

Recent Trends in Crude Oil Stock Levels

by Aileen A. Bohn

Energy Information Administration (EIA) data for March 1996 primary inventories of crude oil were the lowest recorded in almost 20 years. Crude oil inventories, which were generally on a downward trend since the beginning of 1995, fell below the average range in July 1995 and have yet to recover (Figure FE1). On September 27, 1996, crude oil stocks registered 303 million barrels, compared to a normal range of nearly 311 to 332 million barrels for September.¹

Low crude oil inventories can cause price volatility in crude oil markets.² When inventories are low, refiners resort to purchasing supplemental crude oil supplies to fill immediate

needs, driving the price of crude oil higher. Low crude oil inventories can also lead to gasoline, distillate, and jet fuel supply problems.

This article, the third in a series of three³ on petroleum stocks, attempts to identify the components of the decline in the EIA crude oil stock data. To accomplish this, comprehensive data on pipelines, tank farms, and refineries are combined with other information on prices and industry activity. Except where noted, this analysis examines EIA survey data⁴ covering January 1995 through July 1996 (latest available detailed data) and excludes stocks held in the Federally owned Strategic

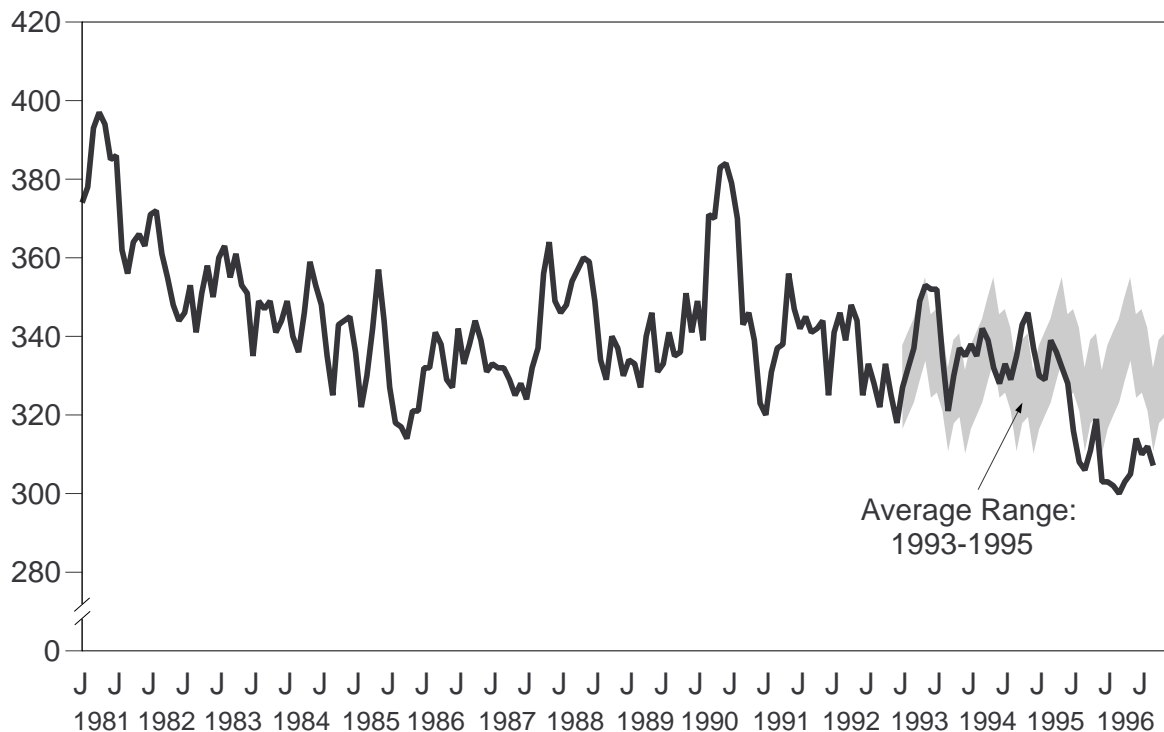
¹Energy Information Administration, *Weekly Petroleum Status Report*, EIA-0208(96-38) (Washington, DC, October 2, 1996), pp. 6 and 39. All discussions of "normal range" or "lower bound" refer to the deseasonalized 3 year average range referencing the period from January 1993 through December 1995.

²U.S. Department of Energy, *An Analysis of Gasoline Markets Spring 1996*, DOE/PO-0046 (Washington, DC, June 1996), p. 4.

³The prior two articles include: Energy Information Administration, "Recent Distillate Fuel Oil Inventory Trends, What EIA Data Show," and "Recent Trends in Motor Gasoline Stock Levels" *Petroleum Marketing Monthly*, DOE/EIA-0380(96/06) (Washington, DC, June 1996), pp. xv-xxviii.

⁴Energy Information Administration, Forms EIA-810 "Monthly Refinery Report," and EIA-813 "Monthly Crude Oil Report."

Figure FE1. Crude Oil Stocks, January 1981 - September 1996
(Million Barrels)



Source: Energy Information Administration, EIA-810 "Monthly Refinery Report," and EIA-813 "Monthly Crude Oil Report." Average range from Energy Information Administration, *Weekly Petroleum Status Report*, EIA-0208(96-38) (Washington, DC, October 2, 1996), p. 39.

Table FE1. Disaggregation of the Change in Crude Oil Inventories
(Million Barrels)

Industry Sector	1994 to 1995	Jan.-July 1995 to Jan.-July 1996
Refiners	0	-6
Tank Farms and Pipelines	-14	-14
Selected Gathering Companies	-1	0
Others	-13	-14
Leases	-1	0
Alaskan in Transit	1	-5
Total Decline in Crude Oil Inventories	-14	-25

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

Source: Energy Information Administration (EIA), EIA-810 "Monthly Refinery Report," and Form EIA-813 "Monthly Crude Oil Report."

Petroleum Reserve (SPR). Inventories in the SPR are analyzed in a separate sidebar entitled "The Role and Status of the U.S. Strategic Petroleum Reserve."

EIA inventory data are disaggregated and examined by industry sector (refineries, tank farms and pipelines, production leases, and Alaskan in Transit) and Petroleum Administration for Defense Districts (PADD). The results of the disaggregations show the greatest decrease in stocks was at tank farms and pipelines, roughly 14 million barrels over the 12 months in 1995, and another 14 million barrels from January to July 1996 compared to the same period the previous year (Table FE1).⁵ Crude oil stocks at refineries did not change much during 1995, but declined 6 million barrels from January to July 1996 compared to the same period the year before. This fact is significant since refiners account for less than a third of the U.S. holdings of crude oil. Stocks on production leases declined almost a million barrels during 1995, but did not decline further in 1996. Stocks in transit from Alaska declined 5 million barrels between January to July 1996 compared to the same months in 1995, after not showing much change in 1995. The drop in stocks is most evident in PADD III where refining and production are concentrated. PADD I had the largest proportional decline in stocks, losing over 15 percent of the crude oil holdings during the January and July 1996 period compared to the same months in 1995.

While existing data are helpful in determining where the decline in stocks occurred, identification of the causes of the decline in stocks is difficult because of the lack of data and the complex nature of the industry. The forces that influence crude oil inventory levels can be divided into two subsets. The first subset consists of short term forces that influence refiners' day-to-day decisions concerning inventory levels. These forces include the current price of crude oil, the expected price of crude oil in the future, interest rates, the cost of storage,

refining margins, and the risk of stock depletions. Inventory models are used to quantify the relationship between inventories and these short term forces. However, the effort to develop and use inventory models is beyond the scope of this analysis.

The second subset of forces influencing crude oil inventory levels includes long term forces such as domestic production, the availability of oil spot markets, the shift to short-haul crude oil sources, vertical integration into crude oil production activities, increased offshore stocks, enhanced inventory management through improved information technology, and consolidation in the number of crude oil storage facilities. The decline in domestic production accounted for at least a 2 million barrel drop in EIA crude oil inventory data in 1995.

Year-to-date averages through July 1996 have yet to register a decline. The impact of other long-term forces is obscured by a number of trends.

Chronology of Petroleum Inventories, January 1995 - July 1996

A chronology of events since the beginning of 1995 provides some insight to the current level of stocks as of the close of the third quarter 1996. Included in the following is a discussion of gasoline and distillate inventory levels. Low crude oil inventories can be balanced by a corporate strategy of high product inventories and vice versa.

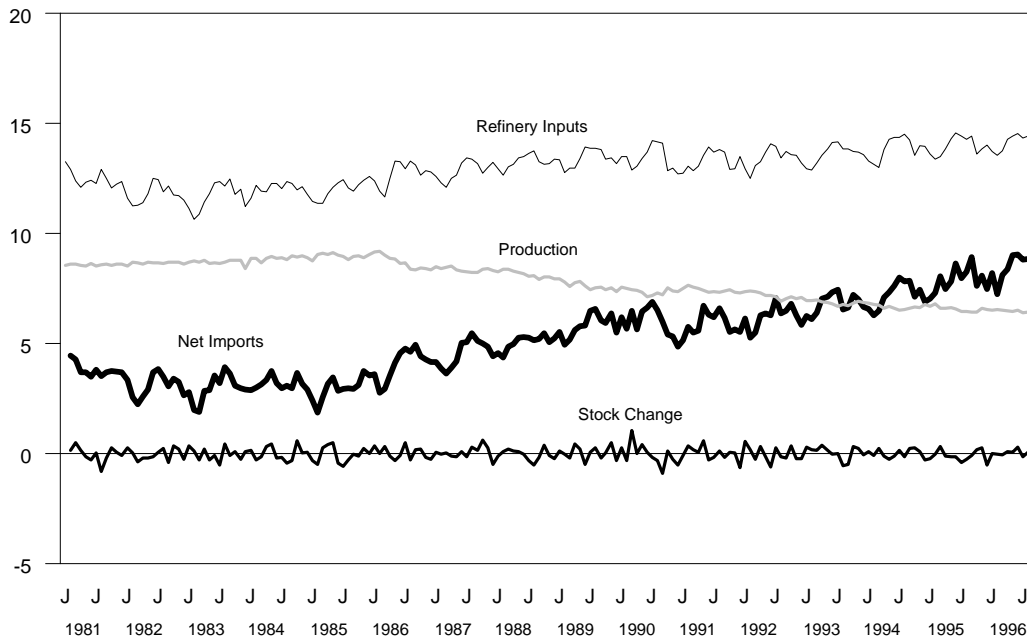
Inventories are used as a means to improve production scheduling and act as a buffer against expected and unexpected supply or demand variations. Inventories can also be a hedge against price changes. The seasonal nature of gasoline and distillate consumption forces the crude oil inputs to refineries to be seasonal, as well (Figure FE2). Crude oil runs peak in the summer to fill the greater gasoline demand and to build distillate stocks for the upcoming winter heating season. Crude oil inventories are usually at an annual high before summer to ensure consistent inputs to the crude oil distillation units during the peak production periods.

1995 Petroleum Inventories

Refiners were well positioned with crude oil and product inventories in January 1995. Gasoline stocks were in the normal range and crude oil and distillate stocks were a little higher than normal as the country experienced a relatively warm 1994-95 heating season. At some point in February

⁵Averages are calculated by summing end of month stock levels and dividing by 12 to represent annual averages, or by 7 to represent averages year to date through July.

Figure FE2. Crude Oil Supply Balance, January 1981 - July 1996
(Million Barrels)



Source: Energy Information Administration, *Petroleum Supply Monthly*, DOE/EIA-0109 (Washington, DC, various issues).

1995, refiners determined that distillate stocks were high enough to last the remainder of the heating season and that it was no longer necessary to put up more crude oil stocks in case distillate supplies ran low. Crude oil stocks ended the first quarter of 1995 nearly unchanged from the beginning.

In the second quarter, crude oil inventories are usually at an annual peak. While changes in crude oil imports accommodate most of the seasonal shift in inputs to refineries in the third quarter, as indicated in Figure FE2, stocks do play a role in seasonal supply balancing. The 1991-1995 average for crude oil inventories reaches 340 million barrels in the second quarter then subsides to 330 million barrels in the third quarter, as refiners attempt to satisfy the demand for gasoline.

Crude oil inventories opened the second quarter of 1995 at 339 million then declined 12 million barrels by the end of June. This resulted in an average 332 million barrels for the quarter. Distillate stocks were in or above the normal range during the second quarter while gasoline stocks drifted to the low end of the normal range.

Even though crude oil stocks did not build in advance of the summer driving season, crude oil inventories were used as feedstock to produce gasoline to meet brisk third quarter demand, forcing inventories below the normal range in July. Stock withdrawals continued as expected during the remainder of the quarter, leaving crude oil inventories 5 million barrels below the normal range.

Gasoline demand ate into gasoline inventories, as well, and stocks sank below normal in August 1995. Additions to distillate stocks in advance of the heating season were somewhat disappointing at the close of the third quarter, but stocks remained in the normal range

Crude oil stocks showed gains in October and November 1995. In December, though, imports from Mexico were reduced by damage from Hurricane Roxanne and expected production from Norway's Heidrun field was delayed.⁶ Crude oil inventories dropped significantly, leaving the total short of the normal range by 7 million barrels.

Distillate stocks failed to rise in October, defying typical patterns. Cold weather in November kept refiners from making up the difference. By the end of 1995, distillate stocks were 4 million barrels below normal. Gasoline stock additions did follow seasonal patterns, rebuilding toward the end of the year; however, the gains were not enough to return stocks to the normal levels after the summer driving season.

1996 Petroleum Inventories

Crude oil traders expected the production problems in Mexico and the North Sea to end so that the crude oil supply situation would improve and prices would decline. With the expectation for lower crude oil prices in the future, it appeared more cost effective, at the time, to forego crude oil purchases, to the extent practical, until the price of crude oil came down. In February

⁶U.S. Department of Energy, *An Analysis of Gasoline Markets Spring 1996*, DOE/PO-0046 (Washington, DC, June 1996), p. 24.

Table FE2. Average Crude Oil Inventories by Industry Sector
(Million Barrels)

Industry Sector	1990	1991	1992	1993	1994	1995	Jan-July 1995	Jan-July 1996
Refiners	105	100	98	99	100	100	102	96
Tank Farms and Pipelines	215	202	200	206	198	184	189	175
Leases	20	19	19	18	18	17	17	17
Alaskan in Transit	19	17	17	15	20	21	22	17
Total	358	339	333	338	336	322	330	305

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

Source: Energy Information Administration, Forms EIA-810 "Monthly Refinery Report," and EIA-813 "Monthly Crude Oil Report."

1996, the U.N. opened discussion of Iraq's oil-for-food proposal, providing even more incentive to wait for crude oil prices to fall. In this environment, crude oil stocks failed to show an increase the first three months of 1996.

Cold weather in January and February forced refiners to place a large call on distillate inventories in the beginning of the year, leaving those inventories well below normal. Although targeting distillate production, the coproduction of gasoline combined with seasonally low demand allowed gasoline stocks to rebuild. Nevertheless, gasoline stocks still did not recover fully from the declines at the end of the 1995 driving season. Gasoline stocks dropped again in March in advance of the 1996 driving season.

The expectation for lower crude oil prices continued into the second quarter of 1996 and refiners avoided adding to inventories. The refiners that resorted to purchasing supplemental crude oil supplies to fill immediate needs drove the price of crude oil higher. Between March 11 and April 15, 1996 the price of West Texas intermediate went from \$19.92 to \$25.13 per barrel.⁷ The relatively high price of crude oil suppressed stockpiling. Crude oil inventories opened at 300 million barrels at the beginning of April then grew by 14 million barrels by the end of June, 10 million barrels short of the normal range. This resulted in an average 307 million barrels for the second quarter of 1996, compared to the 1991-1995 second quarter average of 340 million barrels and the 1995 average of 332 million barrels. Distillate and gasoline stocks made some gains during this period, with gasoline reaching the lower end of the normal range.

The expectation for lower crude oil prices in the future diminished in the beginning of the third quarter of 1996 as the prospect for new crude oil supplies from the North Sea and Iraq dimmed. Crude oil purchases grew and stocks declined by a modest 5 million barrels in July.

Distillate demand (domestic and exports) was high in July, resulting in weak stock builds. Distillate stock builds in August

⁷Reuters News Service, various dates.

⁸"Very Large Crude Carriers" and "Ultra Large Crude Carriers" carry up to 2.1 million barrels of crude oil and can be offloaded at rates that exceed 500 thousand barrels per day. The average refinery can process about 100 thousand barrels per day. Storage is required due to the differences in these rates.

⁹National Petroleum Council, *Petroleum Storage and Transportation*, Volume IV, (Washington, DC, April 1989), p. 21-28.

were also weak. Gasoline stocks were drawn down at normal rates during the third quarter driving season.

As of September 27, 1996, crude oil inventories were 303 million barrels, 7 million barrels below the normal range. Gasoline stocks measured 198 million barrels, 6 million barrels below the normal range. More importantly, distillate stocks were 111 million barrels at the end of the third quarter, 21 million barrels below the normal range, as the nation moves into the heating season.

Stocking Patterns in Various Segments of the Petroleum Industry

EIA collects data on crude oil stocks for four segments of the industry: refining, tank farms and pipelines, production lease sites, and Alaska supplies in transit. Crude oil storage begins in tanks that accumulate oil from producing wells. The volumes held on the leased property awaiting transportation are included in EIA's "leases" category. Small pipelines or tank trucks collect the crude oil and deliver it to intermediate storage for pooling before being transported again via major pipelines. Large diameter pipelines carry the crude oil to hubs, a focal point for a number of pipelines. The volume of crude oil progressing through the pipeline system is included in EIA's "tank farms and pipelines" category. At the hubs, the crude oil is collected for batching and redistribution. Tankers deliver imports to marine terminals and refineries, which are included in EIA's "tank farms and pipelines" and "refinery" categories along with domestic volumes. Storage is required at this juncture because tankers are off-loaded at a rate that differs from the rate of crude oil input to refineries.⁸ Also included in EIA's inventory statistics is Alaskan crude oil being shipped to the lower 48 states, referred to as "Alaskan in Transit". Segregation of crude oil by sulfur content, gravity, and other qualities necessitates substantial storage capacity all along the logistics system.⁹

A comparison of annual average stock levels for each of these segments indicates that the largest reduction in crude oil stocks took place at tank farms and pipelines (Table FE2). During 1995, average annual crude oil stocks declined 14 million barrels. From January to July 1996, average crude oil stocks at tank farms and pipelines dropped another 14 million barrels, compared to the same months in 1995. The overall decline in stocks during that time frame was 25 million barrels. Each sector of the industry is reviewed in detail below.

Refineries

About a third of the crude oil stocks are stored at refineries. During 1995, crude oil stocks at refineries were essentially unchanged, but then decreased 6 million barrels from January to July 1996 compared to the same time period the previous year. The decline was spread fairly evenly across the PADD regions.

The reduction in stocks at refineries translates into lower days supply of crude oil in inventory. Several big refiners have pared back to 4 to 5 days of supply on hand.¹⁰ With the lower stocks, though, refiners risk depleting inventories until supplemental supplies are secured. In January 1996, run cuts were forced on a number of Gulf Coast refiners when exports from Mexico and the North Sea were briefly disrupted at the end of December.¹¹

Tank Farms and Pipelines

Stocks in tank farms and pipelines, representing almost 60 percent of the crude held in inventory, decreased between the beginning of 1995 and July 1996. During 1995, the decline was 14 million barrels. From January to July 1996, average crude oil stocks declined an additional 14 million barrels compared to the same months in 1995. A considerable portion of the reduction was recorded in PADDs III and V.

In an effort to measure the impact of the decline in domestic crude oil production in the pipeline/bulk terminal reporting category, a dozen gathering companies were identified and isolated in the EIA data. Gathering companies arrange for the logistics of newly produced oil and, therefore, are directly impacted by the decline in domestic crude oil production. These companies reported an average 7 million barrels in stocks in 1994 and 6 million barrels in 1995 which persisted through the January to July 1996 period.

The decline in domestic production probably has an effect on pipeline and terminal stocks as well. To reduce the reporting burden, pipeline fill is combined with terminal stocks on the EIA forms and these data are then collected on a PADD, not a site, basis. Without the additional detail, the full impact of the

decline in domestic production is obscured by other industry trends.

Stocks at Production Leases

The crude oil stored on leases awaiting transportation is recorded in EIA's "Leases" category. The drop in domestic production means less inventory held on leases. As anticipated, stocks at production leases decreased from 18 million barrels in 1994 to 17 million barrels in 1995, and changed only marginally through July 1996.

Alaska Supplies in Transit

Tankers deliver crude oil from Alaska to refiners in California, the Gulf Coast, and the U.S. Virgin Islands. As shown in Table FE2, totals increased in 1994 over 1993, due to under reporting by some facilities.

A dramatic drop-off in this category is evident in 1996, when a decline of 5 million barrels in stocks was recorded between January and July compared to the same months of 1995.

Coincidentally, exports to Japan started July 1996 at 42 thousand barrels per day. While EIA takes steps to assure proper reporting, some fluctuations in inventory data can be anticipated until exports are firmly established.

The Regional Decline in Crude Oil Stocks

Crude oil stocks averaged 322 million barrels in 1995, 14 million barrels less than in 1994 (Table FE3). Year to date through July 1996, crude oil stocks averaged 305 million barrels, 25 million barrels less than the same period of 1995. Much of the decline in inventories occurred in PADD III, the Gulf Coast area. PADD I had the largest proportional decline in stocks, losing over 15 percent of the crude oil holdings during the January and July 1996 period compared to the same months in 1995.

A growth in crude oil pipeline capacity serving PADD II, the U.S. Midwest, may have facilitated declines in crude oil stocks in that region. Interprovincial Pipe Line Systems added a 170 thousand barrel per day crude oil pipeline in 1994. In 1995, Mobil reversed the flow on a section of a 200 thousand barrel per day pipeline going from Beaumont, Texas to Patoka, Illinois. In 1996, Seaway opened a 270 thousand barrel per day pipeline to the Mid-continent from Cushing, Oklahoma.

Days supply of crude oil on hand varies from PADD to PADD.¹² The regional difference can be traced as far back as

¹⁰*Petroleum Intelligence Weekly*, "Refiners Test Limits of Lean Inventory Strategy," Vol. 35 #03, (January 15, 1996), p. 1.

¹¹*Petroleum Intelligence Weekly*, "Refiners Test Limits of Lean Inventory Strategy," Vol. 35 #03, (January 15, 1996), p. 1.

¹²Days supply of crude oil is defined as end-of-month inventory divided by the following month's crude oil input to refineries. Not all of this volume is available as input to refineries, though.

Table FE3. Average Crude Oil Inventories by PADD
(Million Barrels)

Region	1990	1991	1992	1993	1994	1995	Jan-July 1995	Jan-July 1996
PADD I	15	16	16	15	16	16	17	14
PADD II	76	71	73	75	72	68	71	65
PADD III	174	165	162	168	164	150	153	144
PADD IV	13	12	12	12	12	12	12	12
PADD V	80	74	71	69	74	75	78	71
Total	358	339	333	338	336	322	330	305

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

Source: Energy Information Administration, Forms EIA-810 "Monthly Refinery Report," and EIA-813 "Monthly Crude Oil Report."

1981. As of June 1996, PADD I, the East Coast, had 11 days of crude oil supply, while PADD V had 29 days supply. The average for all PADDs was 22 days. One possible explanation for this difference is the lack of oil production (and the associated stocks at leases, tank farms and pipelines) in PADD I. Furthermore, PADD I receives most of its supply by water that, unlike pipeline supplies, are unaccounted for in stock data collection efforts.¹³ Over 90 percent of the crude oil inventories in PADD I are stored directly at refineries, compared to less than a third in other PADDs.

Short Term Influences on Crude Oil Inventories

The short term influences of the cost of crude oil inventories, refining margins, the expected crude oil prices, and the risk of crude oil stockouts impact the day-to-day refinery managers' decision about crude oil inventory levels. For this reason, changes in the spot market price of crude oil, interest rates, the cost of storing crude oil, refinery margins, the expected price of crude oil, and international policy have an immediate impact on crude oil inventory levels.

Cost of Crude Oil Inventories

Refiners calculate the cost of crude oil inventories by first multiplying the current cost of crude oil by the interest rate. To that, the cost of handling and storage per month, about 30 cents per barrel,¹⁴ is added. The result is compared to the benefit of holding stocks to determine inventory levels. The cost of crude oil inventories increased since the beginning of 1994, due to

growth in both the interest rate and price of crude oil. The prime lending rate, a short term rate that approximates the interest rate refiners face, increased from 6.0 percent to 8.5 percent through the year. Since then, the prime lending rates leveled off. In Spring 1996, the price of crude oil increased after having been bid up by refiners who purchased crude oil to fill immediate needs. The crude oil price (as measured by the U.S. refiners acquisition cost of imported and domestic crude) grew from \$17.75 per barrel in January 1996 to \$21.60 per barrel in April 1996.

In January 1995, the cost of crude oil inventories was 42 cents per barrel. After a year of increases in interest rates, the cost of crude oil inventories grew to 43 cents per barrel by the end of 1995. Further increases, this time in the acquisition cost of crude oil, pushed the cost to as much as 45 cents per barrel in April 1996.¹⁵ This upward trend in prices could only negatively impact crude oil inventories.

Refining Margins

A barometer of the relative profitability of refining is the refining margin, i.e., the difference between the cost of the input crude oil and the price for petroleum products produced. While refiners incur other costs such as labor, capital, catalysts, etc., and may realize profits from other subsidiaries, refining margins are the most important source of profits. Low margins could force refiners to trim costs in such areas as inventories.¹⁶

In 1994, refining margins edged downwards as increased product prices failed to match gains in crude oil prices.¹⁷ The

¹³The one exception is supplies from Alaska, referred to as "Alaskan In Transit", which are included as such in totals for PADD V.

¹⁴Energy Information Administration, *Petroleum Supply Monthly*, DOE/EIA-0109(96/03) (Washington, DC, March 1996), p. xix.

¹⁵Based on the prime lending rate, the U.S. refiners acquisition cost of imported and domestic crude and an estimated 30 cents per barrel cost to store crude oil.

¹⁶Inventory cost reduction is frequently referred to as a "just-in-time" inventory program. However, this does not correspond to the conventional use of the term in economic theory. Just-in-time inventory programs involve the sharing of both benefits (i.e., lower inventory carrying costs) and risks (e.g., running out of stocks) between suppliers and a manufacturer. Inventory reduction programs in the petroleum industry are generally not characterized by risk sharing but represent the recognition by individual firms that the benefits of carrying lower inventories are greater than the incremental risk assumed or that the risks of stocking out for a given inventory level are now lower.

¹⁷Energy Information Administration, *U.S. Energy Industry Financial Developments 1995 First Quarter*, DOE/EIA-0543(95/1Q) (Washington, DC, June 1995), p. 9.

1995 refining margins were the lowest since 1987.¹⁸ Refiners turned to trimming inventories. The saving associated with this approach has been estimated at \$250 million for both crude oil and petroleum products.¹⁹

Early results for 1996 refining margins suggest an improvement over 1995, though, possibly not enough to change the direction of the cost cutting initiatives undertaken in 1995.

Risk of Stock Depletions

Refiners keep crude oil stocks on hand to provide a constant flow of feedstock to the distillation units. The risks associated with crude oil supplies include embargoes and strikes as well as logistical problems in production, pipelines, and tanker/barge movements. Refiners informally assess risk of supply disruptions on an on-going basis and are prepared to increase inventories if warranted by a change in conditions. Since the 1991 Persian Gulf War, there have been no events impacting a significant portion of U.S. refiners that would lead refiners to calculate a greater risk of supply disruptions.

Rather, the lower number of days supply of crude oil on hand at refineries may be indicative of a belief that crude oil supplies are more secure than previously thought and the risk of a disruption is lower. The lower number of days supply of crude oil on hand at refineries may also be indicative of a belief that decrements to inventories thus far have been small enough as to not appreciably increase the probability of product stockouts. As previously documented, a policy of lower crude oil inventories has led to several run cuts at refineries; however, no product shortages were reported at the time.

Refiners' attitude toward risk is also a determinant in crude oil stock levels. Refiners may simply be willing to shoulder more risk than previously, again leading to lower stocks.

Expected Crude Oil Prices

By December 1995, the crude oil supply/demand balance was tight. Exports from Mexico were reduced by damage from Hurricane Roxanne and production from Norway's Heidrun field was delayed.²⁰ But, crude oil traders expected the supply situation to ease, causing prices to decline. At the end of December 1995, the price for oil 3 months forward in the futures market dropped to almost a dollar less than the price of crude oil for delivery in a month, confirming this expectation. With the expectation for lower crude oil prices in the future, it appeared more cost effective to forego crude oil purchases until the price of crude oil came down. In February 1996, the U.N.

¹⁸Pennwell Publishing Company, *Oil and Gas Journal*, "U.S. Refiners Find Benefits in J.V.s with Foreign Partners," (July 22, 1996), p. 16.

¹⁹*Petroleum Intelligence Weekly*, "Futures to Someday Bring Rebound in Low U.S. Inventories," Vol. 35 #30, (July 22, 1996), p. 1.

²⁰U.S. Department of Energy, *An Analysis of Gasoline Markets Spring 1996*, DOE/PO-0046 (Washington, DC, June 1996), p. 24.

²¹Backwardation occurs when the price of crude oil in the futures market for future months is less than the price of crude oil in the spot or near market. Under this regime, the incentive to purchase crude oil in the spot market for storage is reduced because crude oil can be purchased at a lower price in the future and storage costs can be avoided.

²²Reuters News Service, various dates.

²³U.S. Department of Energy, *An Analysis of Gasoline Markets Spring 1996*, DOE/PO-0046 (Washington, DC, June 1996), p. 58-61.

opened discussion of Iraq's oil-for-food proposal. The on-going talks and other market developments drove the market into further backwardation²¹ by as much as \$4.83 per barrel.²²

The last time expectations led to this level of backwardation followed the Persian Gulf War. Prior to that was the March 1989 oil spill in Valdez, Alaska. However, the circumstances that existed during both of these events were different from those that existed in 1996. The war made some refiners concerned about security of supply stocks, affecting inventory decisions in 1991. In 1989, stocks were already low in response to higher interest rates. The oil spill created backwardation by causing higher prices for crude oil in the near term (for delivery for one month in the future) but left expected prices for 3 months forward unchanged.

Then, as now, the impact of these expectations is difficult to quantify. Of all of the short-term factors influencing crude oil inventory levels (cost of crude oil inventories, refining margins, the expected crude oil prices, and the risk of crude oil stockouts), only current and expected crude oil prices moved in a direction to negatively impact inventories in 1996.

Long Term Influences on Crude Oil Inventories

In addition to the decline in domestic crude oil production, there are a variety of long-term influences impacting inventory levels including the availability of crude oil on the spot market, the increase in crude oil purchases from nearby or short-haul sources, an increase in stocks offshore in the Caribbean, crude oil imports arrangements that foster greater security of supply, the closure of bulk terminal facilities, and enhanced information flow through improved computer technology. These trends are subtle and have almost no impact on the day-to-day decisions on inventory levels, but do affect inventory data over time. Some of these forces represent efforts in response to the persistently poor financial performance in the refining industry.²³

Decline in Domestic Crude Oil Production

The 1986 world oil price collapse initiated the decline in domestic crude oil production. The low prices forced higher cost U.S. producers to shut in wells. Since then, domestic crude oil production steadily decreased (Figure FE2). The first year that crude oil imports accounted for more than half of the inputs

in domestic refineries was 1994. In July 1996, crude oil supplies from foreign sources accounted for 54.3 percent of U.S. refinery inputs.

EIA stock data include information on stocks at leases and gathering operations, each of which are impacted by production levels. The 1995 decline in crude oil stocks on leases was 1 million barrels and another million barrels at gathering companies. In total, the decline in domestic production accounted for at least a 2 million barrel drop in EIA crude oil inventory data in 1995. Year-to-date averages through July 1996 have yet to register a decline. The decline in domestic production presumably also had an impact on pipeline fill, predicated on the decline in selected gathering operations.

Availability of a Spot Market for Oil

As an alternative to purchasing crude oil under term contracts, refiners can turn to a number of spot markets for immediate crude oil supplies. The spot market ostensibly becomes a source of inventory for not only crude oil, but petroleum products as well. Refiners resort to using the spot market during a period of backwardation of crude oil prices for supplemental supplies on an as needed basis to avoid filling inventories with relatively expensive supplies. Given these and other benefits, the volume of spot market oil trade has increased considerably in recent years.²⁴

Short-Haul Sources

With the decline in domestic production, imports have been increasing, particularly imports from the Western Hemisphere, referred to as "short-haul" crudes. In addition to shorter transit times, short haul crude oil allows refiners to reduce inventories because of smaller cargo sizes.²⁵ Crude oil from long-haul sources is delivered in large vessels to reduce transportation costs. "Very Large Crude Carriers" and "Ultra Large Crude Carriers" carry up to 2.8 million barrels of crude oil and can be offloaded at rates that can exceed 500 thousand barrels per day. Short-haul crude oils can be delivered in smaller vessels that are offloaded at slower rates. Since the average refinery can process only 100 thousand barrels per day, storage is required after a vessel is offloaded. Less storage is required for short-haul crudes because short-haul crude oil is delivered in smaller batches at rates that more closely approximate refinery input rates.

In order to have a negative impact on inventory levels, imports from long-haul sources would have had to decline from one

²⁴Energy Information Administration, "Economics of Energy Futures Markets," *Petroleum Marketing Monthly*, DOE/EIA-0380(91/09) (Washington, DC, September 1991), p. 6.

²⁵Energy Information Administration, *Petroleum Supply Monthly*, DOE/EIA-0109(96/03) (Washington, DC, March 1996), p. xix.

²⁶National Petroleum Council, *Petroleum Storage and Transportation*, Volume IV, (Washington, DC, April 1989), p. H-1.

²⁷Pennwell Publishing Company, *Oil and Gas Journal*, "Shifting Pattern of U.S. Oil Import Sources Tests Viability Of Deepwater Port Projects," (August 21, 1995), p. 22.

²⁸Pennwell Publishing Company, *Oil and Gas Journal*, "U.S. Refiners Find Benefits in J.V.s with Foreign Partners," (July 22, 1996), p. 16-17.

²⁹*Wall Street Journal*, "Chevron Holds Talks With Venezuela On an Oil Deal That Is Key to Strategy" (May 29, 1996), p. B5.

³⁰Financial Times, "Unocal Signs Vietnam Oil Joint Venture," (May 29, 1996), p. P4.

period to the next. During 1995, imports from outside the Western Hemisphere decreased only 190 thousand barrels per day, an amount too small to have a measurable impact on inventory levels. Year-to-date data through July 1996 indicate that long-haul crude oil imports increased.

Offshore Stocks

One explanation for some of the decline in crude oil stocks is the growth of stocks in facilities in the Caribbean.²⁶ In 1989, the National Petroleum Council documented 109 million barrels in storage capacity at 9 facilities in the Caribbean. Stocking crude oil in the Caribbean is frequently less expensive than stocking in U.S. facilities. In addition, lightering is more cost effective in the Caribbean. Very- and ultra-large crude carriers are off-loaded in the Caribbean so that the crude oil can be transhipped in smaller vessels that can call at a variety of U.S. ports.

Unfortunately, Caribbean stocks are not surveyed by EIA. The only evidence that supports the possibility of an increase in stocks in the Caribbean is the decline in activity at the Louisiana Offshore Oil Port, LOOP.²⁷ The stocks associated with offloading the large and ultra-large tankers that were previously recorded at LOOP (and are now associated with facilities in the Caribbean) are no longer included in EIA data.

Vertical Integration into Crude Oil Production Activities

Foreign production/domestic refining joint ventures foster a greater security of supply and, in turn, allow refiners to hold less crude oil in stock. Referring to the 1988 Texaco/Saudi Aramco, the 1989 Unocal/Petroleos de Venezuela, the 1992 Shell Oil/PEMEX, and the 1993 Lyondell/Citgo (Petroleos de Venezuela) ventures, the *Oil and Gas Journal* interjected "if two companies can weave themselves together in a way that one's advantage offsets a disadvantage of the other, they can effectively enhance revenue or reduce costs."²⁸ A number of other arrangements, not involving foreign ownership of U.S. refineries, are frequently reported in the trade press. The *Wall Street Journal* reported in May 1996 that Chevron is trying to reach an agreement with Venezuela assuring Chevron long-term access to crude oil in fields owned by Petroleos de Venezuela. To achieve this, Chevron would provide capital and technical expertise.²⁹ In May 1996, Unocal signed a three-year contract with PetroViet-Nam to explore for petroleum off the southern shore of Vietnam. Unocal will have a 45 percent interest in any production from those fields.³⁰

Greater Flow of Information

Improved information technology has given managers the tools needed to optimize stock levels. Computer programs and tracking systems for monitoring sales, production and inventories are more sophisticated than in recent years. The transmission of real time data may have a direct impact on lower inventories.³¹ The impact of these technological improvements is difficult to quantify because of the presence of other trends.

Closure of Bulk Terminal Facilities

Information on specific tank farm sites is scarce. In an effort to reduce reporting burden, EIA collects stock information on a PADD basis, not by individual terminal. Without data to monitor trends, it is difficult to determine how the reduction in the number of terminaling facilities is impacting the overall inventory levels.

Several industry publications indicated that major oil companies are divesting their oil terminals and that independent terminal operators are buying some of these properties. However, it is difficult to know how much storage is being decommissioned by the new owners.³²

Outlook

By the end of 1996, changes are anticipated in most of the short-term influences affecting crude oil inventories. The cost of inventories is expected to fall as the price of crude oil declines. The decline in the price of crude oil will come as new supplies from North Sea and Mexico are delivered. The decline in crude oil prices will also help refining margins improve and backwardation ease as the anticipation for comparatively lower crude oil prices in the future wanes. All of this is expected to lead to a growth in crude oil inventories.³³

Distillate stocks are forecast to be low for the 1996-97 heating season. If crude oil inventories do persist at current levels, price volatility in the crude oil markets can be expected as refiners turn to the spot market rather than stocks to supplement supplies during times of a shortage.

³¹*Fuel Technology and Management*, "Lower Gasoline Inventories Do Not Mean Higher Prices," (March/April 1996), p. 9.

³²Energy Information Administration, *Storage and Transportation Changes Since 1989*, DOE/EIA-Draft Report (Washington, DC, June 1996), p. 5.

³³Energy Information Administration, *Short-Term Energy Outlook*, DOE/EIA-0202(96/Q4) (Washington, DC, October 1996), p. 29 and 31.

The Role and Status of the U.S. Strategic Petroleum Reserve

The Strategic Petroleum Reserve was created pursuant to the Energy Policy and Conservation Act of 1975 to reduce the impact of disruptions in petroleum supplies and to carry out obligations of the United States under the Agreement on an International Energy Program. The reserves can be drawn down when the President determines that an energy supply emergency exists or could exist and is of significant enough nature to adversely impact the economy.

The current SPR facilities are designed to hold 750 million barrels of crude oil in three storage complexes in Texas and Louisiana. The SPR crude can be delivered to refineries in the Gulf Coast and Midwest through various connections to the U.S. crude oil pipeline network. The SPR crude can also be delivered by tanker or barge.

Persian Gulf War

On January 16, 1991, in conjunction with the beginning of Operation Desert Storm, President Bush ordered a drawdown and distribution of Strategic Petroleum Reserve crude oil as part of a coordinated plan agreed to by member countries of the International Energy Agency.³⁴ The Department of Energy issued a Notice of Sale for 33.75 million barrels.

In total, 17.2 million barrels of oil were sold from the SPR to 13 purchasers between January 17 and March 31, 1991. This event marked the first emergency drawdown and sale of SPR oil. Even though the volumes sold were small, the use of the SPR at the onset of Operation Desert Storm provided an instantaneous counter force to the expected market panic.³⁵

Current Sales and Stock Levels

In 1996, under Congressional direction, the U.S. Department of Energy sold 5.1 million barrels of crude oil from Weeks Island between February 26 and March 21 to 4 companies. The proceeds from the sale, totaling \$97 million, were used to close down the damaged Weeks Island facility.

The U.S. Department of Energy then undertook an expedited release of about 12 million barrels. The release was originally required as part of the Federal budget for the 1996 fiscal year to raise \$227 million. The expedited nature of the sale was in response to the increase in petroleum prices in Spring 1996. Between April 29 and mid-May, the announcement of this sale

³⁴U.S. Department of Energy/Office of Fossil Energy, *Strategic Petroleum Reserve Quarterly Report*, DOE/FE-0220P-1 (Washington, DC, May 15, 1991), p. 7.

³⁵*Petroleum Intelligence Weekly*, "President Clinton and How Not to Use the SPR," Vol. 35 #19; (May 6, 1996), p. 7.

along with other factors lowered crude oil prices by \$1.60 per barrel.³⁶

The last of these sales under this effort took place August 5, 1996. In total, the government sold 12.8 million barrels of crude oil from SPR at an average price of \$17.77 per barrel to 9 companies.

After delivery of these volumes, the SPR should have 574.1 million barrels of crude oil as of the end of September 1996,

enough to cover 59 days of U.S. oil imports. Commercial crude oil and product stocks add another 99 days. The total 158 days is well in excess of the 90 minimum required in the Agreement on an International Energy Program. The U.S. ability to cover days supply of oil imports is negatively impacted by the expected growth in imports and the decline in commercial stocks as well as the sales from the SPR.

³⁶U.S. Department of Energy, *An Analysis of Gasoline Markets Spring 1996*, DOE/PO-0046 (Washington, DC, June 1996), p. 7.