175,000 B/D capacity or less	15	17	-
Petroleum products marketer	2	22	1
Public warehouse terminal operator	-	9	1
Pipeline	-	7	1
Other	1	6	1
Total	32	62	5

COMMENTS ON THE SPR RELEASE PROGRAM

1. The decision to open sales to all interested bidders provides an opportunity for non-refiners to acquire and hold SPR crude, awaiting the inevitable rise in price before reselling. Bidders on SPR oil should be required to demonstrate working interest ownership in operating refineries prior to the acceptance of bids. Open sales will only serve to allow intermediaries to achieve profit at the expense of the ultimate consumer.

   [Categories that best fit this company's operation: refiner with 175,000 B/D capacity or less; petroleum products marketer; pipeline.]

2. Supports an SPR owned and controlled by the federal government, as well as the early drawdown policy of the current administration.

   Supports an SPR target of 750 million barrels to be completed by 1995 using general funds. Specifically, filling the SPR to 750 million barrels by 1995 provides a finite capacity and a date certain when it must be filled.

   [Category that best fits this company's operation: refiner with more than 175,000 B/D capacity.]

3. a. In a severe supply crisis, U.S. refiners should have first priority to purchase SPR crude oil.

   b. There should be a limitation on the quantity of SPR crude oil an individual buyer can purchase in a month.

   [Category that best fits this company's operation: refiner with 175,000 B/D capacity or less.]

4. The Department of Energy requested public input as the SPR Drawdown Plan was being developed. The corporation's comments can be summarized as follows:

   a. Eligible bidders from SPR oil should be limited to bona fide domestic refiners. Only a domestic refiner can refine SPR crude into a product and deliver it to the public fast enough to mitigate the effects of an oil disruption. Also, limiting eligible bidders to domestic refiners will permit the sales terms to be simplified.

   b. The SPR drawdown schedule shown at the top of page 2 (of the NPC "1988 Survey of The Strategic Petroleum Reserve") is unrealistically optimistic. It can be expected that reaching the political consensus necessary to declare an emergency will take a long time. The two-phase system described below would alleviate that problem.

In the first phase of the proposed system, SPR crude would be continually offered for sale at a premium above the current market price for comparable crude. In general, there would be little market for the higher-priced SPR crude in times of adequate supply. As supply became tight as a result of an anticipated oil disruption, some buyers might feel it prudent to pay the premium for SPR crude in order to assure their supply.

As SPR crude sales rose above some predetermined level, this would trigger phase two, the auction system outlined in the current SPR Sales Regulations.

This proposed system expedites SPR drawdown by triggering the auction through market forces rather than political decisions. By triggering the auction earlier, consumers will suffer fewer consequences of an oil disruption.

[Categories that best fit this company's operation: refiner with more than 175,000 B/D capacity; petroleum products marketer; pipeline.]

5. While we operate a refinery located in PADD III, our crude supply originates in southeast Utah and northwest New Mexico.

   We do not feel that the SPR Drawdown Plan will have a significant impact on our operation.

   [Categories that best fit this company's operation: refiner with 175,000 B/D capacity or less.]

6. System should be tested periodically to verify drawdown capabilities -- appropriate to test system.

   [Category that best fits this company's operation: other.]

7. Normally pessimistic about government regulated supply programs. This has been worked on and may work. Would have preferred bidders to be limited to refiners but "free market" should prevail. Still concerned about logistics system.

   [Category that best fits this company's operation: refiner with more than 175,000 B/D capacity.]

8. Although not yet adequately tested, we agree that the competitive market mechanism should effectively distribute SPR oil to refiners quickly, without constraint, and on an economic basis which will benefit the ultimate consumer. However, we believe that:

a. SPR stocks should be allocated by competitive auction only to domestic refiners and without the small refiners bias which accompanied controls under the now-expired Emergency Petroleum Allocation Act (1973-81). A price-auction system will allow crude oil to move to the geographic areas where it will be most highly valued and will serve as an incentive to conservation.

b. Receipts from the sale of SPR stocks should be used at a later date to purchase oil to refill the SPR. Purchases should be made when oil supplies are plentiful in order to prevent upward pressure on world oil prices.

[Category that best fits this company's operation: refiner with more than 175,000 B/D capacity.]

9. The supply available to jobbers and distributors and other independent marketers is critical because they supply small towns and rural areas, more than 80 percent of home heating oil, and more than 75 percent of all service stations.

[Category that best fits this company's operation: public warehouse terminal operator.]

10. Generally support the market-oriented competitive bidding approach embodied in the SPR Drawdown Plan, Amendment No. 4, December 1, 1982. However, we feel that purchases should be restricted to U.S. refiners, their purchasing agents, and/or traditional suppliers. Such restrictions would facilitate rapid distribution of products derived from SPR crude oil to consumers at the time of emergency. Unlimited access could lead to hoarding or speculation by those not normally engaged in crude oil supply activities, might cause delays because of lack of expertise in arranging deliveries, and could exacerbate market volatility because of added volume, timing, and price uncertainty associated with resale of SPR oil crude oil. There is a need to assure that the crude oil is used to alleviate the emergency supply conditions that exist as opposed to being held for speculative gains.

[Category that best fits this company's operation: refiner with more than 175,000 B/D capacity.]

11. The public auction should be restricted to end-user refiners that are located within the United States. Export of SPR crude oil should not be allowed. Traders and speculators should not be eligible to bid.

[Category that best fits this company's operation: refiner with 175,000 B/D capacity or less.]

12. There should be some method to prevent "concerns" that would profit most from a shortage from buying up or bidding to an excessive level those stocks intended to avert a crisis.

[Category that best fits this company's operation: petroleum products marketer.]

13. We have two comments:

    a. The oil should be only made available to eligible refiners. Other participants will confuse distribution and lead to increase in prices to the consumer.

    b. PADD V is at a distribution disadvantage for this oil. We would like to see an allocation made available to PADD V refiners.

    [Category that best fits this company's operation: refiner with 175,000 B/D capacity or less.]

14. A price-competitive sales procedure, with awards going to the highest bidders, is fine within the context of a truly free and open market. We would not support this procedure, however, in the event that there were any restrictions or other infringements on the free market process, such as freezing the first purchaser relationship on domestic crude oils or the institution of crude oil or product price controls. Implementation of a product's allocation system would also seem to us to require some method of allocating crude oil, including allocation of SPR drawdown.

    [Category that best fits this company's operation: refiner with more than 175,000 B/D capacity.]

15. On August 14, 1987, we provided comments on the proposed appendix to the final rule for "The Sale of Strategic Petroleum Reserve; Standard Sales Provisions." Among our primary concerns are: the requirement to furnish written confirmation of any verbal corrections within two days; the assessment of liquidated damages for failure of the purchaser to complete delivery arrangements; the reduction of the time from seven days to five days for scheduling of deliveries; the providing of first priority to the highest price offers; the requirement that a purchaser must accept crude oil regardless of characteristics; and the requirement that a purchaser is deemed to have received a mailed notice on the second day after its dispatch in order to replenish funds within five business days and, thereby, to comply with the payment and performance guarantee. In addition, we are concerned that the plan has no provision to accommodate, on a priority basis, deliveries of SPR oil to offset deliveries under the fair-sharing program.

    [Category that best fits this company's operation: refiner with more than 175,000 B/D capacity.]

16. The universe of bidders should be limited to domestic refiners; otherwise foreign countries with large oil productions could purchase the crude oil to keep the supply

restricted. Also, any oil going to our allies should be prorated on the basis of consumption. Since smaller companies will not have the financial resources to compete against the majors, we would like to see some allocation system.

[Category that best fits this company's operation: refiner with 175,000 B/D capacity or less.]

17. Domestic refiners must be given the first opportunity to bid on SPR oil. Only after refinery needs are met should barrels be offered to other interested parties. The DOE should be most concerned with maintaining refining output during a crisis and not who bids at the highest price for SPR crude oil. Under the present plan, it's feasible that refiners could be paying inflated prices for SPR crude oil that was purchased through traders by foreign companies with camouflaged U.S. operations and large cash reserves.

    [Category that best fits this company's operation: refiner with 175,000 B/D capacity or less.]

18. The drawdown program relies on two assumptions: pipeline movement of SPR crude oil to the refinery and "backed out" crude oil to supply refiners not participating (or losing) at auction, or those physically removed from accepting pipeline crude oil. The validity of these assumptions is questioned.

    If a shortfall initiates the auction mechanism, will crude oil availability be indiscriminate on a regional basis -- as DOE hopes? Failure to identify regional shortfalls could result in uneven crude oil distribution, with one region suffering at the expense of another. Also not included in DOE's calculations is the time necessary to move non-pipeline crude oil to certain destinations, particularly those served by marine sources.

    The program should be designed from a regional availability-distribution scenario not solely a price-distribution scenario. Combining these methods ensures a balanced distribution scheme and eliminates any market distortions based on a lack of crude oil supply.

    [Categories that best fit this company's operation: refiner with 175,000 B/D capacity or less; petroleum products marketer.]

19. We are a specialty producer of asphalt and feedstocks that cannot be made from general crude oils. The current bid system is not confined to bona fide refiners, and will likely become a hostage of crude oil traders and speculators.

    [Category that best fits this company's operation: refiner with 175,000 B/D capacity or less.]

20. Limiting eligibility to bid to bona fide refiners will reduce or eliminate the possibility of other parties manipulating SPR supplies (for profit etc.?) when they do not have a direct need. Such manipulation could delay receipt of finished products to those who are suffering in a shortfall situation.

    [Category that best fits this company's operation: refiner with more than 175,000 B/D capacity.]

21. Would bid; the likelihood of being able to out-bid a major company with cash is remote. This method of distribution would force the company to shut down and hold its present customers hostage to larger refining companies with far greater access to cash, as well as its own production. Why not consider a percentage of crude oil run of the National Total and allow for exchanges or sales?

    [Category that best fits this company's operation: refiner with 175,000 B/D capacity or less.]

22. The companies eligible to bid on the SPR oil should be certified refiners or companies with certified processing deals with certified refiners (all U.S.). No brokers, traders, heating oil resellers, doctors, dentists, etc.

    [Category that best fits this company's operation: refiner with more than 175,000 B/D capacity.]

23. The petrochemical industry needs access to crude oil in times of emergency to "trade" with refiners to obtain feedstocks to keep this critical industry operating.

    [Category that best fits this company's operation: other.]

24. In the event of an emergency requiring SPR sales, a bidding procedure seems too ineffective and risky. The time required to complete the bidding process and make deliveries is excessive and in the time of crises would possibly promote further panic. Candidates for delivery should be screened in advance and on file (updated periodically). The government should establish the price of oil at the time of crises and begin distribution immediately, based on a pre-established rationing program.

    [Categories that best fit this company's operation: refiner with 175,000 B/D capacity or less; petroleum products marketer; public warehouse terminal operator; pipeline; other.]

25. We agree with early drawdown, but reassessment depending on duration of the emergency.

    We believe the drawdown should be assigned to refiners on a capacity- and quality-related basis and that refiners not

obtaining oil on a bid basis would be allowed to meet the bid for their entitlement.

[Category that best fits this company's operation: refiner with 175,000 B/D capacity or less.]

26. There should be a floor price on the oil sold. This price should be the greater of the average purchase price of the oil within the Strategic Petroleum Reserve or the average world market price on the day the emergency is declared.

[Category that best fits this company's operation: other.]

27. The Secretary of Energy or the successor to the authority of the Secretary of Energy over drawdown of SPR oil should establish a floor price on the oil sold. This price should be the greater of the average purchase price of the oil within the Strategic Petroleum Reserve or the average competitive world market price in effect during the period of the emergency.

[Category that best fits this company's operation: other.]

28. The bidding process will lead to panic rises in the crude market prices. It will not get the products to the areas of the country where shortages may develop and it will totally exclude the ability of the small independent refiners from participating and hence from supplying their market areas.

[Categories that best fit this company's operation: refiner with 175,000 B/D capacity or less; petroleum products marketer; pipeline.]

29. It is possible if not probable an IEA (International Energy Agency) emergency could be declared during a drawdown of SPR oil. IEA mandatory allocation will likely conflict with the free market approach for SPR oil. During an IEA emergency, procedures should allow for SPR crude oil to replace crude oil or product that a U.S. company diverts to another country in order to satisfy obligations of the United States to other IEA nations under the International Energy Program's oil-supply-sharing agreement. This could be done by either a sale or a timing exchange of SPR crude oil to the U.S. company giving up the cargo of oil to another IEA country. The principle behind such a policy would be to ensure that no U.S. company is disadvantaged by cooperating with the U.S. government and the IEA in meeting U.S. obligations in an IEA-triggered petroleum-sharing program.

With the understanding that the aforementioned "fair sharing" or compensation for companies participating in the IEA program would take priority over any other sell-off of SPR crude oil, we support price-competitive sales as the basic method of distribution of SPR crude oil. The best interests of the United States are served when the marketplace is relied upon to the maximum extent possible. The

provision for the directed sale of up to 10 percent of the SPR oil by the DOE Secretary at market prices offers a means for dealing with critical needs that are not met by the auction for whatever reason.

We disagree that the largest possible universe of eligible buyers ensures the most efficient distribution of SPR crude oil. The participation of foreign interests and speculators in the auction could deny or delay the efficient distribution of SPR oil to U.S. consumers and impede the workings of the marketplace. We believe SPR oil, except for that portion which is discretionary for distribution by the DOE Secretary under the SPR Drawdown Plan, should be made available through competitive sales to a universe of buyers which includes only U.S. refiners and/or their historical purchasing agents.

[Category that best fits this company's operation: refiner with more than 175,000 B/D capacity.]

30. Comments pertaining to the DOE Drawdown Plan, Amendment No. 4, December 1, 1982:

    1. We concur with the General Accounting Office's (GAO) recommendations to Congress as found on pages vii, viii, and 56 of GAO Evaluation of the Department of Energy's Plan to Sell Oil from the Strategic Petroleum Reserve, June 5, 1985. We are particularly in favor of:

        1.1 Restricting certain foreign purchases of SPR oil.

        1.2 Restricting the purchase of SPR oil by brokers and traders.

    2. To enhance the development of intra-company contingency planning for reacting to a potential implementation of the SPR Drawdown Plan, we recommend that the DOE:

        2.1 Establish a mechanism for alerting the petroleum industry when an SPR drawdown is being considered. Additionally, the establishment and maintenance of a computerized list of prospective, prequalified bidders would be one way to expedite notifications and contribute toward the reduction of the time delay between "Declaration of Emergency" and "Notification of Award," an action we strongly encourage.

        2.2 Recognize there is a need to construct Notices of Sale to permit bids for sweet crude, or sour crude oil, in preference to perhaps requiring a bidder to quote on both crude oil qualities as a qualification for award.

2.3 Expand the SPR Annual/Quarterly Report, published by the U.S. Department of Energy, Assistant Secretary for Fossil Energy, Office of Petroleum Reserves, to show within SPR storage locations, not only the on-hand inventories broken down into sweet and sour crude oil groupings (Table 6, page 8, SPR Annual/Quarterly Report, February 15, 1988), but further detailing those location inventories by SPR specifications (i.e., I, II, III, IV, & V). Then the volumes reported within each specification should be cross-referenced to the specific country/crude oil names and volumes which comprise the respective SPR location inventory specification.

2.4 Offer for sale now, five-gallon samples representative of the various SPR crude specifications which would be offered for sale from the various SPR storage locations during an emergency. This would permit prospective bidders to assess further the refining yields that we would expect to receive from the SPR, the results of which have a bearing on the ultimate price bid.

3. The December 31, 1987 SPR crude inventory data indicate that 65 percent of the 540 million barrels in storage is sour crude oil. In contrast, only about 25 percent of our company's normal daily refining runs are sour crude oil. From our point of view, and probably many of our U.S. domestic refinery competitors, the SPR crude oil quality in inventory appears to be imbalanced. Thus, we would encourage future SPR crude oil buys sweet crude oil. In addition to capital appropriation outlays that would be required, perhaps some balancing over time could be achieved, along with other test benefits, through outright "sour test sales," applying that revenue received to offset partially sweet crude oil costs. Otherwise, DOE's anticipated demand for SPR crude oil may be optimistic, because U.S. refining requirements for sour crude oil are generally less at this time, because many refiners are not equipped to handle significant quantities of sour crude oil.

[Category that best fits this company's operation: refiner with more than 175,000 B/D capacity.]

31. Following are two specific comments to excerpts from the Strategic Petroleum Reserve Drawdown Plan, Amendment No. 4 (in quotes), as well as a general SPR comment in item 3.

1. "The primary purpose of the SPR sales and distribution process will be to provide additional supplies of petroleum to domestic energy markets on a timely basis, to substitute for supplies interdicted due to a major fuel supply disruption. The SPR oil distribution

process is intended primarily to supplement national petroleum supplies."

Comment: The DOE should consider restricting sales to domestic refiners, their purchasing agents, and/or traditional suppliers of crude oil for domestic consumption. Bids from large numbers of unqualified bidders or speculators would tend to overload the system and delay the timely delivery of SPR oil.

2. "In developing the SPR distribution system, storage sites have been located in areas that are highly accessible to major commercial distribution systems, including interstate pipelines and marine port and terminal facilities. These locations permit SPR crude oil to be introduced rapidly into the normal U.S. crude oil distribution system, if petroleum supplies to the United States are interrupted... A significant portion of this crude oil is transferred inland through three major interstate pipelines originating in the Gulf Coast. The three pipelines are the Seaway and Texoma Pipelines, both terminating at Cushing, Oklahoma, and the Capline Pipeline, which terminates at Patoka, Illinois."

During the initial stage of an emergency supply disruption, it may be difficult to determine its significance, scope, and duration. In fact there could be many "false alarms." The initial panic response to such perceived emergencies could, in and of itself, cause unnecessary adverse economic affects on the national economy. Because of this and the above-mentioned time-lag factor, it will be incumbent upon the SPR to have approximately 10 percent, or 75 million barrels, of SPR oil available for immediate delivery into connecting crude oil trunk line carriers. Knowledge of this instant availability would tend to mitigate a panic response such as hoarding and disruptive price run-ups.

Since it is anticipated that there could be many withdrawals and recharging of this 10 percent increment, it would have to be part of the system which is designed to handle repetitive withdrawals from a salt cavity without an adverse effect on the cavity structural integrity. This special SPR reserve should also be located where it is unnecessary to disrupt the trading pattern of the existing U.S. flag fleet, i.e. it should be directly connected to the domestic pipeline system. It is suggested that such a reserve should be located in the Capline area, which has access to 5 million barrels per day of U.S. refinery capacity and which would satisfy one of the major study recommendations for the December 1984 National Petroleum Council study on the Strategic Petroleum Reserve, which recommended a

shift of at least 100 million barrels of remaining SPR fill to be placed in the Capline/LOOP complex.

[Category that best fits this company's operation: refiner with more than 175,000 B/D capacity.]

32. We believe the DOE should continually study the 1982 Drawdown Plan to ensure that it is responsive to the changes that have occurred in the international crude oil market since that time. The emergence of the crude oil market and the dominant role of the New York Mercantile Exchange since 1982 will put a premium on rapid government response to any future crisis. Speed will be essential. The drawdown plans should be examined periodically to ensure adequate supplies will be made available rapidly to blunt price spikes that will otherwise occur.

[Category that best fits this company's operation: petroleum products marketer.]

33. Our company is not particularly familiar with the drawdown plan. Generally, we favor a quick response by the government to help moderate any initial price surge. Any huge rise in the price of oil, such as from late 1979 through early 1980, is terrific for the oil industry in the short run, but detrimental in the long run. The situation in 1979 was definitely aggravated by panic or excessive buying, whether because of hoarding or speculating on future increases. Between 1979 to 1981, commercial oil stocks rose 10-115 percent above what is probably normally carried on average. Today, one could argue that commercial inventories are probably about 10 percent below a "normal" level, more because of a perceived oversupply rather than the existence of strategic reserves. The main reason that our Company is carrying a little less than we have in the past is a feeling that oil is readily available to be purchased, and not so much because the SPR exists. However, in the event of a supply crisis, the presence of the SPR would definitely moderate the desire to buy and carry excessive inventory.

One way to best utilize the presence of the SPR would be to not release oil until the spot price had risen by $5-8 per barrel. The fact that the SPR is clearly "waiting in the wings" to release oil, if necessary, would help lessen panic buying and thus dampen a sharp price rise, even without having to release oil. Obviously, this approach would heighten the impact of the SPR as well as avoid the country's added cost of beginning to release oil from the SPR if the supposed crisis turns out to be a false alarm. We are supporters of the SPR concept and would like to see it employed as effectively as possible.

[Categories that best fit this company's operation: refiner with 175,000 B/D capacity or less; petroleum products marketer; public warehouse terminal operator.]

APPENDIX H

CARIBBEAN STORAGE/TRANSSHIPMENT FACILITIES

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CARIBBEAN STORAGE/TRANSSHIPMENT FACILITIES

The network of facilities in the Caribbean provides an important, though sometimes forgotten, link in the U.S. petroleum supply chain. Nine facilities together account for approximately 133 million barrels of storage capacity. Of this total, approximately 80 percent is dedicated to the storage of "dirty" products, i.e., crude oil and residual fuel oil. The facilities themselves and their estimated storage capacities are enumerated in Table H-1.

These facilities perform several functions. First, as transshipment facilities, they serve a simple logistical function, receiving oil from tankers too large for U.S. ports and pumping oil to tankers suitable for U.S. trade. Located close to the world's largest market, they add flexibility and efficiency to the supply and distribution of imported crude oil and refined

TABLE H-1

ESTIMATED STORAGE CAPACITIES OF CARIBBEAN FACILITIES
(Millions of Barrels)

Location	Capacity		
	Dirty	Clean	Total
U.S. Territories	30	10	40
St. Croix	15	10	25
Puerto Rico	15	-	15
Bahamas	20	5	25
S. Riding Point	5	-	5
Freeport	15	5	20
Bonaire	10	-	10
Curacao	16	1	17
St. Lucia	5	-	5
St. Eustatius	2	1	3
Aruba (idle)	26	7	33
Total	109	24	133

products. Also, owing to their location, the Caribbean facilities serve an important commercial hedging role in the world's oil market. Used by both refiners and importers as well as producers, albeit usually at different times, the facilities can reduce the risk of major price fluctuations on long-haul voyages. For example, Caribbean terminals were extensively used by the Middle East producing countries in 1986 to minimize their risks in "netback" crude oil sales. These facilities also serve a commercial speculative role, allowing traders to take advantage of price movements.

APPENDIX I

HISTORICAL PERSPECTIVE ON REFINING CAPACITY UTILIZATION

APPENDIX I

HISTORICAL PERSPECTIVE ON REFINING CAPACITY UTILIZATION

As shown in Table I-1, refining operations in the United States have continued to undergo significant change since the 1984 National Petroleum Council report. The number of operable U.S. refineries and their total crude oil distillation capacity bottomed out in 1985. Since then, despite the number of refineries falling slightly, total crude oil distillation capacity has increased by 400,000 barrels per day mainly due to the reactivation of the 300,000 barrel per day Trans-American Refining Co. refinery in Good Hope, Louisiana. Refinery utilization rates have been on the increase since 1983 and are now approaching a more normal range, from a historical perspective, of between 85 and 90 percent.

The Energy Information Administration's (EIA) definition of operable capacity includes capacity that has been shut down but

TABLE I-1

OPERABLE U.S. REFINING CAPACITY TRENDS

Year	Number of Refineries at Year End*	Crude Oil Distillation Capacity at Year End* (MB/D)§	Average Utilization¶ (%)
1982	258	16.9	70
1983	247	16.1	72
1984	223	15.7	76
1985	216	15.5	78
1986	219	15.6	83
1987	213	15.9	83

*Annual Energy Information Administration Refinery Capacity Surveys.

§Thousands of barrels per day.

¶Energy Information Administration, Petroleum Supply Annual, 1982-1987.

can be placed in operation within 30 days. There is some concern that this definition overstates capacity in actual use, and thereby understates refinery utilization. As a result, the EIA publishes data on idle capacity and operating capacity. The U.S. monthly utilization rates for 1988 on both an operable and operating basis are shown in Table I-2. As the table indicates, there has been a substantial shrinkage in the amount of "spare" refining capacity in the United States, with operating refinery utilization rates now in the 90 percent range. More importantly, industry downstream conversion capacity is more fully utilized now. Downstream conversion capacity includes vacuum distillation, thermal and catalytic cracking, catalytic hydrocracking and hydrotreating, and coking. Operating problems in this refining sector can cause direct and immediate reductions in light product supplies. As a result of this tightening in refining capacity, product imports now play a more significant role in balancing the United States' supply-demand picture.

TABLE I-2

U.S. REFINERS' MONTHLY UTILIZATION RATES, JANUARY-JUNE 1988

Month	Gross Inputs to Stills (MB/D)*	Operable Capacity (MB/D)*	Operable Utilization (%)	Operating Capacity (MB/D)*	Operating Utilization (%)
Jan.	13,172	15,911	82.8	15,018	87.7
Feb.	12,907	15,916	81.1	14,880	86.7
Mar.	13,241	15,861	83.5	14,951	88.6
Apr.	13,330	15,861	84.0	14,921	89.3
May	13,630	15,883	85.8	14,938	91.2
June	13,704	15,929	86.0	14,843	92.3
July	13,803	15,952	86.5	14,860	92.9
Aug.	13,943	15,958	87.4	14,908	93.5
Sept.	13,356	15,965	83.7	15,141	88.2
Oct.	13,315	15,946	83.5	15,114	88.1
Nov.	13,341	15,909	83.9	15,086	88.4
Dec.	13,554	15,919	85.1	14,887	91.0

*Thousands of barrels per day.

Source: Energy Information Administration, Petroleum Supply Monthly, January-June 1988.

APPENDIX J

GRAPHICAL REPRESENTATION OF DEMAND AND PRIMARY INVENTORY LEVELS, 1983 - 1988

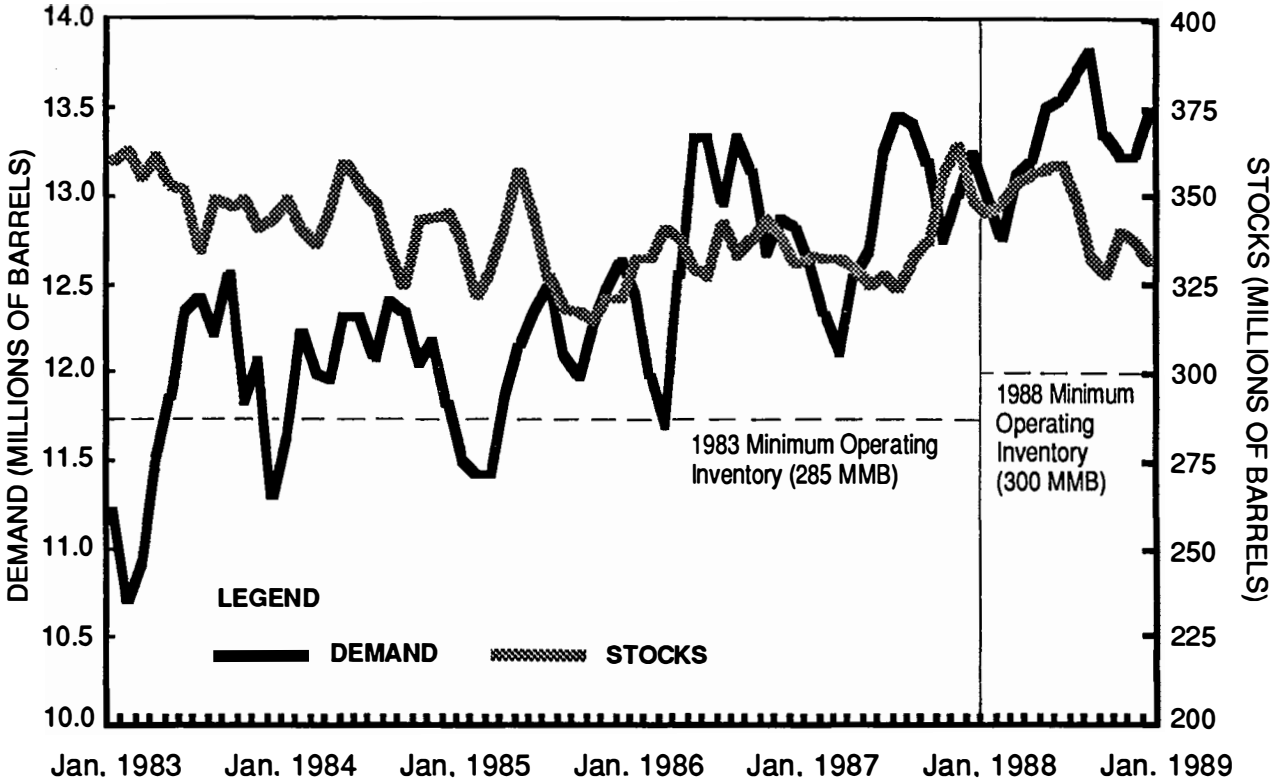

Figure J-1. Crude Oil Demand and Stocks -- Total U.S. (Excluding SPR).

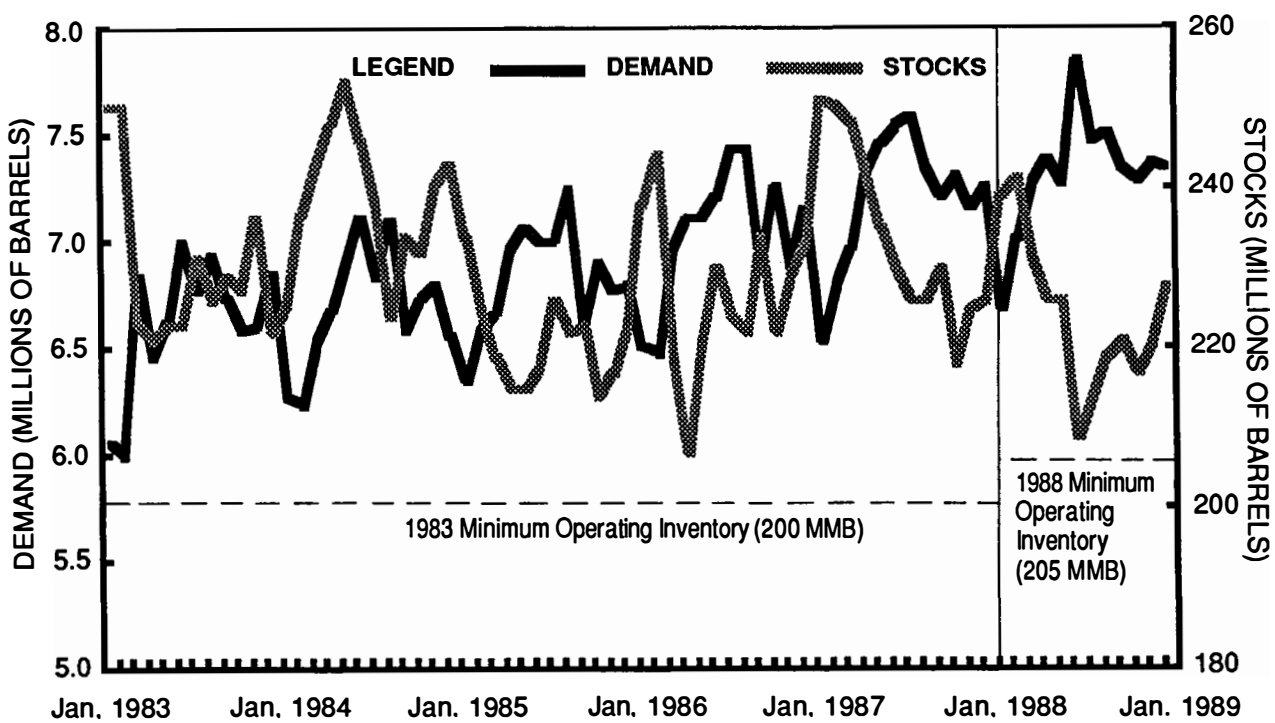

Figure J-2. Motor Gasoline Demand and Stocks -- Total U.S.

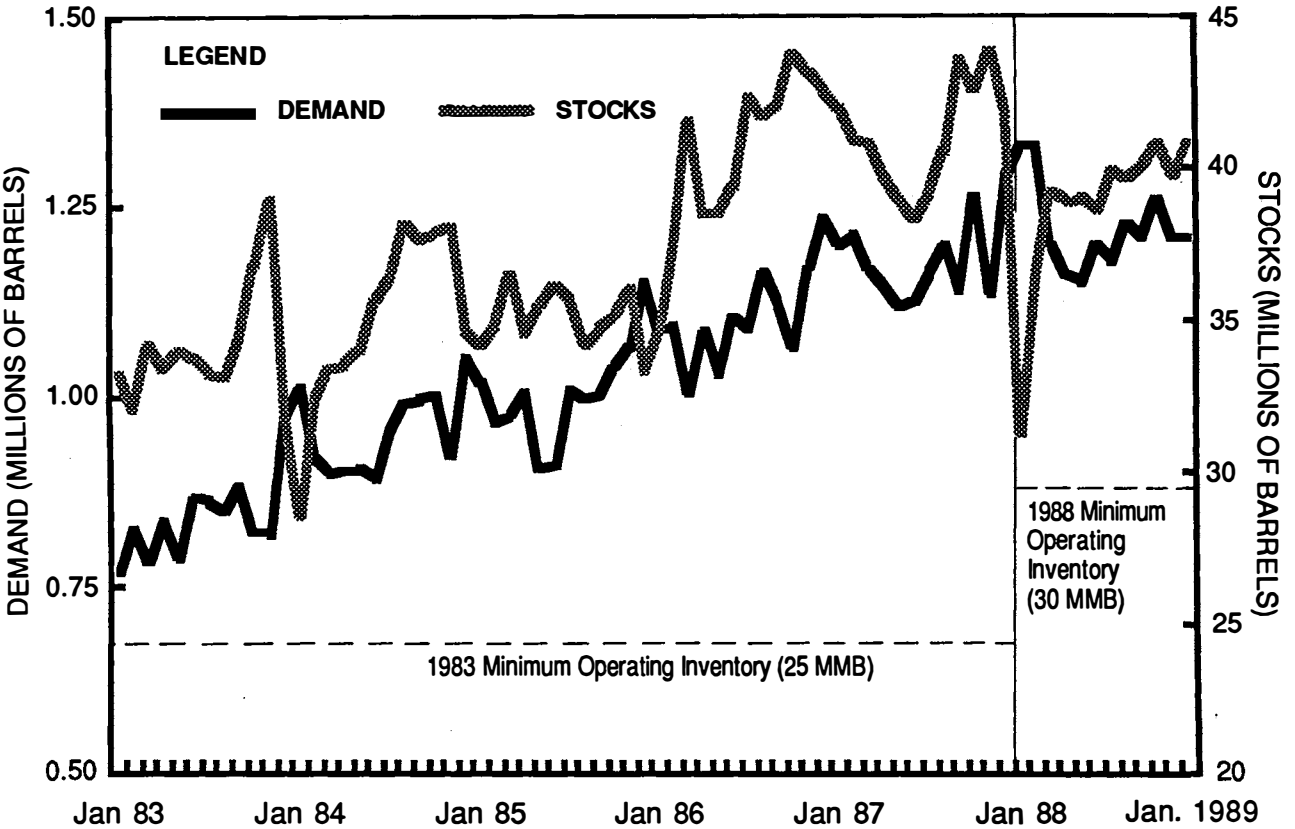

Figure J-3. Kerosine-Type Jet Fuel Demand and Stocks -- Total U.S.

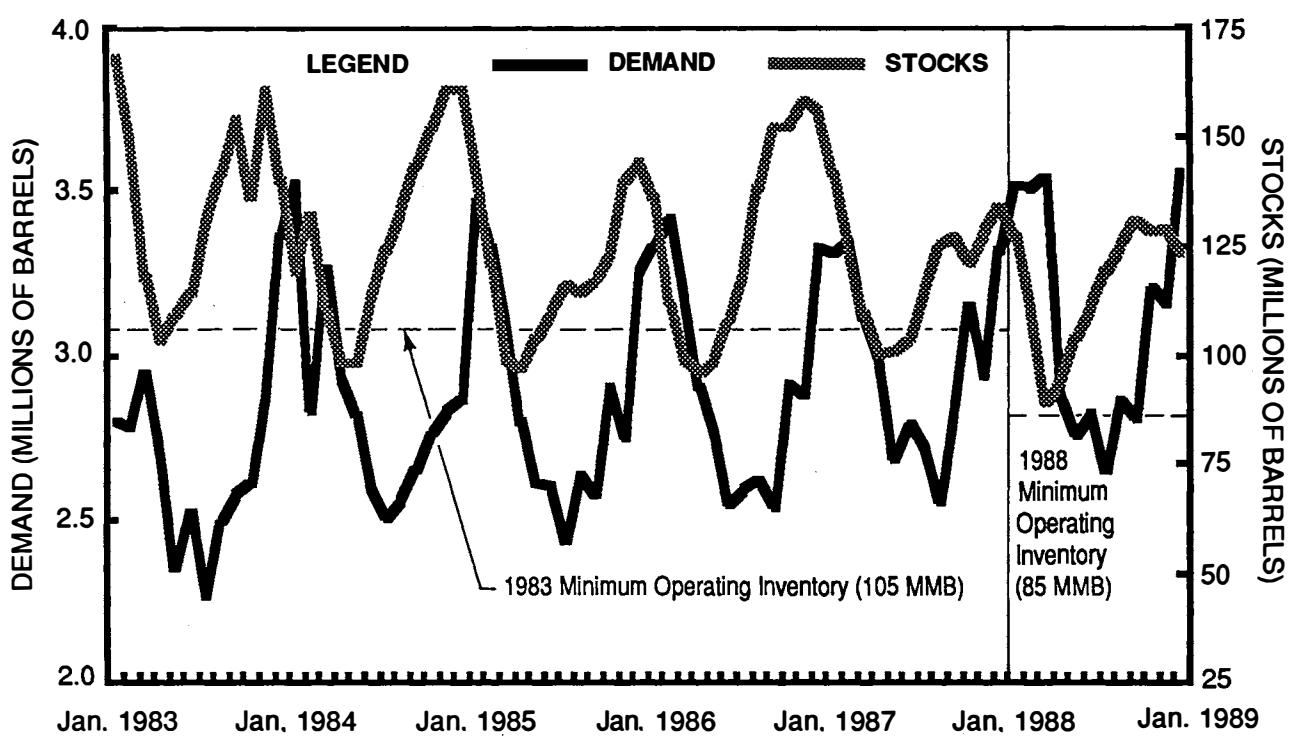

Figure J-4. Distillate Fuel Oil Demand and Stocks -- Total U.S.

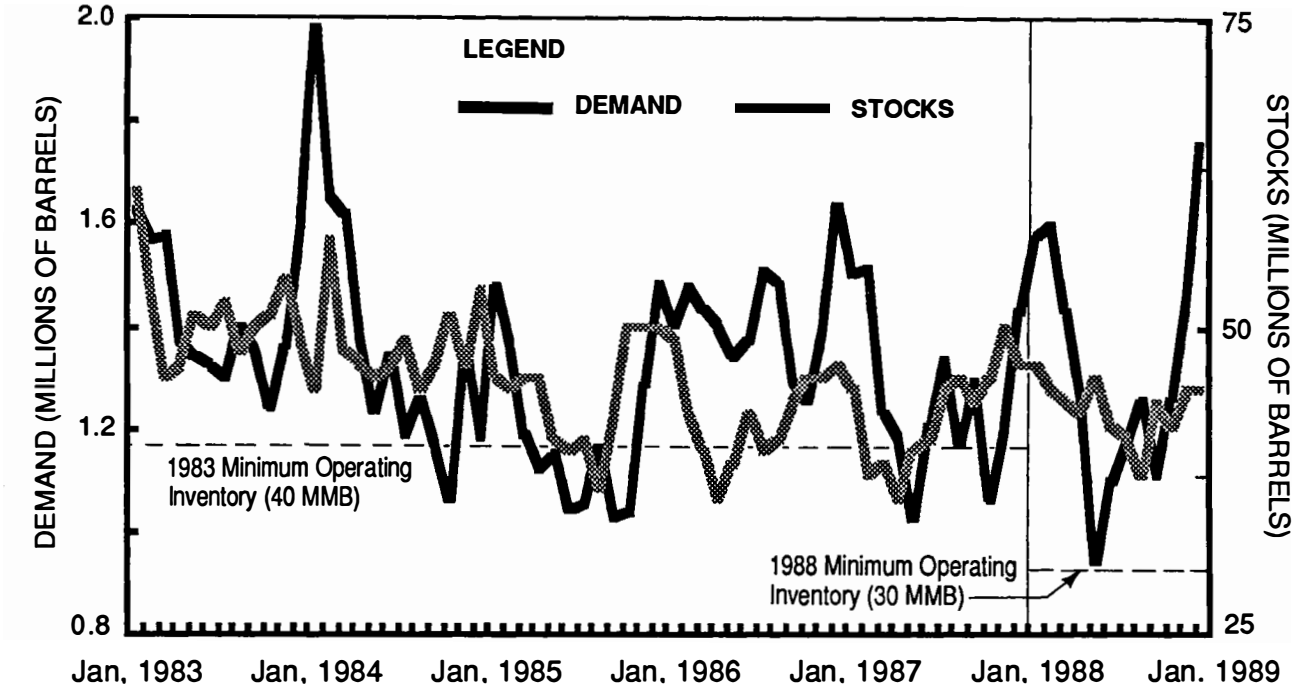

Figure J-5. Residual Fuel Oil Demand and Stocks -- Total U.S.

Data sources for the figures in Appendix J are: Energy Information Administration, Petroleum Supply Annual, Volume 1, 1985, 1986, 1987; Petroleum Supply Monthly, Jan. - Dec., 1988.

APPENDIX K

METHODOLOGIES FOR DETERMINING PETROLEUM INVENTORIES AND STORAGE CAPACITY IN THE SECONDARY PETROLEUM DISTRIBUTION SYSTEM

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METHODOLOGIES FOR DETERMINING PETROLEUM INVENTORIES AND STORAGE CAPACITY IN THE SECONDARY PETROLEUM DISTRIBUTION SYSTEM

INTRODUCTION

The secondary distribution system is composed of two sectors: bulk plants and retail motor fuel outlets. Different methodologies were used to estimate the storage capacity and inventories in each of these sectors. A stratified random sample of bulk plant operators was surveyed to determine their storage capacity and inventories as of March 31, 1988, and inventory as of September 30, 1987. Estimates for the total population were projected from these data. The storage capacity and inventories at retail motor fuel outlets were estimated based on published literature and discussions with industry experts. These methodologies are described below.

BULK PLANTS

The National Petroleum Council's 1988 Survey of Petroleum Inventories and Storage Capacity in the Secondary Distribution System in the United States was designed to determine:

- The total storage capacity for selected petroleum products in bulk plants on March 31, 1988
- The amount of distillate storage that was switchable to motor gasoline
- The total level of inventory of selected refined petroleum products in bulk plants as of September 30, 1987, and March 31, 1988
- The impact of the petroleum futures market on inventories and storage capacity in bulk plants.

Scope of the Survey

The survey was used to collect storage capacity and inventory data for motor gasoline, distillate fuel oil, and residual fuel oil for March 31, 1988, and inventory data for September 30, 1987. Those dates were selected to be consistent with the primary system survey. The survey covered the 50 states and the District of Columbia, but excluded all U.S. territories and possessions. Storage of motor fuels at retail outlets was excluded from the survey.

Description of the Questionnaire

The questionnaire consisted of two parts: Part One, Storage and Inventory; and Part Two, Petroleum Futures. Part One of the questionnaire asked only three questions:

- Total fixed storage capacity by product
- Amount of distillate fuel oil storage capacity switchable to motor gasoline storage without modification to tankage costing over $1,000 per tank
- Inventory by product as of September 30, 1987, and March 31, 1988.

The futures portion of the questionnaire was identical to that in the primary system survey.

The inventory and capacity information was requested by Petroleum Administration for Defense District (PADD) for companies that operate in more than one PADD. A survey without PADD divisions was sent to companies that operate in only one PADD. As in the primary survey, PADD I was divided into three regions: New England (IX), Central Atlantic (IY), and Lower Atlantic (IZ) states. The futures information was requested company-wide. A copy of the questionnaire is found at the end of this appendix.

The Survey Population

Questionnaires were sent to 1,995 companies. The population included the companies in the primary distribution system as well as a stratified random sampling of the non-primary companies.

The non-primary population was defined to be the 26,378 names and addresses from two surveys: the EIA-863 "Petroleum Product Sales Identification Survey" and the EIA-821 "Annual Fuel Oil and Kerosene Sales Report." The EIA-863 survey was mailed in January 1986 to approximately 30,000 names and addresses of companies that were not respondents on the EIA-821 survey. The purpose of the EIA-863 survey was to develop a list of resellers of gasoline and sellers and resellers of distillate and residual fuel oil based on 1985 sales data. The EIA-821 survey is an annual sample survey that collects information on sales of kerosine, distillate fuel oil, and residual fuel oil. For 1985, a question was added to collect sales of motor gasoline.

Stratification Design

The 26,378 names and addresses for this survey were stratified for processing and estimation based on the following:

- Companies that operate in both the primary distribution system and the secondary distribution system were separated from firms that operate only in the secondary distribution system.

- Companies that were known to operate in more than one PADD were separated from companies that were known to operate in only one PADD.

- Companies that were "large," according to available data, were separated from those that were "small."

- Companies for which no volumetric data were available (e.g., nonrespondents to the EIA-863) were separated from the companies for which volumetric data were available.

Each company was assigned to a stratum. The strata were assigned processing codes, which are summarized in Table K-1. All companies that operate in more than one PADD, operate in the primary system, or that were designated as "large," received a survey form. The others were randomly sampled. The extent of follow-up of the nonrespondents varied by strata, depending upon the expected contribution to the overall PADD estimates and the expected variation of the storage capacity within each group. A description of the makeup of each stratum is as follows:

Code PR: Priority, Primary

This stratum is comprised of companies in the primary distribution system that were thought to have a very large storage capacity in the secondary distribution system. They received extensive follow-up.

Code A: Multi-PADD, Primary

This stratum is comprised of the companies in the primary distribution system that operate in more than one PADD, except for those large enough to be assigned to stratum PR.

Codes B-H: Single PADD, Primary

These strata are comprised of all companies in the primary distribution system that operate in a single PADD, except for those large enough to be assigned to stratum PR. Each PADD was assigned a unique processing code.

Code J-K: Multi-PADD, Not Primary

These two strata are comprised of all companies that were not in the primary distribution system, but were known to operate in more than one PADD. The J code was assigned to the "large" companies and the K code was assigned to the "small" companies.

TABLE K-1

SUMMARY OF STRATIFICATION DESIGN

Process Codes	PADD	Description	Number in Population	Number in Survey	Response Rate (Percent)
PR	Priority	Primary*	77	77	66
A	Multi-PADD	Primary	49	49	50
B	IX	Primary	28	28	46
C	IY	Primary	52	52	58
D	IZ	Primary	22	22	79
E	II	Primary	61	61	66
F	III	Primary	82	82	44
G	IV	Primary	13	13	58
H	V	Primary	33	33	63
J	Multi-PADD	Large	103	103	52
K	Multi-PADD	Small	531	531	55
L	IX	Large	56	56	58
M	IY	Large	27	27	48
N	IZ	Large	30	30	47
O	II	Large	31	31	58
P	III	Large	15	15	53
Q	IV	Large	39	39	46
R	V	Large	49	49	51
S1	IX	Small-sample	722	30	53
S2			1,133	62	48
T1	IY	Small-sample	775	25	52
T2			1,992	86	58
U	IZ	Small-sample	2,289	76	46
V	II	Small-sample	8,091	15	56
W1	III	Small-sample	732	25	36
W2			1,660	70	49
X	IV	Small-sample	764	30	40
Y1	V	Small-sample	477	18	67
Y2			689	28	50
ZA	Misc.	Nonrespondent in business	760	38	29
ZB	Misc.	Nonrespondent no data	5,413	108	20

*Companies operating in the primary distribution system.

Codes L-R: Large, Single PADD, Not Primary

These strata are comprised of all "large" companies that were not in the primary distribution system and were known to operate in only one PADD. The definition of "large" varied from PADD to PADD.

Codes S-Y: Small, Single PADD, Not Primary

These strata are comprised of all "small" companies that were not in the primary distribution system, were known to operate in only one PADD, and were not included among codes L-R above. Additional substrata were defined for PADDs IX and IY; and for PADDs III and V. In PADDs IX and IY, substrata S1 and T1 were defined to include companies which reported only residential sales of No. 2 heating oil on the frame surveys. Substrata S2 and T2 consisted of the remaining companies in those districts. In PADDs III and V, substrata W1 and Y1 were defined to include companies that reported only retail sales on the frame survey. The remaining companies in those districts were in substrata W2 and Y2.

Codes ZA and ZB: No Volumetric Data Available, Not Primary

Stratum ZA consists of companies for which no volumetric data are available, but the companies are known to be in business. Stratum ZB also consists of companies for which there are no volumetric data. However, nothing else is known about them either. It is expected that stratum ZB will have a higher proportion of out-of-business or out-of-scope companies.

Estimation Procedures

The U.S. total for a stratum was estimated as the average of the reported data multiplied by the estimated number of companies with storage capacity in the stratum.

Pooling was used in two places: when calculating the estimates of the number of firms with storage, and when estimating the size of the average firm for each product. In the first instance, similar strata were pooled to achieve a more accurate ratio of the number of firms with storage to the number of total responses. The ratio for the entire pool was used for each stratum in the pool to estimate the number of firms with storage in that stratum. In the second instance, the estimated size of the average firm for each product reflected the pooling. This provided additional assurance of confidentiality.

The U.S. total estimates can be viewed as the sum of the responses and of the estimates of the nonrespondents and those not surveyed. The respondents were assumed to resemble the nonrespondents and those not surveyed in terms of their average size and of the percentage that have storage capacity. The estimate for the nonrespondents was distributed by PADD according to the percentage of the sales for the aggregate of the nonrespondents

in that PADD. The sales data available for distillate fuel oil, residual fuel oil, and motor gasoline on the EIA-764 survey were used to determine the appropriate percentages. Although volumetric sales and storage have been shown to be uncorrelated, it was assumed that the sales data provided information concerning the PADDs in which the nonresponding companies operated.

The estimates for the nonrespondents and those not surveyed in strata Z and Z1 were distributed based on the PADD breakdown of the responding small single-PADD firms.

Results of the Survey

Of the 1,995 companies surveyed, 52 percent responded. Analysis was performed on the accuracy of the estimates. No efforts were made to audit the accuracy of the survey responses.

As anticipated at the outset of this survey, the projections have varying degrees of reliability. The national level estimates of storage capacity for motor gasoline, diesel/distillate fuel oil, and residual fuel oil are accurate, at a 95 percent confidence level, to within 16.8, 30.5, and 46.0 percent, respectively, of the actual values. The PADD level estimates range from being quite useful (the estimate of storage capacity of motor gasoline in PADD IX is accurate to within 9.8 percent) to being unreliable (the estimate of storage capacity of residual fuel oil in PADD IY is only accurate, with 95 percent confidence, to 189.7 percent of the actual level). In general, estimates at the PADD level for either primary or nonprimary firms are unreliable. Aggregating up to the total PADD estimate or the national estimate produces increasingly reliable projections.

The results of the survey, confidence levels, and response rates by stratum are shown in Tables K-2, K-3, and K-4, respectively.

Calculations of Variances and Percentage Accuracies

The methodology used in calculating the accuracy of the estimates is described below:

1. Variance of Responses Received - This number is calculated from the data base and is not included in the report.

Formula: $$s^2 = \sum_{i=1}^{n} x_i^2 \, / n - AVG^2$$

where x_i = data in individual company file (if a company has no storage of the surveyed products, x = 0), n = number of responding firms, and AVG = sum of responses received divided by n.

TABLE K-2

NPC 1988 SURVEY OF
STORAGE CAPACITY AND INVENTORY IN BULK PLANTS
SUMMARY OF ESTIMATES
(Millions of Barrels)

		PADD IX	PADD IY	PADD IZ	PADD II	PADD III	PADD IV	PADD V	Total*
Motor Gasoline	Storage Capacity	1.14	1.73	2.43	7.28	2.31	0.96	1.14	16.98
	Inventory	0.53	0.88	1.17	3.43	1.08	0.44	0.56	8.09
Diesel/ Distillate Fuel Oil	Storage Capacity	2.47	3.74	3.73	12.06	4.22	1.44	1.63	29.29
	Switchable to Motor Gasoline	1.36	2.43	2.19	7.19	2.34	0.88	0.95	17.35
	Inventory	0.96	1.32	1.44	4.52	1.70	0.56	0.64	11.14
Residual Fuel Oil	Storage Capacity	0.33	0.70	0.44	1.52	0.56	0.17	0.22	3.93
	Inventory	0.18	0.28	0.29	0.97	0.36	0.10	0.11	2.29
Total*	Storage Capacity	3.94	6.17	6.60	20.85	7.09	2.57	2.99	50.20
	Inventory	1.68	2.48	2.90	8.92	3.14	1.10	1.31	21.52

*Totals may not add due to independent rounding.

TABLE K-3

NPC 1988 SURVEY OF
STORAGE CAPACITY AND INVENTORY IN BULK PLANTS
SUMMARY OF PERCENTAGE ACCURACIES
AT 95 PERCENT CONFIDENCE LEVEL*

		PADD IX	PADD IY	PADD IZ	PADD II	PADD III	PADD IV	PADD V	Total
Motor Gasoline	Storage Capacity	9.8	36.0	37.8	34.8	24.8	19.4	32.9	16.8
	Inventory	11.9	45.5	37.5	45.7	24.1	14.0	36.0	21.2
Diesel/ Distillate Fuel Oil	Storage Capacity Switchable to Motor Gasoline	49.0	75.0	33.0	30.0	228.0	15.0	43.0	38.0
	Inventory	48.5	77.0	33.6	29.8	220.5	14.5	41.7	37.5
Residual Fuel Oil	Storage Capacity	78.4	189.7	23.4	73.6	77.4	31.7	26.9	46.0
	Inventory	164.8	527.0	49.7	131.2	145.0	114.0	88.9	90.0

*This table can be read as: "These estimates are accurate to within _____ percent of the total in 95 percent of the cases." The formula used to calculate the confidence levels is 1.96 (square root (variance of total/total)).

TABLE K-4

RATES OF RESPONSE BY STRATUM

Stratum	Not Applicable	Refused to Respond	Duplicate	Firms With Some Storage	Total Responses Received*	Total Surveys Sent	Response Rate (Percent)
PR	30	1	0	16	51	77	66
A	17	1	0	5	24	48	50
B	8	1	0	3	13	28	46
C	18	1	0	8	30	52	58
D	12	0	0	1	15	19	79
E	31	1	0	5	38	58	66
F	30	2	0	4	35	79	44
G	5	1	0	2	7	12	58
H	16	2	1	2	19	31	63
B-H	120	10	1	25	157	279	56
J	29	10	1	16	53	102	52
K	92	32	2	181	290	529	55
L	14	4	1	17	32	55	58
M	8	1	0	3	13	27	48
N	6	2	0	7	14	30	47
O	10	3	0	6	18	31	58
P	4	1	0	3	8	15	53
Q	6	2	0	10	18	39	46
R	15	3		6	25	49	51
L-R	63	16	1	52	128	246	52
S1	5			8	16	30	53
S2	9	1	0	15	30	62	48
T1	4	0	0	3	13	25	52
T2	13	3	0	28	50	86	58
U	10	6	0	25	35	76	46
V	16	12	1	47	64	144	56
W1	4	4	0	5	9	25	36
W2	6	2	0	25	34	70	49
X	2	4	0	9	12	30	40
Y1	7	2	0	5	12	18	67
Y2	3	2		9	14	28	50
S-Y	79	36	1	179	289	564	51
ZA	7	2	0	2	11	38	21
ZB	16	3	0	6	22	108	19
Total	453	109	6	482	1,025	1,991	52

* (Number of firms responding not applicable) + (Number of firms providing data); excludes firms refusing to respond and includes firms operating in the secondary system that have no storage.

2. Variance of Estimated Total.

   Formula: $V_T = N (N-n) S^2/n$; where N = the number of firms in the population (less duplicates).

3. Percentage Accuracy - This value gives an understandable measure of the accuracy of the national estimates. The numbers should be interpreted as saying "These estimates are accurate to within _____ percent of the total in 95 percent of the cases," with the percentage accuracy number inserted in the blank. A summary of percentage accuracies is presented in Table K-3.

   Formula: 1.96 (Square root of VT/E); where VT = variance of estimated U.S. total (#2 above) and E = estimated U.S. total.

RETAIL MOTOR FUEL OUTLETS

Calculating storage capacity and inventory stored at retail motor fuel outlets in the United States involved estimating the total number of outlets, along with an assessment of the average storage capacity and inventory at these outlets as of March 31, 1988. Gasoline service stations, convenience stores, truck stops, mass merchandisers, and other stores that have retail sales of gasoline or diesel fuel for vehicles were included in the estimates. These estimates were based on data obtained from trade articles and discussions held with representatives of petroleum trade associations, refiners, marketers, jobbers, and firms in related industries. Where practical, independent sources were used to test the reasonableness and accuracy of each element used in the final storage capacity and inventory estimation.

Number of Retail Outlets

The estimate of the number of outlets is the result of a consensus reached by the Council after evaluation of all available data sources.

The U.S. Bureau of the Census estimates that there were about 117,000 gasoline service stations in operation in the United States at the end of 1987 and that there will be about 112,000 at the end of 1988.[1] In a continuation of a long-term trend, the number of gasoline service stations has declined from a peak of 225,000 in 1972, dropping at a rate of nearly 3 percent per year. Based on the estimated rate of decline, there were about 115,000 service stations in operation as of March 31, 1988.

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[1]Bureau of the Census, U.S. Department of Commerce, Franchising in the Economy, 1986-1988. February 1988.

The Census estimate, however, is comprised of only those retail outlets that meet the Census definition of "service station." A "service station" must generate over 50 percent of its revenue from the sale of gasoline and petroleum products. There are many other retail operations that sell motor fuel but generate a smaller fraction of their total revenues from sales of petroleum products. In many parts of the nation, convenience stores (C-stores) such as "7-11" or "Quik-Stop," mass merchandisers such as Sears, K-Mart, and J.C. Penney, car washes, and automotive/ truck repair shops sell motor fuel in the retail market. Studies have shown that the non-service station volume of petroleum products sold is substantial. For example, the National Petroleum News, 1988 Fact Book, estimates that C-stores and mass merchandiser types of non-service station retail outlets account for about 25 percent of the total motor fuel outlets and for over 10 percent of the motor fuel volumes sold in the United States.[2] In addition, National Petroleum News estimated that there are about 15,000 "other" retail outlets selling motor fuel. "Other" outlets are car washes, car dealers, farm implement dealers, and other small outlets.

Expanding the Census service station count by National Petroleum News's estimated percentages of C-stores and the estimated 15,000 "other" outlets gave a projected total number of retail outlets selling motor fuel to be about 170,000 in early 1988. Other sources, such as the Lundberg Letter (March 17, 1987) and independent estimates from petroleum companies, tend to corroborate the retail motor fuel outlet population. The NPC estimated previously that in 1983 there were approximately 210,000 outlets.

Average Storage

The average storage capacity per retail outlet varies with the type of outlet selling motor fuel. The average retail service station (one offering automotive repairs as well as fuel) tends to be an older building with older tankage. New sites that offer fuel only (no repair or maintenance services) are larger-volume sites and have newer, larger in-ground tanks. Several companies have estimated average storage capacity for a variety of outlet types. An average service station has an estimated storage capacity of 16,000 gallons. An average fuel-only outlet has an estimated storage capacity of 30,000 gallons. An average C-store and mass-merchandiser outlet has an average storage capacity of 24,000 gallons. The fuel-only and C-store outlets tend to be newer establishments that have a larger monthly volume of sales and have more tanks to allow the outlet to offer two

[2] National Petroleum News, 1988 Fact Book, Hunter Publishing Company, DesPlaines, IL.

grades of unleaded gasoline, a leaded gasoline, and a diesel fuel.

The average outlet storage capacity times the estimated number of outlets for each of service stations, fuels only, C-stores, and "other" outlets yields an estimate of retail motor fuel outlet storage capacity of 83 million barrels capacity on March 31, 1988. The previous NPC study estimated 87 million barrels of storage capacity in 1983.

Table K-5 summarizes the number and types of outlets, average storage capacity, and total storage for each type of retail motor fuel outlet.

TABLE K-5

ESTIMATED NUMBER OF MOTOR FUEL OUTLETS, AVERAGE TANKAGE, AND STORAGE CAPACITY*

	Number	Average Tankage (Gallons)	Total Storage Capacity (Thousands of Barrels)
Service Stations	70,000	16,000	27,000
Fuel Only	45,000	30,000	32,000
Convenience Stores	40,000	24,000	23,000
Other	15,000	3,000	1,000
Total	170,000		83,000

Source: NPC estimate.

Average Inventory

The amount of gasoline and diesel fuel in inventory at any outlet is a function of the local distribution system. Many large volume outlets have fuel supplies delivered daily. Smaller outlets may receive supplies only once or twice a week. The 1984 NPC report indicated that inventory in tankage was, on March 31, 1983, on average, between 30 and 45 percent of storage capacity. This assumed that some outlets were close to capacity, having just received a delivery, and others were close to empty and due to receive a delivery. In addition, on April 1, 1983, a 5¢ per gallon increase in the Federal Excise Tax on motor gasoline went into effect. This caused extraordinary draws on the inventories of a number of retail outlets.

The Council believes that the fill-draw cycle of a tankage system operates on the premise that no retail outlet wishes to

run out of fuel and, therefore, will operate in such a manner that a safety cushion of fuel is always in the tanks. This means that the outlet cycles from nearly full tanks to, perhaps, only 25 percent full before ordering more inventory. Therefore, in a perfect distribution system, if all retail outlets are averaged, the tanks should be half-full above the safety cushion level at any point in time. Since deliveries are staggered and not uniform for all outlets, and not every outlet gets it tanks "filled" when it receives a delivery, on average tanks should be about 50 percent filled at any point in time.

Adding a safety cushion of 10 to 15 percent to an estimated 35 to 40 percent fill brings average inventory to 50 to 55 percent. This estimated range was corroborated by several petroleum companies' reported operations. As a result, the NPC estimates that there were about 44 million barrels of motor fuel in inventory on March 31, 1988.

The breakdown of the storage capacity at retail motor fuel outlets between motor gasoline and diesel fuel was made by assuming that motor fuel storage capacity is roughly the same proportion as sales volumes. Data for motor gasoline and diesel fuel sales by state from EIA's Petroleum Marketing Annual, 1986 were used to determine PADDs I-IV and PADD V storage capacity for both fuels. The NPC estimates that there were about 75 million barrels of motor gasoline storage and 8 million barrels of diesel fuel storage at retail motor fuel outlets as of March 31, 1988. This is shown on Table K-6.

Average inventories for motor gasoline and diesel fuel by PADD were derived by applying the average inventory estimate of between 50 and 55 percent of capacity on March 31, 1988. This is estimated to be about 40 million barrels of motor gasoline and 4 million barrels of diesel fuel as of March 31, 1988.

TABLE K-6

RETAIL MOTOR FUEL OUTLETS
ESTIMATED STORAGE CAPACITY AND INVENTORY
AS OF MARCH 31, 1988
(Millions of Barrels)

	Capacity			Inventory		
	PADDs I-IV	PADD V	Total	PADDs I-IV	PADD V	Total
Motor Gasoline	62	13	75	33	7	40
Diesel	6	2	8	3	1	4
Total	68	15	83	36	8	44

Source: NPC estimate.

Code Number*_____

NATIONAL PETROLEUM COUNCIL
1988 SURVEY OF

U.S. PETROLEUM INVENTORIES AND STORAGE CAPACITIES (SECONDARY DISTRIBUTION SYSTEM)

Please note any changes to the above information:

Company Name:_____

Address:_____

_____

_____ Zip Code: _____

Person in reporting company to be contacted if questions arise:

_____

Phone: (____)_____

Please report on a company-wide basis; if you are a subsidiary, send this form to your parent company. To prevent duplication of reporting, list on the next page the companies for which you are reporting. If your company does not operate in the secondary petroleum distribution system (see definition on the next page) or if this is a duplicate survey, please mark the appropriate box below and *return the survey to Deloitte Haskins & Sells.*

❑ Not in Secondary Petroleum Distribution System

❑ Duplicate

Please return this questionnaire by May 16, 1988, to:
(A stamped self-addressed envelope is enclosed for your convenience.)

Deloitte Haskins & Sells
Suite 800
1101 15th Street, N.W.
Washington, D.C. 20005
ATTN: NPC Survey Team

If you have questions regarding this survey, please call Mr. Benjamin A. Oliver, Jr. at the National Petroleum Council office, (202) 393-6100.

*This entry, and other NPC Code spaces on subsequent pages, will be entered by the accounting firm for data tabulation purposes.

Code Number_____

The following definitions apply to this survey:

Reportable Storage -- This survey is based on **custody of inventory** in tankage. If you have custody of any of the products covered by the survey (motor gasoline, diesel/distillate fuel oil [excluding kerosine], and residual fuel oil), report the storage capacity in which that inventory is held plus operable, associated tankage not currently in service. Tankage not currently in service should be reported in the product category of its last use.

Secondary Distribution System -- Includes bulk plants and facilities of resellers of petroleum products, such as jobbers and fuel oil dealers. Inventory and storage capacity at gasoline service stations are **not** covered by this survey.

Bulk Plants -- A nonconsumer facility used for storage and/or marketing of petroleum products that has total storage capacity of less than 2.1 million gallons (50,000 barrels) and does **not** receive petroleum products by barge, ship, or pipeline. Include any tanks not currently in service; such tankage should be reported in the product category of its last use.

Petroleum Administration for Defense District (PADD) -- Information is requested on a PADD basis with PADD I subdivided into three areas. The states are grouped by PADD below:

PADD I

New England (PADD IX)
Connecticut
Maine
Massachusetts
New Hampshire
Rhode Island
Vermont

Central Atlantic (PADD IY)
Delaware
District of Columbia
Maryland
New Jersey
New York
Pennsylvania

Lower Atlantic (PADD IZ)
Florida
Georgia
North Carolina
South Carolina
Virginia
West Virginia

PADD II
Illinois
Indiana
Iowa
Kansas
Kentucky
Michigan
Minnesota
Missouri
Nebraska
North Dakota
Ohio
Oklahoma
South Dakota
Tennessee
Wisconsin

PADD III
Alabama
Arkansas
Louisiana
Mississippi
New Mexico
Texas

PADD IV
Colorado
Idaho
Montana
Utah
Wyoming

PADD V
Alaska
Arizona
California
Hawaii
Nevada
Oregon
Washington

Please circle the states in which you have storage.

If you are in the Secondary Petroleum Distribution System, but do not have storage capacity check here and return _____ .

Companies for which you are reporting:

_____ _____

_____ _____

_____ _____

NATIONAL PETROLEUM COUNCIL
1988 SURVEY OF
INVENTORIES AND STORAGE CAPACITIES IN THE
SECONDARY PETROLEUM DISTRIBUTION SYSTEM
(Less than 2.1 million gallons per site)

Code Number _____

Please provide the following information as of March 31, 1988, unless otherwise noted:

1. Total storage capacity (excluding service stations, C-stores, truckstops, and any other retail motor fuel outlet tankage).

PRODUCT	PADD IX (Gallons)	PADD IY (Gallons)	PADD IZ (Gallons)	PADD II (Gallons)	PADD III (Gallons)	PADD IV (Gallons)	PADD V (Gallons)
MOTOR GASOLINE							
DIESEL/ DISTILLATE FUEL OIL							
RESIDUAL FUEL OIL							

2. Amount of Distillate Fuel Oil storage capacity in Question 1 that can be switched to motor gasoline storage without modifications costing over $1,000 per tank.

_____	_____	_____	_____	_____	_____	_____	

3. The total amount of your inventories in the storage capacity reported in Question 1 as of March 31, 1988.

PRODUCT	PADD IX (Gallons)	PADD IY (Gallons)	PADD IZ (Gallons)	PADD II (Gallons)	PADD III (Gallons)	PADD IV (Gallons)	PADD V (Gallons)
MOTOR GASOLINE							
DIESEL/ DISTILLATE FUEL OIL							
RESIDUAL FUEL OIL							

4. The total amount of your inventories as of September 30, 1987.

PRODUCT	PADD IX (Gallons)	PADD IY (Gallons)	PADD IZ (Gallons)	PADD II (Gallons)	PADD III (Gallons)	PADD IV (Gallons)	PADD V (Gallons)
MOTOR GASOLINE							
DIESEL/ DISTILLATE FUEL OIL							
RESIDUAL FUEL OIL							

APPENDIX L

METHODOLOGIES FOR DETERMINING PETROLEUM INVENTORIES AND STORAGE CAPACITY IN THE TERTIARY STORAGE SEGMENT

APPENDIX L

METHODOLOGIES FOR DETERMINING PETROLEUM INVENTORIES AND STORAGE CAPACITY IN THE TERTIARY STORAGE SEGMENT

Estimates for inventories and storage capacities are presented by product and, in some cases, regionally (PADDs I-IV and PADD V). The National Petroleum Council (NPC) cautions that there is less confidence in the individual product categories than in the aggregate product volumes, and less confidence in the regional estimates by PADD than in the total U.S. volumes.

AGRICULTURAL SECTOR

The agricultural sector includes all farms, ranches, and similar entities in the United States. Petroleum storage for this sector includes motor gasoline and diesel fuel used in farm vehicles and equipment. Distillate fuel oil for residential heating on farms and ranches is included in the residential sector.

Data Sources

The estimates of farm petroleum storage are based on two sources. The latest Bureau of the Census survey of farms was completed in 1982. The State Farm Magazine Bureau surveyed 10,000 farmers regarding farm petroleum storage facilities in 1982.

Methodology

The State Farm survey results were adjusted for the distribution of farm size found by the Census Bureau. While the nominal size farm in the State Farm Magazine Bureau survey was 617 acres, the Census data average farm size was only 440 acres. The average storage, by gasoline and diesel, and by farm size, was multiplied by the number of farms in the corresponding Census categories.

Storage Capacity

The combined gasoline and diesel fuel storage capacity was estimated to be 40.1 million barrels, split almost 50/50 between the two products. From data provided by fuel marketers, inventory was estimated to be approximately 35 percent of capacity, or 14.1 million barrels. These data, along with a regional breakdown, are shown in Table L-1.

TABLE L-1

AGRICULTURAL SECTOR
ESTIMATED STORAGE CAPACITY AND INVENTORY
AS OF MARCH 31, 1988*
(Millions of Barrels)

	Total	PADDs I-IV	PADD V
Capacity			
Motor Gasoline	19.7	17.1	2.6
Diesel/Distillate Fuel Oil	20.4	17.8	2.6
Total	40.1	34.9	5.2
Inventory			
Motor Gasoline	6.9	6.0	0.9
Diesel/Distillate Fuel Oil	7.2	6.2	1.0
Total	14.1	12.2	1.9

*PADD estimates based upon 1982 Census of Agriculture Survey.

PADD Estimates

The 40 million barrels of storage capacity and 14 million barrels of inventory were distributed between Petroleum Administration for Defense Districts (PADDs) I-IV and PADD V based on their proportions in the Census of Agriculture survey.

COMMERCIAL SECTOR

The commercial sector includes non-manufacturing establishments such as office buildings, apartment buildings of over four units, motels, restaurants, wholesale and retail businesses, hospitals, and other health and private educational institutions.

Capacity and inventory data for the commercial sector are not regularly collected. The procedure employed to estimate commercial storage capacity and inventories is briefly described below.

The total U.S. commercial sector demand for key petroleum products was determined. An estimate of days' supply of capacity, i.e., the ratio of storage capacity to daily average

demand, was then calculated using demand and storage capacity data from a small sample of commercial users. Total storage capacity was derived by multiplying the commercial sector's daily average demand by the estimate of days' supply of capacity.

Daily Average Demand for Petroleum Products

Demand for key petroleum products, storage capacity, and inventory in the commercial sector is shown in Table L-2. The oil demand includes the oil equivalent demand of commercial users who have dual-firing (oil/gas) capabilities. These commercial users typically use gas, but are included because they also have oil storage capacity.

Storage Capacity

A variety of commercial users was sampled to obtain their annual consumption and storage capacity. The sample included both oil-only and dual-fired users. These data are presented in Table L-3. As shown in this table, the ratio of storage capacity to average daily demand for this sample is approximately 74 days (versus 90 days in the 1983 survey); thus, the average daily demand was multiplied by 74 to derive the storage capacity of the commercial sector. The storage capacity estimate of 33 million barrels for 1988 is slightly lower than the 1983 estimate of 34 million barrels, mainly due to a better estimate of days' supply, reflecting a larger sample of customers supplied.

Inventory

In order to estimate oil inventory on hand as of March 31, 1988, near the end of the heating season, a sample of oil-only commercial users was utilized. Their tanks ranged from 25 to 60 percent full, with the mean about one-third full. It was assumed that oil inventory in the dual-firing portion of the commercial sector was negligible, because oil was not economical compared with gas at the time of the survey and gas supply was readily available.

PADD Estimates

To distribute the storage capacity and inventory estimates between PADDs I-IV and PADD V, it was assumed that the share of storage capacity and inventories in the commercial sector in PADD V was the same as the PADD V share of U.S. total demand in the commercial sector. Thus, it is estimated that there were 2 million barrels of storage capacity and 0.4 million barrels of inventory in the commercial sector in PADD V as of March 31, 1988.

ELECTRIC UTILITY SECTOR

The electric utility sector includes electric utility power plants.

TABLE L-2

COMMERCIAL SECTOR
1987 DEMAND AND ESTIMATED STORAGE CAPACITY AND INVENTORY
AS OF MARCH 31, 1988

	1987 Equivalent Oil Demand (MB/D)*	Capacity (Millions of Barrels)§ PADDs I-IV	PADD V¶	Total
Distillate Fuel Oil	345	25	1	26
Residual Fuel Oil	99	6	1	7
Total	444	31	2	33
		Inventory (Millions of Barrels)** PADDs I-IV	PADD V¶	Total
Distillate Fuel Oil		5.4	0.3	5.7
Residual Fuel Oil		1.3	0.1	1.4
Total		6.7	0.4	7.1

*Average 1987 equivalent oil demand in the commercial sector (279 MB/D of distillate fuel oil, 115 MB/D of residual fuel oil) from Energy Information Administration, Petroleum Marketing Monthly, June 1988. Government demand (46 MB/D of distillate fuel oil, 61 MB/D of residual fuel oil) was excluded to avoid double counting (see Military/Government Sector). Includes oil equivalent 1987 gas demand at dual-fired facilities (112 MB/D of distillate fuel oil and 44 MB/D of residual fuel oil) from American Gas Association, Future Gas Consumption in the U.S., vol. 14, 1987, and discussions with American Gas Association representatives. MB/D = thousands of barrels.

§Based on 74 days' supply of capacity.

¶Estimate based on the PADD proportion of 1986 demand mix.

**Estimated to be one-third of storage capacity at oil-burning facilities only. Dual-fired facilities were assumed to hold negligible petroleum inventory.

TABLE L-3

COMMERCIAL HEATING OIL CUSTOMERS

Regions	Number of Users Sampled*	Total Annual Demand§ (Thousands of Gallons)	Total Storage Capacity (Thousands of Gallons)	Storage Capacity¶ Expressed In Days' Supply	% Wt.**
East Coast	757	4,024	779	71	79%
Midwest	32	1,478	316	78	15%
Pacific Northwest	10	410	100	89	6%
Total	799	5,912	1,195	74	100%

*Includes a mix of oil-only and dual-fired users.

§Includes oil-equivalent demand of dual-fired users.

¶Storage capacity divided by daily demand (annual demand/365 days).

**These areas represent 97 percent of total U.S. heating oil sales. The weighting reflects the proportion of actual 1986 sales in each area, based on EIA data.

To estimate storage capacity and inventory in the electric utility sector, two sources of data were used -- the 1988 Petroleum Marketers' Handbook (published annually by the Oil Buyers' Guide) and the March 1988 Electric Power Monthly from the Energy Information Administration (EIA). The Petroleum Marketers' Handbook contained data on fuel consumption and storage capacities for approximately 90 electric utility companies, with the information provided by state, company, and product. These data were verified by interviews with several of these utilities to determine accuracy. Storage capacity data were also confirmed with the appropriate regional power pools. Data were also checked for all companies that reported changes in storage capacity from the previous edition of the Handbook. A comparison of the data sources indicated that after appropriate adjustments, the storage capacities in the Handbook quite accurately reflected individual companies' storage capacities.

A capacity utilization ratio was determined by dividing the total storage capacity of those companies referenced in the Petroleum Marketers' Handbook by the ratio of the EIA inventories that those utilities represented in total EIA utility inventories on March 31, 1988. This was about 96 percent of residual fuel

oil inventories and 67 percent of distillate fuel oil inventories. The capacity utilization ratio was assumed to be representative of all utilities in all regions.

The final inventory data for March 1988 were obtained from EIA's electric power data base and were adjusted to reflect only those inventories held at utilities. A number of utilities have a cooperative fuel purchasing agreement that allows reduced costs for larger volume purchases. A portion of that fuel is held in the primary distribution system until shipment to the generating site. The NPC adjusted the inventory levels reported to the EIA on the form EIA-759, Monthly Power Plant Report, to reduce utility sector inventories by the volumes held in the primary distribution system.

The disaggregation of storage capacity and inventories by product for PADDs I-IV and PADD V was estimated by using the Petroleum Marketers' Handbook data and EIA's Electric Power Monthly data base for each utility in each PADD grouping. Table L-4 is a breakdown of PADD groupings.

TABLE L-4

ELECTRIC UTILITY SECTOR
STORAGE CAPACITIES AND INVENTORIES
BY PADD, AS OF MARCH 31, 1988
(Millions of Barrels)

	Distillate Fuel Oil		Residual Fuel Oil	
	Storage	Inventory	Storage	Inventory
PADDs I-IV	33	11	89	33
PADD V	8	2	45	15
Total	41	13	134	48

In other areas, such as Texas and California, utilities have been burning natural gas rather than oil, due to its price advantage. These utilities have been maintaining oil inventories above those that appear to be required for their present short-term consumption (often as much as 50 percent of storage capacity). For utilities burning gas in dual-fuel generating units, oil inventories are held as back-up fuel for use when gas becomes unavailable due to higher priority demand on the gas system, such as in cold weather; or whenever oil prices drop below that of natural gas, making electric power generation by using oil more economical. Inventory requirements for these utilities are designed to meet inventory targets based upon sudden and high levels of oil use, rather than on average daily use.

The use of oil for electric power generation has been reduced by 68 percent from the 1978 peak. As a result, utility

oil inventory requirements have also been reduced. Oil inventories at utilities are now approaching 55 percent of their 1978 levels. However, utilities in all regions of the country have found that the presence of large baseload generating units, particularly nuclear units, has increased the variability of the generation from oil and gas units on their systems. The variability of oil use has been further increased by the relative price volatility between oil and natural gas.

For some utilities, the increase in the variability of oil-based electric power generation, combined with the reduction of the overall level of that generation, may actually increase the level of oil inventories required to meet prudent inventory management standards. For other companies, the changing fuel mix for electric power generation will continue to reduce oil inventory requirements.

INDUSTRIAL SECTOR

The industrial sector is composed of the plants and factories in the United States, but excludes retail and service enterprises (see Commercial Sector). In this analysis, construction and off-highway non-transportation uses (e.g., logging and mining) are also included in the industrial sector. For the purpose of this discussion, petroleum refineries and electric utilities are not considered in the industrial sector because fuel for refinery use is part of the primary system, while utilities are reported as a separate sector.

Total storage capacity and inventories in the industrial sector were estimated using information obtained from contacts with industry and various published data on petroleum products and natural gas consumption. The basic methodology is to apply days' supply storage and inventory estimates to a consumption figure.

Storage Capacity

Contacts with industrial sector consumers were used in determining that, on average, industry had storage capacity to hold 30-days' consumption if natural gas were unavailable. It appears that there is quite a variance in these figures with a tendency for facilities with lower petroleum use to maintain less storage capacity relative to consumption. The 30-day estimate reflects a weighting for the differing storage patterns of the users. The 30-day figure was then applied to adjusted consumption. Different methods were used in arriving at adjusted consumption for various products. Following are summaries of the derivation of the consumption figures.

Distillate Fuel Oil and Residual Fuel Oil

There are two components to the consumption estimate for distillate and residual fuel oils. First is estimated actual petroleum consumption by industry, derived from the EIA 1986

data. The following EIA groupings of users were considered as being part of the industrial sector:

- Industrial
- Off-Highway Diesel Use (Distillate Fuel Oil only) -- Defined by EIA as "fueling engines which require diesel fuel, but are not used for transportation, such as construction, logging and road building equipment"
- All Other.

The second component is natural gas consumption switchable to petroleum (in barrels per day petroleum equivalent). American Gas Association data (Gas Requirements Committee, "Future Gas Consumption in the United States," November 1987) were used to determine the volume of gas consumption that could be switched into petroleum, and DOE/EIA data for 1986 were the source for industrial gas consumption. The rationale for including this component is that facilities that could switch to petroleum consumption have storage in place to handle that consumption. Table L-5 shows the adjusted consumption data for distillate and residual fuel oils.

TABLE L-5

ADJUSTED CONSUMPTION OF
DISTILLATE AND RESIDUAL FUEL OILS
(Thousands of Barrels per Day)

	Distillate	Residual
Actual Consumption from EIA Sources	295	313
Natural Gas - Petroleum Equivalent	387	581
Total Adjusted Consumption	682	894

Gasoline

Industrial gasoline consumption is estimated to be 75 percent of the Department of Transportation's figure for industrial, construction, and commercial use as reported in the Federal Highway Administration publication Highway Statistics, 1986. Using these data and the 75 percent consumption estimate, industrial gasoline consumption is estimated at 35,000 barrels per day.

Calculations for Storage Capacity Estimates

Each total consumption figure was factored upward by a plant utilization adjustment of 6.6 percent (see Plant Utilization Adjustment below). This figure was then multiplied by the 30-day

estimate to arrive at storage capacity. Those calculations are shown in Table L-6.

TABLE L-6

INDUSTRIAL SECTOR STORAGE CAPACITY

	Consumption (MB/D)	X	Plant Utilization Adjustment	X	Days' Supply	=	Total Storage Capacity (MB)
Gasoline	35		1.066		30		1,119
Distillate Fuel Oil	682		1.066		30		21,812
Residual Fuel Oil	894		1.066		30		28,590
Total	1,611		1.066		30		51,521

Plant Utilization Adjustment

In 1986, manufacturing plant utilization was 79.7 percent, compared to a practical maximum of 85 percent. To account for the fact that storage capacity was most likely built to accommodate product needs at full capacity, an upward adjustment (plant utilization adjustment) of 6.6 percent was made to the consumption data.

Inventories

As with storage capacity, a days' supply number was applied to daily consumption figures. However, the consumption figures used did not include a natural gas equivalent for the distillate and residual fuel oil categories, nor was a plant utilization adjustment applied. It is assumed that the level of inventories was managed on the basis of actual consumption.

The calculations for inventories (based on 1986 consumption) are shown in Table L-7.

MILITARY/GOVERNMENT SECTOR

The military/government sector includes federal, state, and local governments and all branches of the U.S. military service located in the United States, but excludes municipal utilities.

The Defense Fuel Supply Center provided the actual data for military storage capacity and inventory as of March 31, 1988. No data were available for federal, state, and local governments. An estimating approach was employed to determine storage capacity and inventory in this sector.

TABLE L-7

INDUSTRIAL SECTOR INVENTORIES

	Consumption (MB/D)	X	Days' Supply	=	Inventory (MB)
Gasoline	35		15		525
Distillate	295		15		4,425
Residual	313		15		4,695
Total	643		15		9,645

First, the petroleum demand by major product for each individual federal, state, and local government subsector was determined. Next, data for a sample of selected government units were obtained to determine their storage capacity and demand for various petroleum products. The ratio of storage capacity to average daily demand calculated from the sample was used to estimate the storage capacity of the total federal, state, and local government sector. Finally, the oil inventory held by the government sector was estimated as a percentage of that capacity.

Demand

Estimates of petroleum product demand by major product are summarized in Table L-8. Actual demand data were reported by the EIA for military and civilian federal government activities. However, these data did not segregate fuel oils belonging to federal, state, and local governments into distillate and residual fuel oils. The demand was estimated by product as shown in Table L-8.

Estimates of state and local government demand were derived from a variety of sources. Motor gasoline demand was calculated by assuming that cars, buses, and trucks owned by state and local governments use the same amount of fuel per year as the national average.[1] The split between state and local fleets for cars and trucks was estimated to be 36/64, the ratio of state employees to local government employees excluding teachers.[2] All school buses were assigned to the local government subsector. Distillate and residual fuel oil demand by state and local governments, mainly for space heating requirements,[3] was based on the ratio of state and local government employees (including teachers and an

[1] Motor Vehicle Manufacturers of America, Motor Vehicle Facts and Figures, 1987.

[2] U.S. Department of Commerce, Bureau of the Census, Statistical Abstract of the United States, 1987, 107th ed.

[3] Ibid.

TABLE L-8

MILITARY/GOVERNMENT SECTOR
1987 PETROLEUM PRODUCT DEMAND
(Thousands of Barrels per Day)

	Military*	Federal Gov.§	State Gov.	Local Gov.	Gov. Total	Military/ Government Total
Motor Gasoline	6.8	11.9	41.1¶	91.0¶	144.0	150.8
Kero-Jet Fuel	140.4	3.8	1.0	N/A**	4.8	145.2
Distillate Fuel Oil	57.0	5.0	9.0§§	32.0§§	46.0§§	103.0
Residual Fuel Oil	12.5	6.6	11.9§§	42.4§§	60.9§§	73.4
Total	216.7	27.3	63.0	165.4	255.7	472.4

*Military use of distillate and residual fuel oils is from the EIA report, "Sales of Fuel Oil and Kerosine in 1987" (Petroleum Marketing Monthly, July 1987). Motor gasoline demand was assumed to have increased in proportion to the total U.S. demand increase for motor gasoline between 1987 and 1982. Kero-jet fuel demand in 1987 was assumed to be unchanged from 1982 data as shown in the 1984 NPC report.

§Federal government use is from the EIA federal quarterly energy use reports, FY 1987.

¶Based on vehicles (cars, buses, and trucks) owned by state and local governments and assuming that fuel consumption per vehicle is the same as the U.S. average. Source: Motor Vehicle Manufacturers of America, Motor Vehicle Facts and Figures, 1987.

**N/A = Not Available.

§§Based on the ratio of state and local government employees to federal government employees multiplied by federal government demand. These estimates were adjusted upward by a factor of 2 for local and 1.37 for state governments to reflect consumption by schools as explained in the Military/Government Sector Demand section.

estimated number of students) to federal civilian employees, multiplied by federal government demand. These state and local government data were adjusted upward by a factor of 1.37 for state governments and 2.00 for local governments to account for the larger schoolroom space-heating requirements in school buildings. The higher factor used for local governments reflects a higher ratio of teachers (36 percent of local employees) than for state employees (13 percent of state employees) as shown in Table L-9.

TABLE L-9

LOCAL, STATE, AND CIVILIAN FEDERAL GOVERNMENT EMPLOYEES, 1985*
(Thousands)

	Local	State	Civilian Federal	Total
Total Employees	9,685	3,984	3,021	16,690
Teachers	3,475	526	-	4,001
Employees (excluding teachers)	6,210	3,458	3,021	12,689

*Data taken from Statistical Abstract of the U.S., 1987, Table 468, p. 200.

Storage Capacity

To develop the storage capacity estimates for the government subsector, individual state and local governments were contacted to determine their days' supply of storage capacity. The ratios provided were in the range of 38 to 131 days, as shown in Table L-10.

On average, the ratios were higher for heating oils than for motor gasoline, due to the more pronounced seasonal fluctuation in demand for heating oils. More storage capacity is needed for heating oil to accommodate peak demands in the winter. Therefore, for seasonal products such as distillate and residual fuel oils, a ratio of 90 days (the same as 1983 estimate) was used for the storage capacity calculation, while for products with less seasonality (motor gasoline and kero-jet fuel), a ratio of 50 days (60 days in 1983 study) was used.

In the case of state and local governments, the storage capacity estimate for motor gasoline was adjusted downward by 20 percent to account for fueling of government vehicles at service stations.

TABLE L-10

SAMPLE OF GOVERNMENT USERS
DAYS' SUPPLY OF STORAGE CAPACITY

Government Unit	Fuel	Days' Supply of Storage Capacity
Oregon State	Motor Gasoline*	53
	Fuel Oil§	131
Michigan State	Motor Gasoline¶	60¶¶
	Fuel Oil	63***
Clifton, New Jersey	Motor Gasoline**	38
	Heating Oil§§	83

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*460,000-gallon shell capacity divided by average daily demand (annual demand of 3.15 million gallons/365 days).

§936,000-gallon shell capacity divided by average daily demand (annual demand of 5,755 million gallons/365 days).

¶165,000-gallon shell capacity divided by average daily demand (annual demand of 847,997 gallons/365 days).

**675-barrel shell capacity divided by average daily demand (annual demand of 255,000 gallons/365 days/42 gallon/barrel).

§§4,700-barrel shell capacity divided by average daily demand (annual demand of 740,000 gallons/365 days/42 gallon/barrel).

¶¶25,000-gallon shell capacity divided by average daily demand (annual demand of 152,709 gallons/365 days).

***30,000-gallon shell capacity divided by average daily demand (annual demand of 173,324 gallons/365 days).

The actual military storage capacity data and government estimates are shown in Table L-11.

It was assumed that for the less seasonal products (motor gasoline and kero-jet fuel), government inventories were equal to 50 percent of storage capacity. For seasonal products (distillate and residual fuel oils), it was assumed that the inventories on March 31, 1988, toward the end of the heating season, represented only one-third of tank capacity. The actual military inventory data and government estimates are shown in Table L-12.

TABLE L-11

MILITARY/GOVERNMENT SECTOR
STORAGE CAPACITY AS OF MARCH 31, 1988
(Millions of Barrels)

	Military*§	Estimated Government¶				Military/ Government Total
		Federal	State	Local	Total	
Motor Gasoline	0.5	0.6	1.6**	3.6**	5.8	6.3
Kero-Jet Fuel	10.7	0.3	0.1	0	0.4	11.1
Distillate Fuel Oil	18.7	0.5	0.8	2.7	4.3	22.9
Residual Fuel Oil	2.1	0.6	1.1	3.8	5.5	7.6
Total	32.0	2.0	3.6	10.3	15.9	47.9

*Actual storage capacity as reported to the NPC by Defense Fuel Supply Center. The NPC estimated the products' storage capacity based on the Defense Fuel Supply Center reported inventories of those products.

§Excludes on-board storage capacity of military vehicles, vessels, and aircraft.

¶Storage capacity was calculated from the days' supply of capacity estimates shown in Table L-10 using 50 days for motor gasoline and kero-jet fuel and 90 days of distillate and residual fuel oils.

**Capacity was further adjusted downward by 20 percent to account for government vehicle fueling at commercial service stations.

TABLE L-12

MILITARY/GOVERNMENT SECTOR
INVENTORY AS OF MARCH 31, 1988
(Millions of Barrels)

	Military*§	Estimated Government¶				Military/ Government Total
		Federal	State	Local	Total	
Motor Gasoline	0.4	0.3	0.8	1.8	2.9	3.3
Kero-Jet Fuel	5.3	0.15	0.05	-	0.2	5.5
Distillate Fuel Oil	5.5	0.2	0.3	1.0	1.5	7.0
Residual Fuel Oil	0.6	0.2	0.4	1.3	1.9	2.5
Total	11.8	0.85	1.55	4.1	6.5	18.3

*Actual March 31, 1988, inventory as reported to the NPC by the Defense Fuel Supply Center.

§Excludes on-board inventory of military vehicles, vessels, and aircraft.

¶Estimated inventory was calculated at one-half of storage capacity for motor gasoline and kero-jet fuel and one-third of capacity for distillate and residual fuel oils.

PADD Estimates

No PADD data are available for the military storage capacity and inventory. For the government subsector, it was assumed that PADDs I-IV and PADD V storage capacities and inventories were about 85 percent and 15 percent of the U.S. total, respectively, which is their proportion of the total U.S. population.

RESIDENTIAL SECTOR

Storage for residential heating fuel includes tankage for single family homes and multi-family dwellings of up to four units. Storage for large apartment buildings is part of the commercial sector.

Estimates of residential inventories were based primarily on two sources of data, the Department of Commerce/Department of

Housing and Urban Development's Annual Housing Survey: 1983, "Part F -- Energy-Related Housing Characteristics," (Current Housing Reports, Series H-150-83), the most recent data available on the housing stock, and the trade publication Fuel Oil & Oil Heat, which estimates consumer inventory levels annually. Certain data from Energy Information Administration reports, including Residential Energy Consumption Survey: Consumption and Expenditures, April 1982 through March 1983, "Part 1: National Data," (DOE/EIA 0321/1 [82]), were also used.

Demand

Several factors have contributed to a net decline in the number of oil-heated homes during the 1980s. First, the oil heat share of the new home market has only recently begun to recover from the very low levels it hit after the price increases of 1979-80. For example, oil captured half of the Northeast's new single family home market in 1976 and 1977, and only 13 percent of it in 1981. The share in 1987 had risen to 27 percent. Second, conversions of oil-heated housing units to gas heat substantially outnumbered construction of oil-heated units. In the years 1979 through 1986, according to the American Gas Association, approximately 1.8 million oil-heated housing units (single family and all multi-family) were converted from oil to gas, while about 200,000 new oil-heated units were built. The pace of conversions has slowed in recent years, partly because of price changes and partly because of dissipating fears of oil shortages. In the Northeast, 1986 and 1987 probably saw net increases (albeit small ones) in the number of oil-heated single family homes.

Distillate fuel oil consumption in the residential sector has increased since the 1984 NPC report, rising by nearly 3 percent per year nationwide. Consumption in the Northeast, which accounts for about two-thirds of the nation's residential total, rose more slowly, with the Mid-Atlantic region moderating the rapid growth in New England. Distillate fuel oil consumption had fallen dramatically after the price increases of 1979-1980, and at the 1987 volume of about 500 thousand barrels per day (MB/D), still does not approach the earlier levels (e.g., in 1980 residential consumption was more than 600 MB/D). According to trade estimates, consumption per customer has fallen about 30 percent in the last decade, from more than 1,300 gallons per season in the mid-1970s to 1,000 gallons in the 1986-1987 heating season. The major portion of the drop had occurred by the early 1980s. Industry-wide estimates that reflect changed behavior after the price plunge in 1986 are not yet available.

Storage Capacity

The size of fuel tanks in the residential sector varies from 55-gallon drums mounted on an outdoor stand to 2,000-gallon underground tanks. Most homes, however, have tanks ranging from a capacity of 250 gallons (275 gallons is a standard size tank for a single family home) to 800 gallons.

Based on Fuel Oil & Oil Heat's annual survey of capacity utilization data, the capacity of customer tanks was computed to be 380 gallons on average for all regions in 1987. New England's tanks tend to be smaller (345 gallons), and the Middle Atlantic's tend to be larger (420 gallons) than the average. These regional differences are probably a function of house size; they are echoed in most regional estimates of consumption per customer.

To arrive at an estimate of the total tank capacity and inventories, it was assumed that each tank in a multi-family structure serves three units, and that each single family home has its own tank. There are thus approximately 8.4 million residential oil tanks for No. 2 oil, for a total of 3.2 billion gallons of tank capacity or 77 million barrels. For kerosine, a smaller tank size of 250 gallons was assumed. Kerosine storage capacity is estimated at 2 million barrels, with inventory slightly lower at 50 percent of capacity.

Inventory

The trade publication Fuel Oil & Oil Heat has routinely conducted an annual survey of heating oil dealers to determine the inventory practices of the residential sector. Its data show that customer tanks were 63 percent full, carrying about 240 gallons, on October 1, 1987.

It is important to note that by far the majority of deliveries of home heating oil are initiated by the dealer on the basis of computer account management that calculates degree days, the home's thermal efficiency, the customer's temperature setting, etc. Dealers aim to supply between two-thirds and three-quarters of the tank's capacity with each delivery. That is, they allow the tank to fall to 25-33 percent of its capacity before dispatching another delivery to fill the tank. As a result, tanks will be 60-67 percent full on average. The system has removed the seasonality of consumer inventory levels; tanks will be as full on October 1 as they are on March 31. Only the frequency of deliveries varies seasonally.

So-called "will call" accounts, where the customer requests each delivery separately, will likely still exhibit seasonal swings in their inventory volumes, and on average will hold lower stocks. These accounts, however, represent a small share of the market, according to discussions with heating oil dealers. They are relatively more common in some areas, such as parts of Maine, but overall probably represent about 10-15 percent of the Northeast's home heating oil customers.

Inventories, at 63 percent of tank capacity, were approximately 50 million barrels on March 31, 1988. The Northeast held about half of the volume. Combining the estimates for each of the East Coast regions, we see that residential inventories were about equal to the stocks held in the PADD I primary system at that time. Table L-13 summarizes storage capacity and inventory.

TABLE L-13

RESIDENTIAL SECTOR
ESTIMATED STORAGE CAPACITY AND INVENTORY
AS OF MARCH 31, 1988
(Millions of Barrels)

	Capacity	Inventory
Distillate Fuel Oil/Kerosine	79	50

TRANSPORTATION SECTOR

This sector is comprised of the following categories of transportation modes: railroad, bus, trucking, aviation, marine vessels, taxicab, rental cars, and personal vehicles. As in previous NPC surveys, the analysis includes data from fixed and on-board storage, but excludes payload storage capacity and inventory.

Methodology

Tertiary storage data for the transportation sector's categories are difficult to obtain. In addition to the large

TABLE L-14

TRANSPORTATION SECTOR
ESTIMATED STORAGE CAPACITY
AS OF MARCH 31, 1988
(Millions of Barrels)

Transportation Mode	Motor Gasoline	Kerosine & No. 2 Diesel	Kero-Jet Fuel	Residual Fuel Oil	Total
Railroad	--	9.6	--	--	9.6
Bus	--	0.8	--	--	0.8
Truck	--	6.6	--	--	6.6
Aviation	--	--	10.6	--	10.6
Marine	--	5.1	--	7.2	12.3
Marine Pleasure Craft	5.4	0.6	--	--	6.0
Car Rental	1.5	--	--	--	1.5
Taxicab	0.7	--	--	--	0.7
Motor Vehicle	74.7	21.5	--	--	96.2
Total	82.3	44.2	10.6	7.2	144.3

number of industries that make up this sector, each industry is comprised of many small and large firms. To overcome this difficulty, survey data were gathered from trade associations, government agencies, and the largest firms of the various sectors. The capacity and inventory data thus estimated are summarized on Tables L-14 and L-15 and described by section below.

TABLE L-15

TRANSPORTATION SECTOR
ESTIMATED INVENTORY
AS OF MARCH 31, 1988
(Millions of Barrels)

Transportation Mode	Motor Gasoline	Kerosine & No. 2 Diesel	Kero-Jet Fuel	Residual Fuel Oil	Total
Railroad	--	5.0	--	--	5.0
Bus	--	0.5	--	--	0.5
Truck	--	3.3	--	--	3.3
Aviation	--	--	5.8	--	5.8
Marine	--	2.6	--	3.6	6.2
Marine Pleasure Craft	4.1	0.4	--	--	4.5
Car Rental	0.8	--	--	--	0.8
Taxicab	0.4	--	--	--	0.4
Motor Vehicle	47.0	13.6	--	--	60.6
Total	52.3	25.4	5.8	3.6	87.1

Railroad Transportation

In 1982, the Association of American Railroads conducted an extensive survey of the industry that it serves. This survey included data on fuel use by the railroad industry. As such, it became the basis of the information submitted for the 1984 NPC survey.

The Association of American Railroads has not conducted a formal survey since 1982. However, the Operations and Maintenance Department of the Association updated key diesel inventory data. This information and the monthly volumes of "The Official Railway Equipment Register" are the source of the figures for inventory and storage capacity of the railroad subsector listed on Table L-16.

TABLE L-16

RAILROAD TRANSPORTATION
ESTIMATED STORAGE CAPACITY AND INVENTORY
AS OF MARCH 31, 1988
(Thousands of Barrels)

	Capacity	Inventory
Fixed Storage Tankage	7,695	4,000
On-Board Locomotive Tanks	1,914	957
Total	9,609	4,957

Bus Transportation

The bus transportation subsector is composed of three distinct systems: private bus companies, public transit companies, and school buses. The data in this report include only fixed tankage, not on-board storage capacity, which is instead shown with the motor vehicle estimates. Additionally, fixed storage capacity and inventory data for the school bus subsector are not given here. Such data are included in the military/government sector as part of local government.

Data for the bus systems receiving federal funding were obtained from the American Public Transit Association, while data for the private sector were submitted by the American Bus Association. These are the same sources that used a 1978 survey to furnish data for the 1984 NPC report. Bus registration figures indicate that essentially no growth has occurred since 1983 in the number of buses registered in the United States. Additionally, the American Public Transit Association estimated that the 1978 data on storage capacity and inventory is representative of today's situation. The information listed on Table L-17 reflects this and the fact that inventories are normally held at 60 percent of capacity.

TABLE L-17

BUS TRANSPORTATION
ESTIMATED FIXED STORAGE CAPACITY AND INVENTORY
AS OF MARCH 31, 1988
(Thousands of Barrels)

	Capacity		Inventory	
	Kerosine	Diesel	Kerosine	Diesel
Public Bus Systems	80	238	48	143
Private Bus Systems	--	489	--	293
Total	80	727	48	436

Truck Transportation

The trucking industry can be divided into three categories: for-hire, private, and owner/operator or independent. Companies in the first two categories fill their fueling needs by using their own facilities and purchasing fuel at truck stops, while owner/operators use truck stops almost exclusively. The storage capacity at truck stops is part of the secondary distribution system and is included in that section. Only the on-board and trucking-company-owned storage and inventory figures are considered to be part of the tertiary storage segments transportation sector.

A number of sources were used to attempt to quantify the storage capacity of terminals owned by the trucking industry. However, it was found that no comprehensive study of underground storage tanks in the trucking industry has ever been undertaken. Thus, storage capacity was determined by estimating its relationship to fuel consumption.

The EIA data indicate that in 1986 taxable on-highway diesel fuel demand was 1.2 million barrels per day. About 1.5 percent of this figure, however, was due to automobiles and light trucks. Thus, the trucking industry consumed 1,184 MB/D of diesel fuel in 1986. Of this figure, industry sources estimate that 40 percent or about 475 MB/D were delivered through trucking-company-owned storage facilities.

The American Trucking Association estimates that the normal inventory in fixed tankage of trucking companies (including truck rental firms) is about one week's fuel requirements or 3.3 million barrels. Total storage capacity in the trucking subsector can thus be estimated at 6.6 million barrels, assuming that tanks are half full on average.

Air Transportation

The air transportation subsector includes commercial airlines and airports, general aviation (non-scheduled) aircraft, and helicopters. Storage capacity and inventory for military use are not part of the data reported in this section, since that information is part of the military/government sector analysis.

It is difficult to determine the ownership of the storage capacity and inventory at airports. The fuel may be owned by the airport, the fixed base operator, the fuel supplier, oil companies, airlines, or a combination of these. As such, a number of sources were consulted to obtain data for the air transportation subsector:

- Airline companies
- Air Transport Association of America
- Airport Operators Council International
- Federal Aviation Administration

- General Aviation Manufacturers Association
- National Air Transportation Association
- National Aviation Club.

The NPC surveyed the 30 largest airports in the United States and determined that their combined on-site storage capacity amounts to 350 million gallons (8.33 million barrels). Consumption data for these airports indicate that the 30 largest facilities account for about 90 percent of the commercial kero-jet fuel consumption in the United States. Thus, it is estimated that the combined on-site storage capacity in airports handling commercial aviation amounts to 9,260 thousand barrels of kero-jet fuel. It appears that airlines maintain inventories at about 55 percent of capacity. This figure was then used to estimate the inventory in storage at all commercial aviation airports to be 5,093 thousand barrels.

The Federal Aviation Administration (FAA) estimates that there are approximately 700 general aviation facilities (airports that do not service commercially scheduled aircraft). For this study, it was assumed that each of these locations maintains about 10,000 gallons of kero-jet fuel storage capacity, which is normally filled about 50 percent.

On-board storage capacity and inventory data were estimated from information provided by the FAA, and are summarized in Table L-18.

TABLE L-18

AIR TRANSPORTATION
ESTIMATED STORAGE CAPACITY AND INVENTORY
AS OF MARCH 31, 1988

	Capacity (Thousands Of Barrels)	Average Inventory To Capacity (Percent)	Inventory (Thousands Of Barrels)
Commercial Aviation Airports	9,260	55	5,093
General Aviation Airports	167	50	83
Turboprops/Turbojets - General Aviation and Small Commercial (8,900 @ 900 gallons)	191	50	95
Turbo Helicopters (4,200 @ 140 gallons)	15	50	7
U.S. Commercial Fleet (3,150 @ 13,000 gallons)	975	50	488
Total	10,608		5,766

Marine Transportation

The marine transportation subsector includes all ships and vessels engaged in trade or commerce. As in the 1984 study, the ships and vessels were divided into two basic categories: petroleum and non-petroleum carriers. Each of these categories was then divided by type of transport. The volumes listed in Table L-19 are on-board bunker storage capacity and inventory only.

The data for the marine subsector were compiled with the assistance of the U.S. Coast Guard, Waterborne Statistics Center of the Army Corps of Engineers, U.S. Maritime Administration, and the American Petroleum Institute. The methodology used to estimate the storage capacity for the subcategories is explained in the notes to Table L-19. For the estimated average inventory of the total commercial marine transportation subsector, it was assumed that inventory, on average, represented 50 percent of storage capacity.

Marine Pleasure Craft

The U.S. Coast Guard estimates that there were 10.2 million pleasure boats in the United States at year end 1987. Of these, approximately 9.5 million craft maintained on-board storage for fuel, including portable tankage used in the smallest of craft. Due to the seasonality of recreational boating, fuel demand and inventory vary widely. For this study, it was assumed that on-board inventory in pleasure craft averages 75 percent of capacity, as shown in Table L-20. The high on-board inventory results from the fact that marine pleasure craft are generally stored with full fuel tanks to prevent condensation.

Car Rental Industry

The car rental industry includes the companies that are engaged in daily car and truck rentals for business and personal use. This industry is composed of four major competitors and a large number of smaller firms. As such, fuel storage and inventory data for the car rental subsector were difficult to obtain.

The American Car Rental Association, Securities and Exchange Commission reports filed by car rental firms, and the Motor Vehicle Manufacturers Association were consulted in the compilation of information for the car rental subsector. Based on the figures obtained from these sources, it is estimated that there are about 6,500 car rental locations with fixed fuel storage facilities in the United States. These facilities typically have 10,000 gallons of capacity, thus giving a total storage capacity of 1.5 million barrels of motor gasoline for the car rental subsector. The inventory on hand can be assumed to be 50 percent of capacity or about 750,000 barrels.

Taxicab Transportation

The taxicab subsector includes the for-hire automobile fleet for passenger transportation. The International Taxicab Associa-

TABLE L-19

NUMBER OF MARINE VESSELS AND
ESTIMATED BUNKER STORAGE CAPACITY AND INVENTORY
AS OF MARCH 31, 1988

Vessel Classification	Number of Vessels	Bunker Storage Capacity (Thousands of Barrels) No. 2 Fuel	Residual Fuel Oil	Total	Inventory*
Petroleum Carriers§					
U.S. Flag Ocean Tankers¶	214	68	3,394	3,462	N/A
U.S. Flag Lake Vessels**					
Tankers§§	3	3	3	6	N/A
Barges¶¶	119	51	-	51	N/A
Tugs	215	71	-	71	N/A
Inland Waterway Barges***	3,232	17	-	17	N/A
Towboats	6,000	3,481	-	3,481	N/A
U.S. Coastal Barges§§§	503	8	-	8	N/A
Non-Petroleum Carriers					
U.S. Flag Ocean Drybulk Container Ships¶¶¶	262	79	3,589	3,668	N/A
U.S. Flag Lake Drybulk Carriers****					
Operating	57	114	114	228	N/A
In temporary lay-up	4	4	12	16	N/A
Laid-up over one year	27	-	108	108	N/A
Offshore§§§§	1,046	1,183	-	1,183	N/A
Total	11,682	5,079	7,220	12,299	6,149

* Not available.

§ Approved for petroleum service; excludes liquified petroleum gas carriers.

¶ Over 1,000 GT, and includes 8 Ready Reserve Fleet (RRF) vessels. Oceangoing vessels include those with routes for oceans, coastwise, limited coastwise, and Great Lakes/coastwise.

** Great Lakes vessels include those with routes for Great Lakes, Rivers and Great Lakes.

§§ Over 1,000 GT.

¶¶ Over 150 feet.

*** For U.S. inland barges, it is assumed that each vessel has on-board storage of 250 gallons of fuel for pump engines/machinery.

§§§ U.S. coastal barges (over 150 feet) average over 19,000 barrels of capacity each. It has been assumed that each vessel has on-board storage of 500 gallons of fuel for pump engines/machinery.

¶¶¶ Over 1,000 GT and includes 79 RRF vessels.

**** Over 1,000 GT.

§§§§ Includes boats, tugs, and other equipment used in supplying materials for offshore production facilities.

TABLE L-20

MARINE PLEASURE CRAFT
ESTIMATED ON-BOARD STORAGE CAPACITY AND INVENTORY
AS OF MARCH 1988

	Craft Registrations (Millions)	Average Tank Capacity (Gallons)	Capacity (Thousands of Barrels)	Inventory (Thousands of Barrels)*
Outboard Motor (Gasoline Engine)	8.1	12	2,314	N/A
Stern Driven (Gasoline Engine)	1.0	50	1,190	N/A
Cruiser and Auxiliary Craft (Gasoline Engine)	0.4	200	1,905	N/A
(Diesel Engine)	0.1	250	595	N/A
Total			6,004	4,503

*N/A = Not Available.

tion (ITA) records indicate that there are 6,342 taxicab companies operating 199,766 vehicles in the United States today. In its 1987 annual survey, the ITA obtained operating data on about 1,000 of these firms. The survey results indicate that about 21 percent of these companies maintain their own fueling facilities, while the balance fuel at service stations. The average storage capacity for the approximately 1,500 companies that fuel their own fleet is reported to be 20,000 gallons, for a total storage capacity of 30 million gallons (715,000 barrels) in the taxicab subsector. The average fixed inventory is estimated to be 50 percent of capacity or about 357,000 barrels.

The ITA data indicate that there are 199,766 registered taxicabs. Assuming that the on-board tanks average about 16 gallons each and are kept 50 percent full, a total on-board inventory is about 3.2 million gallons (76,000 barrels) for the taxicab companies.

Motor Vehicle Fleet

The motor vehicle subsector includes private passenger vehicles, motorcycles, buses, taxicabs, rental cars, trucks, and trailers. Only on-board capacity and inventory are included in

this section. The fixed storage capacity and inventory held in those systems that service motor fleets are included in the pertinent subsectors. The EIA, Motor Vehicles Manufacturers Association, and American Public Transit Association were consulted in the compilation of the data shown in Table L-21.

TABLE L-21

MOTOR VEHICLE FLEET
ESTIMATED ON-BOARD STORAGE CAPACITY AND INVENTORY*
AS OF MARCH 31, 1988

	Registered Vehicles 1987§	Average Tank Capacity (Gallons)	Total Tank Capacity Thousands of Barrels (MB) Gasoline	Diesel	Kerosine	Total	Estimated Inventory (MB)
Automobiles	140,770,000	16	52,554	1,073	--	53,627	33,785
Motorcycles	7,610,000	4	725	--	--	725	457
Buses							
Commercial	116,110	125	--	259	86	345	217
School	509,600	35	404	21	--	425	268
Trucks¶							
Light	30,010,795	20	13,576	715	--	14,291	9,003
Medium	7,771,570	100	7,401	11,103	--	18,504	11,658
Heavy	1,733,329	200	--	8,254	--	8,254	5,200
Total			74,660	21,425	86	96,171	60,588

*The Environmental Protection Agency reports that, on average, the motor vehicle fleet maintains on-board inventory of about 63 percent of capacity.

§Motor Vehicles Manufacturers Association's 1986 figures increased by 3 percent to estimate 1987 registrations.

¶Light trucks are under 6,000 pounds, medium trucks are 6,000-26,000 pounds, and heavy trucks are over 26,000 pounds.

APPENDIX M

GLOSSARY

APPENDIX M

GLOSSARY

Alaskan crude oil in transit by water -- crude oil cargoes in transit by tanker from Alaskan loading ports to other states, Puerto Rico, the Virgin Islands, Guam, and the Hawaiian Foreign Trade Zone. Includes crude oil shipped from all sources in Alaska, including Cook Inlet and Valdez.

barrel -- the standard unit of measurement of liquids in the petroleum industry, containing 42 U.S. standard gallons at 60°F.

basic sediment and water (BS&W) -- bottoms, sediments, and water that collect at the bottom of storage tanks.

bulk plant -- a nonconsumer facility used for storage and/or marketing of petroleum products that has total storage capacity of less than 50,000 barrels and does not receive petroleum products by barge, tanker, or pipeline.

bulk terminal -- a nonconsumer facility used for storage and/or marketing of petroleum products that has total storage capacity of 50,000 barrels or more or receives petroleum products by barge, tanker, or pipeline.

clean products -- motor gasoline, kerosine, jet fuel, and distillate fuel oil.

clearinghouse -- subsidiary of a futures exchange which interposes itself between every trade so as to become a party to every contract. Acts as central business office and credit corporation for the exchange. Guarantees performance of all contracts and manages the delivery process.

close a position (to) -- to cancel a long or short position through an offsetting sale or purchase.

Commodity Futures Trading Commission (CFTC) -- Federal agency authorized to regulate futures trading in all commodities.

consumption -- the utilization of a product by an end-user.

contingency space -- space in excess of the maximum operating inventory, exclusive of the unavailable space, that is required to maintain a workable operating system. This space is only used in times of abnormal operations, such as equipment failure (see Figure 4).

crude oil -- technically defined as a mixture of hydrocarbons that exists in natural underground reservoirs and remains

liquid at atmospheric pressure after passing through surface separating facilities. Statistically defined to also include lease condensate (see definition) and small amounts of nonhydrocarbons produced with the oil. Unfinished oils (see definition) and natural gas liquids produced at natural gas processing plants and mixed with crude oil are excluded.

delivery area -- the points specified in an exchange's rules as to where delivery of the physical commodity can be made.

delivery month -- the month in which delivery against a futures contract takes place.

demand -- the withdrawal of stocks from the primary distribution system.

distillate fuel oil (general) -- a general classification for one of the petroleum fractions that is used primarily for space heating, on-highway and off-highway diesel engine fuel (including railroad engine fuel and fuel for agriculture machinery), and electric power generation. Included are No. 1, No. 2, and No. 4 heating oil, conforming to ASTM Specification D396, and diesel fuel, conforming to ASTM Specification D975 for No. 1-D and No. 2-D.

fixed storage -- storage capacity that is held at a central location for eventual consumption by an end-user, such as jet fuel storage tanks at an airport.

forward markets -- non-regulated crude oil and petroleum products markets in which contracts for future delivery of commodities are traded.

futures -- for the purpose of this report, refers to futures trading of No. 2 fuel oil/gas oil, motor gasoline, and crude oil on the New York Mercantile Exchange and the London International Petroleum Exchange.

futures contract -- an agreement to make or accept delivery of a standardized amount of a commodity, of a standardized quality, during a specific month. Futures contracts are traded on an organized central exchange, at prices set by public auction. They are subject to all terms and conditions included in the rules of an exchange. By closing a position before the delivery month, delivery can be avoided.

hedge -- the establishment of an opposite position in the futures market from that held in the physical market as a protection against the possibility of adverse price fluctuations.

idle tankage -- tankage that was idle on March 31, 1988, for reasons other than programmed maintenance, but that could be available for service within 90 days following little or no maintenance work.

in-transit inventory -- inventory that is being transported between domestic storage locations at a given time.

inventories -- liquid barrels of crude oil and certain refined petroleum products located within the customs territory of the United States (excluding Puerto Rico) that are stored in the primary and secondary distribution systems and the tertiary storage segment. Does not include inventories in U.S. territories and possessions.

kerosine (non-aviation use) -- a petroleum product used in space heaters, cook stoves, water heaters, and motor fuel, also suitable for use as an illuminant when burned in wick lamps. Included are the two classifications recognized by ASTM D3699: No. 1-K and No. 2-K, and all grades of kerosine called range or stove oil that have properties similar to No. 1 fuel oil.

kerosine-type jet fuel -- a relatively low-freezing-point petroleum product of the kerosine type used primarily for commercial turbojet and turboprop aircraft engines. Covered by ASTM Specification D1655 and Military Specification MIL-T-5624L (Grades JP-5 and JP-8).

last trading day -- the day when futures trading ceases for a particular delivery month. For products, it is generally the last business day of the month preceding the delivery month.

lease condensate -- a natural gas liquid recovered from gas well gas (associated and non-associated) in lease separators or field facilities. Consists primarily of pentanes and heavier hydrocarbons and is included with crude oil in this report.

lease stocks -- crude oil stocks held in storage on producing properties.

long -- the buying of futures. A long hedge is a buyer's hedge. A long position is one in which a person has committed to buy futures.

margin -- good faith money deposited by buyers and sellers of futures contracts, to ensure performance of the terms of the contract. Minimum margins are set by the exchange's rules and can fluctuate. Margin deposits must vary with changes in rates and futures prices.

maximum operating inventory -- the maximum quantity that could be stored in a defined distribution system while still maintaining a workable operating system (see Figure 4).

minimum operating inventory -- the inventory level below which operating problems and shortages would begin to appear in a defined distribution system. Includes "unavailable"

inventory as well as "required working" inventory necessary to maintain normal operations; does not include seasonal inventory (see Figure 4).

motor gasoline -- a complex mixture of relatively volatile hydrocarbons, with or without small quantities of additives, that have been blended to form a fuel suitable for use in spark-ignition engines. Consists of finished leaded gasoline (including leaded gasohol), finished unleaded gasoline (including unleaded gasohol), and motor gasoline blending components. Specifications for motor gasoline are given in ASTM Specification D439 and Federal Specification VV-G-1690B.

net available shell capacity -- the total shell capacity of tankage less the unavailable space for tank tops and safety allowance (see Figure 4).

NYMEX -- New York Mercantile Exchange.

on-board storage -- the storage capacity that is used to fuel an engine in any transportation mode, such as the gasoline tank in an automobile and diesel tanks on trucks.

open interest -- contracts outstanding at the end of a trading day.

operable capacity (refineries) -- the maximum amount of input that can be processed by a crude oil distillation unit in a 24-hour period, making allowances for processing limitations due to types and grades of inputs, limitations of downstream facilities, scheduled and unscheduled downtimes, and environmental constraints. Includes any shutdown capacity that could be placed in operation within 90 days.

operating cycle -- the cyclic process of delivering oil from one or more supply tanks at one location in the distribution system to another tank or tanks in the system to meet demand. The volume and frequency of the cycle are a function of many factors, including the location of both supply and demand, the level of demand, the availability of transportation and refinery facilities, the mode of transportation, and the availability and size of tankage.

operating space -- space in the primary storage system in excess of the minimum operating inventory, available for holding additional inventories while still maintaining a workable system. Includes seasonal inventories and inventory build-up for planned maintenance (see Figure 4).

options -- contracts, which can be purchased or sold, that represent the right, but not the obligation, to make or take delivery of the underlying futures contract.

PADDs (Petroleum Administration for Defense Districts) -- a geographic aggregation of the 50 states and the District of Columbia into five districts originally designed by the Petroleum Administration for Defense in 1950 for purposes of administration (see Figure 1). PADD I has been divided into three sub-PADDs: IX, IY, and IZ.

payload capacity -- the cargo capacity of any transportation mode used to transport petroleum, such as barge, tank car, and tank truck.

petroleum products -- a generic term used to describe products obtained from distilling and processing crude oil, unfinished oils, natural gas liquids, blend stocks, and other miscellaneous hydrocarbon compounds. Includes all gasoline, jet fuels, kerosine, distillate fuel oil, residual fuel oil, liquified petroleum gases, petrochemical feedstocks, lubricants, paraffin wax, petroleum coke, asphalt, and many other miscellaneous products. Under some statistical classifications, petroleum products may refer to all petroleum, excluding only crude oil and lease condensate.

pipeline fill -- inventory in a pipeline between the shipping and receiving tanks in the pipeline system.

position -- a market commitment. A buyer of futures has a long position and a seller of futures has a short position.

primary distribution system -- the system of tanks, caverns, terminals, pipelines, tankers, barges, tank cars, tank trucks, and refineries that receive, transport, store, and refine crude oil into products for delivery to bulk distribution terminals, the secondary distribution system, or certain end-users. Does not include the Strategic Petroleum Reserve (see Figures 2 and 3).

residual fuel oil -- the topped crude oil of refinery operation, which includes No. 5 and No. 6 fuel oils as defined in ASTM Specification D396 and Federal Specification VV-F-815C; Navy Special fuel oil as defined in Military Specification MIL-F-859E including Amendment 2 (NATO Symbol F-77); and Bunker C fuel oil. Residual fuel oil is used for the production of electric power, space heating, vessel bunkering, and various industrial purposes. Includes imported crude oil to be burned as a fuel.

seasonal inventory -- inventory that is not immediately needed to support current demand levels, but is maintained in anticipation of higher (seasonal) demand levels that cannot be met with then-current manufacturing or transportation capabilities.

secondary distribution system -- includes nonconsumer bulk plants and facilities of resellers of petroleum products, such as

gasoline service stations, jobbers, and fuel oil dealers (see Figures 2 and 3).

shell capacity of tankage -- the design capacity of the tank (see Figure 4).

short -- the selling of futures. A short hedge is a seller's hedge. A short position is one in which a person has sold futures.

speculator -- a trader who is not a hedger. One who assumes risk in order to make a profit through a favorable price move.

stocks -- see definition of inventories.

Strategic Petroleum Reserve (SPR) -- a federal program created by the Energy Policy and Conservation Act of 1975 to establish a reserve of up to one billion barrels of crude oil and/or petroleum products in order to reduce the impact of disruptions in petroleum supplies and to carry out the obligations of the United States under the International Energy Program (see Appendix G).

swing tankage -- tankage that is used to store different products at different times of the year.

tank bottoms -- inventory that falls below the normal suction line of the tank. For floating-roof tanks, the amount required to keep the legs of the roof from touching the tank bottom. The inventory in tank bottoms (including BS&W) is unavailable (see Figure 4).

tankage under construction -- shell capacity under construction (ground has been broken, the construction contract signed, and major equipment ordered).

tertiary storage segment -- inventory and storage capacity of products at the consumer level (see Figures 2 and 3).

total system capacity -- the sum of net available shell capacity, storage caverns, and unavailable inventory outside of tankage (defined as pipeline fill, inventory in refinery lines, operating equipment, and in-transit from domestic sources excluding Alaskan crude oil in transit by water). In the case of crude oil inventories, producers' lease tankage is also included in total system capacity if stocks are routinely reported to the Department of Energy.

unavailable inventory -- includes inventory in tank bottoms, pipelines, refinery pipelines, and operating equipment; quantities set aside as plant fuel or pipeline prime mover fuel; and oil in transit by truck, tank car, barge, and tanker from domestic sources.

unavailable space -- top portion of a tank that is not available to store inventory but is required for design or safety considerations; e.g., to allow for thermal expansion (see Figure 4).

unfinished oils -- mixture or combination of partially processed petroleum oils or any components thereof that are to be further processed; i.e., any refinery operation except mechanical blending.

volume -- the number of transactions occurring during a specific period of time. Equal to the number of purchases or sales of contracts made during the period.

"wet" barrels -- physical barrels.

"wet" barrel delivery -- futures market delivery mechanism involving the physical transfer of the commodity during the delivery month.

working inventory -- that portion of the minimum operating inventory required above the unavailable inventory required to keep the distribution system functioning normally without operating problems and run-outs. Includes volumes needed to support the normal operating cycle of shipments and receipts as levels rise and fall in tanks with oil delivery or removal. Also includes the volume needed to handle unavoidable, recurring operating interruptions and schedule changes, and volumes needed to facilitate the blending of final products to required specification. Does not include seasonal inventory or stocks held for planned maintenance (see Figure 4).

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